GEOGRAPHY PAPER 1 (250/1) BY KITONSA RONALD

1.0 CONTINENTAL DRIFT AND THE DISTRIBUTION OF CONTINENTS AND OCEAN BASINS

Continental drift is a hypothesis that states that continental land masses have changed their relative position as a result of fragmentation and moving apart of the original land masses.

It is believed that continents are mobile, that they drifted from their original positions and are still moving even today.

Several theories have been put forward in an attempt to explain the apparent movement of continents which resulted from the fragmentation by rifting, followed by drifting apart of individual masses of the broken out cells / land masses to form the present day continents and ocean basins.

1.1F.B TYLOR'S THEORY

According to Tylor, originally the earth had two land masses called Laurasia and Gonduana land.

Laurasia was located near the present day north pole from where it drifted southwards towards the Equator.

Gonduana land on the other hand was located somewhere near the South Pole and it also drifted but this time northwards towards the Equator.

Tylor explained the force that caused the movements in terms of the moon's gravitational pull and tidal attraction. He believed that the moon came very close to the earth and exerted an enormous gravitational pull that caused Laurasia and Gonduana land to move towards the equator away from their positions near the poles.

This movement is believed to have taken place sometime in the crustaceous period about 135 to million years.

When there was resistance to this outward flow the crust would flow outwards and bulge upto Form Mountains.

In some cases, the crust stretched and split forming troughs that became ocean basins.

Tylor suggested that the basin of the Atlantic and Indian Ocean were left behind between drifting continents.

When Laurasia and Gonduana land finally collided they formed Fold Mountains e.g. the Atlas in North Africa and Alps in Southern Europe.

WEAKNESSES OF TYLOR'S THEORY

Tylor did not explain why the moon came close to the earth.

It is highly doubted that the moon could ever exert enough force to pull the huge land masses (continents as they are known today).

If at all the moon came closer and exerted such a strong force, the earth's rotation would have stopped within 1year but the fact that the earth's rotation continued throughout the present day makes Taylor's theory doubtable.

Tylor does not explain the formation of earlier fold mountains like Caledonian system of the siluro. Devonian times the Hercynian system of the mid-permian Adi periods and the Apelladian.

1.2 ALFRED WEGNER'S THEORY OF CONTINENTAL DRIFT

He was a German meteorologist who was the 1st to suggest that continents had changed their positions overtime. This led to what is now known as Wegner's theory of continental drift.

According to his theory, the present day continents originated from one Giantic sialic land mass a super continent known as Pangaea.

Pangaea was located near the present day south pole and was surrounded by huge ocean or water body known as Panthalassa.

During the pre-Cambrian period to the permian time (about 250 million years b.p). Pangaea began drifting northwards.

Pangea broke into two super continents known as Laurasia and Gonduana land.

The two continents were separated by a narrow water body known as the “sea of Tethys”.

Laurasia drifted northwards across the equator while Gonduana land remained in the south near the South Pole.

During the late Paleozoic and early Mesozoic eras. Numerous cracks developed in the land masses leading to the separation and consequent drifting.

Finally during the Crustaceous period (approximately 135-70million years ago). The land masses completely broke up.

Gondwanaland gave rise to the southern continents namely Africa, South America, Antarctica, Australia, sub-continent of India and numerous islands.
Laurasia broke up to give rise to North America, Europe, Asia, Greenland, Iceland, UK e.t.c.

In the north Eurasia drifted eastwards while North America drifted westwards.

In the South Africa moved to attain its present position astride the equator.

India drifted northwards to join Eurasia land mass. South America drifted westwards and then northwards towards the equator to join North America through the Panama Canal.

Australia drifted eastwards away from Antarctica approximately 65 million years b.p.

According to Wegner the northward drift was due to the gravitational attraction of the Equatorial bulge called centrifugal force while the westward drift was due to the tidal attraction of the sun and moon.

During the drifting, the oceans between continental blocks became wider forming the present day ocean basins.

Wegner contends that the Himalayas were formed when the Indian sub-continent collided with the Asian land mass thus forming a fold mountain with former ocean sediments on top.

CRITICISMS OF WEGNER'S THEORY

His theory has been criticized on the basis that in as much as the equatorial centrifugal force exists, it is too weak to drag continents from their polar positions.

His theory does not explain what caused the continents to separate or to crack extensively before drifting.

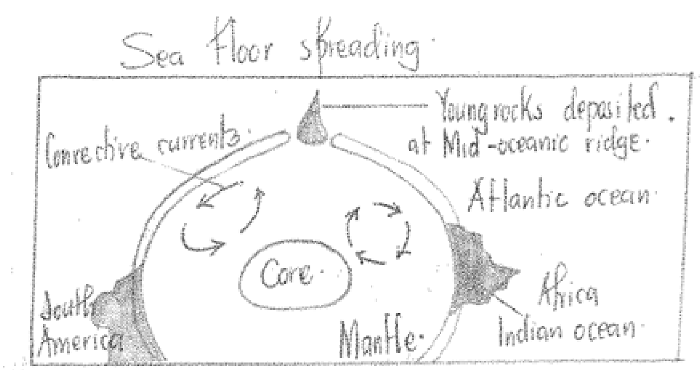
Wegner was a meteorologist and not a geologist. So he did not have enough geological knowledge over which to come up with his theory.

He does not explain the forces which he suggested that were responsible for the drifting of the continents from their original positions.

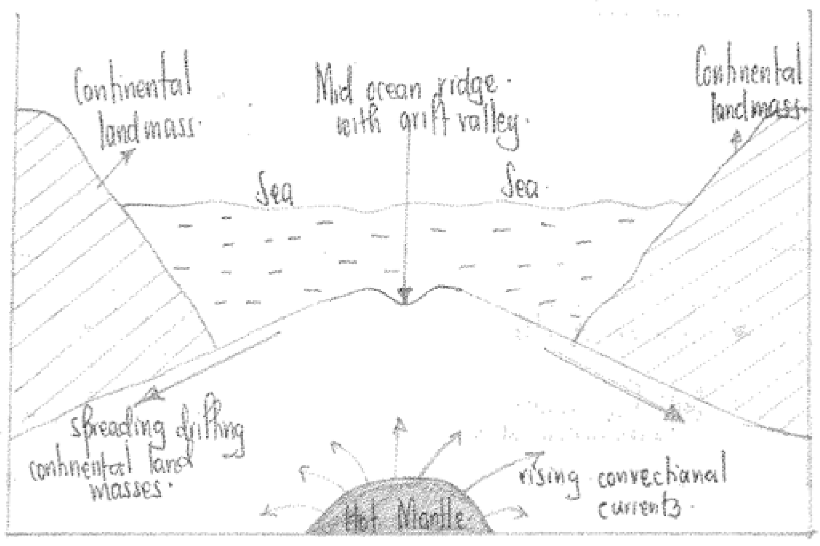
Note: In as much as Wegner's theory had shortcomings, it was exciting and was later adopted by many scholars and geologists.

1.3 THE SEA FLOOR SPREADING THEORY

Diagram:



Further illustration of sea spreading



This is one of the modern and more scientific theories of continental drift, it was put forward by an American geologist called H.Hess in the 1960s.

He forwarded this theory after studying the sea bed of the Atlantic Ocean in which he observed the presence of ridges between Africa and America.

According to H.Hess, the interior of the earth is in a molten/semi-fluid state because of the intense heat resulting from radio-activity and geochemical reactions. These molten rocks are highly mobile and therefore tend to rise from the mantle in form of convective currents.

These move in a circular motion and as they reach the base of the earth's crust, they flow horizontally and exert a drag force on the crust to move in their direction of flow. This causes movement of continents or crustal layer hence continental drift.

After studying the mid ocean ridges, he established that when the convective currents approached this region, they deposited new rocks which displaced/pushed away the older rocks, a fact that shows that the sea floor is spreading apart.

He was further convinced after realizing that as the distance away from the mid ocean ridge increased, the rock age increased as well, a fact portraying mobility/expansion of the ocean each time new rocks are deposited.

1.4 PLATE TECTONIC THOERY

PLATE TECTONICS

This is the most modern theory put forward to explain the continental drift. Plate tectonics is the theory put forward to explain the movement and distribution of the present day continent and the ocean basins and the resultant landforms.

The theory assumes that the crust is divided into a series of tectonic plates or raft or a blocks six major and about 12 minor.

The major plates include:-

- Indian plate
- Pacifican plate
- African plate
- Eurasia plate
- Atlantic plate
- American plate

He asserted that the plates are rigid and mobile. They move because of the energy generated by radio-activity and geochemical reactions in the interior of the earth. The resultant heat causes partial melting of rocks which then rise up in form of convective currents and drive the plates. The movement of the tectonic plates is assisted by plate boundaries or margins i.e. destructive and conservative.

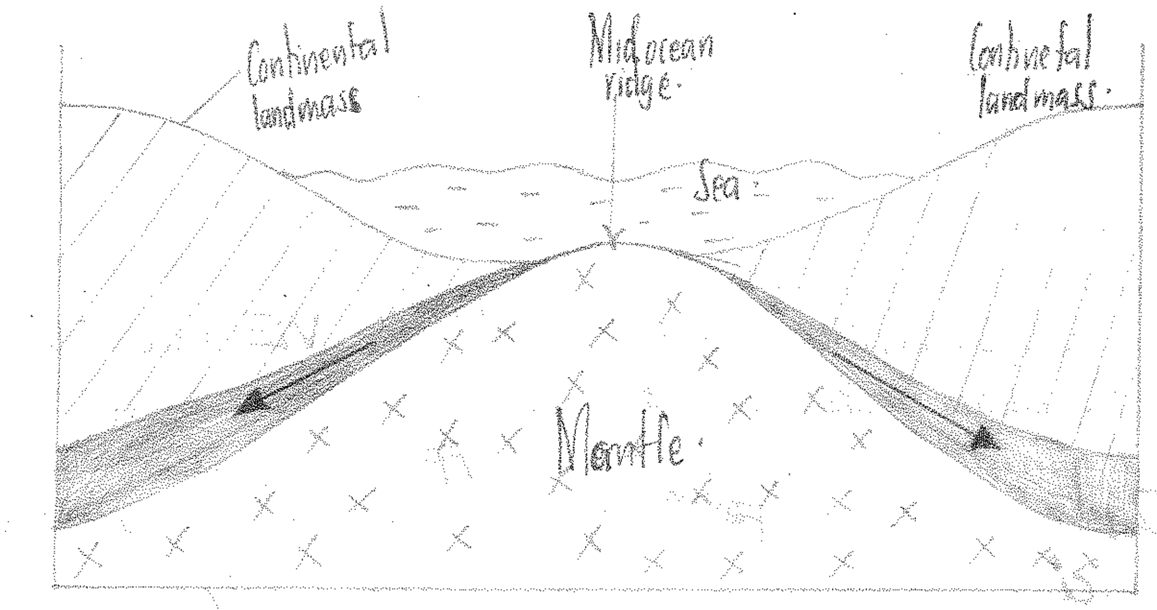
As the plates move so do continents following the direction of plates movement. There are types of movement caused by convective currents that affect the distribution of continents.

(i) Divergent movements

Those case rifting of the crust and consequent outward movement of the continent. In the process, ocean basis characterized by mid-ocean ridges and islands are formed e.g. the mid-Atlantic ridge as it was the case for South America and Africa.

Divergent plate Boundary

(Diagram)



(ii) Convergent plate boundary.

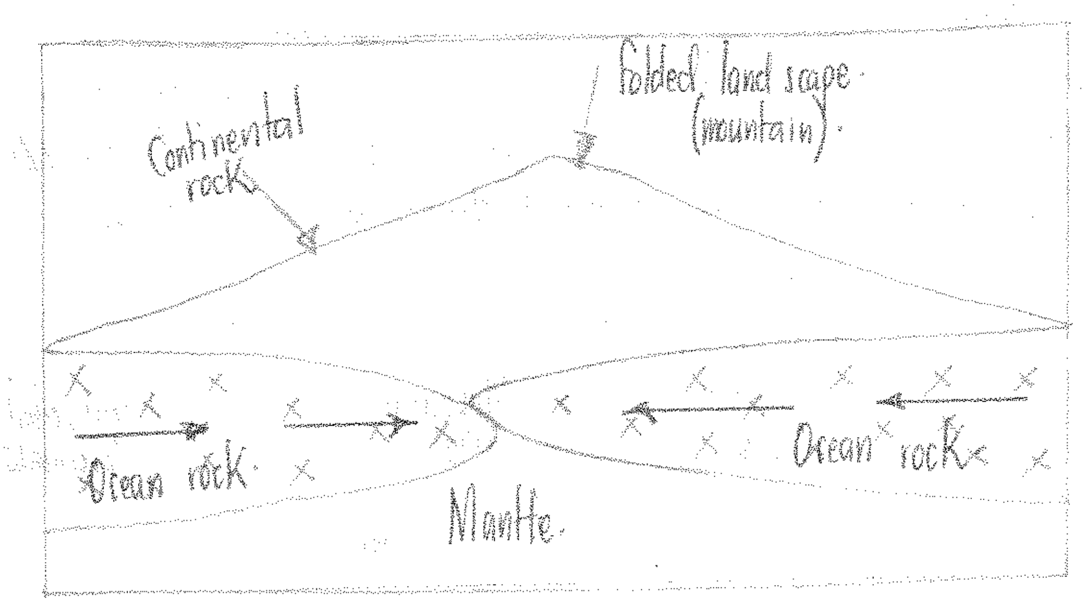
These push continents towards each other e.g. continents may move towards each other, getting closer and in the process, sediments are folded to form fold mountains e.g when India moved towards Asia, forming Himalayas.

Continents may move towards ocean plates, causing sub-duction of the denser simatic rocks. This is assimilated in the mantle forming trenches and volcanic mountains e.g. where South America plate moved against the Nazec plate.

Nazec trench and Andes formed. Ocean crust may move towards each other. This causes narrowing of ocean basins and continents move nearer. In the process, trenches and volcanic arcs form e.g. Pacific and Eurasian plates have led to the formation of Marianna trench and Japan arc.

The convergent plate boundary

(Diagram)

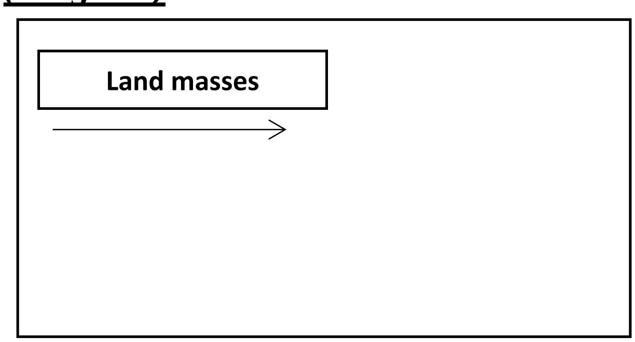


(iii) Transformation movements (Conservative boundary)

These involve plates moving towards each other without causing a collision or diversion. In the process they offset sections of continents, ridges and trenches e.g. North American plate against the pacific plate forming the San Andreas Fault causing off/setting off land to the West.

__NOTE__: The drifting apart of tectonic plates with in the earth's crust resulted into formation of various relief landscape features or landforms e.g. in East Africa, the drifting of tectonic plates set in motion tectonic movement e.g. faulting, volcanicity forming crustal warping.

(Diagram)



Land masses

← **movements**

All the above tectonic plates facilitated the formation of various landforms as will be seen later.

***Qn**. (a) What is meant by plate tectonic?*

(b) How does the theory of plate tectonics explain the present day distribution of continents (2005 UNEB)

1.5 EVIDENCE TO SUPPORT / JUSTIFY CONTINENTAL DRIFT

(i) The jigsaw or Visual fit theory

The present shape of the present land masses is such that most of them have shapes that can fit in each other. If forced to come close to each other e.g. the east coast of South America and West coast of Africa can acculately fit in each other not only at the surface but also at the depth of 2000m. Such is evidence that Africa and South America were once one land mass that was separated.

The coast of Africa, India, Antarctica and Australia can also fit. Arabia fits accurately in the North Eastern part of Africa.

(ii) Geometrical fit

This is related to the jigsaw fit. According to the west coastline of Africa and the eastern coastline of South America fit almost exactly on each other. If rotated through an angle of 57° with rotational points at 40°N and 30°W.

(iii) Matching Geology or Similar Rocks

There is close similarity in the rocks of South America and North Africa. There is a convincing boundary joining between Accra in Ghana and Sao Louis in Brazil. They both have rocks rich in manganese. Similarly the Gold bearing rocks of West Africa in Ghana are similar to those in Guyana in South America. Oil beds of Brazil are also similar to those of Angola in Africa.

(iv) Matching of Orogenic zones

The alignment of belts of Fold Mountains matches across the joint of Africa and South America.

(v) Glacial evidence

Carboniferous glacial deposits exist in tropical and sub-tropical low lands such as Congo basin and in South America. The existence of such deposits in the hot tropical region is proof that land masses at one time were positioned in the cooler latitudes where glacial conditions existed. Similarly, thick deposit of tillites, a fossilized, glacial moraine in Eastern Brazil. Paraguay and Argentina are similar to those of southern Africa and Australia, a fact that suggests that the continents at one time were too close.

(vi) Similar sedimentary rocks

Research has shown that along parts of North Eastern Brazil coast, Nigeria and Cameroon, similar sedimentary rock sequences exist in the lower beds of those basins, match exactly on both continents.

(vii) Coral reefs in temperate regions today

Coral reefs only grow in tropical temperatures where temperatures are as high as 20^{o}C. Their existence in cold temperate conditions like in Greenland, North America and Britain is enough evidence that, these regions were once positioned in the tropical regions where conditions were favourable for the growth of coral reefs.

(viii) Occurrence of lateritic soils

In temperate regions in North America and Europe proves that those continents at one time experienced tropical climatic conditions favourable for the formation of laterites but with time drifted to the temperate regions.

(ix) Similarity of vegetation and Animals

On different continents which seem to have been attached to each other proves the theory of continental drift e.g. the S. American tropical rainforests and West African tropical rainforests which were split by continental drift.

(x) **The presence of petroleum in the Middle East** which is mainly a desert area suggests that the existence of minerals (Petroleum) in the area is due to the effect of continental drift. This is due to the fact that Petroleum and Coal are products of thick vegetation yet the Middle East does not have a climate that supports thick vegetation growth.

(xi) **The existence of salt evaporates** in cold parts of U.S.A, Britain; Russia is evidence for continental drift such evaporates are only found in hot tropical regions. Their formation is associated with evaporation of water from salt solution.

(xii) **The presence of Fold Mountain** proves continental drift; Fold Mountains are formed by collision of tectonic plates during continental drift. As a result, the overflying rocks folded to form fold mountains e.g. the Himalayas, Alps e.t.c.

(xiii) **The existence of large ocean basins**, continents, tremours and earthquakes proves that the earth is in the process of drifting. Hence leading to the continuous crustal instabilities.

(xiv) Existence of a rift valley

About 300 years million ago, the East African rift valley didn't exist but it gradually developed as a result of the earth's instability of continental drift. In fact the valley developed as a result of compressional and tensional forces.

(xv) Evidence of sea floor spreading.

Recent studies of ocean and sea floors reveal that oceans and seas have been expanding over the years. This is probably because of the apparent movement of the continents evidenced by the sea floor spreading e.g. the Red sea has increased from 0.300km wide in the last million years. And the Atlantic Ocean is also believed to be enlarging. On the other hand some sea floors are contracting and this is leading to the reduction in ocean basins or trenches. This is due to tectonic plates moving towards each other due to continental drift e.g. the Pacific Ocean is contracting and the Peruvian plain is narrowing due to the movement of continents.

Similarly, the Mediterranean Sea is also said to be reducing in size because of continental drift.

(xvi) **The proximity of continents** to the North Pole than the south poles proves continental drift. That continent moved northwards from the southern hemisphere.

(xvii) Paleomagnetism Evidence / Theory

This refers to the study of rock magnetism at the time of rock formation. This is based on the fact that igneous rocks which contain iron when cooled retain some magnetism. When igneous activities take place, iron bearing rocks are permanently magnetized in accordance with the earth's magnetic fields.

Studies of paleomagnetic rocks in Australia, India, North and South America show that those rocks no longer point in the North to South directions. The reason … is that continents might have been dislocated relative to their present positions.

Rock magnetism of South America e.g. has been dislocated through 17° and indicates North East as their true North. This shows that continents have been drifting.

1.6 CRITICISMS OF CONTINENTAL DRIFT

Some geographers have disagreed and criticized the continental drift by disagreeing with Wegner's evidences. Some Geographers argue that continents have not been drifting. Instead different geomorphic processes have contributed to the shapping of earth the way it is. Such geographers argue that;

(i) Some of the causes said to be responsible for breaking of Pangaea are vague. The moon's force of attraction (the big bang theory) could not have caused the splitting of Pangaea since the moon's force of attraction is not so high. Besides the moon is much smaller than the earth and its pressure could not lead to the splitting of Pangaea.

(ii) The spreading of ocean floors might be due to continuous erosion and weathering on the main land which make the ocean appear as it expanding or the contraction of the seas and oceans is due to isostatic adjustments because of compressional forces within the earth's crust, could be the ones forcing oceans appear like reducing in size. If this is true, the theory of continental drift is a myth rather than a reality.

(iii) The existence of similar rocks on different continents and identical animals and vegetation on the different continents opposite each other, might not be because of continental drift but because of such regions being found in the same climatic belt e.g. Amazon and Congo rocks are exposed to the same weathering processes and that's why they are similar.

Tropical rainforests in Congo and Amazon basins are similar because they are both found in the equatorial region with heavy rainfall.

(iv) The existence of peri glacial rocks along the equator in the Congo and Amazon basins, might be probably because there existed very high mountains along the equator in remote past but.

2.0 ROCKS

A rock is an aggregate of one or more minerals forming the earth's crust.

The minerals in the rock may include sodium, magnesium, silver, aluminium, Copper, Diamond. There are hard and soft rock that form the earth's surface/crust. The hard rocks include, Quartz, granites, basalt while the soft rocks include, limestone, chalk, and sand, day.

The rocks are classified in different forms according to their mode of formation, age and origin.

Different types of rocks are formed by different geomorphic process. As a result they have different characteristics. The most outstanding rocks are; sedimentary (soft in nature) igneous rocks (hard in nature) and metamorphic rocks.

2.1 SEDIMENTARY ROCKS

These are formed as a result of deposition or sedimentation of weathered rock particles. The materials deposited are produced by chemical and mechanical weathering of former rock masses or by organic action.

The weathered materials are deposited in layers or strata on either dry land, valley or under water in seas, oceans or lakes. Layers are separated by bedding planes which demarcate the end of one depositional cycle and the beginning of another. The layers can be horizontal, gently sloping or steeply dipping.

CHARACTERISTICS OF SEDIMENTARY ROCKS

Generally the sedimentary rocks contain fossils of dead plants and animal tissues.

They stratified or contain layers.

They are non-crystalline in nature.

Strata are separated by the bedding planes of cementing materials, strata are horizontal or gentle dip or steeply dipping.

PROCESS OF FORMATION

Weathering of already existing rocks that is igneous rock or metamorphic or even sedimentary rock itself.

Erosion and transportation of weathered materials.

Deposition of sediments by ice, wind, water or ocean waves.

Stratification of the deposited materials by the overlaying weight. Compression of the stratified materials compaction of the layers takes place of materials.

Cementation of laid down layers by calcerous, siliceous, for igneous materials.

Consolidation of the rock materials

Transformation of sediments into sedimentary rocks takes place.

Formation of the sedimentary rocks can be mechanical, chemical or organic.

MECHANICALLY OR PHYSICALLY FORMED SEDIMENTARY ROCKS

These result from burying unconsolidated rock textures. Varied textures then form varied rock types depending on the agents of erosion e.g.

River deposits form lacustrine or alluvial soils e.g. around Lake Victoria where there are lacustrine and alluvial deposits and along various rivers e.g. Tana and Nile.

Ice / Glaciers form tillites, eskers and fluvial glacial deposits e.g. in Bunyoro and Hoima and Kibale.

Wind deposits form loess e.g. in Karamoja, northern plains of Kenya and Masai land.

Marine deposits form spits, bars e.t.c. e.g. at Tanga near L. Albert etc.

Examples of mechanically formed sedimentary rocks include, mudstones, clay stones grit and boulder day.

CHEMICALLY FORMED SEDIMENTARY ROCKS

These are rocks formed when there is a complete change in the rock mineral composition as a result of precipitation of salt solution and sea water.

Once there has been evaporation, salt pans are left behind. Such salts exist in Narock, Taita tareta, Wajir, Samburu in West Kenya, Lake Katwe, Kasenyi, Nyamunuka, soda ash in L. Magadi.

ORGANICALLY FORMED SEDIMENTARY ROCKS

These are rocks produced from the accumulation of dead remains of plants and animals. As these remains continue accumulating, the pressure in them increases and finally they solidify and form a rock e.g.

Coral polyps die and their skeletons accumulate and compact together to form limestone rocks e.g. coral reefs/limestone at Bamburi and Dar-es-Salaam.
Plants remains which accumulated in the forested swamps during the carboniferous periods which were compressed by sediments, formed coal e.g. the varied types of lignite, peat, brown coal e.t.c. such rocks exist in Ruhuhu valley in Tanzania.

ECONOMIC IMPORTANCE OF SEDIMENTARY ROCKS

Positive importance:-

- They are very good for agriculture because they are normally fertile e.g. alluvial soils.
- They provide construction materials e.g. sand.
- They promote alluvial/placer mining because they contain precious minerals which are deposited in them e.g. rocks in Karamoja, Semuliki, Kaiso-Kisegi flats and Kabale are believed to contain gold in them.
- Sedimentary rocks especially coral reefs and limestone are used for the manufacture of cement and lime. They therefore promote industrialization e.g. coral limestone at Bamburi and Dar-es-Salaam.
- Coral reefs attract tourists who bring in foreign exchange.
- Promote research and study.

Negative importance:-

- They easily get soaked by water and may lead to landslides like mud flows and flooding which may destroy human activities like agriculture, communication lines and settlement.
- Continuous sedimentation on the earth's surface may lead to the burying of mineral ores in the ground which may hinder the development of the mining industry because the minerals may not easily be accessible.
- Sedimentary rocks like sand are not fertile enough to support Agriculture.
- They are porous (sand) and they have very little soil moisture which does not support agriculture.

2.2 IGNEOUS ROCKS

These are fire formed rocks, formed from crystallization and solidification of molten magma. They are formed as a result of volcanicity. This is due to radio activity and convectivity in the mantle. These create lines of weaknesses or fissures through which molten magma is either extruded onto the earth's surface or intruded within the earth's crust.

CHARACTERISTICS OF IGNEOUS ROCKS

- They are fire formed.
- They are crystalline in nature.
- Non-fossilized
- The size of the crystals depend on the rate of cooling. They are hard rocks.
- They are non-fossilized.
- They can be grouped into three groups basing on the level of solidification or by the pre-dominant minerals in the rock (chemical composition). These three groups are:-

(i) **Volcanic rocks**. These are formed on the earth's surface from the fast cooling surface, lava with much smaller crystals due to exposure to oxygen e.g. obsidian, basalt, rhyolite, tranchyte, andesite, pumice.

(ii) **Hypabyssal rocks**. These cool underneath the crust but near the surface. They cool at a moderate rate and have medium sized crystals e.g. Quartz, dolorites, porphyry.

(iii) **Plutonic / Abyssal rocks.** These cool extremely slowly at a great depth due to lack of oxygen and have large crystals e.g. granite, syenite, gabbro and diorite.

Magma from the mantle varies in chemical composition which has an effect on their viscosity. This in turn influences the cooling rate and process of crystallization i.e.

Acidic igneous rocks have high amount of quartz and Felsper.

Basic igneous rocks contain much mica and olivine.

Intermediate igneous rocks have a mixed mineral structure.

Igneous rocks in East Africa re found on volcanic mountains e.g. Mt. Kenya, Mt. Kilimanjaro, along the East African rift valley e.t.c.

ECONOMIC SIGNIFICANCES OF IGNEOUS ROCKS

Positive importance

- Igneous rocks provide construction materials for building houses, bridges e.t.c.
- Igneous rocks cross river profiles and may lead to development of water falls used for H.E.P generation for domestic and industrial use e.g. Bujagali falls and Owen falls dam.
- Igneous rocks are weathered down into fertile volcanic soils which boast agriculture.
- They form mountains e.g. Elgon, Kilimanjaro e.t.c which may attract tourists.
- Igneous volcanic mountains facilitate the formation of orographic rainfall which promotes agriculture e.g. in Mbale and Kigezi highlands.

Negative importance:

- Areas covered by igneous rocks hinder agricultural activities because they are rocky.
- Igneous mountains act as ridges which always interfere with the construction of roads.

- Igneous rocks because they are young in nature, may weather into poor soils which hinder agricultural development.
- Volcanic mountains / rocks facilitate landslides e.g. in Bududa, Bulambuli, Bugimanayi e.t.c.
- Igneous rocks limit land for settlement and agriculture.

2.3 METAMORPHIC ROCKS

These are changed rocks in terms of colour, texture, mineralogical content and internal structure.

They are changed from formally igneous and sedimentary rocks to form new rocks. This change is brought about by excess pressure and heat (hot temperatures)

The excessive heat which turns igneous rocks and sedimentary rocks into metamorphic rocks may be as a result of continuous sedimentation hence causing high temperatures and pressure to lead to metarmophosis.

It may also be as a result of excessive heat developed by magma which may have been introduced or the excessive heat may be as a result of earth movements.

Metamorphic rocks occur due to dynamic / pressure, thermal / heat or a combination of both dynamic and thermal and therefore lead to the formation of three types of metamorphic rocks;

(i) **Thermal / Heat metamorphic rocks.** These changes stones to quartzites, limestone to marble.

(ii) Dynamic / Pressure metamorphic rocks that changes granite into Gneiss.

(iii) Thermal Dynamic metamorphism generated during mountain building that changes clay to slate, coal to graphite and shale to schists.

IMPORTANCE OF METARMOPHIC ROCKS

(a) <u>Positive</u>:-

- They are sources of minerals e.g. Kimberlite in Mwadui that contains diamond that promote mining activities.

- It is a source of raw materials for industries e.g. graphite for manufacturing pencil tips, kimberlite for drilling tips.
- Some metamorphic rocks like Gneiss are used as grinding stones.
- Some metamorphic rocks are used for construction surfacing, stair steps e.t.c.
- Some like graphite, coal are sources of thermal power.
- Some like marble are used for decoration and ornamental purposes.
- Some like slates are used for study purposes and research.
- Because of their hardness, some metamorphic rocks like quartzite out crops form highlands that are good sites for defensive installations, water tanks, and communication masts e.t.c.
- They form strong basements for dams and tunnel construction.
- They facilitate soil formation e.g. slates and shale in Nyanza province which promotes agriculture.
- They are tourist attractions e.g. geo-tourism at Karegea rock in Ntungamo.
- They are acquifar water sources e.g. artesian wells.

(b) <u>Negatives</u>:

- Some e.g. Gneiss break down into poor coarse soils that don't favour agriculture.
- Some e.g. quartzites form highlands which hinder communication construction.
- Some e.g. gneiss out crops hinder settlements.
- They are impediments to drainage e.g. slates.
- They lead to landslides e.g. rock falls.

3.0 LANDFORM EVOLUTION IN East Africa

Landform evolution in East Africa is a product of two major processes namely; endogenic and exogeneic processes.

3.1 ENDOGENIC PROCESSES

These are processes originating from the earth's interior and are classified into two;

(i) Diastrophism / earth movements.

(ii) Volucanicity

3.2 DIASTROPHISM / EARTH MOVEMENTS

This refers to the large sale displacement of the crustal blocks involving localized uplifts, down throws and generally processes of uplifting and sinking. They involve the modification of the landscape without necessarily bringing in new rocks / materials.

It includes process like faulting, folding and warping.

3.3 EXOGENEIC PROCESSES

These refer to the forces that operate onto the earth's surface i.e. Denudation process of weathering, erosion, transportation and deposition.

3.4 EARTH MOVEMENTS AND LANDFORM EVOLUTION IN EAST AFRICA

Earth movements refer to horizontal and vertical instabilities/tectonic instabilities within the earth's interior ***OR***;

Earth movements refer to lateral and vertical movements that take place in the earth's crust.

These instabilities are as a result of radio-activity and geo-chemical reactions within the mantle which lead to convectivity which creates tensional and compressional forces which in turn leads to faulting, folding, tilting, warping of the crust, earthquakes and tramours.

Earth movements are responsible for the evolution of a number of landforms in East Africa as shown below.

3.5 INFLUENCE OF FAULTING ON LANDFORM FORMATION IN EAST AFRICA

Faulting is a form of earth movements which involves the breaking of the crustal blocks on the either side of the fracture.
Faulting is as a result of radio-activity, geo-chemical and geo-physical reactions in the mantle / interior of the earth.

These reactions generate a lot of heat and pressure which melts the rocks to become molten and result into the development of convective currents which move vertically,

horizontally and in a circular motion and lead to the development of various forces like tension, compression and vertical forces of uplifts and subsidence.
Faulting through the above forces results into the formation of a number of landforms e.g:-

RIFT VALLEY

A lift valley is an elongated trough bordered by in facing escarpments along more or less parallel faults.

The origin of the rift valley is still a matter of debate therefore many theories that have been advanced to explain the formation of a rift valley and these theories are related to radioactive and geochemical reactions within the interior of the crust.

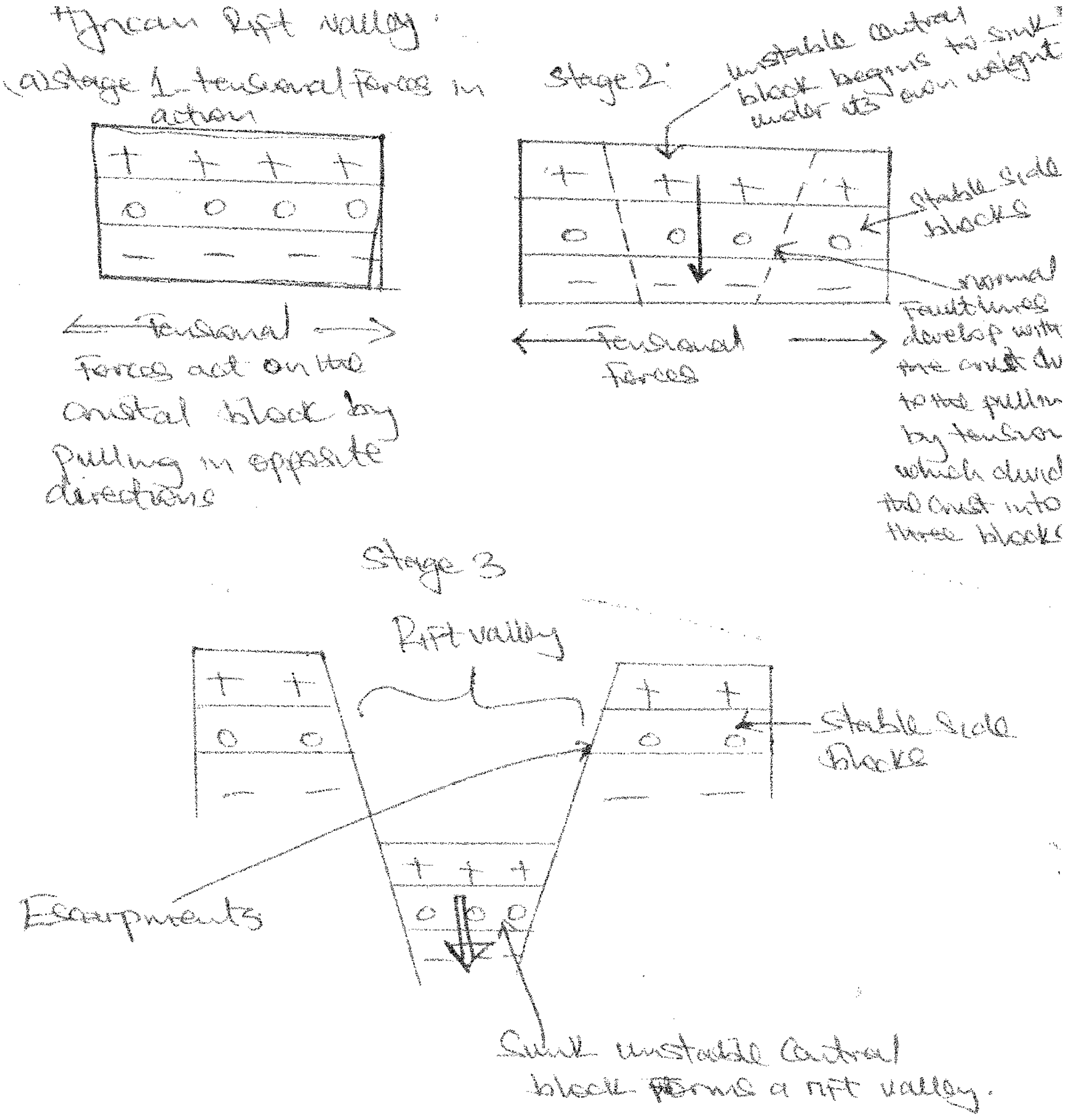
(i) Tensional theory

It was advanced by J.W Gregory. He suggested that radioactive and convective currents produced tensional forces within the earth's crust.

The tensional forces pulled apart the crust in opposite directions from the central point creating normal fault lines. These divided the crust into three blocks. This was followed by displacement of the blocks.

The central block became unstable and sunk under its own weight where as the side blocks remained stable. The sunk unstable central block formed a rift valley.

Erosion, mass wasting and weathering modified the sides of the slopes. The Eastern branch of the East African rift valley is believed to have been formed in this manner.



(ii) Compressional theory

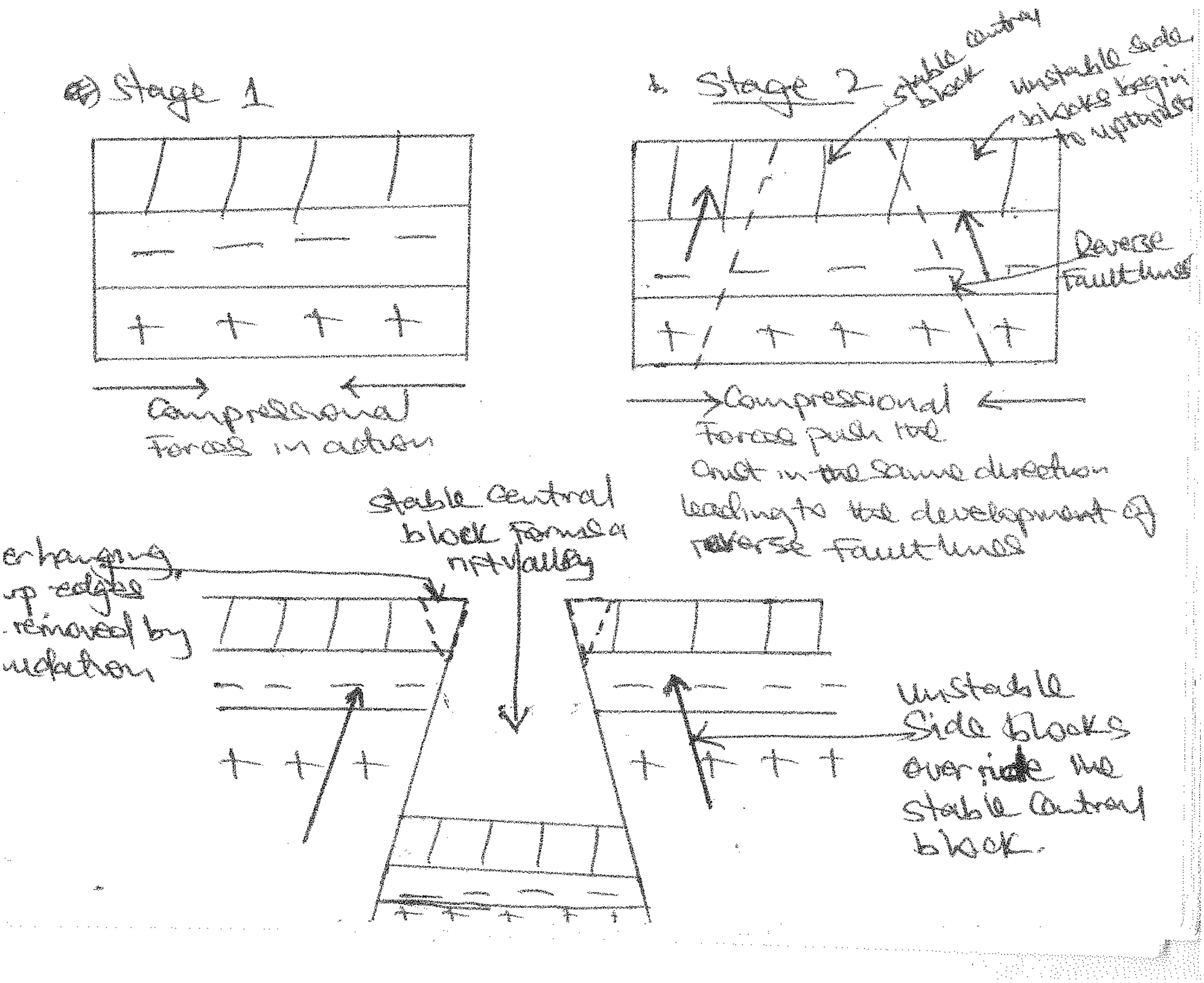
This was advanced by E.J Wayland. He believes that convergent convective currents pushed the crust in the same direction as they created the compressional forces.

The action of pushing by compressional forces created reverse fault line within the crust, dividing the crust into three blocks.

The continued pushing by the compressional forces made the side blocks become unstable and the central block became stable.

The unstable side blocks overrode / upthrusted / uplifted over the central stable block which became a rift valley.

The Albertine section of the East African rift valley is believed to have been formed in this way.

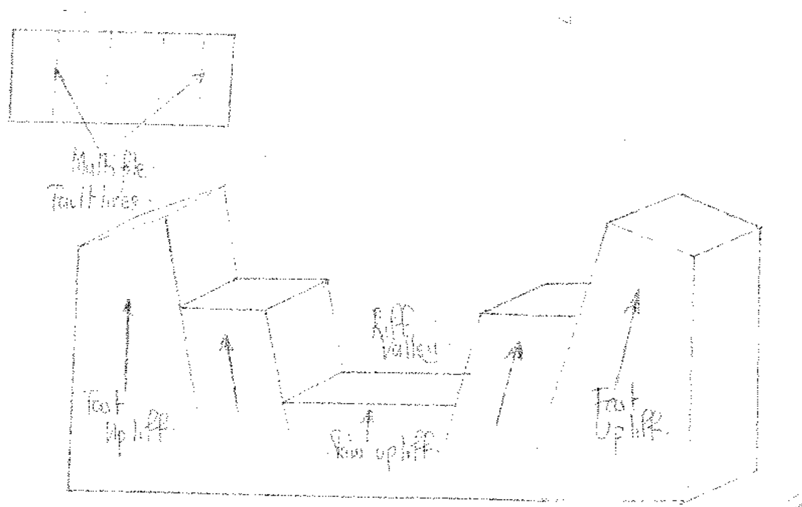


(iii) Differential uplift theory

This was advanced by Trupy and Dixy basing on the Nairobi section of the East African rift valley.

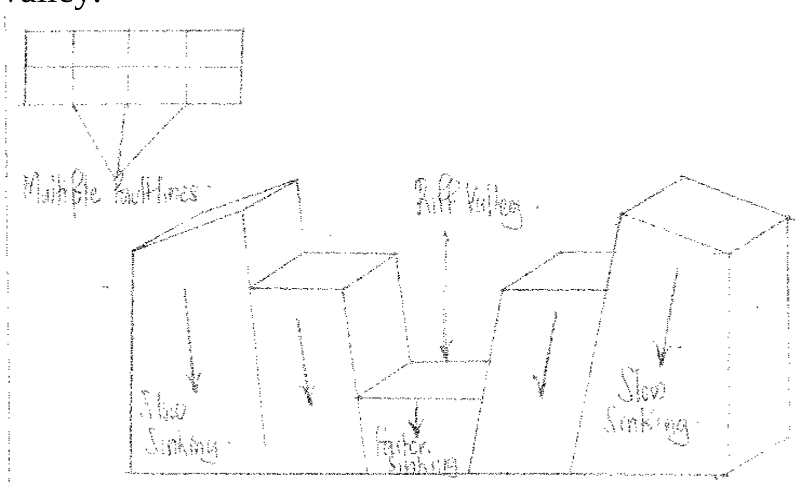
This theory assumes that multiple fault lines developed within the crust, dividing the crust into a series of blocks. This was followed by the general uplifting of the faulted region.

The side blocks were uplifted much faster and higher than the central block which experienced a slow uplift and therefore remained at a low level hence forming a rift valley e.g. the Nairobi section of a rift valley.



(iv) Relative sinking theory

This theory assumes that multiple fault lines developed in the crust and this was followed by a general sinking of the region where the central block sunk faster and lower than the side blocks which remained up. The sunk region became a rift valley.



(2) BLOCK MOUNTAINS / HORST

A block mountain is an upland or raised large block of land surrounded by fault scarps. It generally stands above the surrounding land with sharply defined edges e.g. mountain Rwenzori, Uruhuru, Usambara, Mahenge, Ufipa plateau, Pare, Iramba plateau in Tanzania and Nyiru Ndoto and Mathew ranges in the rift valley near Lake Turkana.

FORMATION PROCESS OF THE HORST

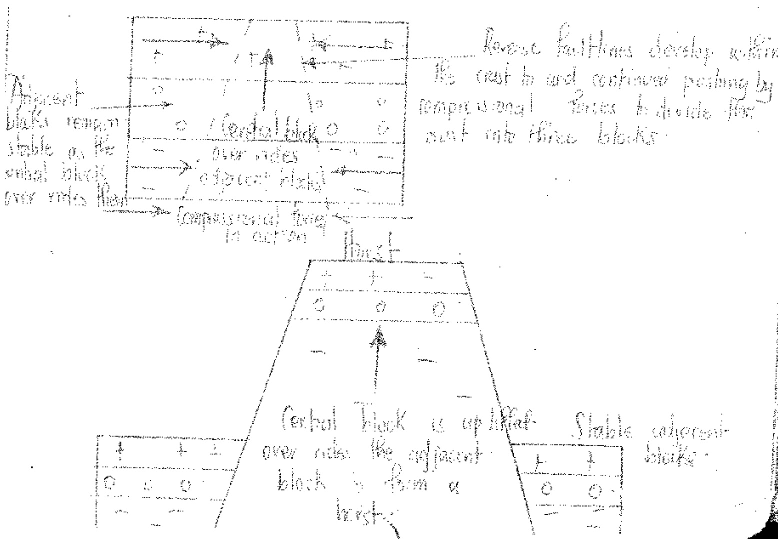
A block mountain is formed by a process of faulting through several theories.

Formation of a block mountain by compressional forces.

Advocates of this theory believe that the compressional forces pushed the crustal block on either sides resulting into stressing and hence development of reverse faultiness. This divided the crust into three blocks.

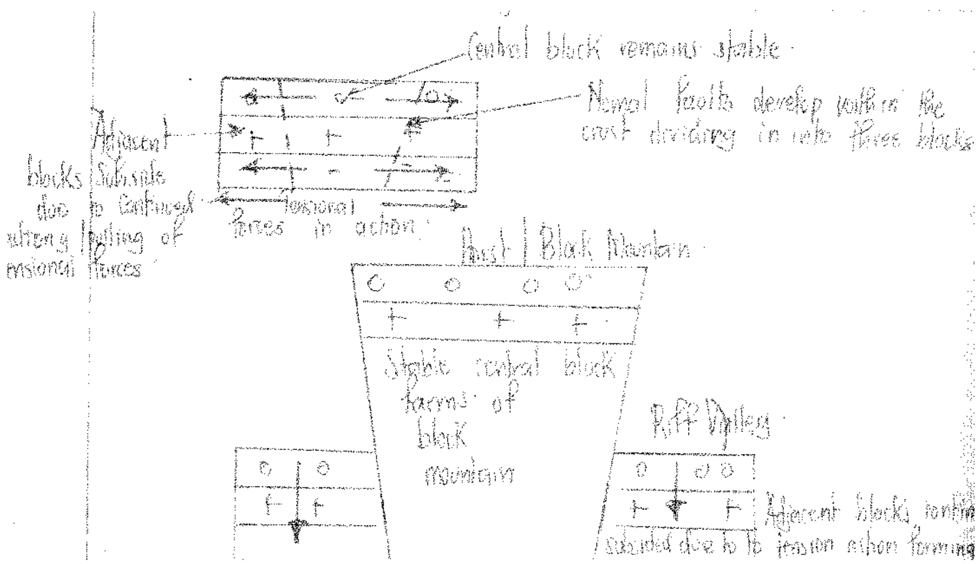
As the action of compressional forces continued, the unstable middle block overrode upthrusted the adjacent stable side blocks.

The risen unstable middle block formed a block mountain / horst as shown below.



Tensional forces acted on the crustal block by pulling in opposite directions away from each other. This led to the development of normal fault lines in the crust which divided it into three blocks.

The continued action of tension forces led to the subsidence unstable side blocks while the middle block remained stable high above the side blocks. These became a horst or block mountain.



Formation of a block mountain by differential uplift theory

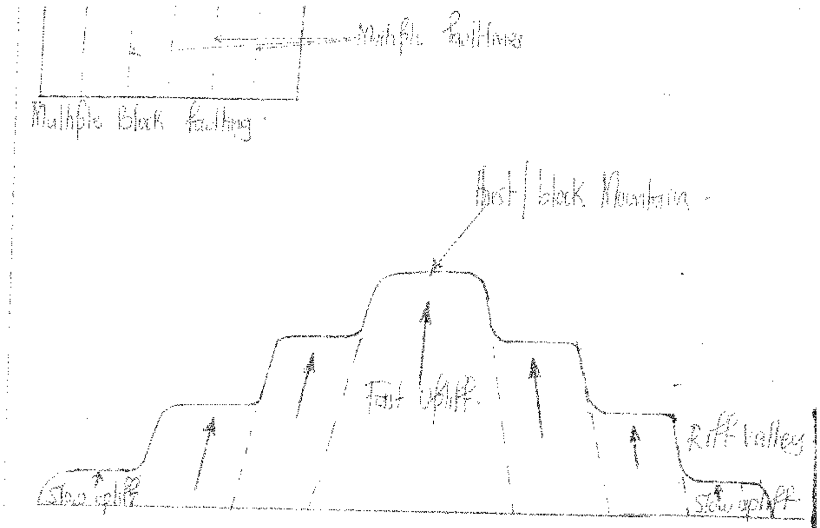
This is due to multiple faulting which formed a series of crustal blocks of varying sizes and densities.

When the forces of uplift acted on the crustal blocks with varying strength, uplift forces were strongest on the central block.

The central blocks were forced to rise faster and higher than the side / blocks to form peaks of a horst / block mountain.

The side blocks didn’t rise high enough but formed the sides of the horst as shown below.

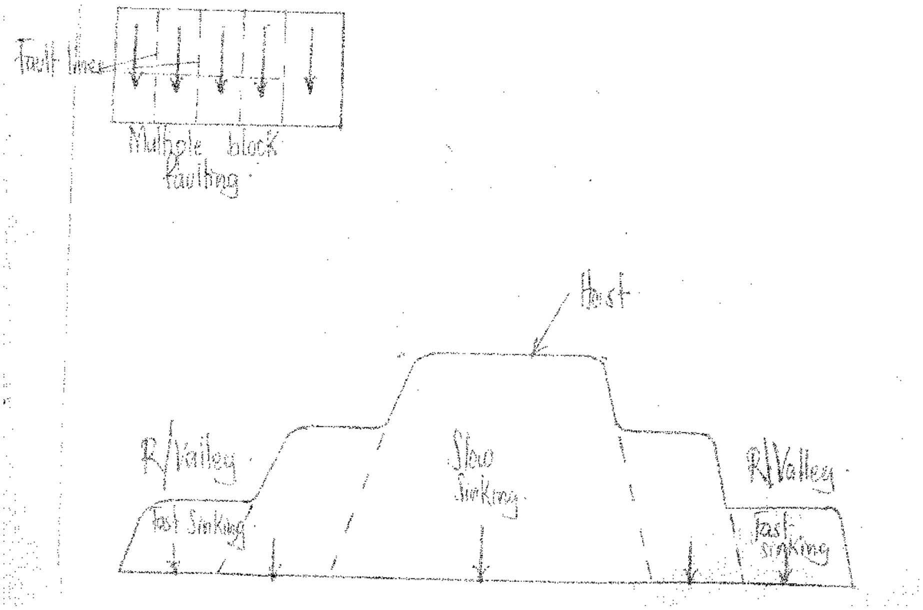
(Diagram)



FORMATION OF A HORST BY RELATIVE SINKING THEORY

Multiple fault lines developed within the crust dividing the crust into a series of blocks. This was followed by the general sinking of the faulted region where the side blocks sunk much faster and lower than the central blocks which remained high above the sunk side blocks. These become the horst / block mountain.

(Diagram)

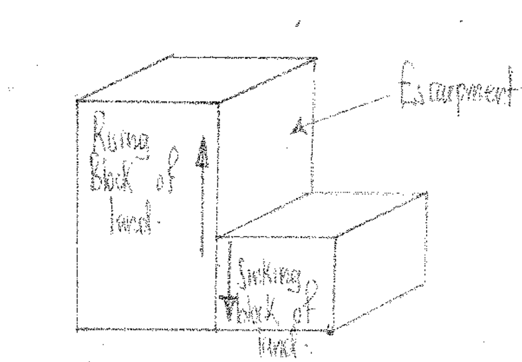


ESCARPMENT / FAULT SCARP

An escarpment is a steep side of a rift valley or block mountain which forms an abrupt change in the gradient / height as one goes down a rift valley / block mountain. It may be as high as 50m from the rift valley floor e.g. Butiaba, Kicwamba, Kyambura, Bunyaruguru in Western Uganda, Manyara and Chungwa in Tanzania, Elegeo and Mau in Kenya. It is formed as a result of faulting when there is development of a single fault line in the crust. One of the blocks on one side of the fault line sinks down along the line of the fault while the adjacent block is either uplifted or remains in its original position, forming a suddenly steep sharp or break in the gradient of the slope called an escarpment.

N.B: When an escarpment is worn down by denudation forces, it becomes a fault scarp which is a gentle slope on either side of the rift valley.

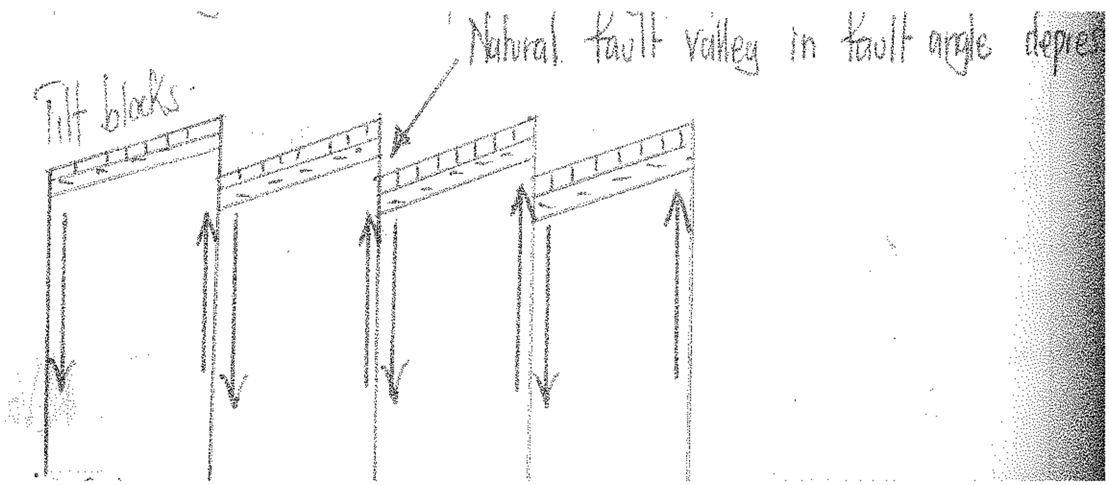
(Diagram)



TILT BLOCKS

There are landforms in form of ridges and depressions formed by faulting and tilting of land along fault scarps followed by displacements. Examples of tilt scarps are along the Rift valley where they form deep bedding planes and western Kenya in Abadare region.

(Diagram)

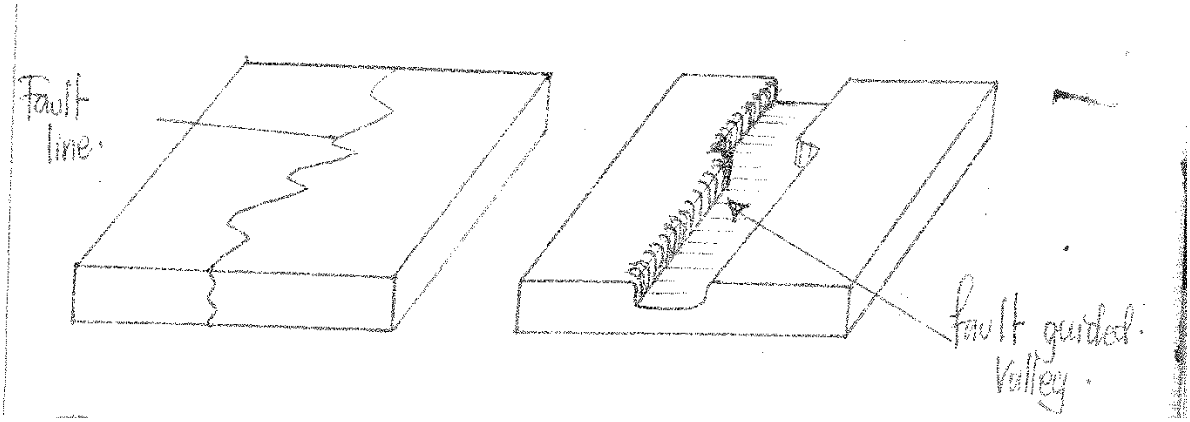


FAULT GUIDED VALLEY

This is a valley as the name suggests that develops in a fault line and follows the direction of a fault line. It is steep sided and has a flat floor. As faulting takes place, the rocks caused by the fault line are crushed and shuttered. The shuttered rocks are then eroded there by rivers resulting into the creating of along depression along which a river may flow e.g. Aswa valley in northern Uganda, Kerio river valley, Ewaso-Ngilo river valley in Kenya, R. Ruha valley in Tanzania.

(Diagram)

(i) Before denudation (ii) After denudation



GRABEN

Account for the formation of a Graben.

Approach:

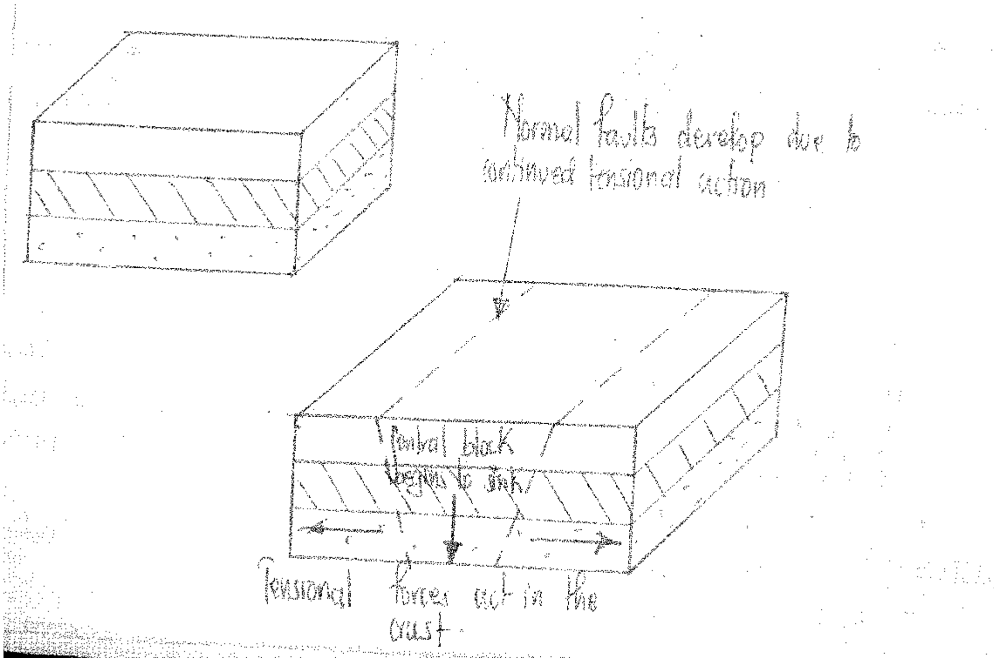
- Define a graben.
- Identify the formation process i.e. faulting.
- Define faulting; describe the origin and causes of faulting.
- Mention the fact that a Graben forms in series / stages i.e. beginning with a formation of a rift valley.
- Then describe the theories responsible for the formation of a rift valley.
- At the end of each theory indicate secondary faulting acting on the floor of a rift valley leading to the formation of a Graben.

FORMATION OF GRABEN

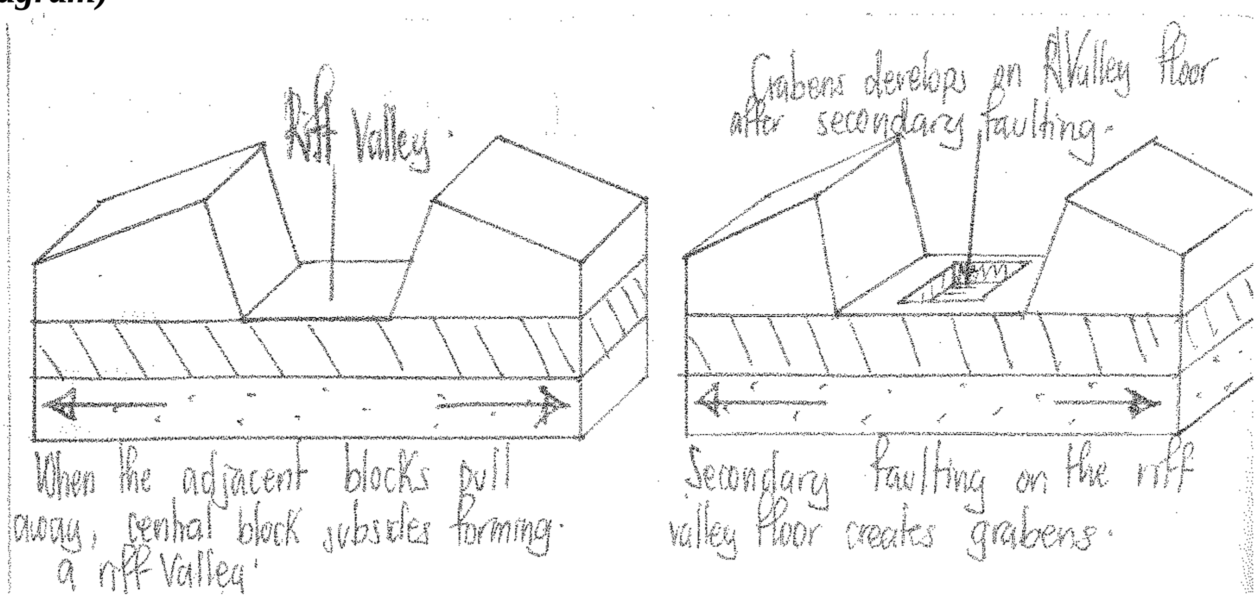
A Graben is an elongated deep steep sided depression on the floor of the rift valley. It is formed as a result of secondary faulting taking place on the rift valley floor which leads to secondary sinking of part of the rift valley floor to form a depression or hollow called a graben. Examples of grabens include; Albert graben, Tanganyika Graben, Turkana graben e.t.c.

Formation of Grabens by compression

(Diagram)



Formation of Grabens by tension
(Diagram)

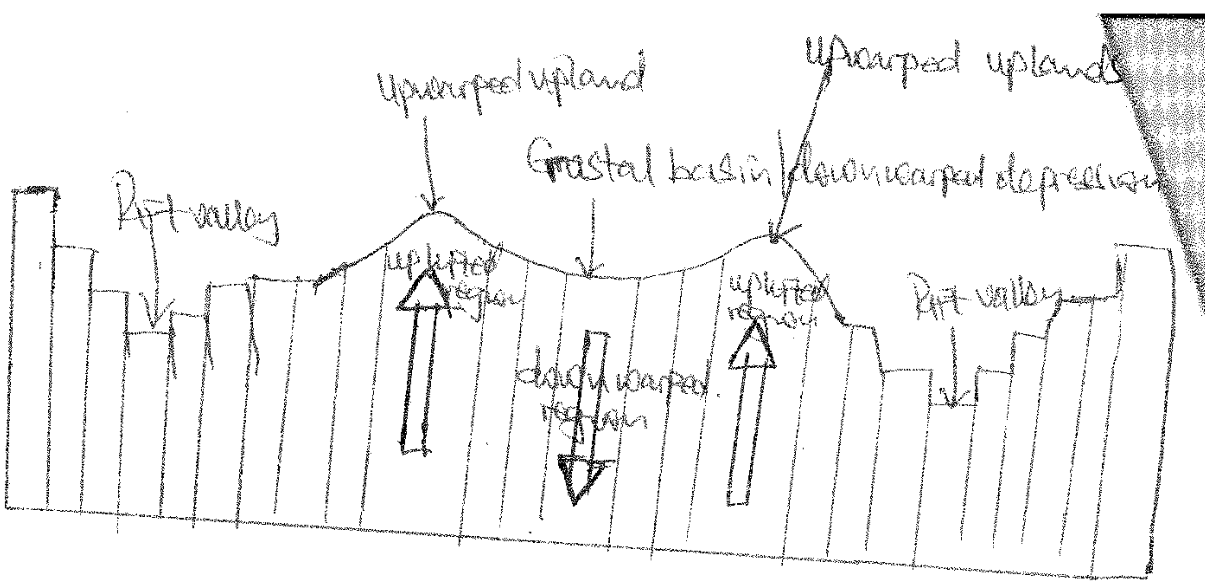


3.6 WARPING

Is a form of earth movement / diastrophism that involves sagging, subsidence / sinking of land masses in one region as other regions are getting uplifted. Warping in East Africa led to the formation of up warped highlands.

This involved land e.g. on the Eastern side of rift valley side of the western arm of the East African rift valley, getting uplifted/up warped after the formation of the rift valley. This created up warped uplands e.g. in Hoima, Masindi e.t.c. warping also led to the formation of down warped / crustal depressions basins. Those refer to extensive, shallow irregular and sourcer depressions onto the earth's surface. They were formed as a result of down warping. After the formation of the great East African rift valley, the Eastern side of the western arm of the rift valley and the western side of the Eastern Branch of the rift valley were uplifted/up warped. While as central East Africa was down warped / sagged / sunk to create a down warped /crustal basin.

(Diagram)

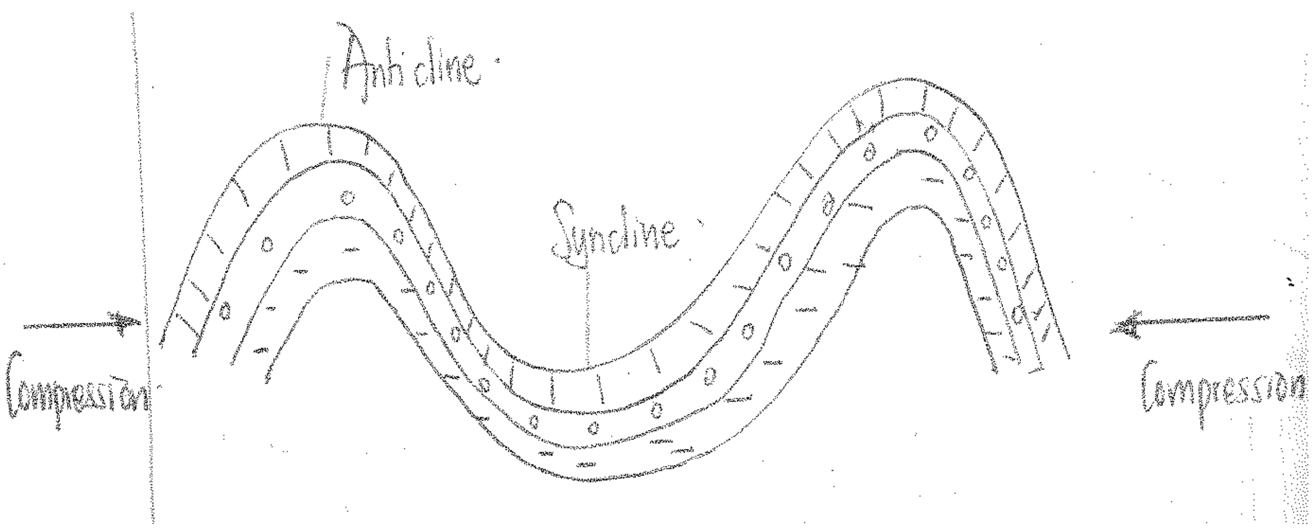


3.7 FOLDING

It leads to the formation of Fold Mountains characterized by anticlines and synclines. This happens when compressional forces within the crust act on young rocks which get folded instead of fracturing.

Outstanding folded mountains with synclines and anticlines are in north western Tanzania, south western Uganda and in Masindi.

(Diagram)



3.8 EFFECTS OF EARTH MOVEMENTS ON THE DRAINAGE OF EAST AFRICA

- Faulting led to the formation of graben lakes e.g. L. Turkana, L. Albert, L. Tanganyika e.t.c.
- It led to the formation of waterfalls e.g. Murchison falls and Kalambo waterfalls on the south western boarder of Zambia and Tanzania.
- Faulting led to the formation of fault guided rivers e.g. R. Aswa and Kerio.
- Warping led to the formation of down warped lakes e.g. L. Kyoga, L. Victoria, L. Wamala, L. Kijanibororo, L. Mburo.
- Upwarping led to river reversal e.g. R. Kafu, R. Kagera, R. Katonga.
- Faulting which created waterfalls led to swift flow of rivers over the waterfalls or escarpments e.g. R. Nile as it enters L. Albert.

- Faulting led to the formation of Block Mountains which are glaciated and are sources of rivers e.g. Mountain Rwenzori with rivers like Mubuku, Bujuku, Nyamwamba, Rwimi which originate from the melting waters of glaciers.
- River reversal due to up warping created several swamps in central and western Uganda.
- Down warping which created crustal basins led to the development of centripetal drainage patterns.
- Faulting which led to the formation of Rwenzori, Block Mountains which has several rivers flowing out of it, led to the development of radial drainage patterns.
- Faulting through the development of fault guided valleys led to the development of trellis drainage patterns where tributaries join main rivers at right angles.

Qns:

(a) Examine the influence of earth movements land form development in East Africa.

(b) Explain the influence of earth movements on the drainage of East Africa.

(c) Account for the formation of a Graben.

4.0 VOLCANICITY

Volcanicity is a geomorphic process which involves the movement of molten rocks (magma, gases and solid particles) from the earth's mantle to the earth's surface to lead to the formation of extrusive features / land forms or magma may be intruded / injected to lead to the formation of intrusive volcanic features.

Volcanicity is a result of geochemical, geophysical reactions and radioactivity within the mantle which lead to the melting of rocks into a molten form called magma which is highly mobile. The magma is pushed with great pressure from the mantle through faults and injected onto the earth's surface to lead to volcanicity.

4.1 INTRUSIVE VULCANICITY

This involves the intrusion, injection of magma within the interior of the earth to lead to the formation of various intrusive volcanic features which when exposed to the surface by denudation, they lead to the formation of landforms / relief features which include;

DYKES

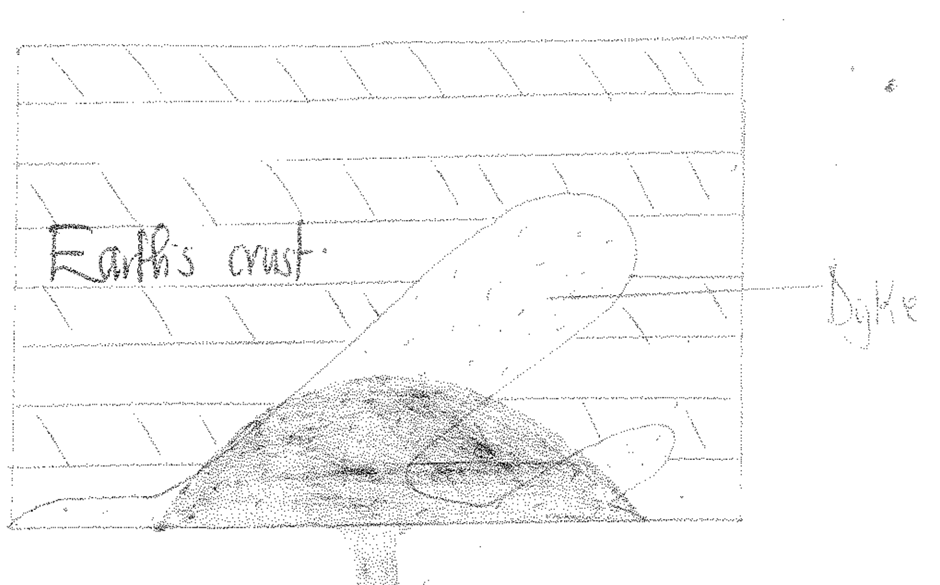
A dyke is a cylindrical mass of rock formed within the earth's crust. They are often perpendicular within the crust.

Dykes are formed as a result of very acidic magma being intruded within vertical fissures / events to form walls of solidified magma. It may be vertical / steeply inclined.

When dykes are exposed onto the earth's surfaces by weathering and erosion. They form elongated ridges / hills if harder than the surrounding rocks e.g. Isingiro ridges / hills, ridges in Busia and Kisumu and Rungwa.

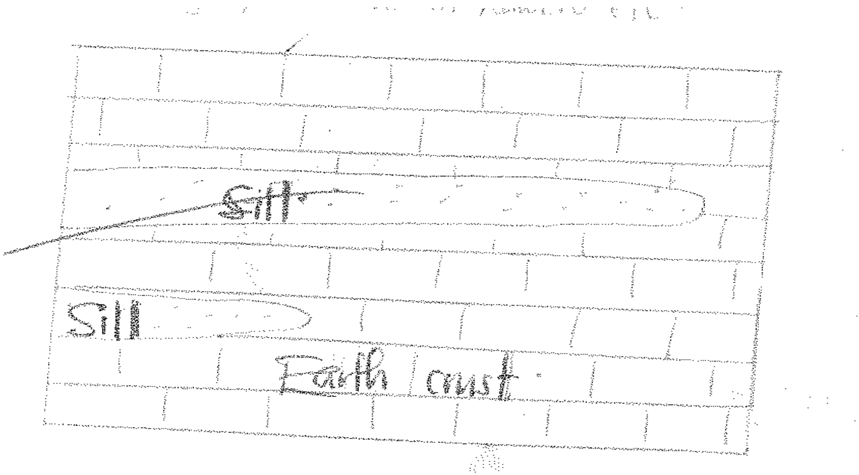
Dykes may form linear trenches if softer than the surrounding rocks e.g. around L. Turkana.

Diagram:
Before denudation



SILL
Is a narrow sheet of solidified magma which is intruded horizontally within the bedding plane. It is formed when basic magma is injected between bedding planes and cools. It forms relief landforms known as flat topped hills, cliffs or escarpments e.g. can be seen along Pakwach, Arua road (Karuma) falls, Mubende hills, Kakinzi in Luwero e.t.c when exposed by denudation.

Diagram:
Before exposure

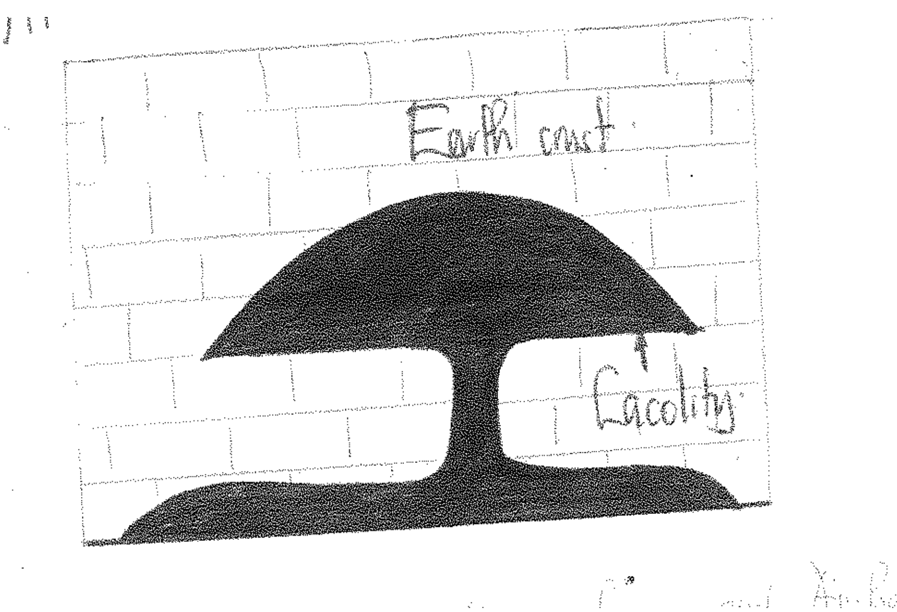


LACOLITH

Is a dome shaped mass of solidified magma with a flat base within the earth's crust. It is formed when viscous / acidic magma fails to spread far and therefore accumulates in a large mass and then solidifies very fast. It forms near the earth's surface.

On exposure, laccolith form uplands e.g. Voi, Kitui in Southern Kenya.

Appearance of lacolith



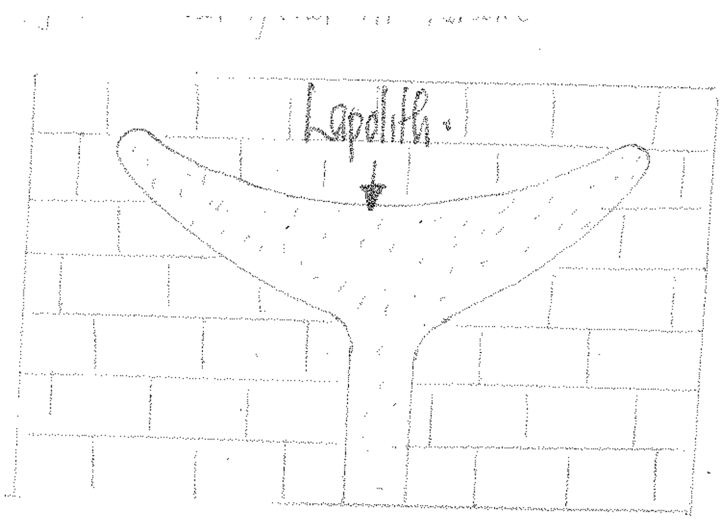
LAPOLITH

This is a very large sourcer shaped volcanic intrusion / mass of rocks within the earth's crust.

It is formed when viscous magma forces its way into the bedding planes, thereby quickly solidifying.

Their shape is as a result of the mass of rock which overlies them which depresses the underlying rocks causing sagging.

When exposed to the earth's surface, a shallow wider sourcer shaped depression called an Arena is formed e.g. Rubanda Arena in Kabale.



BATHOLITH

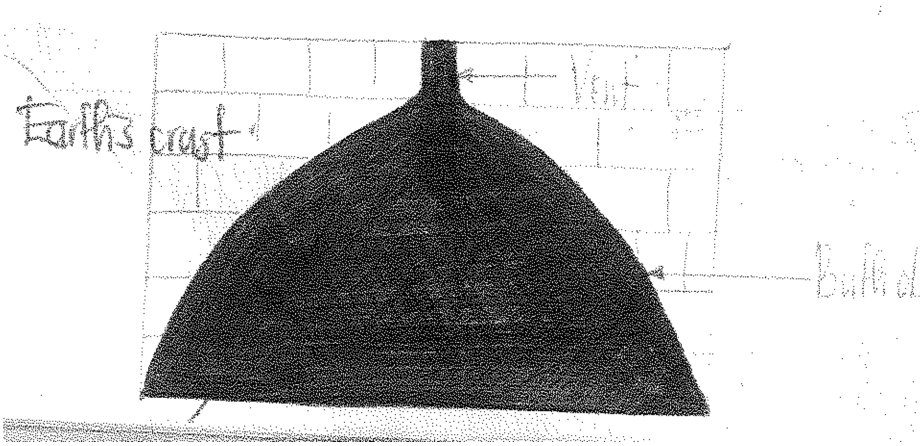
Is a dome shaped mass of solid magma formed at a great depth within the interior of the earth.

They seem to continue up to the earth's core. And they are composed of granitic materials whose base is not identified. They are the largest intrusive volcanic features.

It is formed when acidic magma is intruded at great depth within the earth's crust and solidifies very slowly.

When exposed to the surface, it may form a rocky highland or upland covering hundreds of square kilometers known as an inselberg e.g. Labwor and Parabong hills in Eastern Acholi, Kikandwa hills in Mubende, between Mwanza and Iringa, Kacumbala in Bukedea, Nyero rocks in Kumi.

Where batholith are exposed and are weaker than the surrounding rocks, they form larger saucer shaped depressions known as Arenas.



4.2 EXTRUSIVE VOLCANIC FEATURES

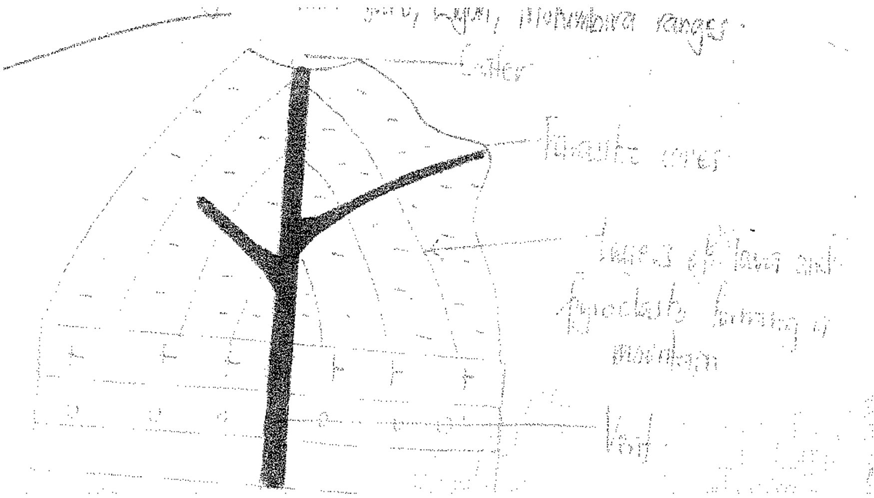
This involves the ejection / extrusion of larva onto the earth's surface to lead to the formation of various extrusive volcanic features which include;

VOLCANOES / VOLCANIC CONE

A volcano / volcanic mountain is a conical shaped steep sided highland ranging from a few to thousands of metres in height containing circular depressions on their tops / slopes known as craters.

It is formed when acidic magma rises through the main vent and on reaching the earth's surface, it piles / accumulates around the vent, solidifies forming a volcanic cone / mountain e.g. mountain Kilimanjaro, Elgon, Mufumbira, Nepark e.t.c.

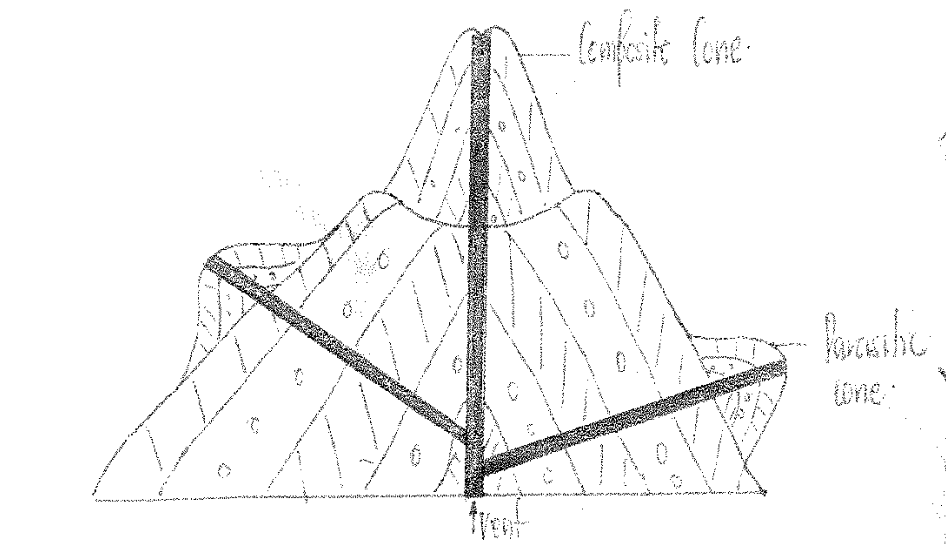
Diagram:



TYPES OF VOLCANOES

Composite volcanoes. This is a volcano which is conical in shape ranging from hundreds to thousands of metres high. It may be surrounded by several volcanic cones with different layers of pyroclasts. It is formed when an explosive eruption takes place in the previous volcanic mountain and forms a small composite cone on top. It is called a “Volcano within a volcano”. E.g. Virunga Mountain ranges East of Zaire, Muhavura mountain ranges in south western Uganda.

Diagram:

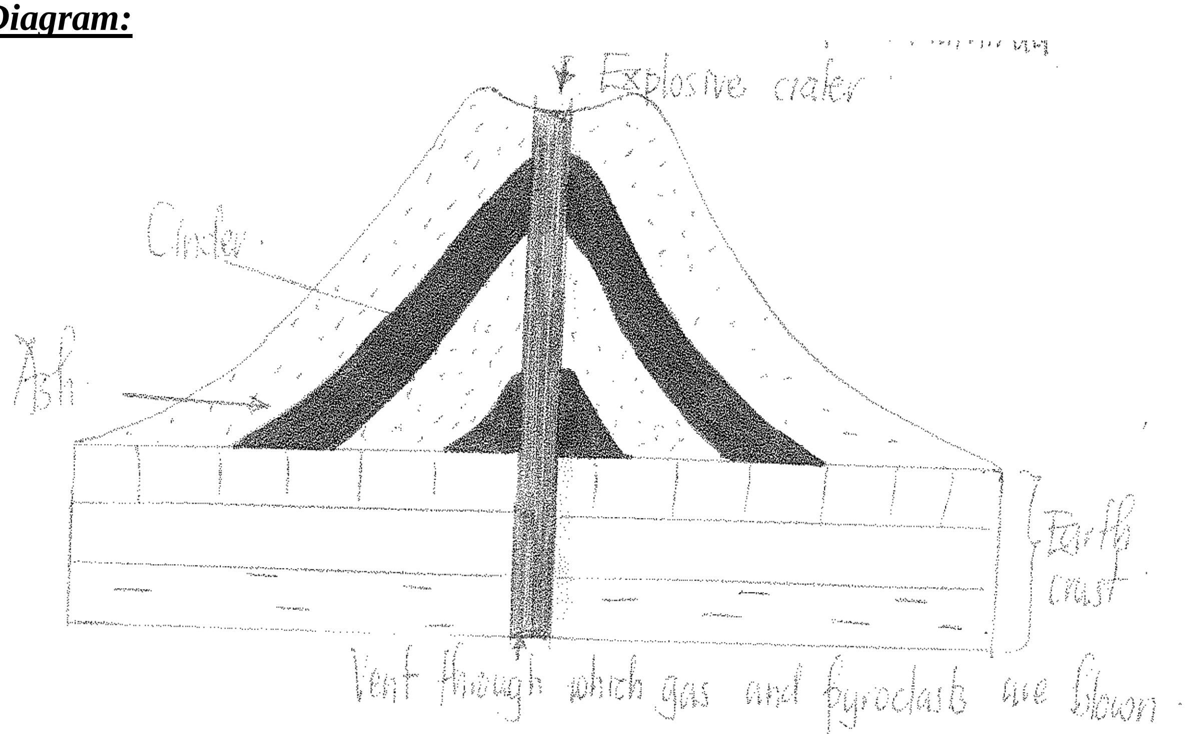


ASH AND CINDER CONES

These are conical hills formed as a result of volcanicity and are composed of alternating layers of pyroclasts (cinder) and volcanic ash which reaches the earth's surface due to excessive pressure and gas from below.

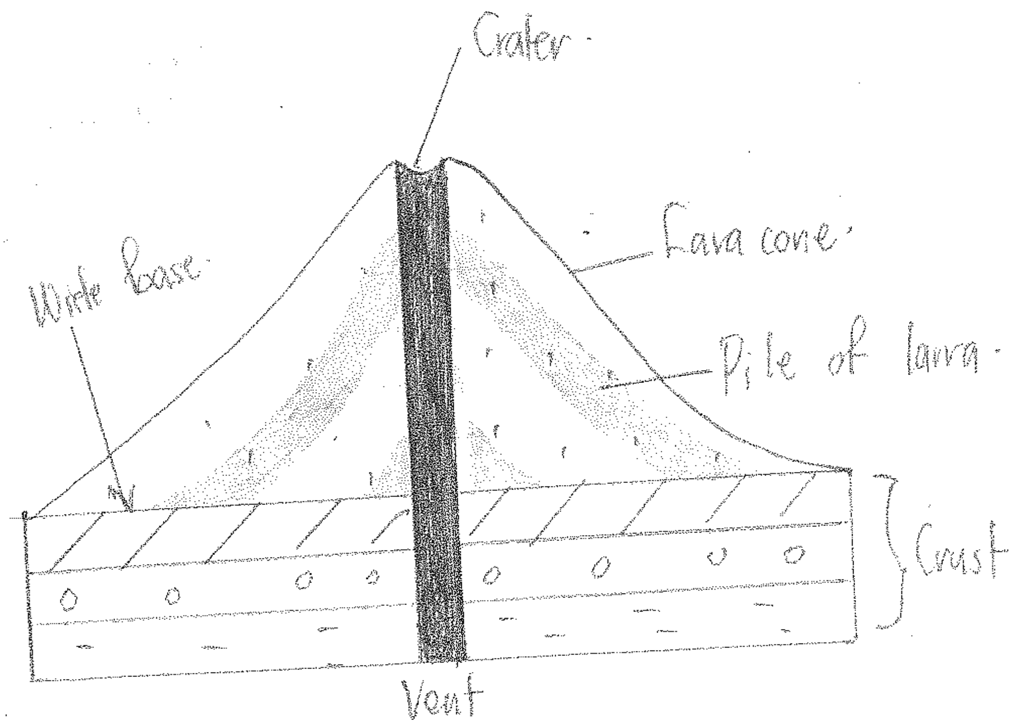
They are formed due to successive violent eruptions of pyroclasts and ash from the vent. Lava is blown to great heights into the air in liquid form and returns to the ground as semi-solid cooled pieces called cinders and ash if very small. They often contain creaters on their summits e.g. include Luiru, Likaiyu, Teleki in Kenya, Nabuyatoni, Abiti-Agituku in north eastern Uganda and between mountain Muhavura and L. Mutanda.

Diagram:



`LAVA CONES

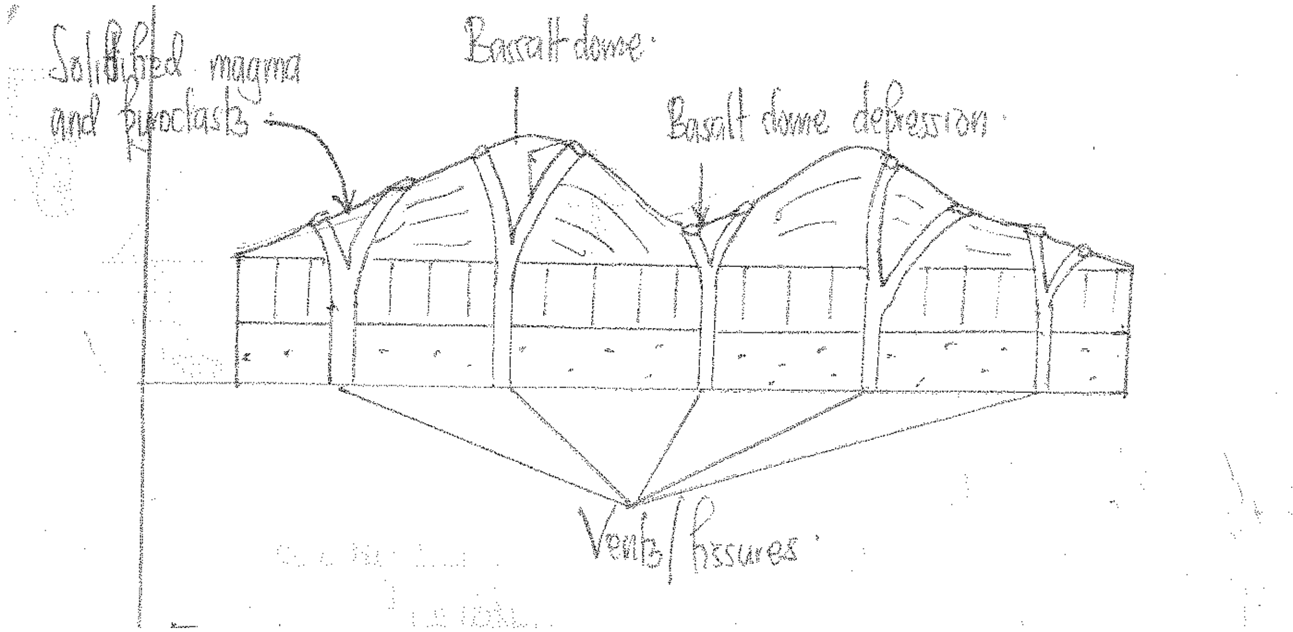
These are cones mainly composed of lava and have gentle slopes and have a wide base. They are formed as a result of lava being ejected onto the earth's surface, pilling around the vent, cooling and solidifying forming a gentle sloping cone.



BASALT DOMES / SHIELD VOLCANOES

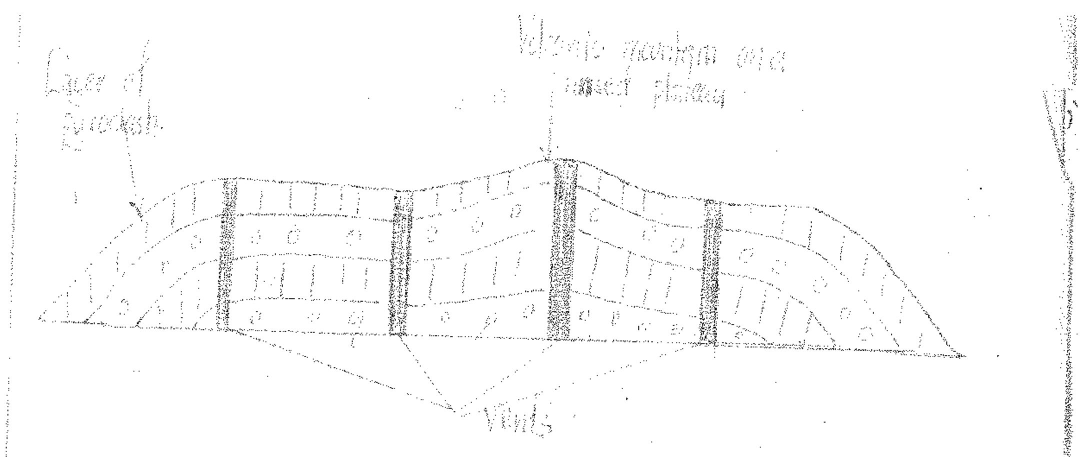
Is a landscape which is dome shaped with a very large shallow depression on gently sloping landscape. It is formed as a result of basic magma reaching the earth's surface through numerous, fissures and may flow for long distances before solidifying.

Their formation involves ejection of gases on the earth's surface and are often explosive e.g. exist in south western Uganda in groups of Nyamulagira where there are about 8 basalt domes, the Virunga and Mufumbira ranges in Zaire and northern Rwanda.



LAVA PLATEAU

Is a raised steep sided flat land. They are formed when basic lava reaches the earth's surface through numerous vents, flows for longer distances as it piles up to form a large raised flat land called a lava plateau e.g. Kisoro highlands, Voi plateau and Laikipia plains in Kenya.

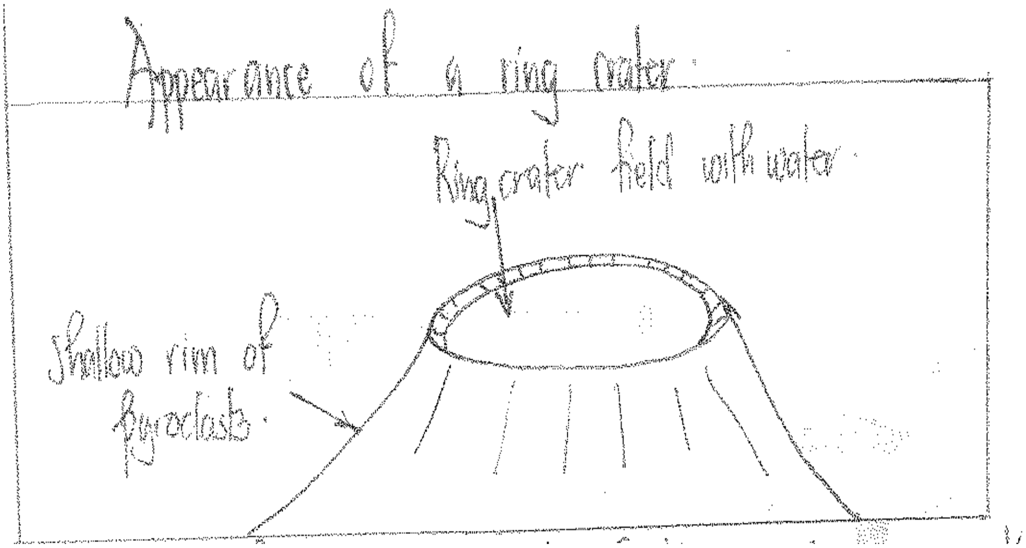


EXPLOSION CRATERS

This is a shallow steep sided depression-surrounded by a low rim of pyroclasts.

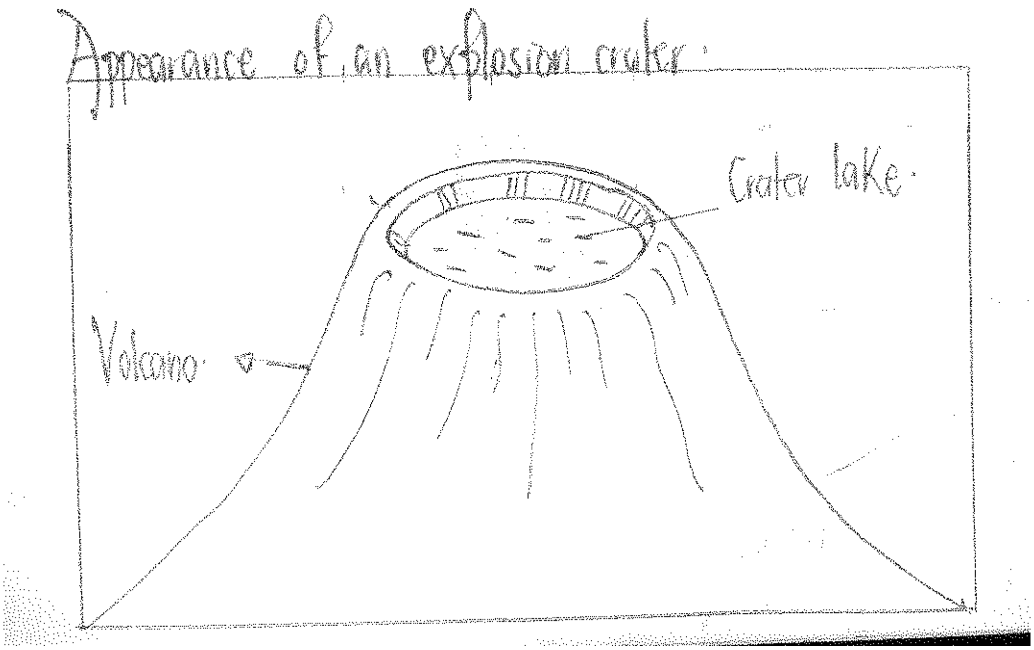
It is formed when an explosion of gases and some pyroclasts takes place on a flat landscape without forming a volcanic mountain and the explosion is less violent, instead, it forms a shallow depression on a slightly raised ground surrounded by a rim of pyroclasts. Examples include;

- Lake Katwe crater,
- Nyamunuka
- Kasenyi
- Munyanyange in Queen Elizabeth National Park
- Nkugute, Rutoto in Rubirizi, Kigera and Nyabikere in Fortportal, Garana and Ndobolo in Tanzania.



MOUNTAIN CRATERS

Are circular depressions found on the top / side of a volcano. It is bowel / funnel shaped with in facing steep slopes. It is formed as a result of successive violent eruptions which blow off the top of a volcano leaving behind a circular depression called a crater e.g. Menengai, Suswa, Kilimanjaro crater, Rutunguru, Shambolo e.t.c.



A CALDERA

Is a large shallow circular depression at the top of a volcanic cone. It may be occupied by small volcanic cones called tholoids.

Two theories are advanced to explain the formation of calderas namely;

A caldera can be formed by a very violent eruption which blows off the top of a volcanic cone leaving behind a large circular depression called an explosive caldera.

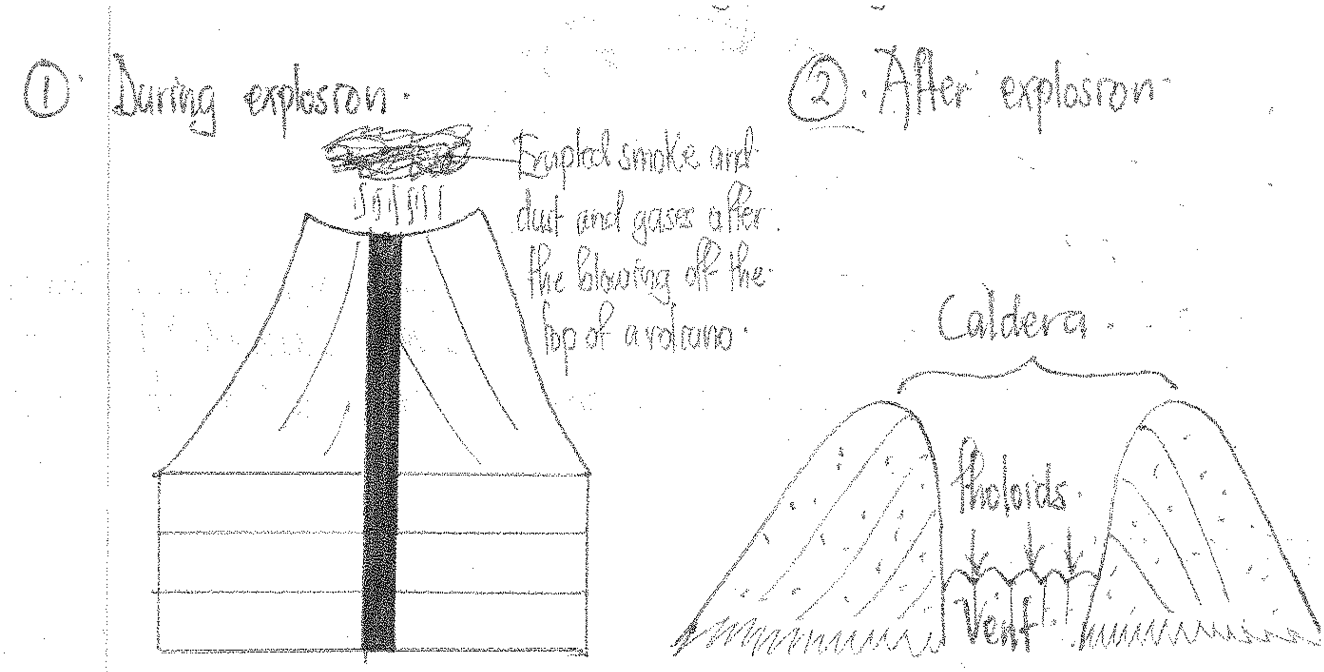
The best examples of calderas include Longnot caldera in the eastern arm of the Rift valley in Kenya.

A caldera may also be formed as a result of cauldron subsidence of rocks on top of a volcanic mountain.

The rock subsidence into the earth's crust due to reduced pressure from the earth's mantle.

In case a volcano sinks, minor volcanic eruptions continue and form volcanic cones called Tholoids at the base of a caldera e.g. of such subsidence calderas include; Manengai, Ngorongoro in Tanzania and Akaigodi caldera in Nyakasura.

Diagram:
During explosion



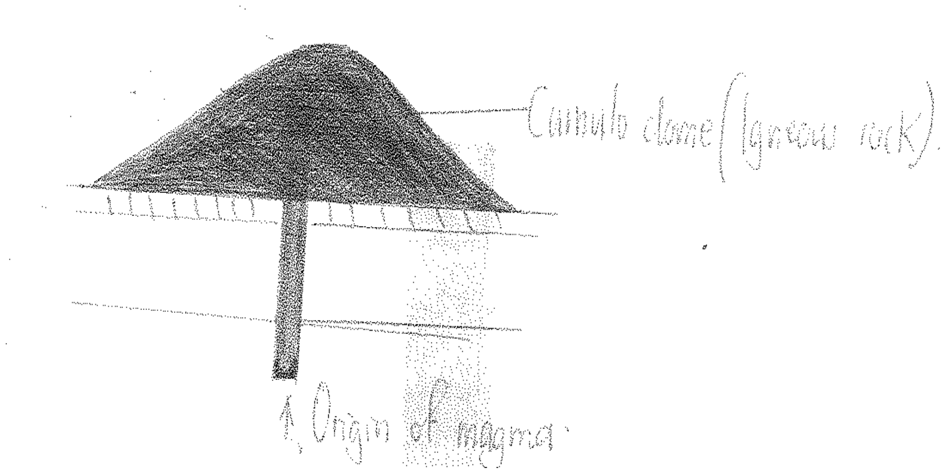
A CUMULO DOME

Is a dome shaped feature/solidified mass of magma which ranges from tens to hundreds of metres forming hills of igneous rocks in a region. They result from volcanic eruptions which fail to reach the earth's surface and magma solidifies within the earth's crust.

Later on, secondary eruptions may push the solidified steep sided convex domes known as cumulo domes.

Cumulo domes may also be formed by viscous magma which solidifies instantly on the earth's surface failing to form volcanic mountains as illustrated below. Examples include Mbea rock in Tanzania, Nakasongola rock, Ntumbi cumulo dome and in the Tsavo national park.

Appearance of a cumulo Dome



VOLCANIC PLUG

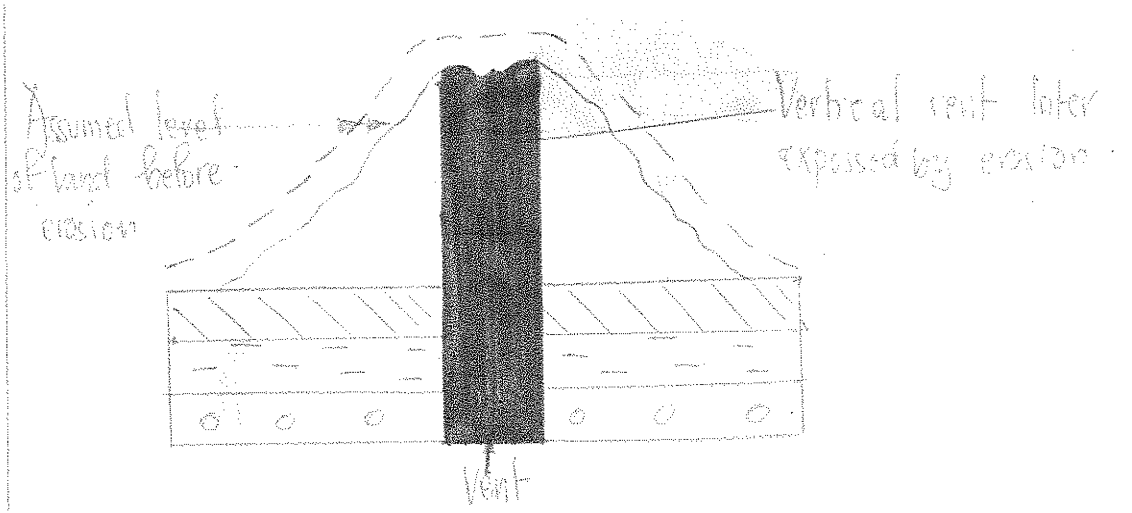
Is a cylindrical dome of igneous rock which stands out prominently vertically on the earth's surface. It is formed when volcanic eruption occurs and the acidic magma gets out of the earth's crust when already solid and cylindrical.

The plug may later be weathered down and eroded or may remain in place for a long while e.g. Tororo rock.

VOLCANIC NECK

This is a cylindrical mass of hard rock standing out vertically on the earth's surface after exposure by erosion of rocks surrounding it.

Volcanic necks are farmer volcanic vents which failed to reach the earth's surface during volcanicity but because of erosion, the vents were exposed onto the earth's surface e.g. Tororo.



4.3 OTHER FEATURES OF VOLVANICITY

1. HOT SPRINGS

These are streams of super-heated warm, water originating from the earth's crust and reach the earth's surface frequently.

They are formed when water from rain, snow or plutonic sources seeps through rock cracks and collects in underground covens/sumps

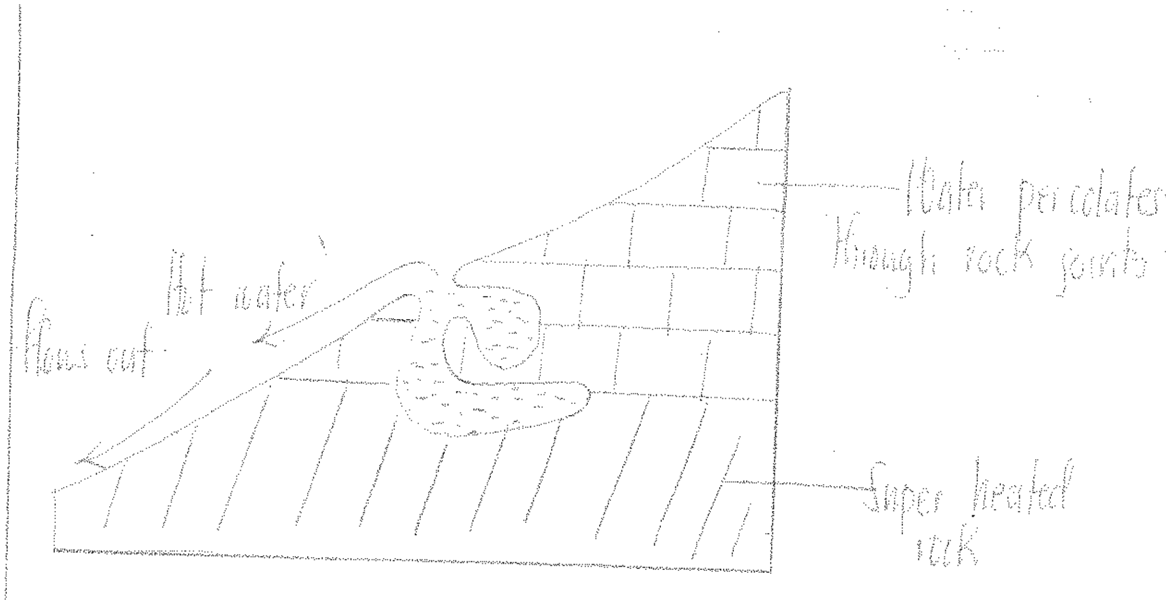
During its passage, the water may come into contact with the hot rocks and later may re-emerge as a spring of warm or hot water after being pushed upwards by underground pressure onto the earth's surface.

At times, the water may carry chemicals in solution which are often deposited in thick layers around parts of rim of the spring exit.

Examples of hot springs include:-

- Sempaya hot springs in Bundibugyo
- Kitagata hot spring in Bushenyi
- Kisizi hot spring in Rukungiri
- Kibiro hot spring in Hoima
- Njorwa, Majiya moto and L. Hannington
- Aboni and Maji moto in Tanzania

Diagram:



GEYSERS

These are jets of boiling water intermittently reaching the earth's surface due to its being pushed from the underground by great pressure. They are formed as a result of water from the rain, plutonic sources e.t.c. collecting in underground rock-sumps that boarders very hot rocks and traps steam behind it.

As the steam increases, its pressure builds up to a point where it pushes water out with violence

Examples are in Lake Hannington in Kenya, Longonot crater, between Elementaita and Naivasha, Menengai in Kenya and in Tanzania at Aboni and Kalimanjaro.

<u>Qn</u>.1:

To what extent are highlands in East Africa a result of volcanicity?

<u>Approach:</u>

- Define highlands
- Make an evaluation i.e. state an extent.
- Show the role of volcanicity in the formation of highlands but first define volcanicity and show its origin and causes.
- Highlands resulting from volcanicity include;
    - Volcanoes

- Composite volcanoes
- Ash and 8 cinder and cones
- Lava cones
- Basalt domes
- Volcanic plugs
- Lava plateaus

Role of other processes i.e.

- Folding led to formation of fold mountains
- Faulting led to formation of block mountains
- Denudation led to the formation of inselbergs
- Conclusion

<u>Qn</u>.2:

Account for the formation of a caldera

- Define a caldera.
- Identify a caldera as a volcanic feature formed by volcanicity.
- Define volcanicity and define its origin and causes.
- Describe the formation of a caldera using the two theories i.e. cauldron subsidence and volcanic explosion.

5.0 MASS WASTING / MASS MOVEMENT

This refers to the downward movement, creeping, flowing of rocks and weathered materials downslope under the influence of gravity.

In the process, water acts as a lubricant and adds weight to rock materials.

Mass wasting can be either slow or rapid movement.

It occurs in mountainous areas like Rwenzori, Rwampala hills, Kigezi e.t.c.

5.1 SLOW MASS WASTING

These are gradual unnoticeable movement of rocks and weathered materials down hills on a gentle slope.

PROCESSES OF SLOW MASS WASTING

SOIL CREEP

This refers to the movement of unconsolidated weathered rock materials on gentle slopes under the influence of gravity. It’s normally facilitated by heavy rains. The rocks get saturated and heavy which prompts them to creep down slope.

It is detected by tilted trees and poles, bulging wire net fences and almost bridging river valleys.

ROCK CREEP
This is the movement of rock debris slowly down the gentle slope.
Such rocks may move under soil creep.
Such rocks may be traced in Sironko and Kapchorwa on the gentle slopes.

SOLIFLUCTION
This is the movement of saturated soil, gravel and weathered rocks on moderate slopes in glaciated regions e.g. Kenya mountains, Rwenzori.

5.2 RAPID MASS MOVEMENTS / LANDSLIDES
Landslides are sudden rapid and unpredictable movements of soils and soil debris/materials down the slope under the influence of gravity.

PROCESSES OF LANDSLIDES

Talus creep
This is the movement of angular rock particles of all sizes on moderate slopes

Mud flows / Earth flows
This involves the movement of semi-liquid mud / materials mixed with gravel and boulders on steep slopes. It is common in volcanic regions of Kigezi, Bududa, Kapchorwa.

Rock slump
This is the fast movement of rock debris on over steepened slopes.

Rock slides
This is the rapid movement of large masses of rocks over steep slopes. It’s common on Usambara and Pare ranges in Tanzania and Butyaba escarpment.

Rock fall
Refers to the free fall of individual rocks or boulders on steep slopes e.g. on the Rwenzori and Sironko.

AVALANCHES
This refers to the falling by gravity of a mass of ice down a steep slope on a mountain side.

In East Africa, it's restricted to permanent snow caped mountains.

5.3 CAUSES OF MASS WASTING

- **CLIMATE**
  Continuous heavy rainfall leads to saturation, adds weight and reduces cohesion of the material in the rock mass. Mudflows begin flowing down slope, rock slide, Talus creep also begin.

  The pounding effect of rain disintegrates the rock surfaces hence causing rock stumps.

  Temperature fluctuations lead to solifluction i.e. hot temperatures lead to melting of snow on glaciated mountains like Rwenzori which saturate the rocks and soils leading to solifluction.

- **RELIEF**
  Very steep slopes like cliffs, escarpments encourage rock falls, rock slump.

  Moderate slopes encourage solifluction.

  Gentle slopes encourage solifluction and rock creep.

- **NATURE OF ROCKS**
  Highly jointed rocks are prone to rock falls whereas where the permeable rocks overly /impermeable rocks, they can easily slide down under the influence of gravity.

  In circumstances where there are hard and soft rocks, landslides are triggered off.

- **NATURE OF SOIL**
  Clay soils become slippery after absorbing rain water thus increasing in weight and lubrication hence leading to mudflows.

  Loose sandy soils are affected by increasing temperatures to creep.

  Crustal instabilities like earthquakes, tramours distabilize rocks and weathered materials leading to rock falls rock slides, rock slump e.t.c.

Over steepening of slopes by river erosion, may lead to rock falls, rock slump.

Overloading of slopes/over burdened by debris over a steep slope, triggers off mass wasting. Any disturbance of that region overloaded with rock debris either by stamping animals, thunder will distablize the debris and flow down slope under the influence of gravity in form of rockslides and rock falls e.g. in Kigezi highlands where buses and heavy trucks trigger off mass wasting.

Human activities like mining and quarrying, building and road construction lead to interference of land and vegetation cover e.g. excavation of large quantities of soils through mining which are left on slopes on mountains. These are set in motion by pounding of heavy rain and thunder thus sparking off rockslides, rock creep e.t.c.

Deforestation and overgrazing of animals on steep slopes or poor farming methods e.g. ploughing up and down a hill where vegetation is removed, soils are exposed and easily soaked with water thus causing mud flows, rockslides.

Also ploughing up and down a hill, sparks off soil creep, talus creep and rockslides.

Living organisms like burrowing animals, loosen the rocks and soils and the stamping action of big and heavy animals like elephants, cause vibrations which lead to mud flows, soil creep, rock creep e.g. in mountain Rwenzori National park due to the disturbing of the unconsolidated rock materials.

Heavy moving objects like Lorries, machines, trains cause vibrations that trigger off rock falls.

5.4 EFFECTS OF MASS WASTING

Negative effects:

- It leads to lose of fertile top soils which adversely affects agriculture e.g. in Bududa, Bulcheko, Bubulo, Bujimanai, Kigezi highlands, Rwampala hills in Mbarara.
- Destruction of life and property e.g. crops, settlement, agricultural land e.g. in Bududa in 2010.
- Destruction of infrastructure like roads, railway e.g. Kapchorwa-Bukwo road, Bugamba road, Fortportal Bundibugyo road.
- Destruction of forests / catchment areas.

- Damming of rivers which may result into back ponding to form temporary water reserves or S. Rivers e.g. R. Bujuku on mountain Rwenzori, L. Mbaka in southern Tanzania. These are breeding grounds for mosquitoes which cause disease.
- Displacement of people and resettlement.
- Lead to …sed government expenditure as it tries to resettle the displaced people.

Positive effects:-
- It exposes fresh rocks to weathering thus facilitating soil formation.
- It leads to the formation of landforms e.g. terracettees, scars e.g. on mountain Rwenzori and Kilimanjaro which promote tourism.
- It creates fertile soils on lower slopes of hills by solifluction, soil creeps e.g. in Kigezi highlands where it facilitates agriculture.
- Promotes research and study for students of higher institutions of learning e.g. Rwenzori, Kigezi highlands.
- Encourages mining as it exposes minerals due to mud flows. This makes easy the process of mining e.g. in Kyamuhunga (Bushenyi gold is often exposed by landslides).
- Mud flows also fill pits and depressions left after mining e.g. in Bushenyi, pits left after tin mining are being filled up by mud flows. Such pits could be mosquito breeding grounds or could be dangerous to man, livestock.

5.5 MEASURES TO CONTROL MASS WASTING
- Afforestation has been done by NFA in areas prone to mass wasting e.g. Kigezi.
- NEMA is conducting education services to people in areas prone to mass wasting like in Mbale and Kigezi the causes and control measures of landslides e.g. people are discouraged from cutting trees.
- Soil conservation measures have been adopted in hilly areas to control mud flows and soil creep.
- When roads are constructed in hilly areas like Kigezi, civil engineering is emphasing reducing the steepness of the slopes near road sides by excavating them at an oblique angle.
- Grasses are also planted.
- Settlements along steep slopes are being discouraged.
- Quarrying and mining are being done following safety provision stipulated by NEMA. As a condition for Quarrying to take place NEMA has to access the impact of the process on the environment e.g. pits and depressions after mining are supposed to be filled

1. Account for the causes of mass wasting in East Africa.

Approach to Qn.1:

- Define landslides.
- Identify areas where landslides occur e.g. Bududa.
- Identify and describe the rapid mass movement processes on
- Identify and explain the factors integrating the factors in as each case.

2. With reference to any one mountainous area in East Africa, account for the occurance of mass wating.

Qn:

- Identify the two forms of mass movement i.e. both rapid and slow, define them and describe the processes of each.
- Identify ONLY one mountainous area and then account for the occurrence of mass movements there.

3. To what extent are landslides of East Africa are result of physical factors.

6.0 DENUDATION

This is the external or exogenic process which involves lowering of the level of land by wearing it away or raising the level of land by deposition.

6.1 WEATHERING

This refers to the chemical decomposition and physical disintegration of rocks into small particles near or at the earth's surface in situ.

There are two major types of weathering i.e. chemical and physical weathering.

6.2 PHYSICAL / MECHANICAL WEATHERING

This is the breakdown of rocks into increasingly small fragments without changes in chemical composition of rocks in situ. It occurs due to temperature fluctuations heating and cooling, frost action and due to the influence of plants and animals (biotic factors)

PHYSICAL WEATHERING PROCESSES

Block disintegration

This is a process where rocks are broken into small blocks known as block disintegration. This process is common in semi-arid and arid areas, dry cloud less regions with a very high marked diurnal range of temperature due to direct heating during day and rapid cooling at night. The rocks successively expands and contracts and soften to enlarge joints in rock masses which ultimately break into small blocks called block disintegrations.

This process is very common in well jointed rocks and leads to the breakdown of rocks into large re-glangular shaped blocks e.g. exposed plutonic rocks e.g. granite.

It also common in areas with heterogeneous rocks. This type of rock disintegration results into the formation of landforms like granitic tors and inselbeSrgs. It's common in Kumi, Kachumbala, Mubende tors, Bismark rock in Mwanza Tanzania.

Exfoliation
In some rocks, the surface can be so intensively heated that it expands more rapidly than the underlying rock layers. Suddenly, cooling may occur during showers such that the upper surface layers peel off from the cooler interior. This process is called exfoliation and it leaves new rock layers exposed to the surface. It results into the formation of features known as exfoliation domes which are common in Soroti, Kumi, Lira, Kitgum, and Serengeti with exposed granites.

Freeze and Thaw (Frost Action)
This is caused by water being converted into ice where temperature fall below freezing point on higher mountains of East Africa e.g. Kenya, Rwenzori. When water fills the cracks within the rock at night and such a volume increases at a rate of 10% as it freezes, this increasing volume, exerts pressure on the sides of the cracks and these widened cracks and deepen causing the rock to weather.

Pressure release (Offloading)
This occurs when the rock masses have been exposed by the removal of the overlying rock debris by denudation. The gradual release of pressure (unloading) causes the rocks especially granites to expand and joints and cracks develop within the rocks. Surface layers begin to peel off like in exfoliation.

Alternatively, rain water begins to penetrate into these joints and cracks and chemical weathering proceeds. It's common on emerging granites of Panyok in Apac, between Mwanza and Iringa, Serengeti and Rukwa region.

Salt crystal growth (Crystallization)
This occurs when some rocks absorb salty water which later collects in rock cavities and pores. The water may later begin to evaporate and hence salt crystals will begin to evaporate and hence salt crystals will begin to grow bigger. As these crystals grow bigger and expand in size, they exert pressure on the surrounding particles hence making them peel off. It is a common process in arid and coastal areas of East Africa.

It's also occurring around L. Katwe, L. Nyamunuka and L. Kasenyi in Queen Elizabeth National park, around L. Magadi and Natron which are salty lakes.

Aridity shrinkage

This occurs when some rocks like clay and shale absorb a lot of water during rainy seasons and increase in size. But when aridity / drought succeed a rainy season, the rocks give off all the moisture they previously absorbed. This creates stress and strain in the rocks which makes them crack extensively. This is what is called weathering.

ORGANIC PHYSICAL WEATHERING

It occurs due to the effect of plant and animal life. The physical disintegration effect of vegetation is mainly due to the penetrating and expanding, power at the tree roots which exert a considerable force as they grow, leading to rock break up.

Animals also help in the excavation of particularly weathered fragments of rocks and also in burrowing / breaking the rocks e.g. rabbits, pigs, squirrels.

Granular disintegration

This form of weathering operate on rocks with differing minerals e.g. granite rocks which consist of quartz, feldspar which are colored differently and therefore have different capacities of absorbing heat. Such rocks disintegrate into small rock particles called granules e.g. in Mubende, Turkana.
It's common in areas with heterogeneous rocks which contract and expands at different periods when exposed to solar radiations. This reaction creates stress within the rock, making it break down into smaller particles.

6.3 CHEMICAL WEATHERING

This is the decomposition / decaying / rolling of rocks in situ at or near the earth's surface leading to a complete change in the mineral composition of the rock. It occurs as a result of heavy /adequate rainfall, high humidity that provide water to act as a medium of chemical reactions and hot temperatures to accelerate the rate of chemical reactions and certain atmospheric gases like oxygen. In chemical weathering there is a change in the chemical composition of the rock e.g. new compounds are formed. It's common in the humid areas with high temperatures and heavy rainfall. This is because all chemical reactions / processes must operate with a medium of water and hot temperature that help to speed up reactions.

PROCESSES OF CHEMICAL WEATHERING

Combination

This is a process of chemical weathering which dissolves the atmospheric gases to form a weak carbonic acid solution. This carbonic acid then dissolves and decomposes carbonate rocks especially limestone changing them to bi-carbonates solutions which are unstable.

This process is dominant in areas which contain calcium carbonate e.g. chalk and limestone areas where rocks are well joined. It's influenced by the presence of water and hot temperature. Rocks form grooves called grikes separated by flat topped ridges called clints. It may also form karst scenery composed of features like stalagmites, stalactites, pillars and caves e.g. at Nyakashura and Tanga.

Oxidation

This is a chemical weathering process which involves addition of oxygen to rock minerals. Oxidation of minerals mainly occurs in association with water which atmospheric oxygen has dissolved. This is a weathering process where rocks containing iron compounds come into contact with water to form iron rust. This causes decay and decomposition of rocks leading to rock shuttering. It's common in areas with laterites with a high composition of iron. Also silicates when combined with oxygen, they are converted to clay, aluminium and iron compounds.

Hydrolysis

This takes place when the rock absorbs water permanently. It involves a reaction between hydrogen ions and mineral elements. It's a major process in the decomposition of felespers. These break down to form potassium hydroxide and alminisilic acids.

It leads to the dissolution of rock structure and common in areas of igneous rocks.

Hydration

This is a process where rocks absorb water and expand, causing internal stress and ultimately decompose.

Mica rocks found in the hot wet regions of L. Victoria basin absorb water and decomposes to residual materials.

Solution

This involves the dissolving of soluble rocks by water. The soluble rock materials are removed in a solution leaving holes called sink holes in limestone areas and in areas with rock salt e.g. L. Katwe along the eastern coast and Nyakasura.

Once evaporation occurs, many will turn back to their original form.

Reduction
A process which is a characteristic of water logged swampy soils where the amount of oxygen ions are removed and hydrogen ions are added.

In these water logged areas, spaces in the rocks are filled with stagnant water and therefore the rock becomes deoxygenated hence the reddish ferric compounds are chemically reduced or given away to a grey blue of ferrous oxide. This is why clay soils in swampy areas have a grey colour. Whenever such soils are exposed to dry ground, reddish colour appears to the surface because the ferrous oxide has been oxidized to form rust / ferric oxide called Hematite.

Reduction occurs in all swampy areas like Kajjansi, Pangani and Tana.

Chelation
This involves base exchanges between plants and rocks which cause changes from either side e.g. plants secrete a fluid through their roots which reacts and causes rock disintegration. This partly explains why plants can grow on rocks.

On the other hand, plants absorb mineral salts from the rocks necessary for their growth which at the same time secrete fluids in the rocks. This changes the composition of the rocks leading to disintegration. This is common in forested areas and savannah woodland areas e.g. Limu, Morongole in Karamoja and Miombo and forested areas of East Africa.

SPHEROIDAL WEATHERING
This process is common in areas which receive heavy rainfall e.g. L. Victoria basin. Once it rains, the upper / outer layers of the soil absorb a lot of water and expand. The water reacts with rock minerals and eventually the upper layer peels away from the major rock. Thus rock disintegration.

6.4 FACTORS INFLUENCING THE RATE AND NATURE OF WEATHERING

Qn. To what extent does the rate and nature depend on climate?

Approach:
- Define weathering
- Types of weathering, description and processes

- Make a stand point (extent)
- Role of climate
- Show the role of other factors

N.B: Integrate the processes affected as you explain the factors.

Climate. This affects the entire importance of different types of weathering. Variations in climate lead to different rates and types /nature of weathering directly and indirectly through its elements of rainfall, temperature in different climatic conditions.

(i) Equatorial climate

- These are characterized by double maxima rainfall.
- Heavy rainfall of about 1500 mm.
- Evenly distributed rainfall throughout the year.
- Hot temperature of over 20°C – 30°C.
- Small diurnal range of temperature.

Such areas include, L. Victoria basin, East African coast, such areas therefore are dominated by chemical weathering process of oxidation, solution, chelation.

However physical weathering is limited due to a small temperature range and areas being wet all the time.

(ii) Tropical / Savannah climate.

- It's characterized by a wet and dry season which alternate.
- Hot temperature between 20°C – 30°C.
- Great diurnal range of temperature during dry seasons of about 10°C.
- Moderate rainfall of between 760mm – 1000mm.
- Less rainfall reliability.
- Moderate humidity of 50/.

Such conditions affect both physical and chemical weathering processes in wet and dry season.

Physical is common during the dry season when rainfall is little and high temperature with hot temperature promoting aridity shrinkage, exfoliation, block disintegration.

Chemical weathering dominates in the wet seasons because of heavy rainfall leading to hydration, reduction, solution. It's common in the northern Uganda, south western Uganda, Luweero, Bunyoro and western Kenya.

(iii) Semi-arid and Arid climate. Characterized by;

- Row rainfall totals of less than 500mm per year.
- Unevenly distributed rainfall.
- Very hot temperature of over 35°C.
- High diurnal range of temperature of 10°C on average.
- Less or no cloud cover
- Low humidity of less than 20%
- Have no definite wet season.

They promote the effectiveness of physical weathering. During the day, temperatures are very hot causing rock expansion and at night temperature are very cold causing rock contraction. This weakens the rock and finally breaks down through processes of block disintegration e.g. in Karamoja, Ankole, Masaka corridor.

In semi-arid areas of East Africa, limited chemical weathering also occurs due to the night dews, occasional rainfall and through capillary action with high evaporation rate taking place on the surface.

(iv) Montane climate

In these areas, cool temperature below 10°C occur. Small temperature ranges, snow limited rainfall e.g. on mountain tops of Rwenzori, Kenya, lead to dominance of physical weathering by frost action.

Chemical weathering is however limited due to absence of water, cool temperature and absence of living organisms to encourage chemical weathering.

(v) Nature of the parent rock

This influences weathering in the following;-

(1) Mineralogical composition of the rock

Different rocks are made up of different minerals and will be affected by weathering differently e.g. rocks like limestone with calcium carbonate react with carbonic acid due to rain water combining with carbondioxide to produce calcium bi-carbonates. A process known as carbonation e.g. Nyakashura.

Some rocks have minerals like Felsper which when mixed with water decompose to form other minerals e.g. potassium carbonate through the process of hydrolysis.

Some rocks have mineral components which react to form new components with water through oxidation e.g. ferrous rocks are turned into brown/red compounds.

Some rocks easily dissolve in water and the solution is carried away leading to decomposition of the rocks.

Some rocks absorb water and expand causing a change in the nature of the rock through hydration e.g. mica.

Igneous rocks and metamorphic rocks are highly weathered and at a faster rate because they are formed under high temperature very different from those on the surface.

Quarantic rocks can only be weathered mechanically even if they are in the tropical regions.

Sedimentary rocks on the other hand are more stable than igneous and more vulnerable to physical weathering.

(2) Rock jointing

Highly jointed rocks like limestone increase the surface area and accessibility of water for chemical reactions to decompose the rocks through carbonation, solution.

Physical weathering process of freeze and thaw is facilitated by cracks or joints on the earth's surface.

Cracks also facilitate plant root growth which sparks off both physical and chemical weathering. When plant roots decay, they leave behind holes where water collects hence chemical weathering processes.

Poorly joined rocks like quartz resist all forms of weathering but can allow exfoliation.

(3) Rock permeability

Permeable rocks allow water to penetrate and weather the rock through carbonation, solution.

On the other hand, impermeable rocks allow water surface run off at a high rate and therefore hunt chemical weathering.

(4) Rock hardness

Soft rocks are easily weathered through the process of carbonation, hydration while hard rocks like quartz are more resistant to weathering and resist all forms of weathering.

(5) Rock color

Dark colored rocks like gabbro, basalt, are weathered much faster than light colored ones through physical weathering like exfoliation at a high rate because they absorb more heat.

While light colored rocks like quartz tend to reflect heat and therefore heat up more slowly and hence take long to be weathered.

(6) Rock solubility

Soluble rocks like rock salt and limestone are more dissolved in water and are removed from a solution which accelerate the rate of chemical weathering.

(7) Rock pH

Acidic rocks are more resistant to chemical weathering but easily weathered by physical weathering because they are hard.

Basic alkaline rocks on the other hand are easily weathered chemically because they are easily dissolved.

Relief

Steep slopes experience a lot of surface run off, causing rapid removal of weathered materials and the exposure of the parent rock to be weathered.

Physical weathering through exfoliation dominate.

Also erosion on the steep slopes exposes the rocks to chemical weathering process but on a minimal scale.

Gentle slopes and low laying areas increase the rate of weathering through solution, hydration because they allow water percolation and accumulation.

Valleys on the other hand reduce the rates of weathering because of much deposition and poor drainage and low temperatures, such conditions slow down chemical and physical weathering.

Mountain tops e.g. Kenya, Rwenzori, are characterized by cold temperatures are covered by snow. This makes physical weathering process of frost action, dominate and limit chemical weathering.

Drainage

Leaching occurs on flat lands because of poor drainage. This dissolves rock minerals and are taken in a solution to deeper layers of the soil.

Poorly drained areas like floodplains are dominated by chemical weathering process of reduction, solution, hydration which helps in decomposing rocks.

Living organism

(i) Vegetation.

Produces humic acids that assist in rock decomposition through hydration hydrolysis.

Plant roots …. Release mineral substances into rocks while extracting other mineral substances from the rock, a process known as chelation.

Vegetation roots leads physical weathering of the rocks in the cracks due to the pressure as they grow leading organic physical weathering.

(ii) Living organisms secrete acids that chemically decompose the rock like uric acid.

Holes dug by burrowing animals e.g. moles, rats, pigs e.t.c. aid water to collect in the loosened rock materials to chemically weather the rocks through solution, carbonation.

(iii) Man's influence

Man may influence chemical weathering through emmition of industrial gases increasing acidity in rain water which accelerates the rate of chemical weathering process in limestone rocks.

Mining, quarrying and agriculture expose the underlying rocks to chemical weathering processes.

Irrigation avails water that increases chemical weathering through carbonation.

Time

It takes time for a rock to undergo chemical and physical weathering.

The longer the time, the longer the rock is weathered chemically.

The shorter the time, the lower the rock is weathered chemically.

1. Account for the dominance of chemical weathering in East Africa.
2. Account for the dominance of physical weathering in East Africa.

6.5 INFLUENCE OF WEATHERING ON LAND FORM DEVELOPMENT IN EAST AFRICA

LANDFORMS RESULTING FROM PHYSICAL WEATHERING

INSELBERGS

These are remnant hills formed by weathering and erosion of the surface leaving behind hard resistant granitic rocks which stand prominently high above the earth's surface e.g. Mubende hills, Nakasongola hills, labwor hills in Acholi.

TYPES OF INSELBERGS

Granitic tors. These are pillars of ridges of rounded weathered bolders produced by the weathering of jointed rocks by block disintegration usually granitic rocks.

They are produced / formed when there is both horizontal and vertical joints in a rock such that disintegration is both vertical and horizontal e.g. Kachumbara rock in Kumi, Mubende, Bismarck rock in Mwanza and Kalegeya rock in Ntungamo, Ngetta in Lira and Kageri in Nakasongola.

Diagram:

Castle Kopje

These are types of inselbergs which are formed when they are only vertical joints within an exposed rock such that rock disintegration is only vertile e.g. Mubende, Nakasongola, Kumi areas.

Diagram

Born Hardts

These are types of inselbergs which are normally smooth and unjointed. When the granitic rock is exposed onto the earth's surface when it is very hard and is massively subjected to intensive cooling and heating, it does not develop any cracks whats ever.

Diagram:

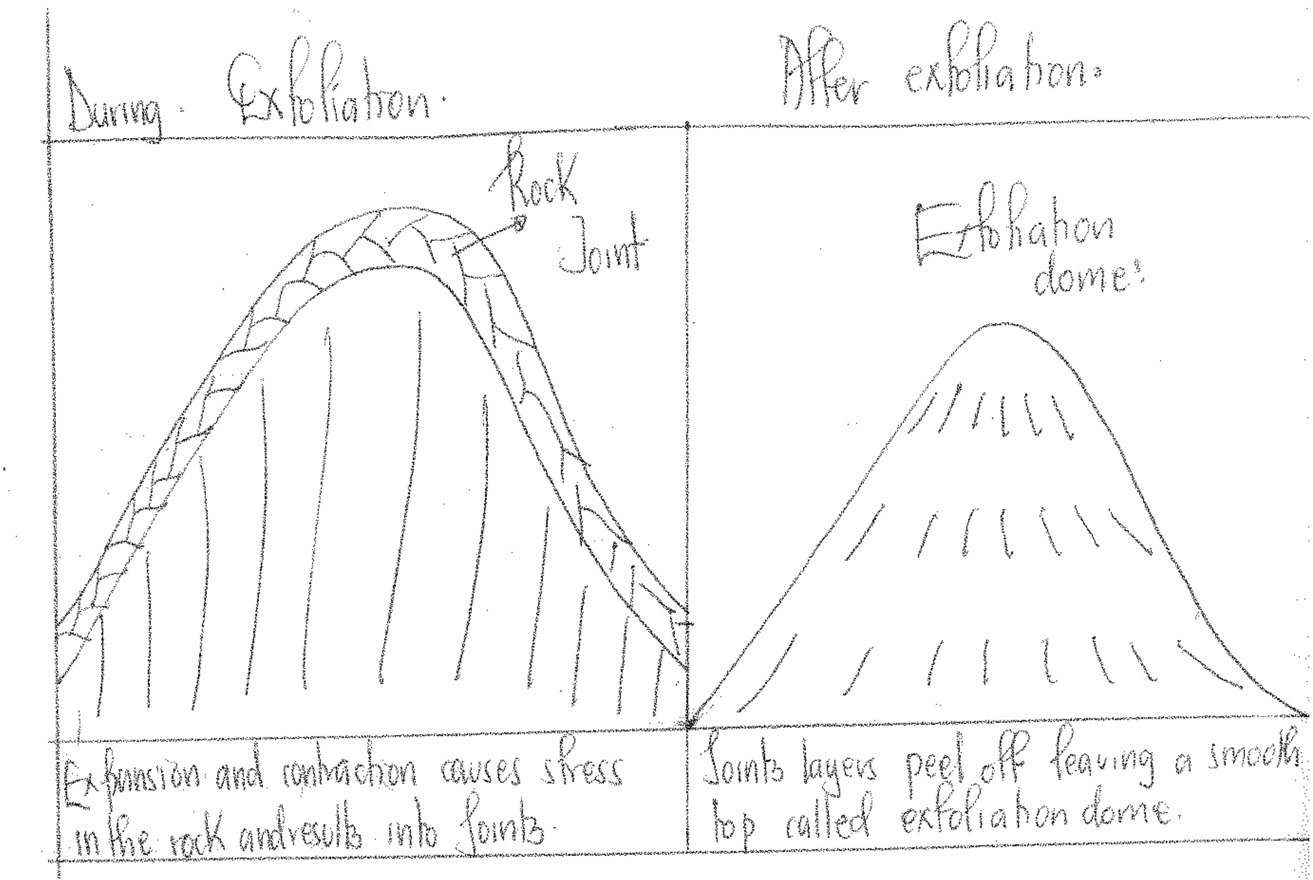
Exfoliation domes

These are smooth and round topped hills found in regions that experience great heating of the sun during the day and rapid cooling at night. This result into the top layer peeling off inform of screes leaving the dome-shaped structure.

Examples of exfoliation domes are common in areas with exposed granites e.g. Mubende, Nakasongola, Soroti, Kumi, lira, Kitgum e.t.c.

Diagram:

Before exfoliation After exfoliation

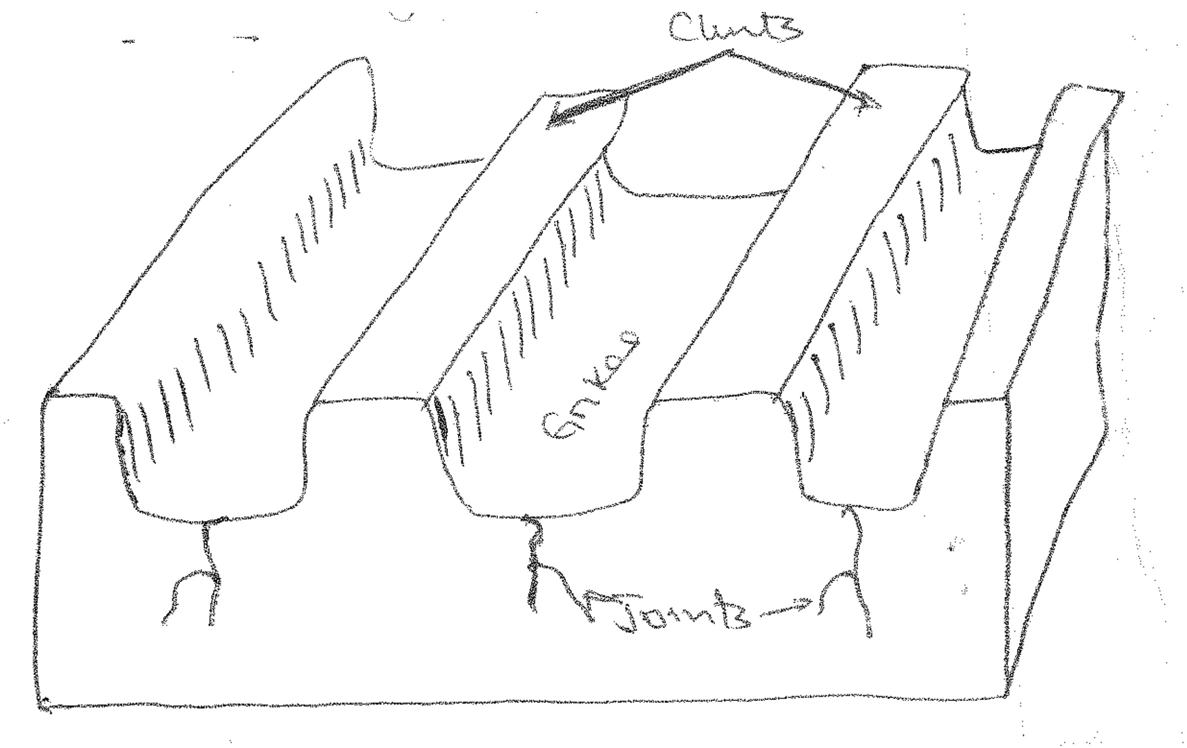


LAND FORMS RESULTING FROM CHEMICAL WEATHERING

1. **Grikes and clints**

   Grikes are deep narrow grooves / trenches in a limestone area.

   They are formed as a result of chemical weathering especially carbonation weathering down the surface of these rocks in the elongated cracks / joints. They are formed when carbonic acid enters the permeable jointed limestone rocks and the joints are attacked and some rock particles dissolved away by carbonation. This expands the joints and open up inform of valleys / trenches called Grikes. While the limestone rocks which are not affected by weathering and remain standing up between the adjacent Grikes, become ribs called dints. Examples can be seen at Mweya Peninsular in Queen Elizabeth National Park, Sukuru hills in Tororo, Wazo hills in Tanzania and Kambe Kilifi in Kenya.



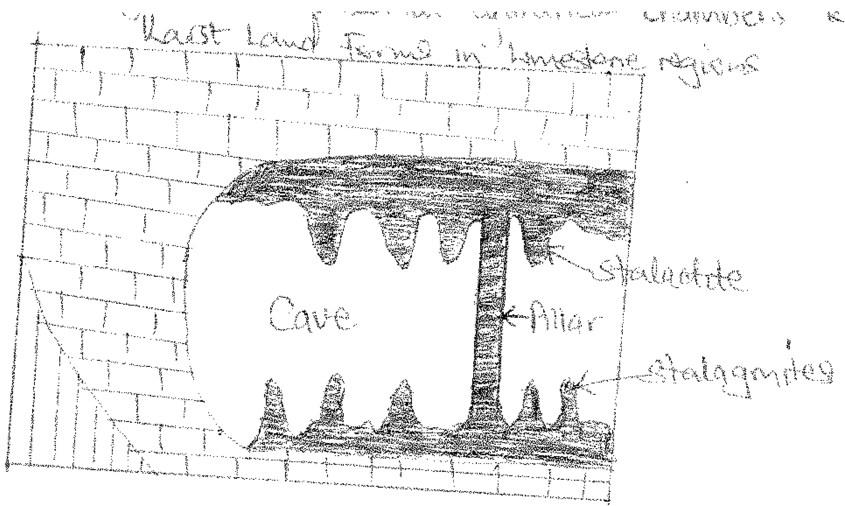
2. Karst landforms

These are landforms which form in limestone areas. They include;-

(a) Caves.

These are horizontal cylindrical chambers in a limestone region. They are formed as a result of rainwater or underground streams, dissolving limestone underneath and washing it away in a solution form, leaving behind horizontal cylindrical chambers known as caves.

Diagram:



(b) Stalactites.

These are finger like protrusions/projections of solidified calcium carbonate on the roof of a chemically weathered limestone cave. It is formed when water enters a limestone rock (carbonic acid dissolved by rain water). It dissolves some of the materials turning it into a calcium bicarbonate solution which begins to leak through the roof of the cave. Later when water evaporates, it leaves behind hardened protrusions of the former leaking solution which hangs up on the roof of the cave called stalactites.

(c) Stalagmites

These are finger like protrusions of calcium carbonate on the floor of the limestone cave. They are formed from accumulation of the leaking calcium bi-carbonate solution and accumulate at the base and form finger like projections called stalagmites.

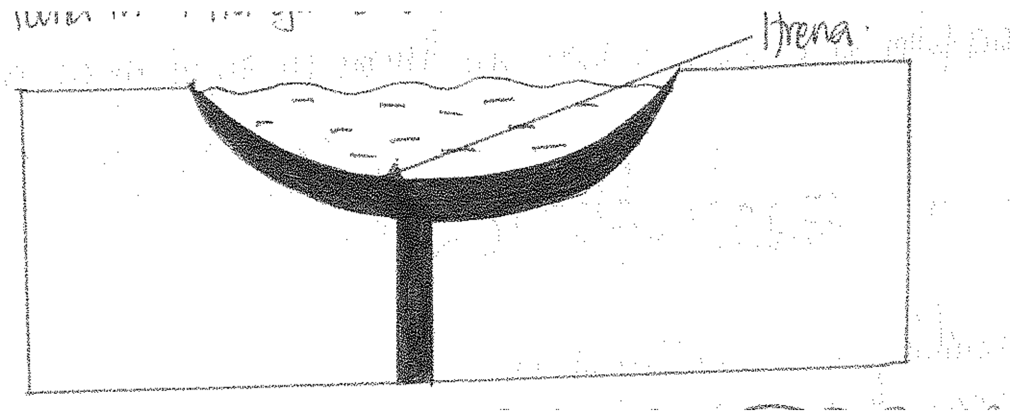
(d) Pillars

These are walls of solidified calcium carbonate connecting the roof cave to the cave base. They are formed when stalactites and stalagmites meet e.g. of stalagmites, stalactites, caves and pillars are found in Nyakasura where they are locally known as "Amabere ga Nyina Mwiru" along the eastern coast of Tanga, Nyanamira in Kisoro e.t.c

(e) Arena

An arena is a large sourcer shaped depressions on the earth's surface. They develop in areas with alternating portions of soft and hard rocks or rocks with different mineralogical composition e.g. rock salt is weathered in solution.

Limestone and doromite are decomposed by carbonation and removed leaving behind circular depressions called arenas.

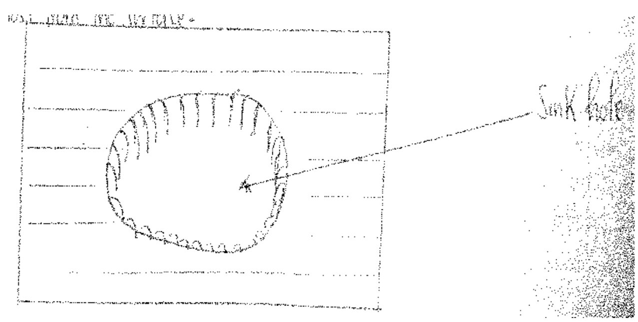


(f) Sink hole

These are deep holes with nearly vertical sides leading to the underground cave systems. They are formed as a result of surface collapse and surface dissolving of limestone, leaving behind deep holes that penetrate in the caves.

It's also found where a river disappears underground and where it reappears on the surface.

Diagram:

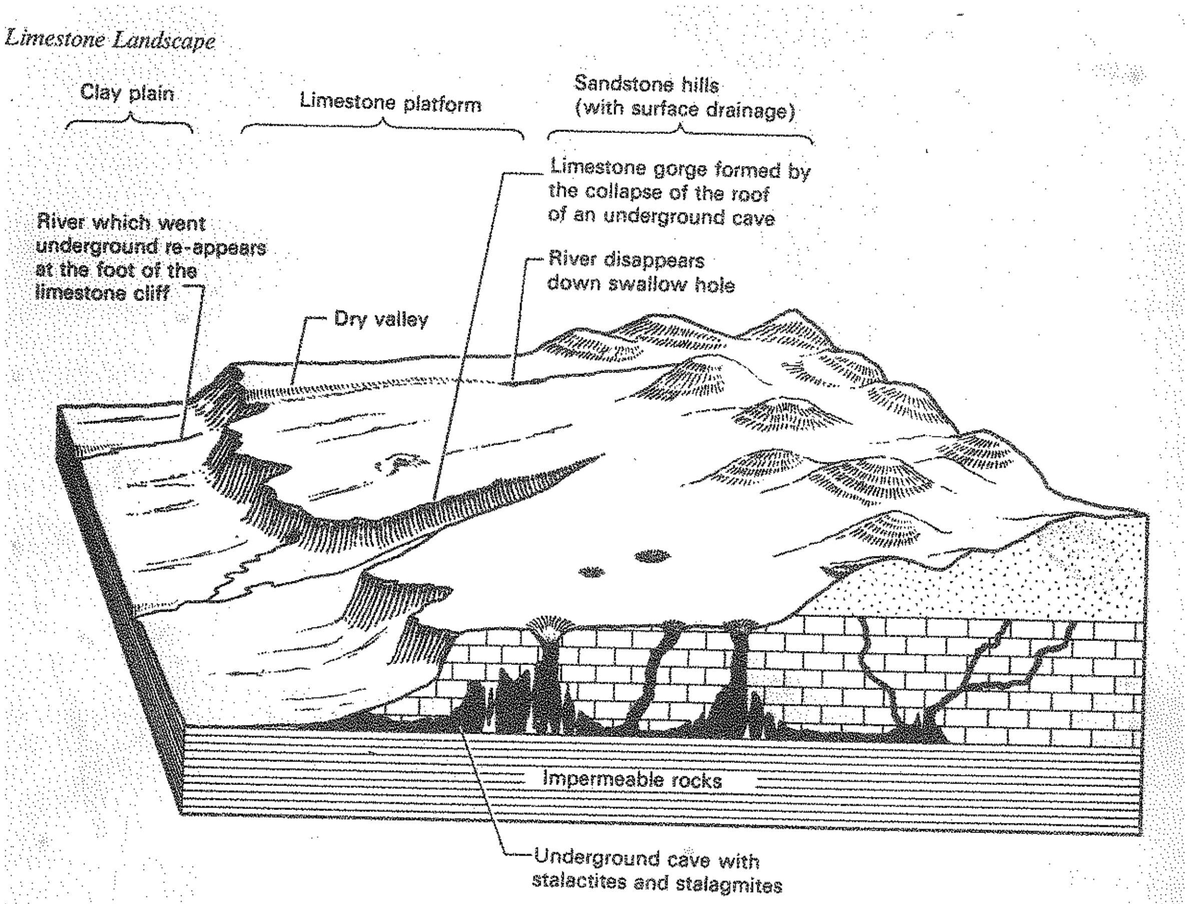


(g) Dolines

These are shallow depressions / holes with gently sloping sides and are circular in shape originating from carbonic acids percolating underground at the intersections of major joints, dissolving the rocks within the joints widening them. They are also formed when a large number of sink holes join as a result of carbonation and solution to form a large hollow known as a doline.

(h) Dry valleys

Rivers flowing from non-limestone regions may finally reach limestone rocks region which are very permeable and may disappear underground, only to re-appear at the end of the dimestone rock. The area between the points where the river appears and re-appears on the surface is what is called a dry valley.



LIMESTONE GORGES AND WATERFALL

A limestone gorge is a deep narrow steep sided river valley produced when the roof of the cave collapses e.g. of Nyakashura. At the same point normally limestone waterfalls develop at the same point.

Q1. Examine the influence of weathering on land form development in East Africa.

Q2. Account for the formation of landforms resulting from carbonation.

Approach;

- Define carbonation
- Explain the resultant landforms and how they are formed.

7.0 MAPWORK AND PHOTOGRAPHIC INTERPRETATION

Map reading is a science that deals with the reading of maps and the ability to interpret the geographical phenomena on a map.

7.1 LOCATING FEATURES ON THE MAP EXTRACT

Features on the map can be located using 3 methods namely;

- Use of place names,
- Grid reference and
- Use of latitudes and longitudes

Use of place names

This method / skill involves looking for the name of a geographical feature / phenomena.

Use of Grid references to locate features

We use a formular E.N when locating features where each stands for eastings and north for northings.

Illustration:

Locating features using latitudes and longitudes on a map

(a) Determining hemisphere on a map.

Look for the latitude figures on a map and determine the direction in which they are increasing . If they are increasing northwards, then the place is located in the northern hemisphere and if they are increasing southwards then the place is located in the southern hemisphere.

Then write your answer considering the latitude figures and the direction in which they are increasing as evidence.

Eg Apoka is located in the northern hemisphere because of the presence of the latitude lines increasing northwards.

Describing location of the area shown on a map

Describe the location of Apoka.

- Use both latitudes and longitudes

Apoka is located between latitude 3^o35^1 and 3^o45 north of the equator and longitude 33^o40 and 33^o45 east of the Greenwich.

Locating places using bearing on a map

What is the bearing of Martha from Phionah?

- Locate the two points.
- Draw a straight line linking the two places
- Draw a compass at the point which is at "from"
- Then use a protractor to determine the bearing.
- Write the bearing with 3 figures
- Include the direction.

Q1. What is the bearing of Geremech trigonometrical station from Kareki hill?

196^o

7.2 CALCULATING SKILLS

E.g. Calculating:
- Distance
- Area
- Height of hill
- Amplitude
- Horizontal equivalent
- Gradient of the slope of a curve
- Trend
- De'tour index
- Vertical interval

(i) Calculating the vertical interval on the map

VI = Difference between two close contours

= 4500 – 4450

= 50ft

(ii) Amplitude

Amplitude = Highest point – Lowest point

(Look for the highest trigonometrical station and highest contour)

Amplitude = 5528ft – 2250ft

= 3278ft

(iii) Height of the hill

Height of hill = last numbered contour + VI $\times$ No. of unnumbered contours

= 3400 $\times$ 4150

= 3400 + (50 $\times$ 4)

= 3400 + 200

= 3600 ft

(iv) Distance

Establishing distance along a curve

Procedure:-

- Locate the curve whose distance you are asked to establish.
- Mark the two points between which you are to establish the distance.
- Get a thread, mark the beginning point of the thread, place the thread on the curve on the beginning point and go on stretching it along the curve upto the end and mark the end point on the thread.
- Transfer the thread on the measuring scale and establish the distance in kilometres.
- Establish the distance covered by the dry weather road.

= 8km

(v) Area

Area = No. of full squares + $\frac{\text{No.of half squares}}{2}$

Calculate the area, east of the dry weather road

Full squares = 3

Half squares = $\frac{16}{2} = 8$

Area = 3 + 8

= 11 squares

Since area = 11 squares

Where 1 square = $1km^2$

Hence Area = $11sq \times 1km^2$

Thus area = $11sq\ km^2$

(vi) Horizontal equivalent

Horizontal equivalent = $\frac{\text{Horizontal distance} \times \text{horizontal scale}}{100{,}000}$

Procedure:

- Locate the curve and mark the two points between which you are asked to calculate the horizontal equivalent.
- Get a thread and place it along the two points
- Establish that distance on a curve by placing it on a ruler in cm.
- Substitute that horizontal distance in the formula
- Horizontal equivalent = $\frac{(16cm \times 50{,}000)}{100{,}000}cm$

  = 8km

(vii) Gradient of the slope of the curve

Gradient of the slope of the curve = $\frac{\text{Horizontal equivalent} \times 1000}{\text{Amplitude}}$

Procedure:

- Locate the curve whose gradient of the slope you are to calculate.
- Mark the two points.
- Place a thread along the curve between the two points marked
- Transfer the thread on the scale and establish the equivalent (distance in km0 and substitute it in the method.

- Then for amplitude get the highest and lowest contours that cross the curve between the two points on the curve, get their difference and substitute in the method, then calculate the gradient of the slope of the curve.

Gradient of the slope of the curve $= \frac{Horizontal\ equivalent \times 100}{Amplitude}$

$$= \left(\frac{8km \times 100}{200\ ft \times 30}\right)$$

$$= \frac{4}{3}$$

$$= \underline{\underline{1.3}}$$

(viii) Trend

Calculating / determine the curve.
i.e. Calculate the trend of R. Athieno between the two confluences.

Procedure:

- Locate the curve (R. Athieno)
- Mark the two points on the curve.
- Draw a straight line linking the two points.
- Determine the mid-point of the straight line.
- Draw a compass at the mid-point.
- Use the protractor to measure the two angles.
- Also determine the direction.

Diagram:

<u>075° North East – 255° south west</u>

(i) Determine the trend of Kyaka county boundary.

Trend of Kyaka county boundary = <u>090° NE – 270° SW</u>

(ix) D'tour index

Calculating D'tour index along the curve e.g. calculate the D'tour index of the dry weather road.

Procedure:

- Locate the curve.
- Mark the two points given or the end points of the curve if no points are given.
- Draw a straight line to join the two points or end points.
- Measure the distance of the curve and the straight line and substitute them into the formula/method.

D'tour index

$$\frac{\text{Actual distance (distnance on the curve)} - \text{Distance on straight line}}{\text{Actual distance}} \times 100$$

$$= \frac{48 - 28km}{48} \times 100$$

$$= \frac{20km}{48} \times 100$$

$= \underline{41.7\%}$

7.3 SKETCHING SKILLS

(i) Drawing of sketch maps

(a) Map reduction

- Using a reduction factor.
- Reduce the map of Mpara by 2½ times and draw a sketchmap and on it mark and name physiographic regions, land use activities, drainage features.
- Measure the length and width.
- Divide the length and width by the reduction factor.
- Draw a new frame using the new length and width obtained.
- Mark and label the features asked on the sketchmap "itself"

Length = $\frac{32.8}{2.5} = 13.12cm$, Width = $\frac{30.7}{2.5} = 12.28cm$

A REDUCED SKETCHMAP OF MPARA SHOWING PHYSICAL AND MANMADE FEATURES

Calculating a new scale for the reduce sketchmap

New scale = Original scale × Reduction of factor

New scale = 1:50,000 × 2.5

New scale = 1:125,000

MAP REDUCTION USING A NEW SCALE

Given the new scale, 1:200.000, draw a sketch map of Mpara and on it mark and name the physical and manmade features.

Procedure:

- Compare the original and new scale.
- If the new scale is bigger than the original then you are being asked to reduce the map.
- Then 1st find the reduction factor.

$$\text{Reduction factor} = \frac{\text{Original scale}}{\text{New scale}}$$

$$= \frac{1}{50,000} \div \frac{1}{200,000}$$

$$= \frac{1}{50,000} \times \frac{200,000}{1}$$

$$= \underline{\ 4 \text{ times}\ }$$

- Then measure the length and width of the frame and divide them by the reduction factor obtained, then draw a new frame using the new length and width calculated.
- Include all the marginal information.

MAP REDUCTION USING A PERCENTAGE

Qn. Reduce the map of Mpara by 40% and draw a sketchmap and on it mark and name physical and man-made features.

- Measure the length and width of the frame and multiply them by the given percentage e.g.

$$L = 32.8 \times \frac{40}{100} = \underline{13.12\ cm}$$

$$W = 30.7 \times \frac{40}{100} = \underline{12.28cm}$$

MAP REDUCTION GIVEN NORTHING

Draw a sketchmap of Mpara and on it mark and name.

Procedure:

- Determine the shape of the frame and draw a similar frame either rectangular or square form.

N.B: your frame should cover atleast half of the page.

A sketch map of Mpara showing physical and manmade features given nothing.

MAP ENLARGEMENT

(a) Using an enlargement factor

- Enlarge the area east of easting 75° and south of northing 42 by 3 times and draw a sketch map and on it mark and name physical and manmade features.
- Locate the given area.

- Measure the length and width of the area.
- Multiply the length and width with the enlargement factor.
- Draw a new frame using the new width obtained.
- Mark and name the features.
- Include the marginal information.

Sketchmap of Mpara showing physical and manmade features of area east of easting 75° and south of northing 42 by 2 times.

(b) Calculating new scale for enlarged sketchmaps.

Qn. Given the new sale 1:25,000, draw a sketchmap of the area above and on it mark and name physical and manmade features.

Procedure:
- Compare the new and the original scale.
- If the new scale is smaller, then you are being asked to enlarge.
- Then calculate the enlargement factor.

$$\textbf{Enlargement factor} = \frac{New\ scale}{original\ scale}$$

$$= \frac{1}{25{,}000} \div \frac{1}{50{,}000}$$

$$= \frac{1}{25{,}\cancel{0}00} \times \frac{50{,}\cancel{0}00}{1} = 2$$

- Then multiply the length and width of the given area by the scale factor obtained ie 2 in this case.

(i) <u>A reduced sketchmap of Mpara showing physical and manmade feature.</u>

$$\text{Length} = \frac{32.7}{4} = \underline{8.1cm}$$

$$\text{Width} = \frac{30.6}{4} = \underline{7.7cm}$$

(ii) <u>A sketchmap of Mpara showing physical and manmade feature</u>

DRAWING A SKETCHMAP USING A TRACING PAPER

Procedure:

- Locate the area given on the map.
- Mark the area using stars.
- Place a tracing paper on the area marked.
- Mark the points marked on the map extract on a tracing paper.
- Trace the features asked and name them on the tracing paper.
- Draw a frame on the tracing paper joining the marked points.
- Draw a compass on the tracing paper.
- Number your work accordingly.

Qn. Using a tracing paper, draw a sketchmap of the area east of easting of 70 and south of northing 47 and on it mark and name relief features, drainage features, communication routes, settlement and vegetation type.

Drawing of cross-sections / line transact / Relief sections / Transverse

Procedure:

- Locate the area between which you are being asked to draw a cross-section.
- Mark the area.
- Draw a straight line linking the two points,if the area does not lie along a straight line.
- Place a straight edge of paper on the straight line and mark the area.
- Mark and write the contours that cross the straight edge of paper.
- Mark the features asked on the straight edge of paper.
- Transfer the edge of the paper on a scale and determine the distance of the two points.
- Transfer the straight edge of paper to the graph paper.
- Draw the vertical lines at the points marked.
- Scale the vertical line which should not exceed 6cm.
- Plot the contour values marked on the straight edge of paper.
- Join the dots using a curve with a free hand.
- Shade the area below the curve.
- Plot / Mark and name the features asked / plotted on the straight edge of paper.
- Write a title.
- Number your work.

E.g. Draw a transverse section along northing 50 between eastings 70 and 77 and on it mark and name;

- Two geomorphological regions.
- Two drainage features.
- Vegetation type.

- Communication line and boundary

CALCULATIONS ON A CROSS SECTION

VI = Difference between two closest points on a cross section.

Amplitude = HP – lP

= 4900 – 3800

= 1100

Gradient of the slope $= \frac{\text{Horizontal Equivalent}}{\text{Amplitude}} \times 100$

Horizontal equivalent $= \frac{\text{Horizontal distance} \times \text{horizontal scale}}{100{,}000}$

Vertical exaggeration $= \frac{\textit{Vertical scale} \times (300 \textit{ or } 100) \textit{dependingon its used on the map}}{\textit{Horizontal scale}}$

$= \frac{1}{100 \times 30} \div \frac{1}{50{,}000}$

VE $= \frac{1}{3000} \times \frac{50{,}000}{1}$

$= \frac{50}{3}$

= 16.7

7.4 Description skills

(a) Relief

(i) Describe the relief of Mpara.
(ii) Describe the physiographic features of Mpara.
(iii) Describe the geomorphological set up of Mpara.
(iv) Describe the landscape of Mpara.

Diagrams:-

Mountainous areas / Highlands / uplands

Steep slopes

Gentle slopes

Low lands / flat lands

Ridges

Spurs

Conical hills

Dome shaped hill

Flat toped hill

Narrow valley

Broad valley

Low lands

Basins

- They are indicated by swamps and lakes

Isolated hills

Rugged relief

Escarpments / cliff

(b) Drainage

Drainage patterns

- Radial
- Centripetal
- Dendritic
- River meanders

(iii) Vegetation

✓ Use the key to describe the various vegetation types e.g. forests, scrubs.

Describe the vegetation of Mpara.

Presence of forests vegetation evidenced by forests in the north, central, south west of Mpara and south east of Mpara.

There is swampy vegetation evidenced by the papyrus swamps, marshes and bags in the north east, north, west and south east of Mpara around Kyegegwa boundary, east of Katonga hunting area.

There is thicket in the north and south east of Mpara as evidence.

Describing land use activities on a map.

- Settlement
- Roads
- Forestry / forest reserve
- Mining / quarrying
- Farm / plantation / Estate / Crop growing
- Fish farming
- Animal rearing
- Industries / factory
- NP and GR
- Hunting area.

- Trading centres / market / shops
- Landing sites.

Economic activities
- Transport due to roads, railways, ferry route, land site.
- Forestry, lumbering evidenced by forests (trees)
- Mining – Quarry evidenced by a quarry or mineral works
- Farming
- Fish farming – ponds, land sites
- Industrialization
- Tourism, NP, GR, lodge
- Hunting – hunting area
- Trade and commerce, roads, market, TC, dense settlements.
- Pastoralism / Ranching – Cattle dips, ranches

Describe the land use activities of Mpara
- There is a road evidenced by a dry weather road in the south east of Mpara.
- There is settlement evidenced by clustered settlement along a footpath at Kanyegenyege, Waliri in the south east of Mpara.
- There is forestry or forest reserve in Mpara evidenced by forests in the North West, south west and north east of Mpara.
- There is mining evidenced by several outcrops in the central part of Mpara.
- Presence of hunting area in the south west of Mpara evidenced by Katonga hunting area near the boundary of Kyaka and Kibale counties in the south west of Mpara.

Describe the economic activities on map Mpara.
- There is transport due to the presence of roads evidenced by a dry weather road in the south east of Mpara.
- There is hunting evidenced by Katonga hunting area in the south west of Mpara.
- There is forestry evidenced by forests in the north, south west and south of Mpara.
- There is mining evidenced by the outcrop rock in the central part of Mpara.

Describing settlements on a map.
- Dense settlement in Iringa.
- Moderate
- Scattered / few dispersed
- No, Nil, Absence of settlement.

Describe the settlement of Mpara.
- There is clustered settlement in the south west of Mpara at Rwahunga, Kanyegenyege evidenced by the present of foot paths.

- There is scattered settlement in the south west of Mpara at Bahura at Bulimga.
- There is no settlement in the west and south west of Mpara.

Describing settlement patterns.

1. Linear settlement pattern where settlements are found along road sides, river banks / sides.
   Diagram:

2. **Clustered / grouped settlement pattern**
   These are isolated but connected by foot path.
   Diagram:

Grid / planned settlement pattern

This is settlement where are centrally planned near developed transport routes health centres, education.

It is common in urban centres, plantations and prisons.

Diagram:

Scattered / Dispersed settlement pattern

This is a settlement pattern where settlements are widely spread. It is common in rural areas.

Diagram:

7.5 EXPLAINING RELATIONSHIPS ON A MAP

1. **Relief and Drainage**
   - Identification of the relationship.
     Lake Nabugabo occupies a basin in the central in the north.
   - Permanent swamps are confined in low lands in the East of Masindi.
   - Seasonal swamps are favoured by broad valley in the East, south west.
   - Low lands in the south east are poorly drained.
   - Broad valley in south east are poorly drained.
   - The basins in the south west are poorly drained.
   - Rivers flow from highlands to lowlands/high elevation to lowlands in south and west.

- Rivers flow through narrow valleys in the south east.
- Radial drainage pattern on Fumbyo hill.
- Centripetal drainage pattern is favoured by a basin in south west.
- Bore holes are confined to gentle slopes, low lands and broad valleys.
- Ponds are constructed in lowlands and broad valleys.

2. Relief and Vegetation
- Forests are found on gentle slopes in the North, south west.
- Forests are confined to low lands in the south.
- Papyrus swamps are found in low lands on the east.
- Papyrus swamps are confined to broad valley of the east.
- Crop vegetation is found on gentle slopes on Bojeje Estate.
- Scrubs are found on gentle slopes in the south, south west.
- Scattered trees are found in the low lands in the south east.

3. Drainage and vegetation
- Papyrus swamps, mangrove, trees swamp, marshes, bogbens are favoured by swamps and found in poorly drained areas.

Forests
Woodlands
Shrub and thicket
Scattered trees
Grass

grow/favoured by good drainage/well developed areas

Physical – Human relationships

(i) Communication and Relief
- Loose surface road is following gentle slopes
- Loose surface road is confined to low lands
- Dry weather road confined by the gentle slopes.
- Dry weather road confined by the gentle slopes
- Dry weather road confined by low lands
- Food path is found in:- Steep slopes
  - Gentle slopes
  - Low lands

Give reasons for each relationship

(ii) Communication and Drainage
- All communication roads e.g. air strips, dry weather road, air strips, loose surface roads are constructed in well drained areas.
- Poorly drained areas are covered by foot path.
- Roads cross rivers by use of culverts.

Give reasons in each case.

- Roads cross rivers by use of bridges.
- Lakes are crossed by use of ferry routes.
- Roads cross poorly drained areas by use of culverts.

(iii) Settlements and Relief
- Dense settlement are found in low lands.
- Gentle slopes

(iv) Scattered / Few settlements are found on:
- Steep slopes; these slopes have no settlements.
- Low lands have few/scattered settlement.
- Low lands have no settlements.

Give reason in each case.

(v) Settlement and Drainage
- Dense settlement is confined to well drained areas.
- No settlements in swamps.
- No settlements in poorly drained area.
- Lake shores attract a dense population at the landing sites.
- Rivers attract linear settlement.

Give reasons in each case.

7.6 PROBLEMS FACED BY THE AREA SHOWN ON A MAP EXTRACT.

NB: Problems are delivered from the nature of relief, vegetation, drainage and land use types or activities.

(a) Relief
Mountainous / steep slopes encourage soil erosion, landslides, hinder the development of roads, limit land for settlement and hinder agriculture mechanization.

(b) **Low lands** lead to flooding, hinder construction of roads especially the poorly drained low lands.

(c) **Forests.** Limit land for settlement, limit land for agriculture, pests and diseases, habour dangerous wild animals which attack man.

(d) **Swampy vegetation.** Lead to water borne diseases because of the snails that cause bilharzia.

(e) **Lakes and rivers** result into water borne diseases limit land for agriculture and settlement.

8.0 PHOTOGRAPHIC INTERPRETATION

8.1 Types of photographs

There are two types of photographs namely;
(a) Ground photographs,
(b) Aerial photographs

GROUND PHOTOGRAPHS

These are photographs taken with a ground dash camera. Ground photographs can be divided into two namely;

- Ground view photographs,
- Ground oblique photographs.

Ground view photograph are taken when the camera man stands directly infront of the feature and photographs it whereas ground oblique photograph is taken when a camera man stands on a raise ground e.g. cliff, tree, infront of it and photographs it.

CHARACTERISTICS OF GROUND PHOTOGRAPH

- The skyline/horizon is visible.
- The features in the fore ground are bigger than those in the background.
- Cover a smaller area.
- Features are clearer.

AERIAL PHOTOGRAPHS

These are photographs taken when the camera man is in an aeroplane / from above. They are categorized into two namely; Aerial vertical and aerial oblique.

Aerial vertical photographs are photos taken directly above the feature, when the camera is held at right angle. Only tops of the features are visible, no horizon visible.

Aerial oblique

Those are photographs taken when the plane approaches the feature and the camera man holds the camera at an acute angle and photographs the feature of interest. The feature may show more than one dimension and sky line may sometimes be visible.

GENERAL CHARACTERISTICS OF AERIAL PHOTOGRAPH

- Generally cover a wider area.
- Features are not clear.
- Features are not easy to interprete.
- Show only one dimension.

8.2 Drawing landscape sketch of the photograph/photo sketch / panoramic view of a photograph.

Procedure:-

- Draw a frame of the same size.
- Divide the photographs into grounds i.e. fore, middle and back ground and then divide them into sub-grounds as shown below.
- Draw the features in pictorial form only.
- Label the features on the sketch drawing only.
- Never include a compass because it's not a sketch map.

8.3 DESCRIBING FETURES ON A PHOTOGRAPH

Note: Refer to Map work but give evidence in form of grounds.

- Describing relationships on a photograph.
- Refer to map work but give evidence in terms of grounds.
- Problems faced on the photograph, refer to map work.

8.4 Area where the photograph was taken from;

- Area depends on the main theme shown on the photograph.
- Give the smallest unit / area possible.
- Avoid giving districts and regions.

Qn.1. Draw a landscape sketch of the area shown in the photograph and on it mark and label;

(i) Relief regions
(ii) Vegetation types

(iii) Drainage and land use activities

9.0 DRAINAGE PATTERNS

Drainage pattern refers to the physical lay out of a river and its tributaries on the earth's surface.

The main types of drainage patterns in East Africa are controlled by;-

- ✓ Slope of the land scape.
- ✓ Differences in rock hardness over which the river may be flowing.
- ✓ Structure of the rock as it may be determined by different geomorphic processes.
- ✓ Climatic factors and earth movements.

9.1 There are **two** bread groups of drainage patterns namely; ***accordant and discordant drainage patterns.***

Accordant drainage patterns is the one where the drainage is related to the structure of the rock eg dendritic, trellis, annular etc

While discordant is the drainage pattern which does not show any relationship between the river system and the structure of the rock and relief eg super-imposed drainage pattern.

The distinctive drainage patterns in East Africa include;

9.2 ACCORDANT DRAINAGE PATTERNS

- ✓ **Dendritic drainage pattern**

  Is the one whose structure is shaped like a tree trunk and the branches of the tree or the structure of a leaf and its veins.

  The tributaries converge on the main stream from many directions at a cute angles eg rivers Panagani, Rufigi, Ruizi, Tana, Congo, Wankaw on the cape coast of Ghana, Victoria Nile, Malagalasi, Ruvuma, Nyando, Nzoia etc.

CONDITIONS FOR THE DEVELOPMENT OF DENDRITIC DRAINAGE PATTERN

- ✓ It develops in a region which is made of homogeneous crystalline (igneous) rocks which offer the same resistance to erosion and which have a uniform structure.

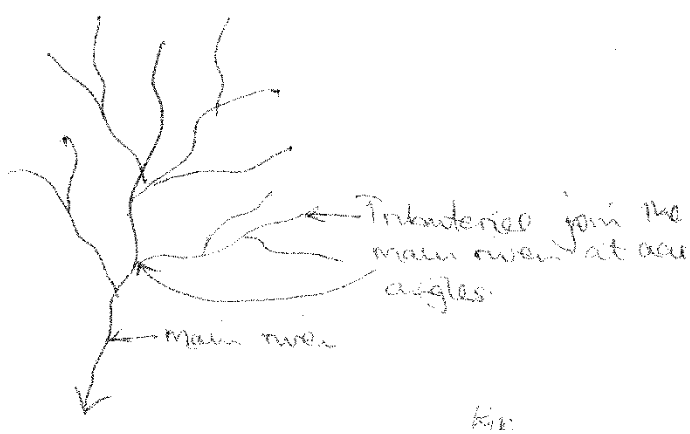
- ✓ It develops on gently dipping / sloping land scape and this determines the direction of the river and its tributaries.

- ✓ Each tributary flows in a valley proportional to its size or volume of water and maintains its flow.

- ✓ It develops in regions which receive heavy rainfall which is reliable. That is why it is most prominent in the equatorial / tropical regions where there is heavy and reliable rain fall to support the multiple tributaries.

- ✓ It develops in a common large catchment area. The multiple tributaries cover at a large catchment area.

Diagram



- ✓ **Radial drainage pattern**
  This one develops on a dome on volcanic cone. The rivers flow outwards forming a pattern like the spokes of a wheel eg Mt. Elgon with rivers like Siroko, Siti, Koitobosi, Mara, Manafa, Nzoia and Mountains Meru and Kilimanjaro areas where the tributaries of R. Tsavo and Ruvu form a radial pattern and on Mt. Rwenzori where rivers Mobuku, Nyamugasani, Nyamwamba, Mugusu, Lume, Ruanoli etc originate.

CONDITIONS WHICH FAVOUR DEVELOPMENT OF RADIAL DRAINAGE PATTERN

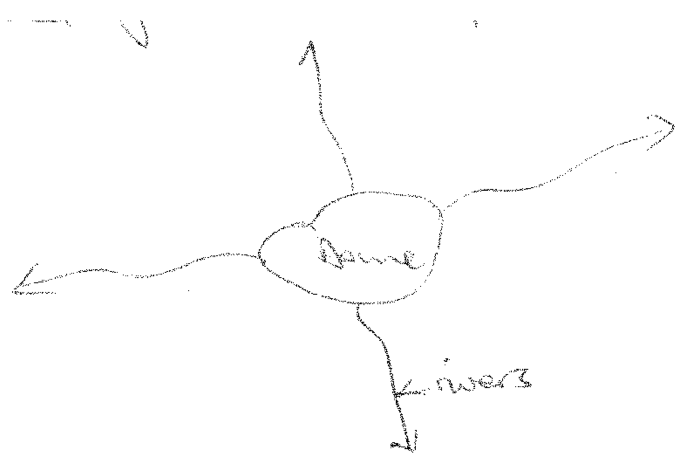
- ✓ Presence of a dome or cone shaped highlands such as a volcanic cone / mountain or highlands which provide the source of the rivers.

- ✓ Presence of steep slopes which accelerates down ward movement and erosion of the rocks to create channels along which rivers flow.

- ✓ It develops in areas of homogeneous and crystalline (igneous) rocks which offer the same resistance to erosion. This enables the rivers to erode on any side of the mountain. Thus the development of a radial pattern.

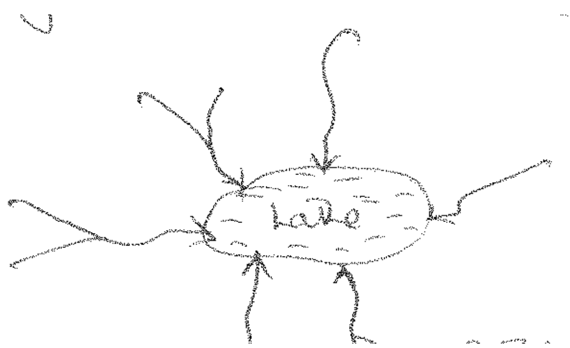
- ✓ High precipitation in the catchment area inform of rain fall, snow or the melting of glaciers which provide a continuous supply of water needed for the development of rivers.

Diagram



CENTRIPETAL DRAINAGE PATTERN

This is a pattern characterized by a large number of rivers from different directions converging onto a common point. It is commonly formed in areas of in land drainage eg around L.Victoria where rivers Katonga, Kagera, Nzoia and Sio flow and L.Baringo where rivers like Loboit, Ol mukutani, Ol Arabel and Malo converage.



CONDITIONS FOR ITS DEVELOPMENT

- ✓ Basin landscape on valley which could be formed by warping like the case of L.Victoria or faulting line in the case of L. Baringo. Such basins accelerate or steepen the gradient of the adjacent rivers which then undertake head-ward erosion towards common point.
- ✓ Heavy rain falls to support the multiple rivers flowing towards the common point.
- ✓ Develops in regions which offer equal resistance to erosion. Generally soft rocks favour the development of the river through head ward erosion.

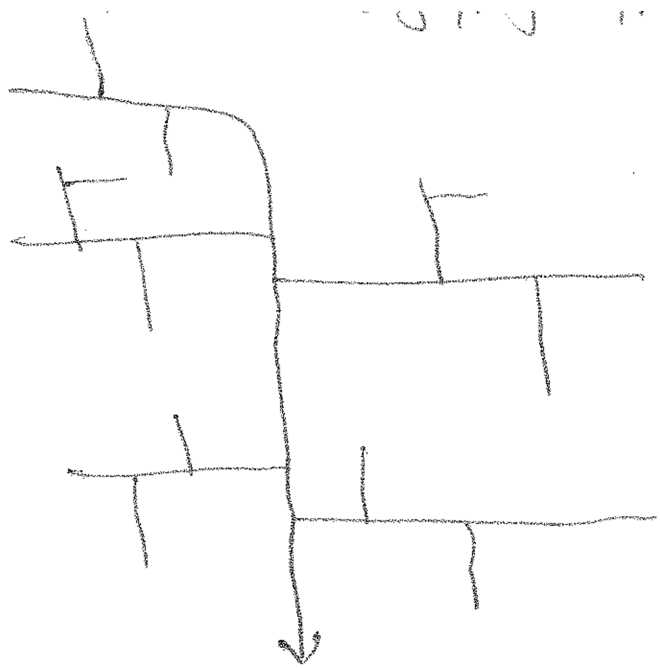
TRELLIS DRAINAGE PATTERN

It develops in areas made up alternating belts of hard and soft lakes where all dip in the same direction and which lie at right angles to the general slope down which the principal (consequent) river flows.

The tributaries (subsequent) extend their valleys by head ward erosion into the weak rocks which are turned into wide valleys called **vales** and the hard rocks stand up as escarpments.

Trellis pattern also occurs in areas that have been affected by faulting eg R. Kerio in Kenya and R. Mayanja with tributaries Kato, Wasswa, R. Aworanga, Pager, Aswa, Tiva and Galano.

Diagram



CONDITIONS FOR THE FORMATION OF TRELLIS DRAINAGE PATTERN

- ✓ Develops in areas of heterogeneous rocks ie areas with both soft and hard rocks.
- ✓ It develops also in areas of jointed rocks due to faulting.
- ✓ Heavy and reliable rainfall to support development of consequent and subsequent rivers which constitute to the drainage pattern.
- ✓ Cover a large catchment area with reliable rainfall since the streams are widely spaced.

- ✓ May also develop due to river capture eg along river Tiva, Galana, Aswa, Tochi, pager etc.

RECTANGULAR DRAINAGE PATTERN

This is a pattern which displays a rectangular shape with tributaries joining the main stream at approximately right angles (90^0) eg R. Mayanja- Kato, Wasswa.

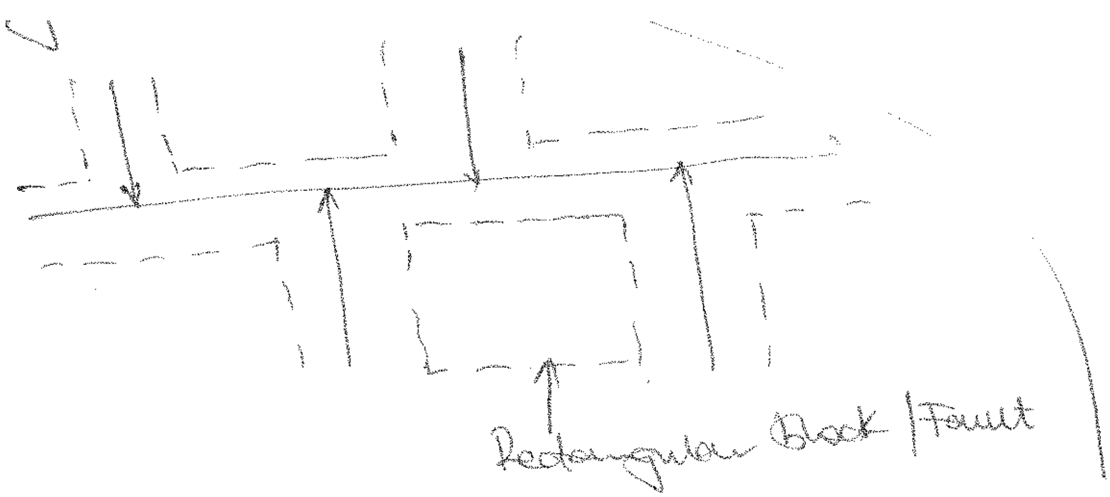
It develops in areas which have been affected by earth movements and where the faults intersects each other almost at right angles.
Streams may develop along such faults and such streams will therefore be fault guided and all will acquire a rectangular pattern eg R.Aswa, Tochi, Awovanga and pager.

CONDITIONS FOR ITS DEVELOPMENT

- ✓ Areas must be receiving ample reliable rainfall to maintain the flow of streams to complete the patterns.

- ✓ Structural control with streams following joints or fault lines in the rocks ie faulting influences rectangular drainage pattern development.

Diagram

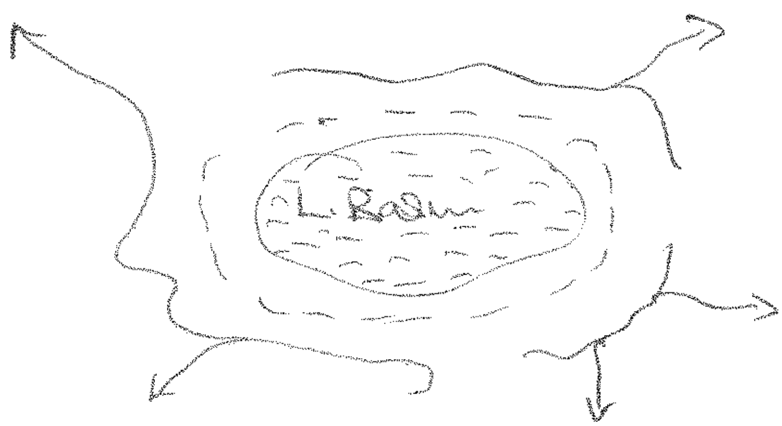


ANNULAR DRAINAGE PATTERN

Is a pattern where tributaries join the main stream at sharp angles but in a series of curves.

It develops in volcanic regions where rivers flow sharply in a series of curves around craters or calderas eg around Ngorongoro caldera.

Diagram



CONDITIONS FOR ITS DEVELOPMENT

- ✓ It develops on a dissected dome / upland with alternating hard and soft rock which favours its development where streams erode valleys in less resistant strait.
- ✓ Presence of heavy rainfall to supply water to the flowing streams.
- ✓ Rivers must flow in concentric curves conforming to the weaker rock out crops and flow outwards eg around L. Bosumutwi in Ghana where rivers Banko and Buonim flow in concentric curves.

PARALLEL DRAINAGE PATTERN

This is a pattern where streams and their tributaries flow parallel to one another on side by side down slopes eg rivers on Mt. Rwenzori, R. Nkusi and R. Hoima flow parallel to each other on Butiaba escarpment before joining L. Albert, and west of Mau ranges, where tributaries of river Athi such as R. Nairobi, Thirika, Komu and Ruiru flow parallel to each other and rivers flowing from Mt. Muhawula.

CONDITIONS FOR ITS DEVELOPMENT

- ✓ Develops in areas of alternating bands of soft and hard rocks. Soft rocks are eroded to form the river channel while the hard rocks resist erosion to form a divide which limit chances of adjacent rivers joining each other.

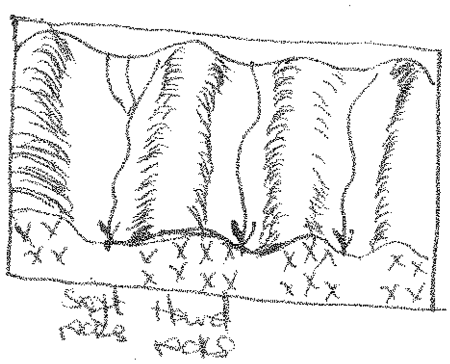
- ✓ Rivers flow in the same direction each forming its channel through hardward erosion of the soft rocks.

- ✓ Pronounced divides made up hard resistant rocks between the rivers limits the chances that the rivers could join each other.

- ✓ It also develops in faulted regions in that rivers tend to flow by eroding through the lines of weakness (fault lines) created by earth movements.

- ✓ Reliable rainfall and a large catchment basin important to sustain the existence of the river.

Diagram

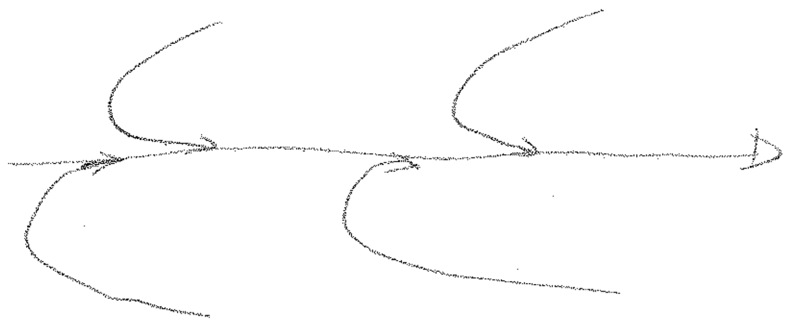


BARBED OR HOOKED DRAINAGE PATTERN

Is the one where tributaries of a river join the main stream at angles contrary to the original flow of tributaries ie at acute angles.

It develops on rivers whose direction of flow has been reversed due to warping on one side and uplifting on the other eg R.Ruizi, Kagera, Kafu, Katonga all of which are reversed rivers.

Diagram



CONDITIONS FOR ITS DEVELOPMENT

- ✓ Existence of alternating dips of slope. The rivers joining the main rivers originated from a higher point opposite to the source of the main river. After the change in gradient as a result of the uplift in the direction of the main river, the joining rivers reverse to join the main river because they fail to climb or erode through the steep gradient created a head of them.

- ✓ River capture where a strong river diverts the waters of a weaker stream into its system.

- ✓ A big catchment area and reliable rainfall.

BRAIDED DRAINAGE PATTERN

This is found or formed in flood plains of a river where the energy of the river to transport sediments is considerably reduced and the river is forced to drop some of its lead along its channel / course dividing it into several channels eg the lower parts of the Nile, Kilombero, Rufigi, Mkomanzi.

CONDITIONS FOR ITS DEVELOPMENT

- ✓ Reduced energy of the river to transport sediments.
- ✓ Reduced gradient.

- ✓ High competence of the river to erode in the upper and muddle course of the river. Hence carrying a large load.

9.3 Discordant /obsequent drainage pattern

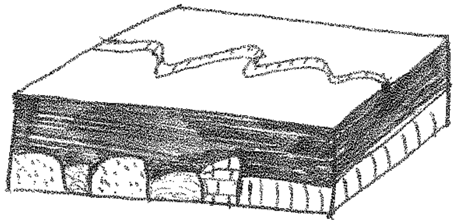
Super imposed drainage pattern
Is the one where rocks on which the river was initially flowing has been worn away and the river is now flowing over older and different land scapes to which the river is not adjusted or related.

If the drainage pattern from above is maintained and is not affected by the structures of the current exposed older rocks, then, it is super imposed eg R. Zambezi was super imposed on the Karro rock sediments R. Nile at Sabaloko in Sudan.

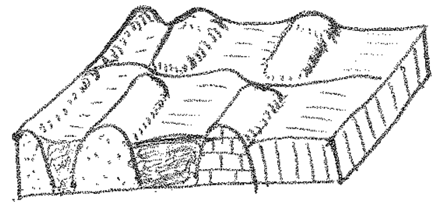
Conditions for its development

- ✓ It develops where there is no direct relationship between the river and the rocks upon which the pattern is flowing.
- ✓ When the drainage pattern / river is energetic enough to erode or under cut far deeper and reach new rock structures.
- ✓ When the river is able to maintain its drainage pattern, original course and direction on the new rock structure.
- ✓ When the original rock onto which the river originally developed were soft and therefore, highly eroded through down cutting / incision to reach the new set of rocks down wards.

Diagrams



Bef the removal of the cover rocks.



After the removal of the cover rocks

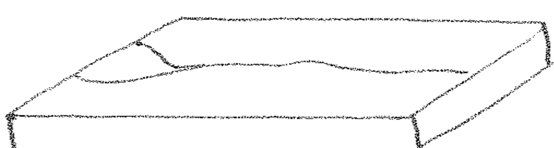
2. **Antecedent drainage pattern**.

   Is another type of discordant type /pattern. They are common in areas where uplifting took place slowly enough for the river to maintain its down cutting and where there has been insufficient time for the drainage to become completely adjusted to the structure.

   Their formation involves an uplift of land within the river course. As the uplift occurs, the river maintains its course by down cutting at a rate balanced by the rate of uplift.

   Therefore, the rate of uplift should be slow enough to allow a river to maintain its course through vertical erosion.
   Thus creating a deep gorge within the uplifted region eg along R. Ruaha in the irringa highlands of Tanzania and the Lukuga river which flows into the Zaire basin.

   Diagrams



Before uplifting

After uplift by faulting

10.0 SOILS

Soil is a natural body made up of weathered rock particles and decayed plants and animals tissues existing as a thin layer covering the earth's surface.

It is composed of mineral particles, air, water, living organisms and weathered rock particles. Soils are formed by the process known as weathering.

There are various soil types e.g. loam soils, sand soils, clay and pod soils.

10.1 FACTORS THAT INFLUENCE SOIL FORMATION

(1) CLIMATE

It influences soil formation through its elements of temperature and rainfall. Its importance lies in its control of the rate and nature of weathering.

Equatorial climatic conditions. The hot temperatures and heavy rainfall, accelerates chemical weathering resulting into the formation of mature deep and fertile soil. The presence of water also leads to leaching and eluviation leading to the development of mature fertile soils in well-developed soil profiles e.g. along shores of L. Victoria.

Tropical climatic conditions of alternate wet and dry conditions accompanied by warm temperatures lead to the formation of lateritic soils through the process of leaching leading to undeveloped soil profiles. During the dry season, physical weathering operates leading to the formation of regolith with undeveloped soil profile.

In wet seasons, chemical weathering occurs leading to developed soil profile.

Temperate and polar climatic conditions. The cold temperatures and less rainfall have resulted into less intensity of weathering and soil formation processes are very low in such areas. They have thin stony soils, in undeveloped soil profile.

Arid and semi-arid areas. The very hot temperatures of above 30°C and absence of rainfall in semi-arid areas like Karamoja and Northern Kenya lead to slow process of soil formation e.g. red desert soils are thin, sandy and have a high salty content due to increased evaporation, limited leaching resulting in undeveloped soil profile.

The hotter and dry conditions result into high evaporation rates high capillary attraction, leading to the formation of alkaline soils which are shallow, poor with undeveloped soil profile.

Climate influences soil formation in the following ways:-

It influences the rate of gradual breakdown into increasingly small particles until soil is formed by dissolving salt.

In areas where rainfalls with great intensity. It results into a beating action on the rocks especially where the ground is bare. It erodes the surface and removes the particles from one locality to another and depth through erosion and leaching by rain. This lead to the formation of different soil types.

The hot temperatures and heavy rainfall increases the rate of decay and decomposition of plant and animal materials which provide humus to the broken down rocks to form mature fertile soils in well-developed soil profiles.

Temperatures also influence the growth of bacteria which decomposes the dead matter into humus which makes the soils fertile when added to the broken down particles thus formation of well-developed soil profiles.

Climate also influences vegetation cover growth indirectly , an important element in soil formation which decomposes into humus forming mature well developed soils.

(2) PARENT ROCK

This refers to the material that breaks down to form soil particles by mechanical and chemical means. Rocks differ in many ways and influence soil formation in different ways:

(i) Rock resistance

Soft rocks containing mica minerals e.g. limestone are weathered easily and this accelerates the rate of soil formation, forming deep fertile soils in a well-developed soil profile. Hard and resistant rocks limit the rate of weathering resulting into the formation of thin skeletal soils in undeveloped immature soil profile.

(ii) Mineralogical compositions. This is where the mineral matter of the soil is derived from. This determines;

- The nature and fertility of soils e.g. rocks of volcanic origin weather into fertile soils which are deep and well-developed.
- Quartz forms grains which are resistant to chemical weathering, forming sandy soils in undeveloped soil profiles. Ferricate, rich in iron tend to be dark coloured and therefore weather to produce soils which are well-developed in well-developed soil profiles.

(iii) Age of the rock

Rocks of recent formation don't weather into well-developed soils. They form thin stony soils with underdeveloped soil profiles. Whereas old rocks weather into well-developed soils because of being exposed to soil formation process for a long period of time. Thus development of mature soil profiles.

(iv) Rock jointing

Well jointed rocks allow easy penetration of water and gases thus accelerating the rate of chemical weathering, forming deep mature soils in well-developed soil profiles.

Unjointed rocks are not easily broken down so they produce thin immature soils in undeveloped soil profiles.

(v) Rock colour

Dark coloured rocks absorb a lot of heat hence easily weathered forming deep well-developed soils in well-developed mature soil profile. Brightly coloured rocks like limestone reflect heat and don't absorb it hence making it difficult for them to be broken, leading to the formation of thin immature soils in undeveloped immature profiles.

(vi) Basic igneous rocks and sedimentary rocks are hard to break down they produce shallow immature soils in immature undeveloped soil profiles.

(vii) Rock permeability

Permeable rocks allow water to percolate, leading to deed chemical weathering, thus forming deep mature soils and form a well-developed soil profile. Impermeable rocks don't allow water to enter them, thus reducing the rate of their breakdown thus forming immature soils in undeveloped soil profile.

(3) VEGETATION

The nature of vegetation influences soil formation in the following ways:-

(i) It produces hums compounds which make up soil. Tropical forests therefore produce a lot of humus derived from the decay of leaves.

(ii) It also determines the amount of water which is retained which in turn determines the rate of weathering. Tropical rainforests retain more moisture.

(iii) The vegetation helps to protect the soils from soil erosion and deep soils form because the weathered materials are not washed away.

(v) Where vegetation is scanty, soils are eroded resulting into the formation of thin soils in undeveloped immature soil profile.

(vi) Vegetation roots also lead to the disintegration and formation of deep mature soils. Forested areas therefore tend to have deeper soils in well-developed soil profiles while areas with thin vegetation have thin skeletal soils and poorly

developed profiles.

(4) LIVING ORGANISMS

The influence of living organisms is largely mechanical. Earth worms, termites e.t.c contribute to soil formation through changing the texture as they make passages through the rocks leading to formation of deep soils with developed soil profile.

(i) Burrowing animals like wild pigs, churn up rock fragments thus improving aeration and drainage which promotes weathering and soil formation, thus forming deep mature soils in a well-developed soil profile.

(ii) Man's influence on soil formation through practices like agricultural road construction, quarrying e.t.c. all these lead to breakdown of rocks and formation of deep fertile soils thus forming deep mature soils in well-developed soil profile.

(5) TOPOGRAPHY / RELIEF

The nature of slope influences soil formation from deep to thin soils.

On steep slopes, erosion is more rapid than on gentle slopes. This facilitates the washing away of weathered materials and consequently steep slopes develop thin skeletal soils.

On gentle slopes erosion is slow and there is a lot of deposition which leads to the formation of mature soils in developed soil profiles.

Low lands on the other hand are poorly drained and characterized by a lot of deposition. This slows down soil forming processes, resulting into the formation of poorly drained infertile clay soils in undeveloped immature soil profiles.

(6) TIME

Soil formation process is very long and slow. Ample time is therefore needed for the formation of mature fertile deep soils in well-developed soil profile.

If the time is short, immature or azonal soils are formed with poorly developed profile e.g. the soils of Nyamulagira are still skeletal because they have not been exposed to the weathering process for long.

10.2 SOIL FORMING PROCESSES

Processes refer to activities which operate materials and dead materials or matter to produce soils. They include:-

(1) Weathering

This involves the physical breakdown of big rocks into small particles forming skeletal stony immature soils. There is also chemical weathering which involves decomposition of rocks into small pieces in situ forming deep soils with developed soil profiles.

(2) Leaching

This is the process which involves the washing down of soluble mineral nutrients in a solution or suspension from horizon A to horizon B of the soil profile. This empoverishes horizon A and enriches horizon B of the soil profile.

(3) Eluviation

This involves the movement of mineral nutrients in a solution or suspension from one place to another either horizontally or vertically. This process enriches horizon B and empoverishes horizon A of the soil profile.

(4) Illuviation

This process involves the accumulation and precipitation of the leached and eluviated soil nutrients from horizon A into horizon B. this process enriches horizon B with mineral nutrients.

(5) Humification

This is a process which involves the decomposition of dead organic matter forming humus which is added to the broken down rock materials to form deep fertile mature soils with well-developed soil profile. Consequently areas with thick vegetation like L. Victoria basin where there are tropical rainforests develop fertile deep mature soils.

(6) Mineralization

This is a process of soil formation which takes place under extreme conditions of heavy rainfall and hot temperatures in which decomposition of organic matter exceeds humification i.e. humus is broken into other inorganic substances e.g. carbondioxide, water and silica. This mainly occurs in horizon A of the soil profile hence enriching it.

(7) Podsolization

This process prevails in cool temperate regions especially in Boreal and coniferous forest regions. This process which leads to formation of podzols includes leaching, eluviation and humification.

Humification is very important here because it results into acidic conditions which intensifies other processes of soil formation in such areas. These acids result from decomposition of organic matter.

Podzolisation results into the formation of the best developed soil profile with different horizons and sub-horizons clearly developed.

(8) Salinization

This process involves the formation of a thin layer of salt on the surface of the earth through capillary action. Capillary action involves a wide range of soluble mineral salts as a result of excessive evaporation, accumulating on the earth's surface. It enriches horizon A of the soil profile with salts.

(9) Gleization

This process leads to the formation of frozen soils in the temperate regions while in the tropical regions; it leads to the formation of peat soil which are pre-mature due to low temperatures and poor drainage. These two factors don't allow complete decomposition of organic matter because soil bacteria are not serviving.

This process mostly occurs in frozen areas especially in glaciated regions where permanent frost provides an impervious horizon / layers usually at shallow depths.

(10) Laterisation

This is a process which involves the formation of laterites and lateritic soils. The process require the following conditions in order to occur:-

- Deep and intense weathering under humid tropical conditions or sub-tropical conditions.
- Availability of abundant supply and rapid decay of organic matter.
- Mildly acid to mildly alkaline pH (5-8) which results from the rapid process of mineralization.
- Decomposition of clay to kaolinite. The laterisation results into formation of various soil types that differ from each other e.g. Ferruginous, latosols and oxisols. The laterisation process also takes place in humid regions.

Qn. Account for the formation of lateritic soils in East Africa.

Approach:

- Identify and describe lateritic soils.
- Locate them in East Africa.
- Give the factors responsible for the formation of lateritic soils.
- Explain the formation process of lateritic soils.

Answers:

Lateritic soils are red / black residue soils created from weathering of rocks under humid and hot tropical conditions.

Lateritic soils consists of either iron or Aluminium oxides and they are formed either as hard pans, soft clays or as horizontal granules in East Africa.

In East Africa lateritic soils are found in various areas of savannah and equatorial forests, Buganda hills due to the following factors:-

- **Relief or nature of slope**. Lateritic soils form under conditions of low relief. This allows percolation of water and leaching of horizon A and deposition in horizon B.
- **Geological time**. Lateritic soils require long geological period to allow formation and accumulation of oxides e.g. many laterites in East Africa are relics of tertiary weathering process.
- **Chemical weathering.** By oxidation, solution changes the colour and transports the cementing silicates, by oxidation respectively.
- **High temperatures**. This is required during the rates of chemical reactions.
- **Vegetation cover**. This helps to hold the soils to be leached and to allow weathering in situ to provide organic matter.
- **Human activities**. The formation of laterities is interrupted by human activities like mining.
- **Drainage**. Poorly drained soils do not allow formation of lateritic soils. They form in well drained areas.
- **Nature of the parent rocks**. Rocks shouldn't be extremely hard and should contain iron and aluminium for oxidation to take place.
- **Deep and intense weathering** under humid tropical and sub-tropical regions.
- Decomposition of clay into kaolinite.

- Mildly alkaline and mildly acid pH about 5 – 8 which results from rapid process of mineralization.

PROCESS OF FORMATION OF LATERITES

Laterites formation is due to excessive rainfall and hot temperatures which bring about decay and intense weathering of rocks.

Silica from rocks is removed by water and transported from horizon A to horizon B of the soil profile through a process of eluviation and leaching.

The iron and aluminium compounds are also moved to horizon B through eluviation and leaching.

When temperatures rise, the iron and aluminium are carried to the soil surface through capillary action which fuses together with soil particles and harden to form a layer known as "duricrust" or may remain in presence of surface moisture to form soft clays called kaolinite.

1O.3 SOIL PROFILE

This refers to the vertical arrangement or section through the soil from the surface upto the parent rocks. It's composed of soil layers called horizons which are differentiated in terms of colar, texture and mineralogy.

Soil profiles differ from place to place however an ideal profile is composed to four horizons as shown below.

A	A_{oo}	Undecomposed organic matter
	A_o	Decomposing organic matter
	A_1	High humus content
	A_2	Maximum leaching
	A_3	Transitional zone
B	B_1	Transitional zone
	B_2	Maximum deposition
	B_3	Transitional zone
C		Partially weathered rocks
D		Unweathered rock / solid parent rock

The soil profile is made up of four horizons i.e. horizon A which is comprising of the top soil. This is sub-divided into sub horizons.

- Aoo : Un Decomposed organic matter

- A_0 : Decomposing organic matter
- A_1 : High humus content
- A_2 : Maximum leaching
- A_3 : Transitional zone

Examine the processes responsible for the development of soil profile.

- Define soil profile.
- Draw.
- Describe it.
- Identify and explain the processes indicating their effects on soil profile development.

HORIZON B

This is comprising of the sub-soil. It is also called the illuviation zone. It's sub-divided into;

B_1 – Transitional zone
B_2 – Maximum deposition
B_3 – Transitional zone

Horizon **C** which is made up of partially weathered rock materials.

Horizon D which is made up of unweathered parent rock.

- **Factors responsible for the development of soil profile.**
  Refer to the factors for soil formation.

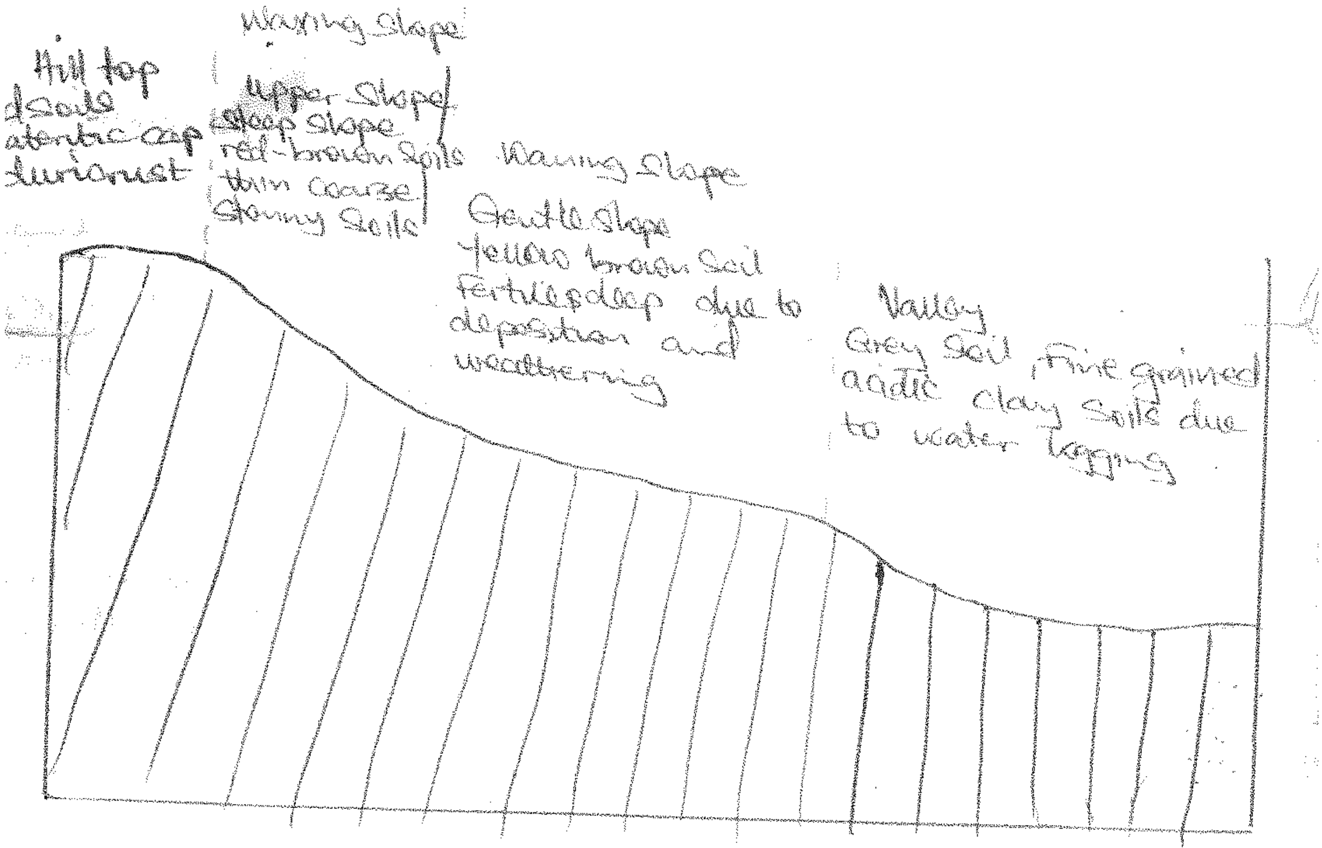
- **Process responsible for soil profile development**
  Refer to the processes for soil formation

10.4 SOIL CATENA

This is the horizontal / sequential arrangement of soils along a slope from the hill top to the valley bottoms formed under similar climatic conditions.

Soil catena thus shows different characteristics in terms of colour, depth, texture and water content as one progresses from the hill top to valley bottoms as shown below.

Diagram



10.5 FACTORS THAT INFLUENCE SOIL CATENA

(1) Relief

Flat hill top develops lateritic reddish brown soils due to high rates of leaching.

Steep slopes / waxing slope develop reddish brown thin stony skeletal soils due to high rates of soil erosion.

Gentle slopes / waning slopes develop,
Brown soils which are deep fertile and well developed soils due to deep chemical weathering and high rates of deposition.

(2) Drainage

The poor drainage / water logging conditions in the valleys / lowlands limit activities of living organisms and lead to low temperatures thus facilitating the formation of grey acidic water logged clay soils.

The good drainage on gentle slopes and the high water holding capacity result into the formation of yellow brown soils which are deep fertile and well developed.

The high rate of surface run off and limited water pacoration on the steep slopes limit chemical weathering and therefore result into the formation of reddish brown thin stony skeletal soils.

The high rate of water pacoration and good drainage on the flat hill top lead to high rates of leaching and therefore formation of lateritic soils or a duricrust.

(3) Climate

Heavy rainfall and hot temperatures lead to high rates of leaching and oxidation on the flat hill top, thus forming lateritic soils.

Heavy rainfall leads to high rates of soil erosion on the steep slopes thus forming reddish brown stony thin skeletal soils.

Heavy rains lead to high rates of water pacoration and the hot temperatures on gentle slopes lead to deep chemical weathering thus forming yellow brown deep fertile well-developed soils.

Heavy rains in valleys / lowlands lead to water logging conditions which facilitate the formation of grey acidic water logged clay soils.

(4) Living organisms

The limited activities of living organisms in low lands due to water logging conditions leads to the development of grey acidic water logged soils.

Living organisms like worms, bacteria help in churning the soils as they make passages through the soils, facilitating water pacoration on gentle slopes thus facilitating deep chemical weathering. Thus forming yellow brown, well-developed deep fertile soils.

Human activities of quarrying, agriculture on steep slopes encourage removal of soils and erosion thus facilitating the formation of reddish brown stony thin skeletal soils.

(5) Time

Ample time is required for the development of an ideal soil catena.

10.6 TYPES OF SOILS

There are 3 broad categories of soils:
- Zonal soils
- Intra-zonal soils.
- Azonal soils

ZONAL SOIL

These are mature soils with a well-developed soil profile due to the prolonged action of climate and vegetation. These soil types are largely as a result of climatic factors which contribute to their forming processes. They develop under conditions of good drainage. They develop on gentle slopes and flat landscape.

Zonal soils are mainly divided into two namely;

- **Pedacals.** These have high calcium carbonate content under conditions of low rainfall.

- **Pedalfers.** These are rich in aluminium and iron.

The resultant soil type is closely related to the nature of weathering that takes place under specific type of climate. These include:-

- In the low latitude areas, the hot humid conditions give rise to latosols and tropical black soils (basisols).
- In mid-latitudes, climate of humid conditions are associated with the development of podisols and brown soils.
- In areas receiving seasonal rainfall in the mid-latitudes, chernozems soils develop e.g. on the Canadian Prairies.
- High latitude climate lead to the development of Tundra and acidic brown soils.
- Semi-arid conditions yield chestnut coloured soils.

INTRA-ZONAL SOILS

These are mature soils classified according to the great influence of relief and the parent rock during their formation. They include:-

- **Peat**. These are soils formed in low lying areas and poorly drained areas.
- **Calcerous soils**. These are derived from limestone rocks. They are of two types namely;
- **Terrarossa**. These are red soils which form in limestone regions under semi-arid areas e.g. Northern France and parts of Yugoslavia.
- **Rendizina**. These are soils of limestone origin formed in areas with heavy rainfall. They are best developed in parts of England and are well known for the growing of cereals like wheat and barley.

AZONAL SOILS

These are immature soils with undeveloped soil profiles. They can't be distinguished from one another because of their recent formation. So their development is incomplete and therefore no marked horizons.

The soil forming process is incomplete either because the period of formation is either short that the horizons have not been formed or because of the steep slopes where surface run off is greatest.

The soils are skeletal with shallow profiles and show characteristics of their original parent rock material which weather into situ and resist change. They are derived from unconsolidated rock materials e.g. alluvium, sandy and volcanic ash.

Azonal soils include;

- **Volcanic soils**. These are young deposits of lava and ash which are weathered rapidly to form soils eg in kenyan highlands and south western Uganda.
- **Alluvial soils**. These are soils got from sandy, silt and clay deposits along water courses. They are very fertile and where they occur are areas of dense population e.g. Nile delta in the Sudan and Egypt.
- **Glacial soils**. These are soils of glacial origin and consist of out washed moraines of sand and gravel and clay deposits laid down in glacial lakes.
- **Wind deposits**. They include sand sheets, loess and sand dunes.

- **Screes**. Formed by weathering.

FACTORS THAT INFLUENCE THE FORMATION OF AZONAL SOILS.

- **Weathering.** Weathering of the parent rock leads to the formation of screes on the slope. These soils usually show the characteristics of their original material and resist change.
- Tectonic deposit of lava via volcanic action which leads to the formation of lava ash, cinder and pumice**.**
- Materials may be transported by high rate of erosion and get deposited in low lands e.g:-
  - Wave action which leads to formation of marine deposits forming soils like mud flats, marine clay soils.
  - Wind action which leads to the formation of loess soils, sand sheets and sand dunes.
- Glacial action which forms fluvio glacial soils e.g. out washedsands and gravel and resorted clays deposited in glacial lakes.
  - River action leads to the formation of alluvial soils in lowlands and valleys.
- **Climate.** High amounts of rainfall cause river floods that lead to deposition of alluvial soils in the lower course.
  - Temperature changes on mountain slopes influence physical weathering, consequently forming screes.
  - Human activities like quarrying leads to the breaking of rocks, forming screes.
  - Deforestation, bush burning and overgrazing exposes the parent rock which leads to formation of young soils.
- **Relief**
  Steep slopes influence soil erosion of screes on mountain slopes and their subsequent deposition hence forming new soils called screes.
- **Time**
  Azonal soils are immature soils and this mainly depends on a short period of time entailed in their course of formation.

10.7 SOIL EROSION

Qn. To what extent is soil erosion in East Africa a result of physical factors?

Approach:
- Definition of soil erosion.
- Areas affected by soil erosion.
- Description of soil erosion processes in details.
- Evaluation / stand point.
- Physical factors with processes intergrated.
- Other factors / Human factors.
- Conclusion.

Soil erosion is the washing away of soil materials from one place to another by agents like running water, wind e.t.c.

Soil erosion is most dominant in highland areas of East Africa like Kigezi, southern Tanzania highlands, Rwenzori and dry flat areas of East Africa like Kondoa of central Tanzania, Karamoja, Turkana, Ankole, Masaka dry corridor.

10.8 TYPES OF SOIL EROSION

(1) Splash erosion

This is a type of soil erosion is caused by the impact of rain droplets which dislodge loose soil particles and these join running water to move in any direction.

(2) Sheet erosion

Removal of a uniform thin layer of the top soil by running water and wind. It involves a slow movement which covers a wide area. It's common on gentle slopes and flat areas e.g. Nakasongola and Nyika plateau.

(3) Rill erosion

Is a process of soil erosion which occurs where water runs in small channels which guide soil movement on the surface of the earth.

It takes place over gentle and steep slopes. In most cases the small channels widen to form wide gullies/grooves.

(4) Gulley erosion

This is a form of erosion where there are deep wide channels/grooves in which soil is washed down slope by running waters. It occurs in areas of heavy rainfall. It occurs in areas of heavy rainfall. It occurs on gentle and steep slopes.

It results into formation of waste lands / Bad Lands.

(5) Wind erosion

A form of erosion by the deflation process of wind. Deflation is the removal of loose soil particles from one part of the earth's surface to another. Deflation is very active in dry flat areas like northern Kenya, Central Tanzania.

10.9CAUSES OF SOIL EROSION

(1) Climate

Heavy torrential rainfall received in highland areas of East Africa like southern Tanzanian highlands Kabale largely accelerate gulley, sheet erosion.

Unreliable / unpredictable rainfall in dry areas like Turkana, Karamoja have led to gulley, sheet erosion.

Strong winds in dry flat areas like Kondoa also lead to deflation which leads to soil removal hence soil erosion.

(2) Relief

Steep and gentle slopes of Bundibugyo, Kabale encourage rill splash erosion.
Flat areas like Turkana, Kondoa encourage wind erosion.

(3) **Lack of vegetation cover** e.g. in Turkana, Kondoa facilitate gulley, sheet, wind erosion because the soils are directly exposed to erosion.

(4) **Crustal instabilities like earthquakes** that destabilize the rock particles making them vulnerable to gulley, sheet and rill erosion.

(5) Nature of soils

Unstable soils like sandy and volcanic soils are greatly affected by gulley, sheet erosion in Turkana, Kisoro.

(6) **Overgrazing by wild animals** e.g. in National Parks like Queen Elizabeth, Tsavo exposes the soils hence accelerating gulley, sheet.

(7) **Wild bush fires** exposes soils to gulley, sheet, rill erosion as it leaves the soils bear.

Human factors:

- Defforestation in Kigezi, Kabale which exposes the soils to sheet and gulley erosion.
- Overstocking or over grazing in Karamoja, Ankole, Masaka, dry corridor, Kondoa hence leading to gulley and sheet erosion.
- Monoculture which results into soil infertility and this makes the soils exposed to gulley and sheet erosion e.g. in Mbale where bananas are grown, Mukono with tea plantations.
- Up and down cultivation which encourages runoff through rill and gulley erosion e.g. in Bundibugyo.
- Planting poor cover crops like sorghum, maize which leads to the soils being exposed to erosion hence facilitating sheet and gulley erosion.
- Mining and quarrying in hilly areas e.g. Kireka, Kilombe, Mbuya hills which involves clearing of vegetation first exposes the soils to soil erosion agents thus facilitating sheet and gulley erosion.
- Construction of roads, settlement e.t.c. which involves removal of vegetation first, exposing the slopes e.g. along the northern by-pass in Kiwatule, Bwaise, Bundibugyo, Entebbe Express Highway.

10.10 EFFECTS OF SOIL EROSION

Positives:

- Leads to soil formation in the lower areas where the eroded soils are deposited e.g. on the foothills of mountain Elgon in Mbale.
- Exposes several volcanic features like Inselbergs which attract tourists.
- Exposes hard rocks that are used for installation of TVs, Telephone masts e.t.c.
- Removal of top soil exposes fresh rocks to weathering thus formation of new soils.

Negatives:

- Created Bad Lands in Machakos, Kondoa and Nyanza which discourages agricultural mechanization.
- It's one of the causes of drought in northern Kenya, Ankole Masaka corridor, Kotido.
- It involves washing of top fertile soils which reduce agriculture productivity. Hence food shortage, leading to famine e.g. in Northern Kenya.
- Leads to siltation of lakes and rivers where eroded soils are deposited e.g. Manafa and Kibimba are highly silted by erosion from the Elgon.
- Leads to flooding of rivers like Manafa due to silting up in kampala, floods are also due to Nakivubo channel.
- It has led to scarcety of pastures in pastoral areas like Turkana, Karamoja which has led to death of animals.
- Lowers the water table whereby eroded materials are deposited in lowlands.
- Soil erosion especially wind erosion leads to poor visibility due to the dust in the atmosphere e.g. in Moroto and Turkana.
- Forced migration of people from areas seriously affected by soil erosion to other unaffected areas e.g. Bakiga from Kabale to Kibale.

10.12MEASURES:

- Terracing has been adopted in mountainous areas like Kigezi.
- Strip cropping.
- Sacks and gabions are filled with soil and stones and placed in gullies along steep slopes to provide protection against surface run off e.g. in Bundibugyo.
- Crop rotation has been adopted to control monoculture effects e.g. in Kabale, Masaka and Mbale.
- Artificial and natural fertilizers are being applied to replace the lost fertility e.g. cow dung in Mbarara and Mbale.
- Cover crops like beans, sweet potatoes are widely grown to control rain infiltration and reduction of splash of rain drops on soils e.g. in Kabale, Kericho and Arusha.
- Contour ploughing in highlands like Kigezi; this involves digging of land and planting crops across the slope.

  This reduces the movement of soils down slope.
- .afforestation and re-afforestation measures in Kabale.

- Public awareness through mass media, magazines, seminars to teach people in those areas the soil conservation measures.
- Controlled grazing and introduction of ranching in areas of soil erosion.
- Mulching in Mukono, Bushenyi e.t.c.
- Controlled bush burning.
- Setting up of organisations like NEMA, NFA to address the dangers of environmental degradation, thus control soil erosion.

Qn. Account for the soil degradation in East Africa.

Approach:

Define soil degradation
It's the reduction in the productive value of soil which results into low crop yields.

Identify where it occurs.
- Turkana
- Nakasongola
- Kisoro

Identify and describe the forms of soil degradation and their causes which include:-
- Loss of soil nutrients through leaching, eluviation, crop removal.
- Soil erosion

11.0 VEGETATION IN EAST AFRICA
- Account for the growth of equatorial vegetation in East Africa.
- Location
- Characteristics which must be accounted for.
- Factors for the distribution with characteristics integrated.

NATURAL VEGETATION IN EAST AFRICA

This refers to the green plant cover onto the earth's surface which regenerates automatically without man's influence.

Although East Africa lies astride the Equator, its vegetation is not purely equatorial forests. She has a variety of vegetation types namely tropical vegetation, Arid and semi-arid, montane, and swampy vegetation and equatorial vegetation.

11.1 EQUATORIAL / TROPICAL RAINFOREST VEGETATION

This covers a small percentage of the total land area limited to L. Victoria shores e.g. L. Victoria island e.g. Bugala, Kalangala, Kome in Bunyoro, e.g. Budongo, Bugoma, Kibale, Karinzu, Bwindi Impenetrable Immaramagambo, Marabigambo in Rakai and along the East African coast.

CHARACTERISTICS

- Characterized by a close cover of tall trees with a strong stem ranging from 8 – 50m because they are looking for sunlight.
- Form dense ever green canopies of 3 – 4 layers because they are searching for light.
- They don't occur in pure stands because they are natural and not planted by man on a planned basis.
- They often look thick under growth because sunrays never penetrate these canopies to facilitate the growth of grasses and other undergrowth.
- Large ever green trees which develop due to excessive water intake.
- Trees have buttress roots to support the great height and size of trees.
- Trees are broad leaved to facilitate evapo-transpiration.
- Trees are ever green because they shed off leaves at different intervals throughout the year.
- They develop into thickets at their margins due to man's encroachment.
- They have creepers like lianas and epiphytes because they are looking for light and support.
- Contain tropical hard wood tree species such as Mvule, Mahogany, Okoume, Ebony, Rose wood, Teak; this is due to the constant hot temperatures that accelerate the loss of water from leaves.

- Trees have a long gestation period of over 50 years because they are indigenous which take long to mature.
- They are umbrella shaped to preserve water around the plant.
- Have shallow roots due to heavy rainfall and abundant water in the soil.

CONDITIONS FOR THE GROWTH OF EQUATORIAL FORESTS

- Favourable climate, characterized by;
- Heavy well distributed reliable rainfall of 1500-2000 mm annually which favours the growth of tall ever green trees.
- High humidity of over 80% which favours the growth of hard wood ever green trees.
- Uniformly hot temperatures between 20 – 30^{o}C which favours the growth of ever tall green trees.
- Abundant sunshine which favours the growth of broad hardwood tree species.
- Deep fertile soils which favours the growth of ever green tall tree species.
- Well drained soils which favour the growth of a variety of tall ever green tree species.
- Latitudinal location between 0 and 5^{o} north and south of the Equator which areas are characterized with uniform hot temperature, heavy rainfall due to high evaporation and evapo-transpiration and over heading sun which favour the growth of hard wood tree.
- Altitude between 1800 – 2500mm which altitude is characterized by hot temperatures which encourage the growth of tall broad hard wood tree species.
- Relief characterized by gentle slopes, well drained lowland areas which favour growth of evergreen trees.
- Favourable government policy for gazetting forests e.g. Mabira, Kibale has led to their continued existence.

- Limited human encroachment for agriculture, lumbering e.t.c. which has led to the continued growth of forest.

PROBLEMS OF LAND USE IN EQUATORIAL FORESTS

- High temperatures and heavy rainfall encourage multiplication of dangerous pests in these forests.
- Heavy rainfall makes the soils boggy which makes transport difficult which hinders economic activities.
- Sparse population of these areas hinders their exploitation.
- Trees of great economic value are widely scattered which makes their exploitation difficult.
- They habit dangerous wild animals which are a threat to human beings.
- Very big logs of the trees make transport difficult.
- Closeness of the trees makes their felling difficult.

11.2 TROPICAL / SAVANNAH VEGETATION

Account for the distribution of tropical vegetation in East Africa.

Approach:
- Identify types of tropical vegetation.
- Locate each type.
- Describe the characteristics of each type.
- Then explain the factors, integrating the types of savannah.

Tropical / Savannah vegetation covers half of East Africa's total land area. It's divided into 3 broad categories i.e. Savannah grasslands, Woodlands and Dry Savannah.

SAVANNAH GRASSLANDS

This is a form of savannah dominated by a continuous cover of tall grasses dotted by trees.

Most of Uganda is covered by Savannah grassland and is more pronounced in Luweero, Bunyoro, Arua parts of northern Uganda, Nyika plateau in Kenya, Queen Elizabeth National park in Kasese.

CHARACTERISTICS

- Tall grasses of 5 – 8m tall.
- Elephant and spear grass dominate.
- Grasses turn yellow – brown colour during dry seasons.
- Grasses grow in turfts with sharp edges.
- Grass has fibrous roots.
- Grasses dry up during the dry season.
- Scattered trees are dotted within grasses.
- Trees are deciduous in nature.
- Trees are umbrella shaped.
- Trees are hardwood species.
- Deep rooted trees.
- Drought resistant trees.
- Baobabs and acacia dominate.

CONDITIONS FOR THE GROWTH OF GRASSLANDS

- Favourable climate characterized by;
- Moderate rainfall of 760 - 1000 mm which favours the growth of tall grasses with scattered trees.
- Seasonally distributed rainfall and wet seasons which favours the growth of trees and dry seasons that favour yellowing and browning and drying up of the grasses.
- Low humidity of about 30% which favours the growth of tall grasses.

- Hot temperatures of 20 - 30ºC which favour the growth of a continuous cover of tall grasses with scattered trees.
- Good / fair drainage which favours the growth of tall grasses with scattered trees.
- Relief of lowlands and plateau which favour the growth of tall grasses.
- Latitudinal location of 5 – 15º north and south of the Equator which areas are characterized by hot temperature and moderate rainfall which favour the growth of a close cover of tall grasses with fewer contours.
- Altitude below 1800 m above sea level favouring the growth of tall grasses because of their hot temperatures.
- Man's encroachment on woodlands for charcoal burning, lumbering which degenerates them to grasslands.
- Government policy of conserving grassland areas into national parks and game reserves e.g. Queen Elizabeth, Tsavo which has led to the continued existence of the grassland.

SAVANNAH WOODLANDS / MIOMBO WOODLAND

This is the type of savannah vegetation with more or less continuous cover of trees and shrubs intertwined.

It's dominate in western and south west Tanzania where it's called Miombo, parts of western rift valley region, south western and Eastern Kenya, southern Arua, parts of northern Uganda and Nakasongola.

CHARACTERISTICS

- Moderate height of trees of 8 – 16 m high.
- Umbrella shaped trees.
- Continuous cover of trees because of moderate water supply.

- Predominance of Acacia and Cacti tree species.
- Deciduous trees.
- Dense undergrowth.
- Trees are intermingled with xerophytic thorny lianas, cactie and ferry hardy shrubs.
- Trees have gnarled / twisted stems.
- Trees have thick barks.
- Trees have small leaves to reduce transpiration.
- Drought resistant trees due to swollen trunks and long tap roots.
- Fire resistant trees.
- Most trees develop branches close to the ground.
- Hard wood trees species.

CONDITIONS

- Moderate rainfall of 760 – 1500 mm per annum which favours the growth of continuous cover of trees.
- Seasonal rainfall, concentrated in one peak which favours the growth of shrubs.
- Dry conditions which favour shading off leaves.
- Hot temperatures of about 20 – 30^o which lead to dominance of drought resistant trees.
- Moderate humidity of 50%. Favour the growth of a continuous cover of medium sized trees.
- Fairly fertile soils with a water holding capacity to encourage the growth of continuous cover of trees.
- Relief of low lying and gentle slopes. Favour growth of a continuous cover of trees.
- Latitudinal location of 5 – 15^o north and south.
- Good drainage / lack of / limited drainage encourage the growth of medium sized trees.

Biotic factors e.g.:

- Minimal human activities due to presence of tsetse flies and bees.
- Man's activities in tropical rainforest e.g. deforestation, lumbering degenerate the tropical rainforests to woodlands.

DRY SAVANNAH VEGETATION

This is a type of savannah characterized by scrubs, bush and thickets with stunted trees found in the drier margins.

It's found in the fringes of northeastern Uganda, Ankole-Masaka dry corridor, central Tanzania, Turkana.

CHARACTERISTICS:

- It's characterized by scrubs and thicket.
- There are scattered trees.
- Trees are stunted.
- Trees have thick barks.
- Trees are deep rooted to suck underground water.
- Trees are drought resistant due to swollen trunks and deep roots.
- Trees have small leaves to minimize water loss.
- Trees have no or very few leaves.
- Trees produce very many seeds which remain dormant during dry season as a form of insurance.
- The leaves of the trees have a waxy / oily coating to reflect sun's insolation to minimize water loss.
- Trees are thorny for defense purposes.
- Trees are small to avoid being broken by strong winds.

- Drought resistant trees.
- Fire resistant trees.

CONDITIONS:

- Low rainfall below 250 mm which is highly unreliable and unevenly distributed which have enabled the growth of scrubs.
- Very hot temperatures above 30°C which have favoured the growth of drought resistant trees.
- Very low humidity below 20% which has enabled the growth of thicket.
- Fair drainage encouraging the growth of scrubs and thickets.
- Poor infertile sandy soils favoure the growth of scrubs.
- Low flat lands which are fairly drained encourage the growth of scrubs and thicket.
- Altitude of below 1000m above sea level encourage the growth of thicket.
- Latitudinal location between 5 and 15° north and south of the equator characterized by hot to very hot temperatures encourage the growth of thicket.
- Human activities of deteriorating, overgrazing, bush burning of grasslands which degenerates the grasslands into dry savannah.

Qn. Account for the existence of dry Savannah in East Africa.

11.3 ARID AND SEMI-ARID VEGETATION

Note: - Refer to dry savannah for areas of occurrence.
- Characteristics and conditions.

11.4 FACTORS FOR THE DEGENERATION / MODIFICATION CHANGE / DETERIORATION / TRANSFORMATION OF SAVANNAH VEGETATION

Qn. To what extent have physical factors modified Savannah vegetation?

Approach:
- Describe Savannah, types and location.
- Briefly outline some of the characteristics.
- Make a stand point / evaluation.

- Show the role of physical factors.
- Show the role of other factors.
- Conclusion.

PHYSICAL FACTORS:-

- Pests e.g. termites in Nakasongola which have degenerated savannah grassland to dry savannah through eating them.
- Locusts in Turkana have degenerated dry savannah to Arid and semi-arid.
- Prolonged drought / desertification which leads to the drying up of grasslands degenerating them to dry savannah and woodlands are degenerated to grassland savannah and dry savannah to arid vegetation.
- Wild bush fires during dry seasons which destroy savannah grasslands degenerating them to dry savannah and dry savannah degenerated to arid and semi-arid or these are burnt and replaced by bare ground.
- Flooding during heavy rainfall in areas of Kumi-Soroti which leads to the decaying of grasslands replacing them with swampy vegetation.
- Overgrazing by wild animals on the grasslands e.g. along Kazinga channel which have degenerated grassland savannah to dry savannah or bare ground.
- Human factors:
- Defforestation of woodlands reducing them to grasslands for charcoal burning.
- Crop cultivation which lead to disappearance of woodlands replacing them with planted crops.
- Animal grazing e.g. in Mbarara degenerates grasslands to dry savannah.
- Clearing grasslands, woodlands for settlement leading to their disappearance completely.
- Bush burning by cattle keepers and hunters which changes grasslands into scrubs.

- Road construction leading to the disappearance of woodlands replacing them with tarmac.

11.5 SWAMPY VEGETATION

This is a type of vegetation which grows in poorly drained lowland areas. They include papyrus which are mainly found in central Uganda along the shores of Lake Victoria and mangrove forests along the coast.

MANGROOVE SWAMPS

These are found growing along the East African coast mainly at Mombasa, Dar-es-Salaam, Tanga, Lamu and Malindi.

They grow best in salty waters at high tides.

CHARACTERISTICS

- Trees are ever green throughout the year due to constant high rainfall and adequate water supply by wave action.
- Trees shed off their leaves at different intervals as they fully mature.
- Trees have broad leaves in order to trap sunlight for photosynthesis and aid evapotranspiration in case of excess water in trees.
- Trees are short approximately 10m.
- Trees have short stumpy roots supported by aerial roots that bend at right angle to support the stout trunks.
- Trees are umbrella shaped and develop branches close to the ground.
- Trees form a close cover with bushy stands.
- Hard wood tree species due to constant high temperatures that accelerate water loss from trees.
- Trees develop grey foliage on their stems and the shrubs in the neighbourhood also have grey and silver foliage.

- Trees have a long gestation period of 40 years.
- Trees and thick shrubs grow parallel to the coast due to constant alluvial deposits by waves.
- Trees have limited undergrowth.

CONDITIONS:

- Hot temperatures of over 20°C which influence high rates of evapotranspiration.
- Heavy rainfall above 1000 mm favouring the growth of broad ever green leaves.
- High humidity of 70% favouring the growth of broad and ever green trees.
- Low altitude of 500m above sea level which are associated with hot temperatures.
- Deep leached alluvial soils ideal for the growth of forests.
- Shallow marine salty soils which at certain points allows the growth of shrubs.
- Poorly drained and heavily logged soils to allow forest growth.
- Government policy of conservation and preservation of forest.

ECONOMIC IMPORTANCE OF MANGROOVE FORESTS

- Mangroove forests act as a link between terrestrial and marine systems i.e. marine organisms depend on mangrove forests for part of their life cycle.
- Mangrove forests export organic matter to the sea for marine survival.
- They contribute to man's food web through their production of organic matter.
- Mangrove forests provide food for the animals at the coast.
- They promote timber production and thatching materials.
- Trees are traditionally known for the extraction of sugar and alcohol (Nipa palm).
- Contribute to honey and bees wax production since they provide spaces for bee hives.
- Mangrove swamps are sources of medicine e.g. Chincona tree which is highly processed to provide malaria drugs.

- Trees and shrubs are used to promote the art and craft industries.
- They act as homes for many birds and animals hence promoting tourism.
- Promote research and study for both marine and parastoral environment.
- Promote fishing activities e.g. lung fish and mud fish which are caught in the muddy environment.
- Provide timber for the construction of boats and floats for fishing.

Negative importance:

- They have poor soils due to leaching and salinity hence limiting agriculture.
- They are remote due to inaccessibility.
- Habour dangerous wild animals like crocodiles.
- Marshy areas act as habitats for disease vectors like snail and mosquitoes which transmit bilharzia and malaria.
- Hinder port construction.

11.6 MONTANE VEGETATION

This is the type of vegetation mainly found in cool mountainous areas of East Africa. It consists of vegetation zones on mountains. They vary due to varying altitude. They include the following:

Diagram:

Probable swampy vegetation and Mangroove forest below 500m above sea level.

Note: For characteristics and conditions, refer to the above notes.

This is followed by Savannah vegetation in areas below 1800m above sea level. This is categorized into;

- Dry savannah between 500 and 800m above sea level.
- Grassland savannah between 800 – 1500m above sea level.
- Woodland savannah between 1000 – 1800m above sea level.
- This is followed by Equatorial vegetation between 1800 and 2000m above sea level.

Note: For characteristics and conditions for the above vegetation refer to the above notes.

This is followed by temperate forests between 2500 and 3000m above sea level.

CHARACTERISTICS

- Coniferous soft wood trees like cedar, cypress, podar cap, camphor, e.t.c.
- Evergreen trees.
- Thick barks.
- Shorter trees particularly as rainfall decreases.
- Needle shaped leaves.
- No under growth.
- Trees have straight trunks and small branches.
- Trees are cone shaped.
- Trees are cone shaped.
- Trees appear in pure stands.
- Trees have a shorter gestation period.

CONDITIONS

- High altitude of 2500m – 3000m above sea level which favours the growth of coniferous trees.
- Cool temperatures of about 10^{o}C favouring the growth of coniferous trees.

- Low levels of humidity of less than 20%.
- Shallow infertile soils.
- Fairly drained soils.
- Steep slopes.
- Favourable government policy of conserving forest.
- Limited man's interference due to high altitude and steep slopes.

BAMBOO FOREST 3000 – 3500m above sea level

Characteristics:

- Bamboo plants have segmented stems and are hollow inside.
- Have small tough pointed leaves.
- Greenish when young but yellowish when mature.
- Have prop roots.
- Are single in layer.
- Trees are light.
- Trees have small and bent branches.

Conditions:

- High altitude of 3000 – 3500m above sea level.
- Cool temperatures of about 10oC.
- Low levels of humidity of less than 20%.
- Fairly drained soils.
- Thin skeletal infertile soils.
- Favourable government policy of conservation.
- Limited man's interference due to steep slopes.

MORE LAND AND HEATH (3500 – 4000m above sea level)

It consists of grass, shrubs and flowers. Plants include lobelia and giant ground sel, ferns and lichen.

- Plants appear very short.
- Flowers are turfted.

Conditions:

- High altitude of 3500 – 4000m above sea level.
- Thin skeletal infertile soils.
- Steep slopes.
- Cool temperatures of below 10ºC.
- Low levels of humidity of less than 20%.
- Low rainfall of below 700mm.
- Fairly drained soils.

Qn1. With reference to any mountainous in East Africa, account for the vegetation distribution.

- ***Approach:***
- Identify the mountain.
- Describe the vegetation zonations.
- Describe the characteristics of each vegetation cone and the conditions for each zone.

Qn2. To what extent have natural factors degraded / modified natural vegetation in East Africa?

Qn3. Examine the factors that influence the distribution of natural vegetation in East Africa.

- ***Approach:***
- Define natural vegetation.
- Identify, locate and describe all the characteristics of the various natural vegetation types in East Africa.

- Identify and explain the factors which affect the distribution of all the vegetation types, integrating the types.

12.0 CLIMATOLOGY

This is the study that involves analysis of specific distribution of the atmospheric conditions / phenomena out of which climate is composed.

CLIMATE

Average atmospheric conditions of a large area/place studied and recorded for a long period of time e.g. equatorial, tropical, arid and semi-arid climate.

WEATHER

Refers to the day-to-day atmospheric conditions of a small area studied and recorded for a short period of time e.g. rainfall, temperature, sunshine e.t.c.

Note: The above elements of weather are studied and recorded at a weather station where there is a Stevenson's screen.

12.1 STEVENSON'S SCREEN

It's a special box designed to keep thermometers used to measure weather elements at weather station e.g. wet and dry bulb thermometer e.t.c.

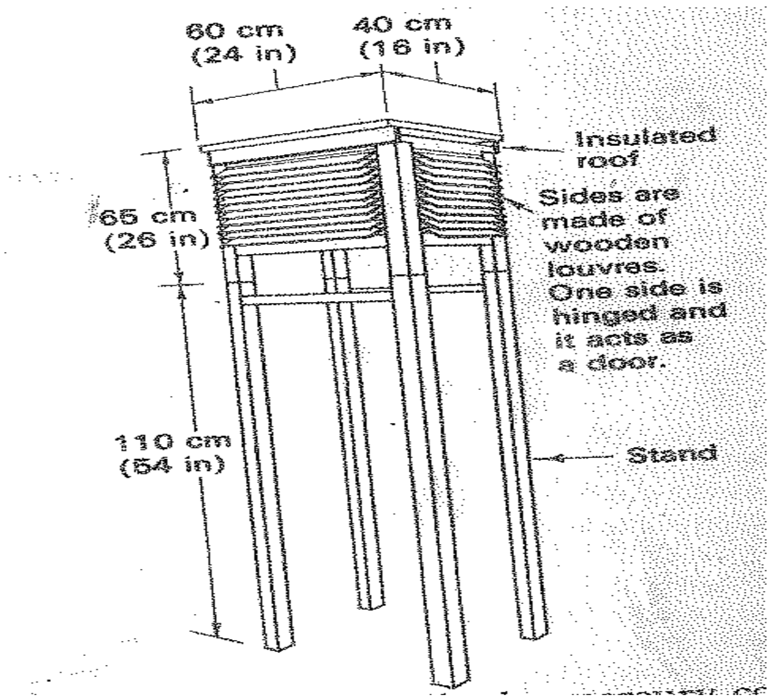
Designing of a Stevenson's screen

- It's designed in such a way that;
- It's about 1.2m in height above the ground to ensure that air temperature is measured.
- It's set up in an open space without surrounding houses and trees so as to measure only air temperature and to avoid exaggerated air temperatures from buildings and trees.
- It has louvers which protect the thermometers from direct sun rays and also to allow free circulation of air whose temperature is to be measured by the thermometers inside.

- The screen is painted white in order to reflect sun rays and heat to avoid exaggerated results.
- It's made of wood which is a poor conductor of heat to limit direct insolation.
- It must stand on a grass covered ground to minimize heat from the ground.
- The roof must be double boarded to prevent heat from reaching inside.

A Stevenson's screen

Diagram:



12.2 MEASURING OF THE ELEMENTS OF WEATHER

(1) Temperature

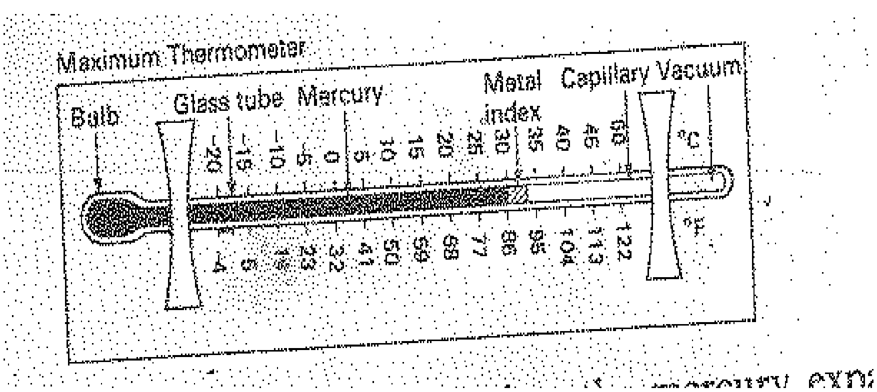
Is the balance of heat received from the sun's insolation and the heat lost by the earth through radiation i.e. it's the degree of hotness or coldness of atmospheric air expressed in degrees centigrade or <u>fareignheight.</u> The instrument used to measure temperature is called a thermometer.

There are 3 main types of thermometers i.e. maximum, minimum and six's thermometers.

(2) Maximum thermometer

It's designed to measure the maximum temperature of the day. It contains mercury. On top of the thread, there is a metal index which is pushed up by the expanding mercury to record the highest temperature of the day. If temperature falls, the mercury contracts but the metal index remains behind. The maximum temperature is then obtained by reading the scale at the end of the index which was behind the mercury. The index is pulled back by a magnet.

<u>Diagram:</u>



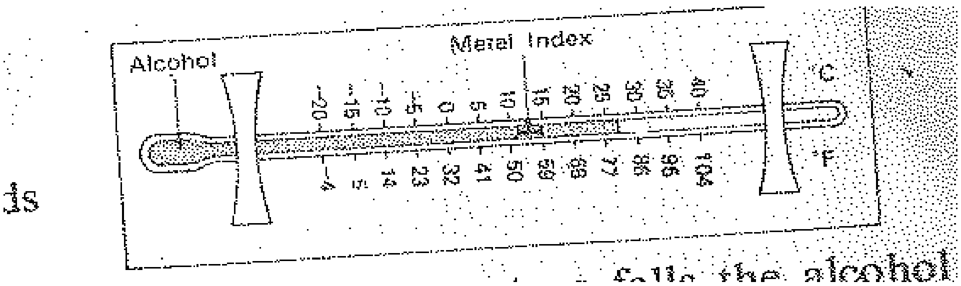
(3) Minimum thermometer

It's designed to measure the minimum temperature of the day. It contains alcohol within which a metal index is suspended.

When the temperatures falls, the alcohol contracts and its meniscus pulls the index along the tube.

The minimum temperature is then obtained by reading the scale along the tube. The index is then returned to its normal position by tilting the thermometer.

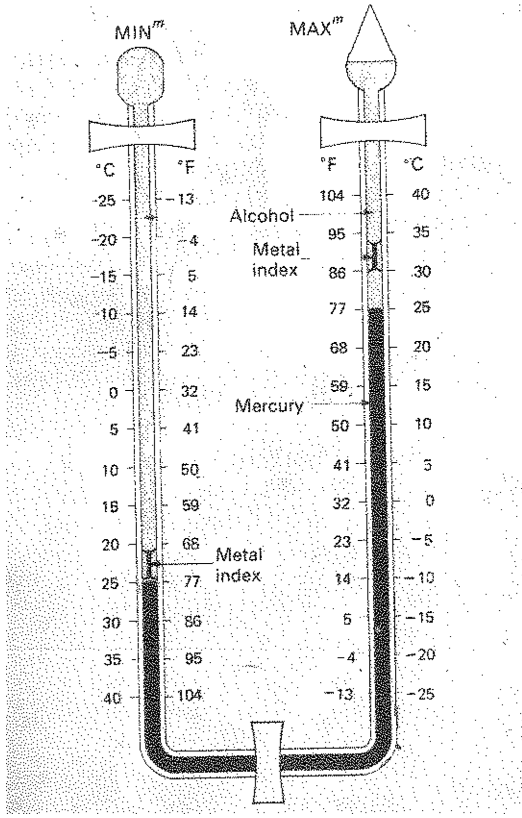
Diagram:



(4) Six's thermometer

It's designed to measure both the minimum and maximum temperatures of a day concurrently. It's a two limbed thermometer which contains mercury and alcohol. When atmospheric temperatures rise, alcohol of the left limb expands and pushes mercury down the limb forcing mercury in the right limb to rise and record the highest temperature of the day. The alcohol will have vapourised and occupied the space in the bulb. When temperature falls, the alcohol in the left limb contracts and in the process, the mercury in the left limb pushes the metal index upwards to measure the lowest temperature of the day.

Diagram:



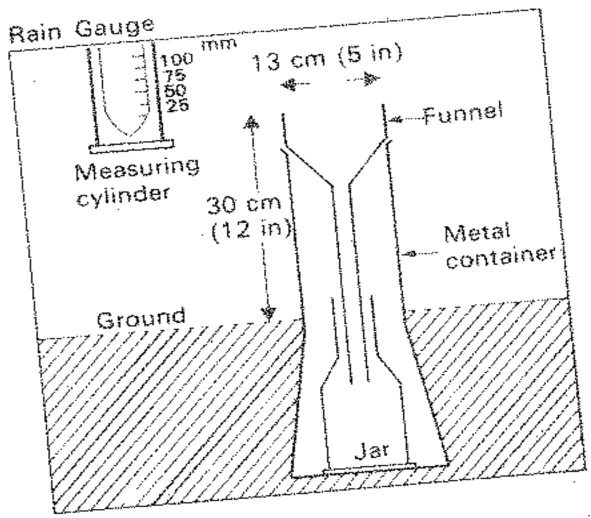
MEASURING OF RAINFALL

Rainfall is a type of precipitation in form of water droplets.

The instrument used to measure it is a rain gauge. It consists of an outer cylinder/metal container inside which is funnel which fits in the neck of a collecting bottle. It's sunk into the ground and only part of it (top half) is visible.

The rain falls into the open top of a funnel and the funnel directs the water into a collecting bottle. Each day the bottle is removed from the container and its water is emptied into the measuring cylinder to measure the rainfall received in mm or inches.

Diagram:



Positioning of a rain gauge at a weather station.

- It must be placed in an open place so that no water enters it from buildings, trees or any shelter.
- It must be sunk a few centimeters into the ground to avoid evaporation of the collected water.
- About 30cm (12 inches) of the rain gauge must be stuck above the ground to prevent water from splashing into the jar and prevent surface run off from entering the jar.

HUMIDITY

Refers to the amount of water vapour in the atmosphere.

Absolute humidity

This is the actual amount of water vapour present in the given quantity of air at a given time. It's expressed in g/cm^3.

It depends on temperature and pressure.

Relative humidity

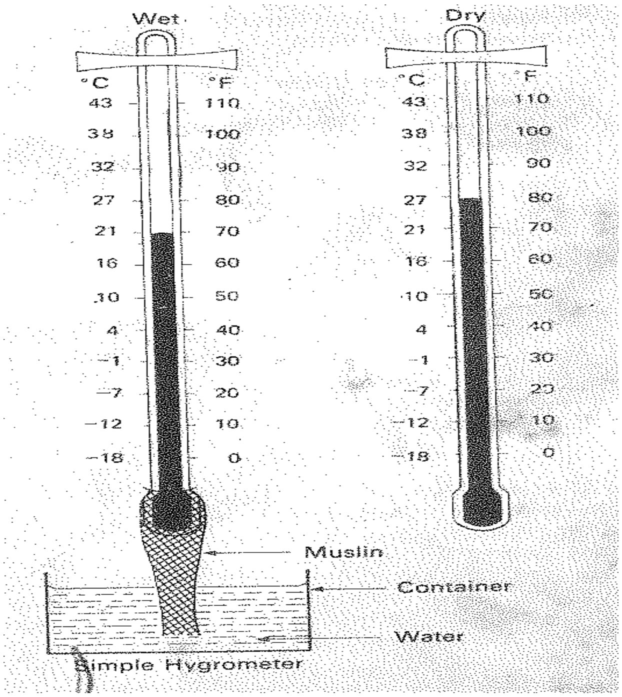
Refers to the actual amount of water vapour present in a given volume of air expressed as a percentage or ratio the maximum it can hold when saturated.

It also depends on temperature and pressure.

Measuring of Humidity

The instrument used in a simple hygrometer. It consists of two ordinary thermometer one tied in muslin which dips into a container of water. This is called the wet bulb thermometer and the other is the dry bulb thermometer which is left free in the atmosphere. When the air is not saturated, water evaporates from the muslin and cools the wet bulb thermometer, causing the contraction of mercury.

Diagram:



The two thermometers show different readings i.e. same reading means that there was no evaporation and the atmosphere was saturated.

A small difference in the readings means that humidity is high in atmospheric air.

A large difference means that the humidity is low in the atmospheric air.

ATMOSPHERIC PRESSURE

Is the force exerted onto the earth's surface by the atmospheric weight. It keeps on changing depending on latitude, altitude, temperature differences and rotation of the earth.

It is highest at sea level where it measures upto 1.034kg force per cm.

The instrument used to measure pressure is called a mercury barometer. It consists of a mercury container with a long glass tube inverted onto the mercury in the container.

The weight of atmospheric air above the surface of mercury will force the mercury to enter the tube hence determining atmospheric pressure of the environment.

If atmospheric pressure decreases, the mercury column falls and if it increases, the mercury column rises.

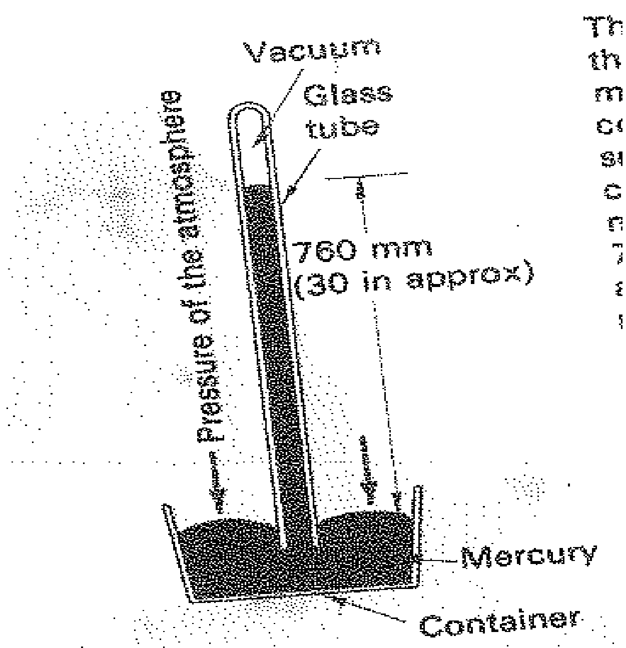
At sea level the mercury column is normally between 735 – 745mm.

Such a reading in mm is converted into millbars by using a special log book were 1000milbs = 760mm. the glass tube of 760mm supports an atmospheric pressure of about 18kg altitude.

At different places of the world, the atmospheric pressure is not the same. This difference leads to the development of winds where air masses blow from high pressure zones to low pressure zones.

A MERCURY BAROMETER

Diagram:

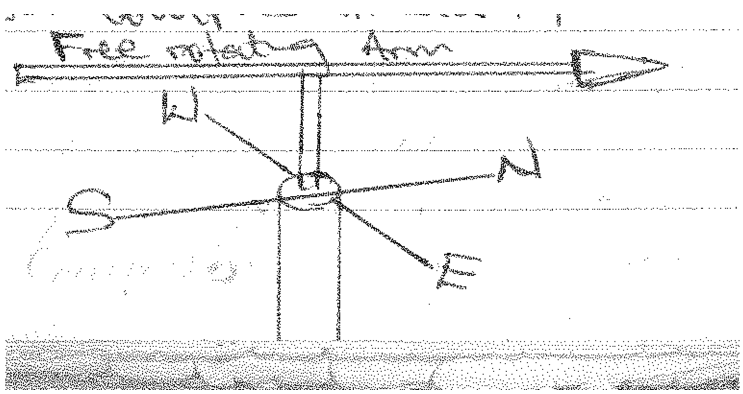


WIND DIRECTION

Wind is determined by the wind vane. It contains a free rotating arm pivoted on a vertical shaft and the arrow of the wind vane will always point in the direction from which the wind blows and wind will be named after that direction.

A WIND VANE / COMPASS DIRECTION

Diagram:

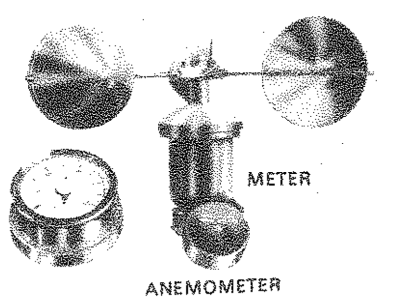


WIND SPEED

It's measured by an instrument called the anemometer. It has got 3 or 4 horizontal arms pivoted on a vertical shaft metal caps are fixed at the end of the arms. When there is wind, the wind hits the caps which forces the arms to begin rotating. The rotation of these arms operate a meter which records the speed of wind in km per hour.

The higher the speed of wind the more the meter moves and vice versa.

Diagram:



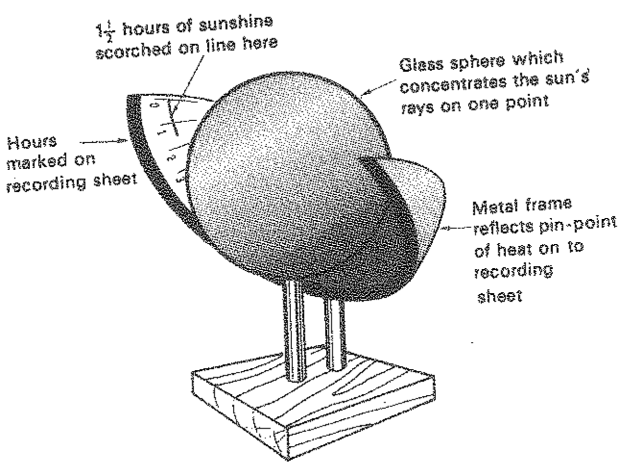
SUNSHINE

To measure the duration of sunshine for a day, meteorologists use a sunshine recorder or compabells stoke apparatus. It determines the hour of the day when it's brightest outside.

The instrument consists of a glassphere, recording sheet of paper and metal frame. The sphere focuses the sunrays on the sensitive recording card gradiated in hours. When the sunshine burns, it / scotches a line on the sensitive card in the hour when it was brightest. Faint sun rays even at down or when the sun is obscured, are not recorded.

A CAMPABELL STOKE APPARATUS / SUNSHINE RECORDER

Diagram:



12.3 VISIBILITY

This refers to the extent to which light or weather enables one to see things at a distance. Visibility varies due to constituents in the atmosphere. These include:-

- **Haze**

  This is a mass of smoke particles in the low atmosphere where humidity is relatively low.

It reduces visibility to below 2km.

- **Mist**

  Water droplets formed as a result of condensation of water vapour floating at ground level. It reduces visibility to about 1000m.

FOG

Is a dense mass of water droplets containing smoke and water particles. Reduces visibility to less than 1000m.

TYPES OF FOG

(1) Smog

This is a type of fog which occurs in industrial areas where fog and smoke combine. It reduces visibility to less than 200m.

(2) **Advection fog** is a type of fog formed when warm air blows over a cold surface which cools it instantly forming fog.

(3) **Radiation fog** occurs as a result of the rapid cooling of the land surface which cools the air near the surface to saturation level, forming fog. It occurs in temperate regions during winter and in swampy areas in the tropics during early morning and night.

(4) **Sea fog** occurs when cooling takes place over water bodies where warm and cold ocean currents meet and the warm air above the warm ocean current rises above the cold ocean current which cools it instantly, forming fog.

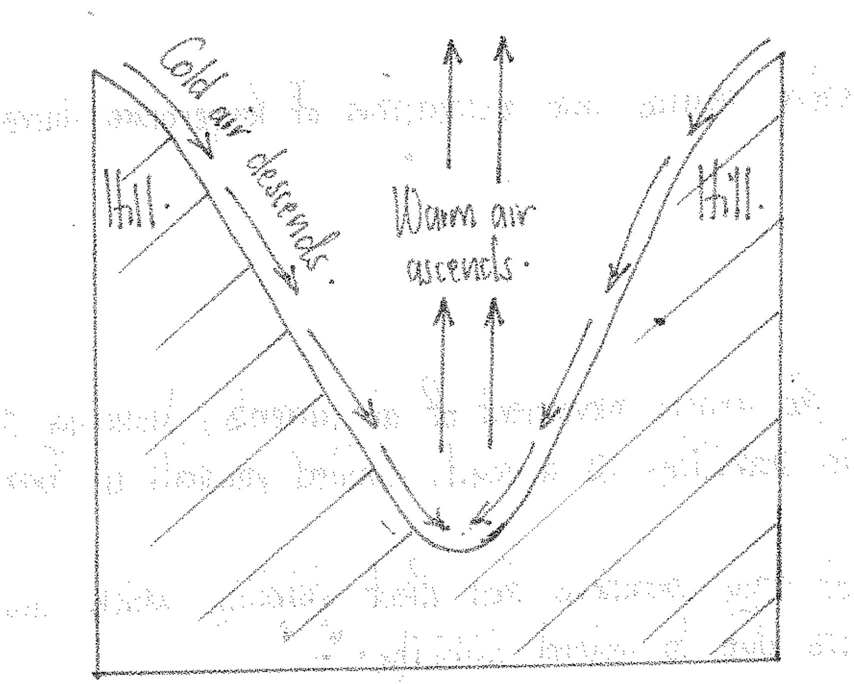
(5) **Frontal fog** formed when a warm air mass falls under a cold underlying air at a front forcing it to cool and condense to form frontal fog.

(6) **Hill fog** which occurs in hilly areas in the early morning. It occurs during dry and calm weather. During the day, much insolation is received, leading to intense heating of mountain slopes.

Radiation and rapid cooling occurs at night on the hill slope. Heavy cool dense/air descends into the valley and collects into the hollow displacing the warm air to higher levels. At the edges of cool and warm air, mixing occurs resulting into condensation at lower levels, forming hill fog.

GENERAL CAUSES OF FOG

Diagram:



- Meeting of cold and warm ocean currents.
- Rapid radiation (radiational form)
- Warm air blowing over a cool land / water surface (advection fog)
- Falling of warm air into a cold underlying air nearer the earth's surface at a front (frontal fog).
- Industrial emission of gases which combine with fog to form smog.

EFFECTS OF FOG

- It leads to poor visibility which leads to accidents.
- Leads to coldness related diseases e.g. pneumonia, Asthma.
- Frost conditions in valleys discourage the growth of some crops as it limits flowering and fruiting of crops.
- Cool conditions limit working hours.
- Unfavourable cold temperatures discourage settlement in valleys e.g. Kigezi highlands.
- In East Africa occurrence of fog in the morning is followed by clear skies and hot temperatures in the afternoon.
- Fog leads to temperature inversions.
- Fog may favour the growth of some crops such as pyrethrum, tea, sorghum and temperate crops e.g. apples, vines e.t.c.
- Fog results into easy spread of industrial pollutants at a high level i.e. industrial fumes being warm, rise first through fog and then spread fast on reaching the level of warm air.

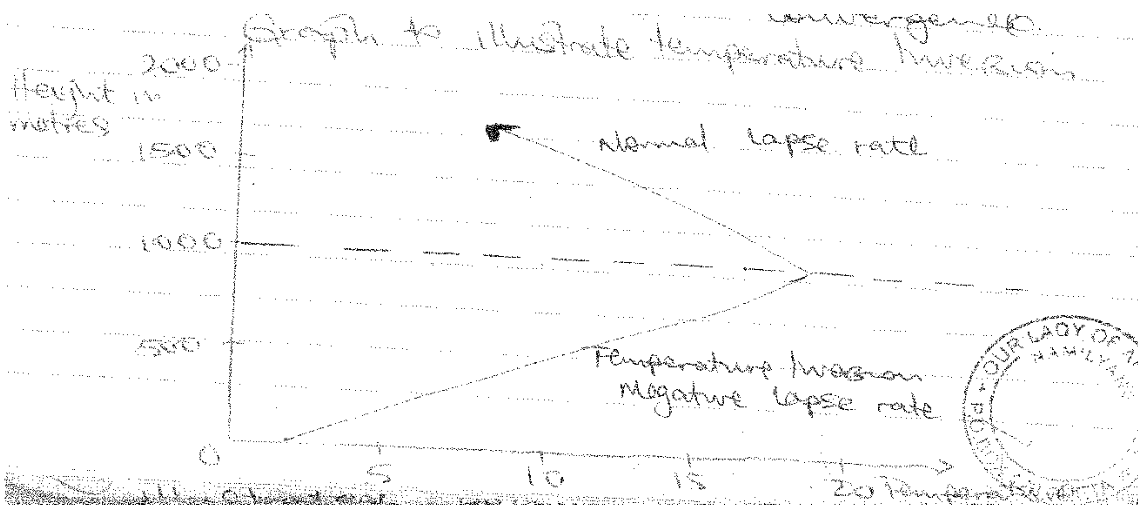
12.4 TEMPERATURE INVERSIONS

- Temperature inversion refers to an atmospheric condition in which air temperature increases with height into the atmosphere.

Note: It's the reverse of normal / environmental lapse rate where temperatures decrease with altitude.

- With temperature inversion, the higher you go, the warmer it becomes.
- However in the troposphere, the increase in temperature with altitude is up to a certain level referred to as the temperature inversion point level. Beyond this point, the normal lapse rate applies.
- In the troposphere, temperature inversion is a temporary phenomenon. It's experienced in the morning hours.
- As the temperatures rises/as the sun warms up the air, the condition later disappears.
- There are basically two forms of temperature inversions i.e. low ground level, temperature inversion especially in the hilly areas due to rapid outward radiation / when warm air is advocated over a cold surface.
- There is also the high level inversion that occurs due to frontal convergence.

Diagram:

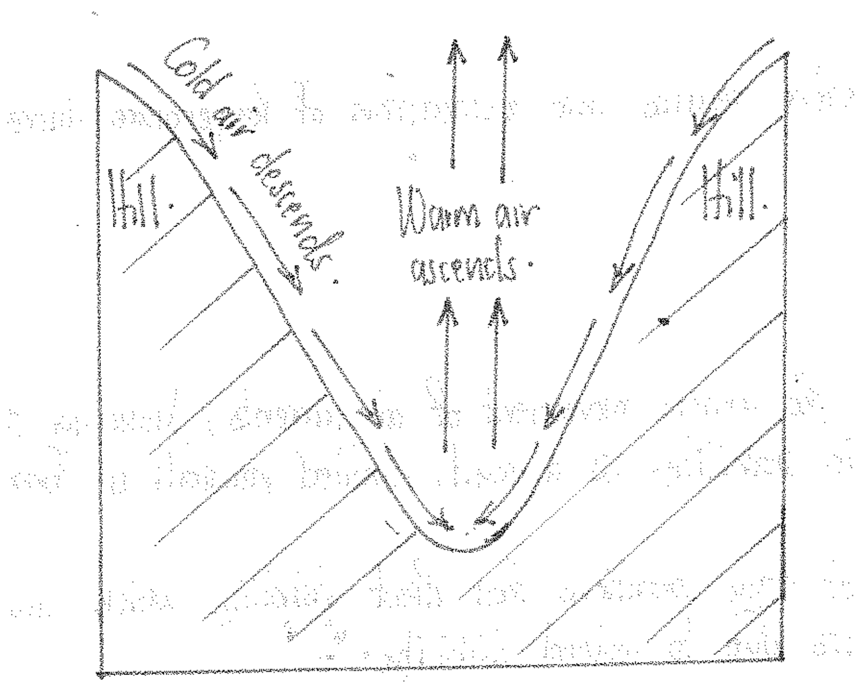


In East Africa, temperature inversions are common in hilly / mountainous areas and areas of limited cloud cover marked by air stability/calm weath.

CAUSES / CONDITIONS FOR TEMPERATURE INVERSIONS

- **Hilly and valley nature of relief.** Out radiation and rapid cooling at night on mountain / hill slopes, results into cold dense air. This dense cold air then descends down into the valleys under the influence of gravity and collects in the valley / hollow, displacing warm light air upwards to the higher levels. This results into formation of fog, mist and is normally experienced in the early morning.
- The subsidence of cold dense air results into temperature inversion referred to as Katabatic effect.
- It's common in Kigezi highlands, Ankole hills and central Buganda hills e.t.c.

Diagram:



- Radiation cooling due to rapid outward radiation by the surface at night due to limited or lack of cloud cover. This excessive loss of heat, results into a cold surface that cools the air immediately above it.

- Meanwhile the air layers further above are warmer since some of the heat is retained by the greenhouse gasses, humidity and dust particles. This may also be referred to as nocturnal radiation temperature inversion.
- Frontal convergence of two air masses of different characteristics i.e. the meeting of a warm light air mass and a dense air mass at a frontal zone. The warm air being lighter is lifted above the cold dense air mass or the cold air mass under cuts, the warm air leading to temperature increase with altitude.
- This is referred to as frontal/cyclonic temperature inversion and occurs within the ITCZ zone in East Africa.
- Advection also results into temperature inversion. This is when a mass of warm air current horizontally blows over a cold surface. The lower layers of the air mass will be cooled by the cold surface while the overlying layers remain warmer.
- The layer in contact with the cold surface may be cooled to form advection fog.
- This is referred to as advective temperature inversion.
- Trade winds blowing at a higher altitude tend to be warmer than the air close to the surface. This therefore results into a situation of temperature increase with altitude.

EFFECTS OF TEMPERATURE INVERSIONS

- Temperature inversions retard the vertical movement of air currents, inducing a state of atmospheric stability. As a result, limited rainfall is formed.
- Low rainfall may also be due to premature / surface condensation.
- Formation of fogy conditions that affect visibility / transportation which poses a risk of accident due to reduced visibility.
- Frosty conditions are created which discourage the growth of some crops.
- Frost tends to destroy the flowers of crops e.g. bananas and fruits.
- Cold / frosty conditions reduce morning working hours.
- Cold / frosty conditions discourage settlement in the valley bottoms.

- It leads to occurrence of coldness related diseases e.g. cold, Asthma e.t.c.
- It results into easy spread of industrial pollutants at high levels i.e. industrial fumes being warm, rise fast through the cold air and then spread horizontally on reaching the level of warm air.

12.5 HAIL / HAIL STONES

Form of precipitation falling in form of small pellets of ice / hail stones. It's made up of frozen rain droplets which range between 5 – 50mm in diameter.

It's associated with extreme instability in the atmosphere resulting from uplift of air by convective currents.

It usually occurs, in unstable cumulo nimbus clouds where vertical uplift / rise of air are strong enough and carry condensed droplets above to great heights of the freezing level i.e. where they are turned into ice crystals at very high altitude.

The initial droplets freeze above the freezing point hence condensation nucleus ice. After being carried upwards to great height by upward currents, an additional layer of ice is formed on the original ice nucleus by collision and coalescence with super cooled water vapour / droplets around.

The pellets fall and rise many times until the weight of the enlarged ice crystals is sufficiently great to overcome any uprising current, then the crystals fall as hailstones due to gravity.

12.6 TEMPERATURE

Is the balance of heat released by the sun onto the surface and the heat lost by the earth to the atmosphere through radiation.

The world's atmosphere exists at varying temperatures and the main source of heat energy for the earth is the sun that measures upto 51800ºC. The sun constantly emits solar energy which influences temperature on the earth. This solar radiation is what is known as the sun's insolation.

SOLAR RADIATIONS / SUN'S INSOLATION / HEAT RECEIVED

This refers to the total energy / heat released by the sun through the atmosphere onto the earth's surface where it's converted into heat energy which is eventually distributed onto the earth's surface and into the atmosphere to raise environmental temperatures. It passes into the atmosphere as a beam of short waves. It occurs during day time.

Note: The water, land surfaces and atmosphere all attract the emitted heat from sun's insolation.

TERRESTRIAL RADIATION

Refers to the heat energy transferred from the earth's surface to the atmosphere after receiving solar radiation which is converted into heat energy. Its transferred in form of long waves and occurs all the time i.e. both day and night.

The amount of terrestrial radiation varies with the nature of the earth's surface, area and size e.g. water surfaces emit less radiation than land surfaces. Mountain tops emit less radiation than lowlands.

Terrestrial radiation gives arise in atmospheric temperatures.

FACTORS INFLUENCING TEMPERATURE DISTRIBUTION

(1) Latitudinal location

The overhead sun in the tropics leads to hot temperatures because sun's insolation is distributed over a narrow area.

Whereas outside the tropics the sun appears to be at a distance and temperatures are correspondingly lower because sun rays are spread over a wider area and travel for longer distances.

(2) Movement of the overhead sun north and south of the equator.

An overhead sun in the northern hemisphere causes high mean annual temperatures in July while at the same time causing low mean annual temperatures over the Capricorn.

On the centrally an overhead sun in the January causes higher mean annual temperatures over the Capricorn in the southern hemisphere but at the same time causes low annual means of temperature over the cancer. (Northern hemisphere) at the same time.

(3) Altudinal location

High altitude areas have low temperatures throughout the year. Temperatures decrease with an increase in altitude this is because of the rare fied atmosphere. This makes higher altitudes unable to trap sun's isolation / heat and the heat escapes rapidly.

Whereas at low altitudes, the atmosphere is full of impurities which trap / preserve a lot of heat at the lower altitude. Hence raising environmental temperatures and it reduces as one gains height.

Infact environmental temperatures change at a rate of 1^{o}F for every 300ft rise and this is called environmental lapse rate.

(4) Prevailing winds

These influence environmental temperatures by transferring heat from one place to another e.g. the north east trade winds originate from the Arabian Desert and are hot winds. They raise the temperatures of Turkana and Karamoja.

In temperate latitudes (45 – 65°), prevailing winds from the land to the sea lower winter temperatures but may raise the summer temperatures.

The prevailing winds from the sea to land, lower summer temperatures and raise winter temperatures.

In tropical latitudes, on shore winds modify temperature of coastal areas because they will have blown over cool ocean surfaces.

The local winds in different environments often produce rapid upward and downward changes in temperatures and the inland lakes and slopes of mountains.

(5) Ocean currents

These transfer temperatures from one place to another e.g. warm ocean currents like Mozambique, Guinea and Agulhas, have a warming effect which raises temperatures of the adjacent land masses.

On the centrally cold ocean currents such as Benguela and Canary currents, tend to lead to low temperatures on coastal lands adjacent to them.

(6) Cloud cover

Clouds reduce the amount of solar radiation reaching the earth's surface and amount of the earth's radiation leaving the earth's surface. This explains why day temperatures in tropics rarely exceed 30^{o}C and why night temperatures never fall below 21^{o}C.

Whereas the absence of clouds in desert and semi-desert environments explains why temperatures may rise above 38^{o}C and fall below 21^{o}C during the night.

(7) Large water bodies

Such as oceans, lakes, rivers, wetlands e.t.c. also have a cooling effect / moderating effect on mean annual temperatures through a combined effect of breezes and on shore winds on the adjacent land masses.

(8) Surface cover

These influence temperature due to the ability of such surfaces to absorb insolation.

Ice surfaces such as on mountain Rwenzori reflect heat hence low temperatures.

Whereas dark colored land surfaces absorb much insolation leading to high mean temperature ranges.

(9) Aspect

It influences temperature distribution in that slopes facing the direction of the sun are often warmer than the slopes on the other side of the sun's insolation e.g. in the tropics, the East facing slopes of mountain are warmer in the morning and cooler in the evening.

Whereas the west facing slopes are warmer in the evening and cooler in the mornings.

In the northern hemisphere, the south facing slopes are warmer than the north facing slopes whereas in the southern hemisphere the north facing slopes are warmer than the south facing slopes.

12.7 FACTORS FOR THE VARIATIONS IN HEAT RECEIVED / SOLAR RADIATION

(1) **The amount of heat received varies** due to obstacles between the sun (source of radiation) and the earth's surface.

(2) **Influence of cloud cover**. Cloud cover reflects, absorbs isolation and this reduces the amount of heat reacting the earth's surface.

(3) **Distance between the sun and the earth's surface**. This varies with altitude. The overhead sun gives higher isolation at the equator than at the southern and northern hemisphere during summer.

At the poles, the amount of the sun's isolation is low. This is also true of the northern and southern hemisphere during winter seasons. When the sun is far from the earth's surface. These are largely the effects of the earth's rotation.

(4) **Length of the day and night**. The day light hours of summer are longer than nights. This leads to more isolation / heat than during winter where the nights are longer and days are shorter in temperate regions, leading to less heat received.

(5) **Existence of increased greenhouse gases** and the depletion of the ozone layer. This makes ultra-sun's isolation reach the earth's surface, leading to more heat being received.

(6) **Influence of aspect**. Slopes facing away from the sun receive minimum heat well as slopes facing the sun receive maximum heat (more).

(7) **Latitudinal location influences the amount of heat received**. Tropical regions being astride the equator, receive maximum heat whereas those far away areas in temperate regions, receive less heat.

TEMPERATURE READING

(1) Diurnal range of temperature

= Difference between daily maximum and daily minimum temperature.

(2) Mean daily temperature

$$= \frac{Daily\ maximum + daily\ minimum\ temperature}{2}$$

(3) Mean monthly temperature

$$= \frac{Average\ daily\ temperature\ of\ the\ month}{Number\ of\ days\ in\ the\ month}$$

(4) Mean annual temperature

$$= \frac{Sum\ of\ mean\ monthly\ temperature\ of\ year}{12\ months\ of\ the\ year}$$

(5) Annual range of temperature

= Difference between maximum monthly temperature and minimum monthly temperature of the month i.e. the difference between hottest and coolest month of the year.

12.8 HUMIDITY

It refers to the amount of water vapour in the atmosphere.

FACTORS INFLUENCING HUMIDITY VARIATIONS IN EAST AFRICA

(1) Temperature

High temperatures encourage high rates of evaporation leading to high humidity while low temperatures lead to low rates of evaporation leading to low humidity.

Consequently areas with high temperatures e.g. around the equator like L. Victoria basin have high humidity while areas with low temperatures like the highland areas have low humidity.

(2) Water bodies

These are sources of water vapour consequently areas with large water bodies have high humidity while areas with limited water bodies e.g. North eastern Uganda, Northern Kenya have low humidity.

(3) Altitude

There is high humidity at low altitudes due to hot temperatures and being near water vapour sources and also because water vapour molecules are pulled downwards by gravity from high altitude well as areas at high altitudes e.g. mountains have low humidity.

(4) Vegetation cover

Areas with thick vegetation cover lead to high humidity. This is because the thick vegetation there is high evaporation leading to a lot of water vapour in the atmosphere whereas areas with scanty vegetation e.g. semi and vegetation in Karamoja, Turkana have low humidity because of limited evaporation.

(5) Air masses / winds

Winds have the ability to transport water vapour from one place to another, thus influencing the amount of water vapour in a given place e.g. the south east trade winds pick a lot of moisture from the Indian Ocean leading to high humidity at the East African coast.

The westerly winds from the Congo pick a lot of moisture from the Congo forest leading a lot of humidity in some parts of western Uganda.

The north east trade winds originate from dry areas leading to low humidity in northern Kenya and Karamoja.

(6) Ocean currents

Areas near Warm Ocean currents like of East African coast are affected by the warm Mozambique ocean currents have high humidity because of high evaporation.

Well as areas boardering Cold Ocean current like canary and Banguela currents have low humidity because the cold ocean currents don't experience evaporation because of the low temperatures.

(7) Human activities

Human activities like deforestation, swamp reclamation, bush burning e.t.c. reduce evaporation and evapotranspiration leading to low humidity in an area.

Man's activities like afforestation and reafforestation and cloud seeding increase humidity in an area.

(8) Continentality / distance from the sea

Areas near the sea tend to have high humidity because the sea is a source of water vapour while areas far away from the sea have low humidity because of being far away from water vapour sources.

(9) Seasonal, weather changes / ITCZ

When the sun is over head a certain area, there are hot temperatures resulting into high evaporation and high humidity. The hot temperature leads to low pressure resulting into being a zone of convergence (ITCZ) and winds that converge to such areas bring humidity from their sources, leading to high humidity in July in northern Uganda and in January in southern Tanzania.

(10) Influence of relief

The wind ward sides of mountains act as barriers to the moisture bearing winds hence loading to the high humidity on the wind ward sides of mountains.

Generally flat land areas e.g. northern Uganda, north eastern Uganda, central Tanzania and northern Kenya have less humidity because the moisture bearing winds just blow over such areas. Uninterruptedly without rising or being trapped / to a rise humidity of such areas.

Questions:

(a) Distinguish between absolute humidity and relative humidity.

(b) Account for the variation in humidity in East Africa (UNEB 2007)

12.9 WINDS

Wind is moving air blowing from one environment to another.

The development of wind is as due to many factors e.g. difference of wind in pressure and rotation of the earth.

FACTORS THAT INFLUENCE THE DEVELOPMENT OF WINDS

- Influence of the earth's rotation. Stationary air can be forced to move by the rotation of the earth i.e. as the earth rotates it forces stationary air to begin moving as wind.
- The rotation of the earth also deflects wind to the right in the northern hemisphere and to the left in the southern hemisphere.
- In the diagram below, the dotted lines represent the path that the wind would take if the earth was stationary.
- But winds don't follow the straight line, for they get deflected as shown by the continuous lines below (Pic.9)

DIFFERENCES IN PRESSURE AND TEMPERATURE

These influence wind in that air blows from high pressure zones where temperature is generally low to low pressure zones where temperature is high. This can be illustrated by land and sea breezes.

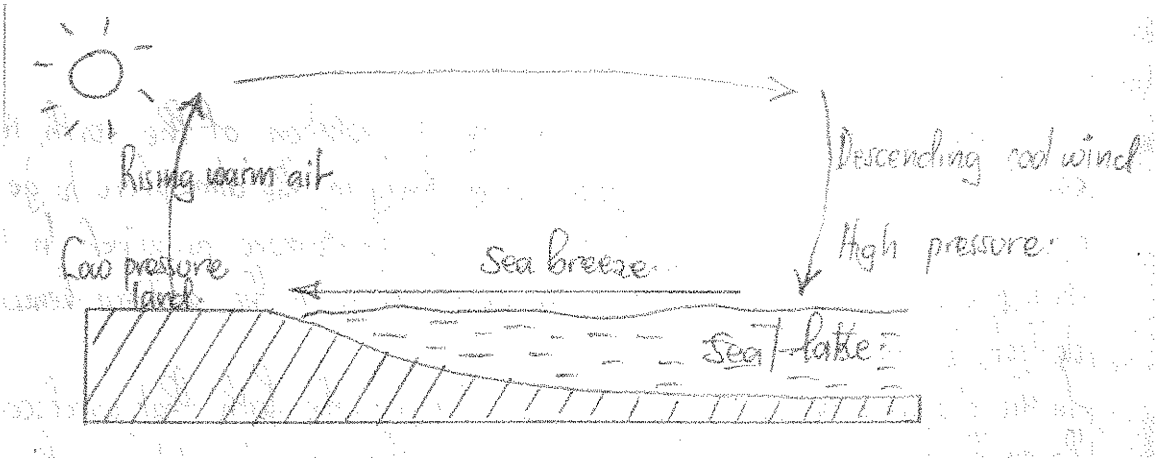
SEA BREEZE

A sea breeze is a local wind which occurs in areas where land is lying in close proximity to a water body e.g. shores of Lake Victoria and coastal areas of East Africa during the day.

During day time, land adjacent to the sea heats up much quicker than the sea / water.
Air above land becomes warmer, expands and begins to rise.

A cooler air from the sea then flows towards the land to occupy space of the rising warm air. The rising warm air eventually cools, condenses to form cumulo nimbus clouds and later results into heavy showers usually in afternoon.

Diagram:



EFFECTS OF SEA BREEZES ON CLIMATE OF ADJACENT LAND MASSES

- Lowering of temperature of land in the afternoon.
- It leads to formation of foggy / misty conditions on land and leads to poor visibility.
- On shore rainfall is formed which is usually received in the afternoons.
- It results into high thunder and lightning.
- It results into high humidity on land.
- It leads to formation of cumulo nimbus clouds after the warm air has been displaced upwards and has condensed.

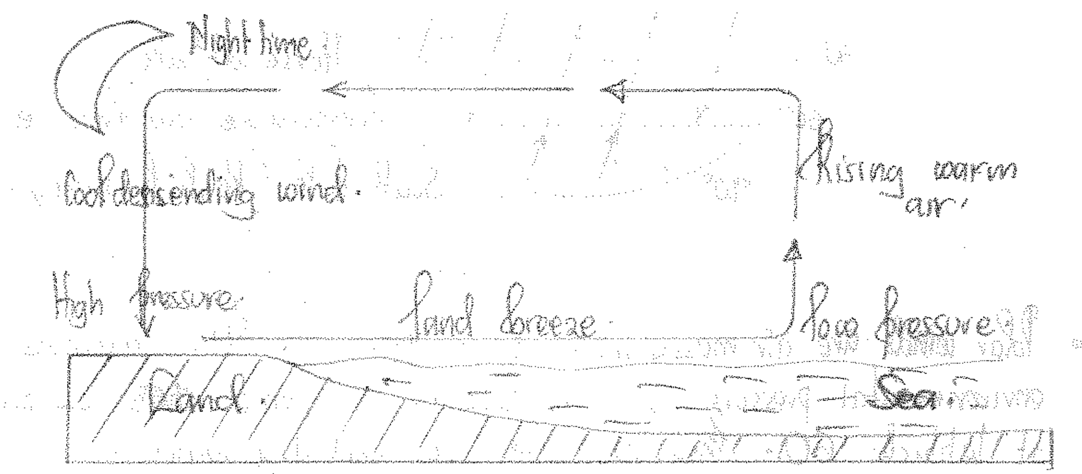
LAND BREEZE

Is a local which occurs in an area lying in close proximity to water body e.g. shores of L. Victoria, coastal areas of East Africa during the night.

During the night, the land experiences rapid loss of terrestrial radiation at coastal lands / shores. Cools much faster than the sea / water which retain much of its heat. Water loses heat much slowly such that air above it also warms up; low pressure is created over the warm sea and high pressure over a cold land.

Cold air from land where there is high pressure, blows towards the sea to replace the rising air hence a land breeze.

Diagram:



EFFECTS OF LAND BREEZE ON CLIMATE

- It decreases temperature of the sea.
- It leads to the formation of foggy conditions over the sea which results into poor visibility.
- Offshore rainfall is formed over the sea.
- Dry conditions on land because little or no rainfall is received.
- It results into violent thunderstorms and lightening.
- It results into high humidity over the sea or lake.
- It results into the formation of a thick cloud.

PREVAILING WINDS

Are winds / type of air masses which blows more frequently over a particular region.

Prevailing winds in different regions depends on environmental temperature-pressure systems and rotation of the earth.

The overhead movement of the sun determines the latitude within which the prevailing winds exist.

Prevailing winds are often named according to the direction from which they blow. The air includes polar winds, westerlies and trade winds.

Note: If the earth was stationary, winds would blow in the straight line but they are deflected to right in the northern hemisphere to the left in the southern hemisphere by the rotation of the earth.

CHARACTERISTICS OF POLAR WINDS

- Polar winds are air masses which blow from the poles where environment pressure is high towards the temperate low pressure zones at latitude 60. They are often cool and dry winds.
- They are more pronounced in the southern hemisphere. They are deflected to the right to become the north east polar winds and to the left in the southern hemisphere to become the south east polar winds.
- They are irregular in the northern hemisphere.

CHARACTERISTICS OF WESTERIES

- They blow from the horse latitude to the temperate low pressure latitude 60^o.
- They are deflected to the right to become the south westerlies in the northern hemisphere and to the left in the southern hemisphere to become the north westerlies.
- They are variable in both direction and strength.
- They contain depression.

CHARACTERISTICS OF TRADE WINDS

- They follow regular path / route.

- They blow from horse latitudes to doldrums.
- They are deflected to the right in the northern hemisphere to become north east trade and to the left in the southern hemisphere to become the south east trades.
- They are very constant in strength and direction.
- They sometimes contain intense depression.

Qn. **(a)** What is an air mass?
(c) Explain the influence of air masses on the climate of East Africa.

AIR MASSES

An air mass is a larger body of air with uniform horizontal temperatures and humidity conditions.

An air mass forms when stationary air settles over a larger area for long enabling it to acquire uniform conditions of humidity and temperature.

Air masses have got certain characteristics

- They have definite source origin / latitudes e.g. polar winds from the poles.
- Trade winds from the tropics
- Uniform humidity and temperature conditions.

- Air masses blow from areas of high pressure to areas of low pressure.
- They blow either overland (tropical continental) or over the sea (tropical maritime)
- Air masses converge at a front.
- They may modify completely/partially conditions of areas – they blow over.

Air masses which affect the climate of East Africa include:-

- Tropical maritime or south east trade winds. These originate from the Indian Ocean and blow on shore of the adjacent land masses.
- They lead to high humidity modified (cool temperature) cloudy conditions and heavy rainfall along the east African coast.
- They transverse mainland of Tanzania when they are hot and dry causing very hot temperatures less humidity, clear skies and dry conditions there.
- Over Lake Victoria they are recharged with moisture and deflected to the right at the equator thereby bringing conditions of high humidity, cloudy and wet conditions over the northern shores and north eastern shores of L. Victoria.
- However because of this deflection they blow off Ankole-Masaka dry conditions leading to low humidity, unreliable rainfall and clear skies.

NORTH EAST TRADE WINDS

These originate from the Arabian desert drop all their moisture on the leeward side of Ethiopian highland and on descending into northern Kenya, north western Kenya and north eastern in Uganda they are dry and hot, causing conditions of very low humidity, clear skies and low / unreliable rainfall.

Often times, tropical marime and the north east trade winds meet at the I.T.C.Z and in the process, the warm moist tropical air masses are forced to rise, thereby giving rise to cumulo nimbus clouds, light variable winds, frequent thunderstorms and cyclonic rainfall.

Westerlies

These blow from Congo basin and they are warm and moist. During their east ward journey, they blow over western Uganda highlands bringing heavy rainfall, thick cloud cover, high humidity, modified temperatures.

On descending the leeward side of, the western Uganda highlands the western are hot and dry which cause conditions of no clouds, no rainfall, very hot temperatures e.t.c. in eastern Kasese and Ankole - Masaka dry corridor.

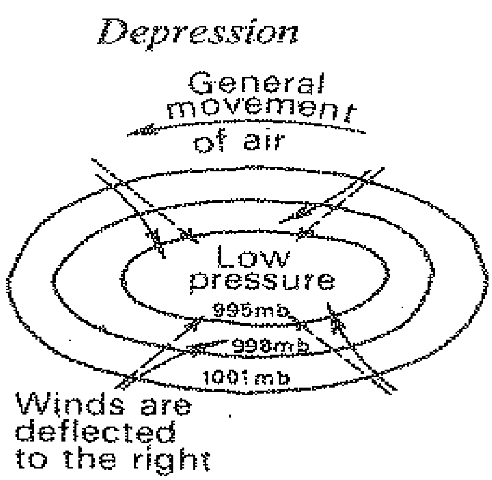
12.10 DEPRESSIONS / CYCLONES.

A cyclone is a low pressure cell or it's a mass of air whose isobars form an oval shape with low pressure at the centre but increases towards the outside.

Cyclones develop when two air masses meet and as a result they start swirling either anti clockwise in the northern hemisphere or clockwise in the southern hemisphere.

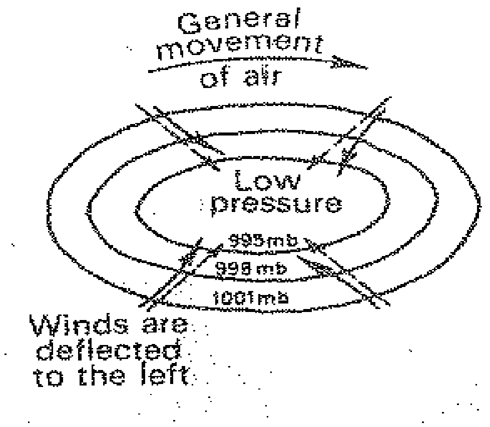
(a) Northern hemisphere

Diagram



(b) Southern hemisphere

Diagram



Depression are well developed in the westerlies along latitude 60 and they sometimes develop in the tropics especially in the doldrums / in the tropics.

MAIN CHARACTERISTICS OF CYCLONES / DEPRESSIONS

Depressions in the Northern hemisphere have their air circulating in anticlockwise direction and in the southern hemisphere; they swirl in a clockwise direction. This is mainly because of air deflection resulting from the rotation of the earth.

Depression often have very low pressure at the centre. This is often as a result of the warm environmental conditions.

Temperate cyclones develop cyclonic rainfall which is in form of drizzles and last for longer periods. Whereas cyclonic rains in the tropical cyclones are often in form of heavy showers and last for shorter periods.

Cyclones develop converging winds due to low pressure at the centre. The converging winds are often misty and cause rainfall which cools the area to create a high pressure zone. Cyclones are often cloudy and have a lot of moisture due to the converging moist winds.

TYPES OF CYCLONES

(1) Temperate (Mid-latitudes) cyclones

These are low pressure cells which develop in the temperate regions as a result of polar winds from the Polar Regions meeting with the westerlies from the tropical high pressure latitude 30°N and S of the equator at the temperate low pressure latitude 60 which begin to swirl to create low pressure at the centre.

(2) Tropical cyclones / low latitude cyclones

These are low pressure cells which form as a result of trade winds meeting at the doldrums or within the tropics swirling and creating low pressure at the centre.

EFFECTS OF CYCLONES OR DEPRESSION ON CLIMATE

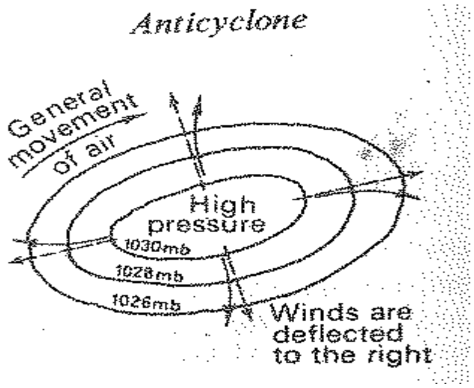
- Lead to the development of strong converging winds due to low pressure at the centre.
- Associated with low pressure at the centre due to the warm environmental conditions.
- Associated with high temperature at the centre due to the warm conditions.
- Leads to thick cloud cover due to moist converging winds.
- Lead to foggy conditions.

12.11 ANTI-CYCLONES

These are high pressure cells. They develop when two air masses of great density meet at a front, causing a high pressure at the centre which later sets off diverging winds.

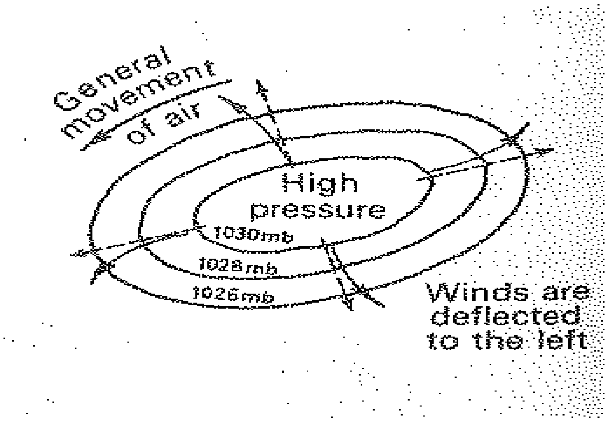
(a) Northern hemisphere

<u>Diagram</u>



(b) Southern hemisphere

<u>Diagram</u>



CHARACTERISTICS OF ANTICYCLONES

- They swirl clockwise in the northern hemisphere and anti-clock wise in the southern hemisphere due to rotation of the earth.
- Develop high pressure at the centre due to cool environmental conditions. They are associated with diverging winds due to high pressure at the centre.
- They are associated with clear skies due to the diverging cool dry winds.
- They lead to dry conditions due to the divergence of winds.
- Lead to no humidity due to dry cool diverging winds.

12.12 LOCAL WINDS

A local wind are winds which develop as a result of local environmental conditions and cover a small geographical area.

Local winds may develop around pressure cells /cyclones water bodies and mountains, they include:

(1) Depressional winds

Those are converging winds which develop in depressions / cyclones due to low pressure.

(2) Land and sea breezes

Note: Refer to previous notes.

(3) Ascending (Anabatic) and Kabatic winds / descending winds

These are local winds which develop as a result of the existence of a hill / mountain in the environment

ASCENDING (ANABATIC) WINDS

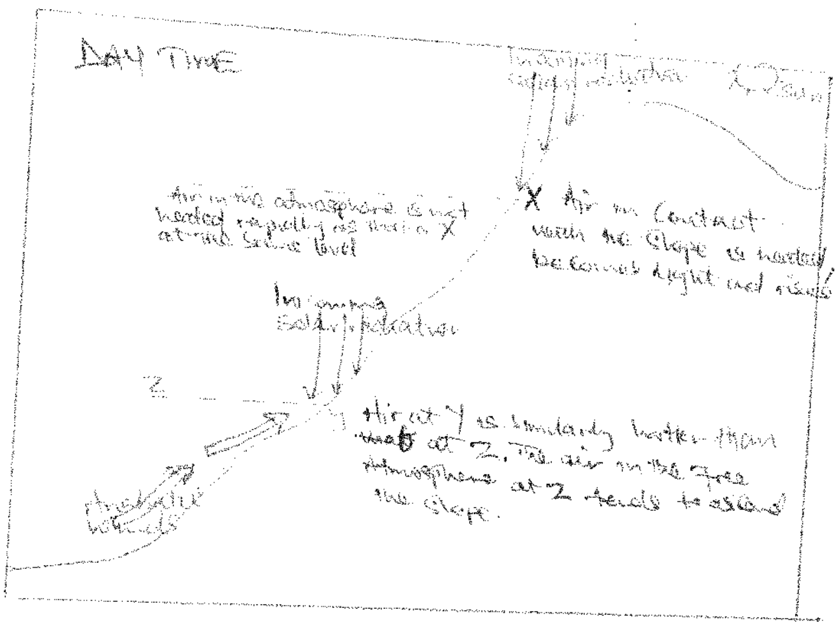
These are local winds which blow from the valley up the mountain slopes during day. They are as a result of differential heating of the slopes both at lower or upper slopes.
Thus during the day, the sun heats up the slope more than the valleys because they are exposed.

The air in contact with slopes is heated, expands, becomes light and begins to rise thus convectional rising of air on the upper slopes. This creates a low pressure area on the slopes.

The cool and dense air in the valleys where there is high pressure rises up the slopes to displace or replace the light warm air up slope. These winds from the valley flowing upslope are called Anabatic / Ascending winds.

Ascending winds cool at a rate of 4.5^0C for every 1000m ascent.

Diagram



WEATHER CONDITIONS ASSOCIATED WITH ANABATIC WINDS

- ✓ It leads to formation of mist and fog in the upper slopes of mountains.
- ✓ It triggers off convectional currents which leads to formation of orographic rainfall in mountainous areas.
- ✓ It leads to formation of low clouds in the highland areas due to its cooling of air to and beyond its dew point / condensation level.
- ✓ Anabatic winds transport cold temperatures to the upper slopes.

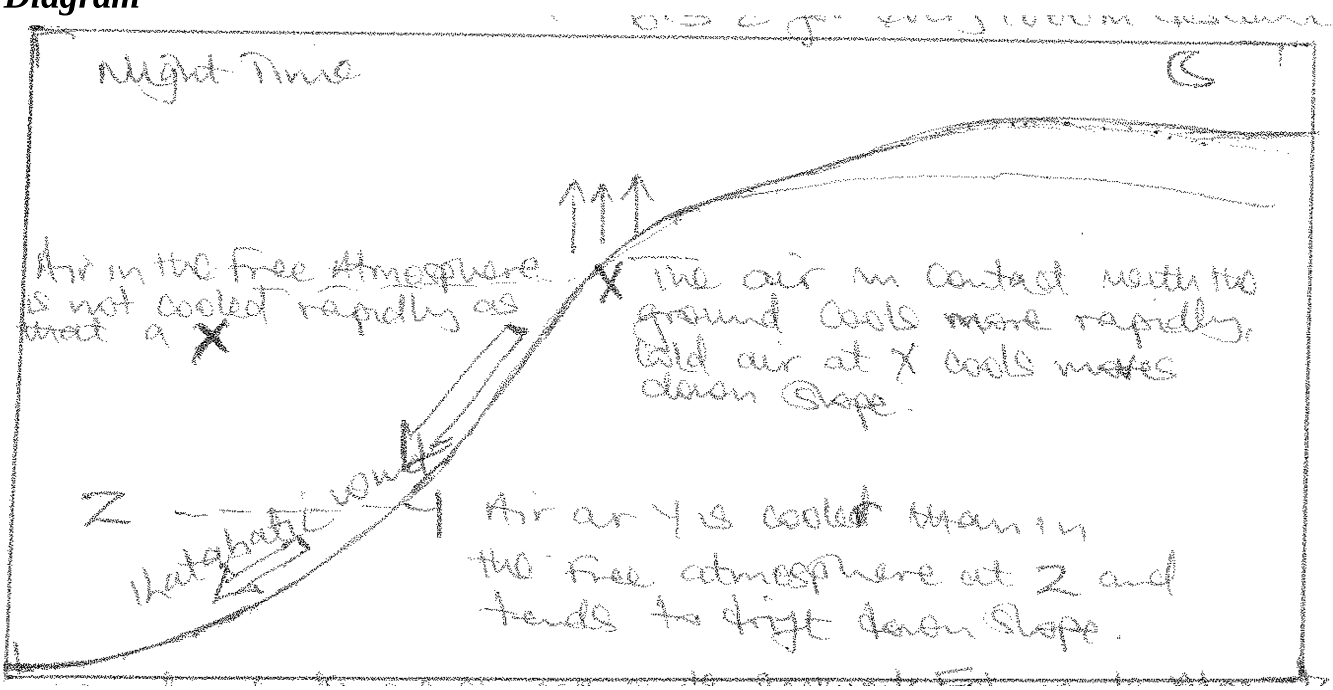
KATABATIC WINDS / DESCENDING WINDS

There are winds which flow down slope under the influence of gravity during the night.

Because the slopes are more exposed than the valleys, they lose a lot of heat through radiation, then cool down much faster than the valleys. Hence becomes areas of high pressure. So the air becomes denser than the air in the valley which is warm and light creating a low pressure area.

So wind from upper slopes descends down in the valley. This wind is called the katabatic wind. Katabatic winds warm at a rate of 6.5^0C for every 1000m descent.

Diagram



WEATHER CONDITIONS ASSOCIATED WITH KATABATIC WINDS

- ✓ They cause frost due to rapid cooling in valley areas.

- ✓ Temperature inversions take place. This is where cold air in the valley is colder than air above it.

- ✓ Leads to formation of fog and mist due to radiation cooling.

1. **LAND AND SEA BREEZES**

   These are local winds which develops as a result of the existence of a river or lake in an environment.

   The lake and rivers lead to environmental temperature differences and pressure distribution such that air will be set in motion to create sea and land breeze.

   Note; refer to the previous work

Note:Both local and prevailing winds influence the environmental climate by bringing about changes in the environmental temperature, Rain fall, cloud cover, atmospheric moisture, pressure systems and other elements of wather.

12.13 PRECIPITATION AND RAINFALL

It is the condensation of water moisture which may be in form of a gas into small water droplets as a result of very low temperatures.

Precipitation results into the rainy clouds, mist, fog or dew. It is this precipitation which may lead to the development of rainfall in various regions.

RAINFALL

Rainfall is a type of precipitation in form of rain droplets.

TYPES OF RAINFALL

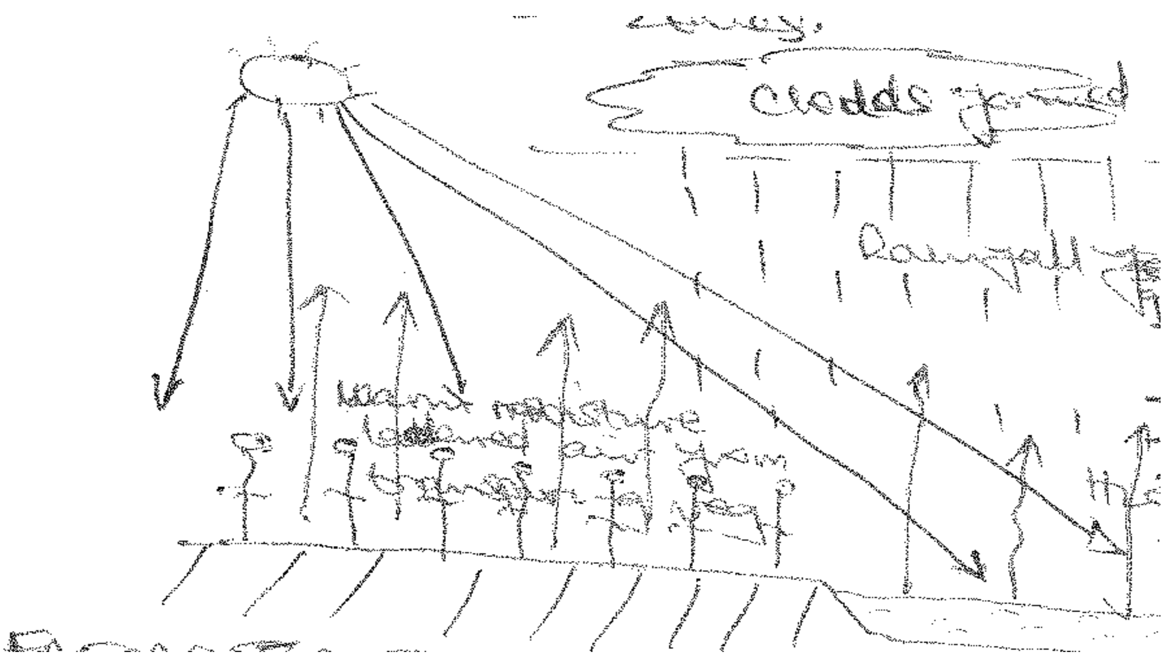
(1) Convectional rainfall.

This is the type of rainfall received around water bodies and forests.

It's received during the day when there is maximum heating by the sun's insolation. The heating of the earth's surface by the sun which causes evaporation of the water bodies and release a lot water vapour which rises and condenses on reaching the condensation level causing thick clouds which consequently result into heavy rainfall which is normally received during the day when there is maximum heating and in the early hours on the morning due to land breeze.

It is received in Lake Victoria basin around Budongo forest, Bwindi e.t.c.

Diagram:



Conditions / factors for development of convectional rainfall

- Presence of large water bodies and forest which supply a lot of water vapour through evaporation and evapo-transpiration.
- Hot temperatures resulting from maximum heating by the sun's insolation which result into high evaporation and evapo-transpiration rates.

Land and sea breezes

Latitudinal location astride the equator where the sun is overhead which causes maximum heating and evaporation and evapotranspiration rates.

Position of the sun

Where the sun is overhead, there is maximum heating which results into high evapotranspiration and evaporation rates thus facilitating convectional rainfall.

- Human activities – Afforestation
- Altitude ie low altitude characterized by hot temperatures
- Trade winds ie South East trade winds along the East African Coast.

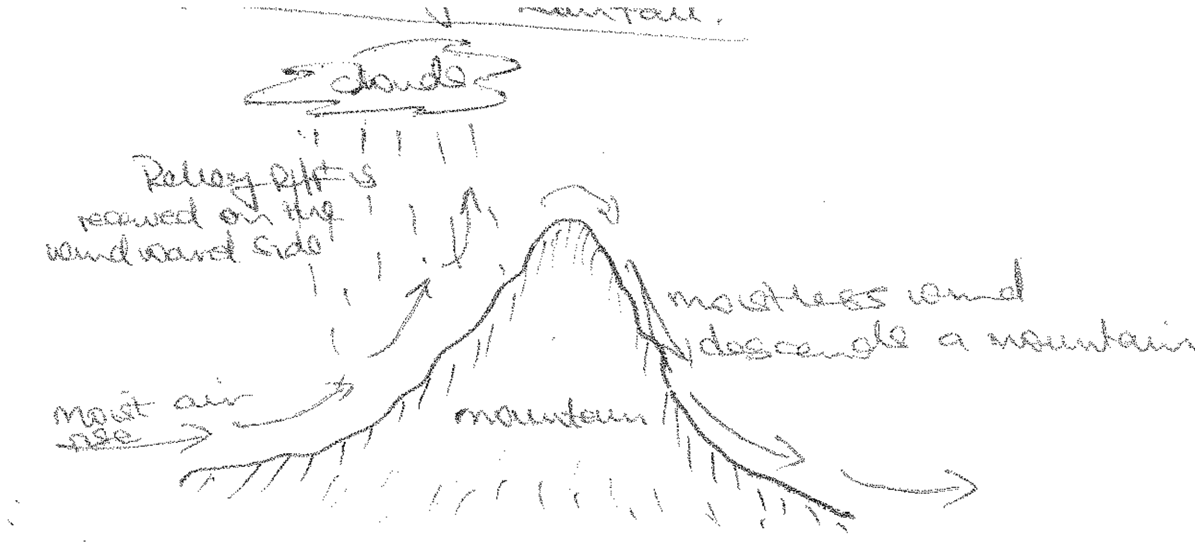
(2) RELIEF / OROGRAPHIC RAINFALL

It is a type of rainfall received in highland areas like Rwenzori, Kilimanjaro, Kenya and Elgon.

It is formed when warm moist air is forced to rise by a mountain acting as a barrier against free flow of wind on the earth's surface.

On rising, the moisture in the wind is condensed at a high altitude and later develops into clouds which consequently result into heavy relief rainfall on the windward side of the mountain side as the leeward side / slope remains dry and rainless because of the hot dry descending winds.

Diagram:

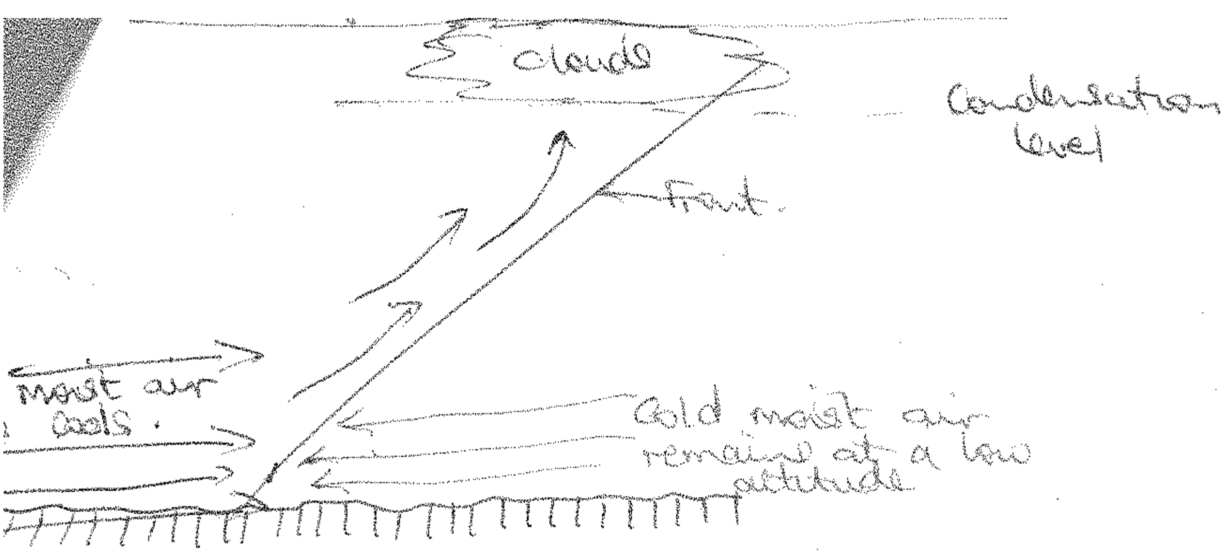


(3) FRONTAL RAINFALL

It is a type of rainfall which is received in depressions / cyclones. It develops when two air masses of different characteristics meet at a front; the warm air is forced to rise over the cool air and on reaching its dew point. It condenses to form clouds which consequently result into formation of cyclonic, frontal, depressional rainfall.

Frontal rainfall in temperate regions in form of drizzles which last for longer periods where as in the tropics, it is in form of heavy showers which last for shorter periods.

<u>Diagram:</u>



12.14 OCEAN CURRENTS

Ocean currents are general movements or drift of the surface waters of the ocean in a defined direction.

They are generated / caused by;

(1) **Differences in salinity or density of ocean waters**. Water with a high salinity thus flows to areas of less salinity and vice versa e.g. the surface current which flows from the Mediterranean Sea to the Atlantic Ocean is due to high salinity of the Mediterranean Sea due to the limited rainfall and limited number of inflowing rivers plus a high evaporation rate.

(2) **Effects of winds.** Prevailing winds tend to drift water / of oceans from one place to another creating different currents, the north east and south east trade winds e.g. generate oceanic currents that move from mid-latitudes towards the equator.

(3) **Earth's rotation.** It inflicts a deflective force over the oceans called cariolis force. This causes the currents to flow clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere.

(4) **Shape of the adjacent landscape / Nature of coast / Coastal configuration.** The coastal configuration and the presence of sub-marine ridges can also cause currents. Both the north equatorial and south equatorial currents are deflected north and south respectively due to the shape of the coast.

(5) **Tides**. The sun and the moon exert a gravitation pull onto the earth's surface. This results into rising and falling motions to develop on water of large oceans. These risings and fallings, produce tides which result into movement of ocean water in form of currents.

12.15 WARM OCEAN CURRENTS

This refers to the drift / movement of surface ocean waters which have relatively high temperatures than the surrounding areas e.g. the Guinea current on the coast of Guinea, Brazilian current on Brazilian coast, North Atlantic drift on the coast of UK, Norway, Kurosiwa current along the coast of Japan, Mozambique current on Mozambique coasts.

CHARACTERISTICS

Characterized by hot temperatures e.g. Brazilian current.

- They flow from low latitudes to high latitudes i.e. they flow pole wards from the equator.
- Generally flow on the eastern sides of continents in low latitudes e.g. Brazilian, East Australia currents except for Guinea currents.
- In the mid-latitudes and high latitudes, they generally flow on the western side of continents e.g. Pacific currents and North Atlantic drift.
- Characterized by low density / high salinity.
- Flow on the surface but lose temperatures as they flow towards the poles.
- Move clockwise in the northern hemisphere e.g. gulf stream and anticlockwise direction in the southern hemisphere e.g. East Australian and Mozambique currents.

INFLUENCE OF WARM OCEAN CURRENTS ON THE CLIMATE OF ADJACENT LAND MASSES

(Effects of warm ocean currents)

- They tend to raise the temperature of the adjacent land masses due to the warm on shore winds blowing over it e.g. the North Atlantic drift raises temperatures of coasts of Portugal, Britain, Norway and ocean ports remain ice free in winter.

- Durban on the eastern coast of South Africa is affected by the warm Mozambique Ocean current and has temperatures of 24.4°C compared to Port-Nolthi of the west coast on the same latitude which has 15.5°C because of the cold Benguela current.
- They increased the humidity of adjacent land masses because of moist on shore winds which blow over them and due to high temperatures which enhance evaporation e.g. areas like Natal which are affected by the warm Mozambique current and Western Europe washed by the North Atlantic drift.
- They enhance the formation of cyclonic rainfall when warm moisture laden air rises over cold dry air. Also much rainfall is received in Natal because of the warm Mozambique current this is because of the warm Mozambique currents.
- They increase the cloud cover of adjacent land masses. This is because as winds blow over the warm ocean currents they absorb the moisture over that current and became moisture laden. As winds meet the current the vapour is cooled down to condensation level leading to formation of thick moist Cumulo Nimbus clouds e.g. the West Europe coast washed by the warm North Atlantic drift.

Other effects:

- As warm ocean currents induce heavy rainfall this has favoured plantation farming e.g. Natal sugarcane plantations, Cocoa and Palm oil plantations along the West African coasts, boarder warm currents.
- The heavy rainfall received has promoted the growth of thick tropical rainforests e.g. along the West African coast boardering warm Guinea currents. This has promoted lumbering.
- The warm ocean currents passing along the East African coast has favoured coral reefs which have boosted the cement and tourism industry.

- Favoured the growth of planktons which have favoured the growth of fish hence boosting the development of the fishing industry.

12.16 COLD OCEAN CURRENTS

These refer to drifts or general movement of the surface water of the ocean in defined direction characterized by lower temperatures than the surrounding areas e.g. Canary current along Morrocan coast, Benguela current along the Namibian coast, Peruvian currents along the coast of Peru, Californian current along the coast of California, Oyashio current along the coast of Japan.

CHARACTERISTICS:

- They are characterized by low temperatures e.g. the canary current along the Moroccan coast.
- They flow from high latitudes to low latitudes i.e. they flow equator wards from the poles.
- Generally flow on the western sides of continents e.g. Benguela currents, Peruvian (humboldt current) and in the mid-latitudes, they flow on the eastern sides of continents e.g. Labrador and Oyoshio.
- Characterized by high density / less salinity.
- Characterized by upwelling along the coast.

EFFECTS (on climate of adjacent land masses)

- Tend to lower the temperatures of the surrounding areas / land masses due to the influence of land and sea breezes e.g. Benguela current lowers the temperature of the adjacent Namib coast e.g. Walvis bays average temperature is 16°C compared to Durban's 25°C at the same latitude.

- They are associated with offshore winds and cause low levels of condensation leading to the development of desert conditions e.g. Sahara, Kalahari and California which are adjacent to canary, Benguela and Californian currents respectively.

- Cause the formation of offshore fog when there is rapid radiation cooling e.g. there are frequent fogs at Sanfranscisco and also North east Canada because of the Labrador current.

- They are associated with a low humidity and low cloud cover.

- Coasts of higher latitudes which are boardered by the cold ocean currents in contrast their slopes are characterized by cold winters and cool summers.

Other effects:

- Cold ocean currents favour fishing. This is because they favour the growth of planktons which attract fish in an area that's why major fishing grounds boarder cold ocean currents e.g. Cape Agulhas and Moroccan fishing grounds boarder cold currents.

- Aridity along the cold ocean currents has encouraged pastoralism e.g. pastoral group of Fulani of Sahel and Hottentos of Namibia.

Qn1. Examine the effects of ocean currents on the climate of adjacent land masses.

- ***<u>Approach:</u>***

- Define ocean currents.
- Causes
- Types.
- Characteristics of each type.
- Effects of each type.

Qn2. Examine the effects of warm ocean currents on the climate of adjacent land masses.

- ***Approach:***
- Define warm ocean currents.
- Give examples.
- Explain the causes.
- Characteristics.
- Effects on climate.

12.17 CLIMATE OF EAST AFRICA

Although East Africa lies outside the equator, its climate is not purely equatorial. This is because of a number of factors.

CLIMATIC ZONES OF EAST AFRICA

(1) Equatorial climate

This is confined to limited areas of East Africa i.e. areas laying astride the equator between 0.-5^{o} North and south of the equator e.g. shores of Lake Victoria, coastal areas of East Africa, Kigezi highland, Kenya highlands, islands of Lake Victoria e.g. Ssese island.

Characteristics:

- Temperatures are generally hot. There is great uniformity of temperature throughout the year between 25 – 28^{o}C on average.
- It has a small diurnal range of temperature between 2 – 3^{o}C on average.
- Receives heavy rainfall of 1500mm – 2000m per annum.
- Convectional type of rainfall is received during afternoon, evenings and early morning accompanied by thunderstorms and lightning.

- Rainfall is well-distributed throughout the year.
- Double maxima rainfall with two peaks in March to May and September to November each year (Bi-modal pattern)
- Thick cloud cover.
- High humidity of over 80% due to high rate of evapotranspiration and evaporation.
- It is no clear/marked dry season.
- There is dominated by converging winds at the ITCZ hence region of calmness. Thus, the presence of low pressure.

(2) Tropical / Savannah climate

It is experienced in areas located between 5 – 15^{o}N of the equator e.g. in the Nyika plateau, Luwero, Bukoba, North of Tanzania, parts of Northern Uganda.

Characteristics:

- Alternate dry and wet seasons. Dry seasons between two – four months (2 - 4) months.
- Mean monthly temperature range between 25 – 38^{o}C.
- Great diurnal range of temperature during the dry season of about 10^{o}C.
- Moderate rainfall of between 760m – 1000mm and it increases towards the equator.
- Rainfall reliability is less.
- Rainfall is associated with thunderstorms.
- Convection rainfall is received.
- Moderate humidity of 50%.
- Fairly dense cloud cover dominated by cumulo nimbus clouds.

(3) Arid / Semi-Arid climate

It is experienced in North eastern Uganda, Ankole-Masaka corridor Rift valley floor in Kasese, L. Albert flats, North western Kenya (Turkana), north eastern Kenya, and Central Tanzania.

Characteristics:

- Low rainfall total of less than 500mm per annum.
- Unevenly distributed rainfall which is unreliable and seasonal is received.
- Very hot temperatures of over 30^{o}C.
- High diurnal range temperature of 10^{o}C.
- Less or no cloud covers especially during dry seasons.
- Has no definite wet season.
- Low relative humidity usually less than 20% because of intensive clear skies and low levels of evapotranspiration.
- Has a long dry season of over 9 months and a short wet season of only 3 months.
- The air / wind is dry due to constant desiccating / dry winds blowing across the area.

12.18 FACTORS INFLUENCING THE CLIMATE OF EAST AFRICA

(1) Altitude

It affects climate because climatic conditions change with increasing altitude. Areas of East Africa at high altitude e.g. mountain Rwenzori, Kenya, Elgon e.t.c. experience high levels of condensation which leads to the formation of thick clouds and consequently receive heavy rainfall. This is possible due to the very low temperature.

At the same time, areas at such high altitudes over 1000m above sea level experience very cold temperatures because of the rarefied atmosphere. Whereas areas at low altitudes like rift valley floor, experience limited condensation due to the hot temperature and therefore are characterized by very low humidity, limited cloud cover, very little and unreliable rainfall.

Altitude also affects atmospheric pressure. Places at low altitude experience high atmospheric pressure e.g. the East African coast whereas, areas at high altitude of highland areas of East Africa experience low pressure.

(2) Latitudinal location

It affects climate in that places which lie astride the equator e.g. Entebbe, Mukono, Wakiso and Jinja receive heavy reliable and evenly distributed rainfall because of excessive evapotranspiration due to overhead sun. East Africa also generally experiences hot temperatures most of the year due to the overhead sun which raises the environmental temperature.

Note: However the temperature and rainfall keep on changing with the movement of the overhead sun.

(3) Deforestation

This has involved clearing of large expenses of forest cover for charcoal burning, timber production e.g. Nakasongola, Northern Uganda.

This has deprived the atmosphere of sources of water vapour thus leading to reduced rainfall, reduced humidity, increased temperature and limited cloud cover.

(4) Industrialization

Massive industrial development especially in Kenya has led to a massive emission of thousands of tons of carbon monoxide in the atmosphere which has led to depletion of ozone layer thus leading to ultra-sun's isolation reaching the earth's surface thus leading to extremes of temperatures, reduced rainfall, reduced humidity, cloud cover e.t.c.

(5) Relief / Aspect

Mountainous areas of East Africa e.g. Kenya, Elgon, Rwenzori act as barriers to the blowing winds which forces them to rise and condense on the windward side of these mountains which raises humidity, cloud cover and the heavy rainfall received in these areas e.g. Kabale, Bundibugyo whereas the leeward sides of these mountains e.g. Ankole, Masaka dry corridor, Albert flats, North eastern Uganda experience hot dry descending winds which lead to arid conditions of very little and unreliable rainfall, low cloud cover, low humidity, very hot temperature.

Flat areas of East Africa e.g. central Tanzania, Northern Kenya, North eastern Uganda experience arid conditions of very hot temperatures, very low humidity, little and unreliable rainfall, limited clouds because winds just blow across such areas without rising to form rainfall.

Aspect influences climate of East Africa in such a way that the east facing slopes of mountains / hills experience warm temperatures in the morning because they are facing the direction of the rising sun and experience cool temperatures in the evening because they are facing away from the direction of the setting sun whereas west facing slopes are warmer in the evening because they are facing the direction of the setting sun.

The mountainous areas of East Africa experience temperature inversions at night due to the cold descending winds into the valleys which displace the warm air upwards leading to increase in temperature with altitude, a situation commonly known as temperature inversions.

(6) Influence of water bodies.

The availability of large water bodies in only a few regions of East Africa has also contributed to the climatic variations. Areas surrounding lakes e.g. Victoria shores receive heavy rainfall, high humidity, thick cloud cover due to the high evaporation rates of these water bodies which when heated lead to high water vapour in the atmosphere which condenses. Water bodies also moderate temperatures in East Africa through land and see breezes at different times of the day e.g. along the shores of L. Victoria and along the East African coast.

Whereas areas of East Africa without large water bodies e.g. central Tanzania, Northern Kenya, North eastern Uganda are devoid of sources of water vapour. Therefore this makes them have low humidity, limited cloud cover, very low and unreliable rainfall and therefore frequently suffer from prolonged droughts.

(7) Influence of vegetation cover.

Areas of East Africa with thick vegetation cover e.g. Mabira forest, Budongo, Bwindi impenetrable forest, Mangroove forest along the East African coast experience high rates of evapotranspiration leading high humidity, thick cloud cover, and heavy rainfall. These thick forests also have a modification effect of lowering environmental temperatures. Whereas areas of East Africa with scanty vegetation e.g. North Eastern Uganda, Northern Kenya, Central Tanzania, Albert flats, Ankole-

Masaka corridor experience low evapo-transpiration rates, leading to arid conditions and very limited and unreliable rainfall, very low humidity and limited cloud cover.

(8) Influence of the position of the overhead sun.

The position of the overhead sun greatly affect the climate of East Africa. Particularly the location of the ITCZ zone which is a low pressure belt and a zone of convergence of winds.

The overhead sun twice a year in March and September leads to hot temperatures, heavy rainfall along the equator due to the high evaporation and evapo-transpiration rates hot temperature and therefore convergence of winds lead to high humidity; the thick cloud cover and consequently high rainfall while the rest of East Africa remains dry during the period.

In January the overhead sun in the southern hemisphere leads to hot temperature, low pressure, convergence of winds and therefore high humidity, thick cloud cover and consequently heavy rainfall in southern Tanzania. At the same time, Northern Uganda is dry.

In July, the overhead sun in the Northern hemisphere lead to hot temperatures, low pressure convergence of winds and therefore high humidity, thick cloud cover and consequently heavy rainfall in Northern Uganda. At the same time southern Tanzania is dry.

(9) Influence of the rotation of the earth.

When the earth rotates, it deflects winds to the right in the Northern hemisphere and to the left in the southern hemisphere.

The deflected winds cause variations in the local climate in various parts of East Africa e.g. the deflected North east trade winds are partly responsible for the aridity conditions in the North eastern parts of Kenya.

(10) Influence of air masses or trade winds

The North east trade winds which lose all their moisture on the Ethiopian highlands cause arid conditions of limited cloud cover, very low humidity and little or no rainfall in North eastern Uganda, North eastern Kenya and North western Kenya.

The south east trade winds from the Indian Ocean are moisture laden and therefore cause high humidity, thick cloud cover and heavy rainfall along the East African coast.

As they continue to cross central Tanzania, they are hot and dry and therefore cause conditions of low humidity, limited cloud cover and very little and unreliable rainfall.

As they continue blowing inland, they are deflected to the right and cross Lake Victoria which remoisturises them. This makes them to cause heavy rainfall, thick cloud cover and raise humidity in the northern shores of Lake Victoria.

The Westeries from the Congo, on ascending the western Uganda highland, cause heavy rainfall, thick cloud cover and raise humidity on the windward side e.g. Kabale, Kisoro and Kasese.

As the westeries descend the western Uganda highlands, they are hot and dry causing very low cloud cover, low humidity, very little and unreliable rainfall in Albert flats, Ankole-Masaka corridor and Kasese.

(11) Human activities

Human activities of afforestation and re-afforestation and forest conservation like Mabira, Bwindi, mountain Elgon and Rwenzori forests have helped in constantly supplying the atmosphere with water vapour hence leading to high humidity, thick cloud cover and heavy rainfall.

Whereas human activities of swamp reclamation, deforestation, bush burning, overgrazing deprive the atmosphere of water vapour sources hence leading to conditions of very hot temperatures, limited cloud cover and very little rainfall.

Qn1. Examine the factors that influence the climate of East Africa.

Qn2. Although East Africa lies astride the equator its climate is not purely equatorial. Discuss.

Qn3. To what extent do air masses influence the climate of East Africa?

Approach: to qn 1 and qn2

- Define climate.
- Describe the climatic types of East Africa i.e. identify them, locate them and describe all the characteristics of each.
- Explain the factors that influence the climate of East Africa.

Account for the formation of coral landforms.

Approach:

- Define coral landforms.
- Describe the conditions.
- Describe the formation process.
- Describe types.
- Describe the three theories.

Note: Don't give factors and conditions.

COASTAL GEOMOPHOLOGY

13.0 CORAL REEFS / CORAL ROCKS / CORAL LANDFORMS

Qn. Account for the formation of coral landforms.

These are limestone ridges along the sea shores formed as a result of the deposition and accumulation of skeletons of tiny marines organisms known as polyps which live in millions of colonies and have skeletons formed from calcium carbonate contained in the salty sea water.

The tube like skeletons in which the organisms live extend upwards and outwards as old polyps die and new ones are born.

Coral polyps cannot grow out of water and therefore are formed below the level of low tide.

13.1 CONDITIONS FOR THE GROWTH AND DEVELOPMENT OF CORAL POLYPS / REEFS / LANDFORMS

Favourable climate characterized by;

- Warm temperatures between 20 – 30°C within the tropics between 30° north and south of the equator.
- Clear sunlit water to a depth of 60m.
- They grow on the eastern sides of continents where there are warm ocean currents.
- They need salty oxygenated sea water of 27 – 40 parts per 1000 salinity. This acts as additional food for polyps where they extract calcium carbonate necessary for the formation of the hard skeletons.
- Abundant planktons which act as food for the polyps.
- They need a shallow extensive continental shelf with a depth of not more than 60m to allow sunlight penetration and oxygen.
- Existence of clear silt free water away from river mouth where silt laden fresh water empties into the sea which destabilizes coral formation.

- Sea level changes that cause sub-mergence of coasts.
- Variations in water levels i.e. high and low tides facilitate the death and accumulation of polyps.
- Presence of solid bedrock to provide a firm foundation.

13.2 PROCESS OF FORMATION

Coral landforms are formed when coral polyps die and the softer parts of their bodies decay leaving the shells.

The coral shells that are made up of calcium carbonate (limestone) accumulate on the continental shelf.

With the continued accumulation of skeletons overtime, the coral polyps increase in weight get compressed, become compacted and cemented to form a consolidated mass of rock called coral reef.

Other organisms like calcerous, algae and echinoderms help in facilitating the consolidation process which cements the spaces between the dead corals.

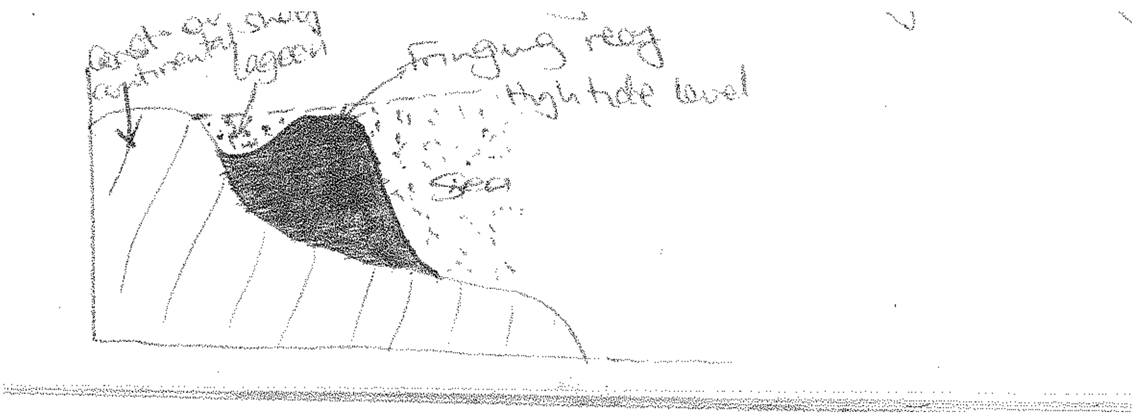
13.3 TYPES OF CORAL LANDFORMS

(1) FRINGING REEFS

This is a coral platform which forms close or near to the coast and is joined to the coast and is separated from the coast by a narrow and shallow lagoon.

It fringes along the coast. It is steeper seawards. Examples include, Shanzu beach north of Mombasa, Kiilfi and Dar-es-Salaam along the coast of East Africa.

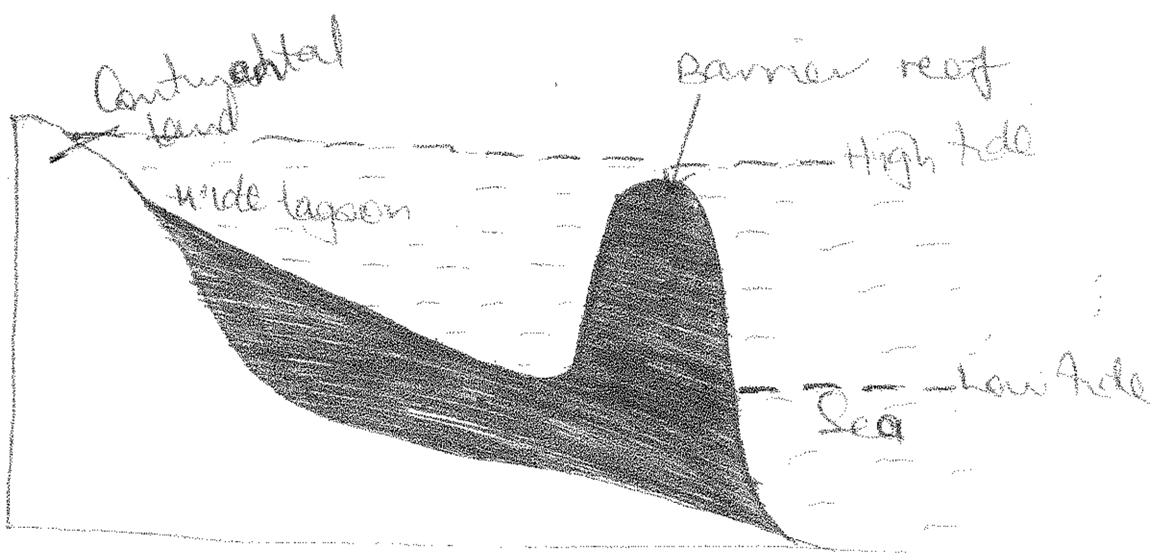
Diagram:



(2) BARRIER REEF

These are coral platforms which form far away from the coast. They are connected to the coast. They enclose a wider and deeper lagoon. Examples exist around Madagascar on Mayotte Island and the Great Barrier Reef found at the coast of Queen's land in Australia.

Diagram:



(3) ATOLL REEFS

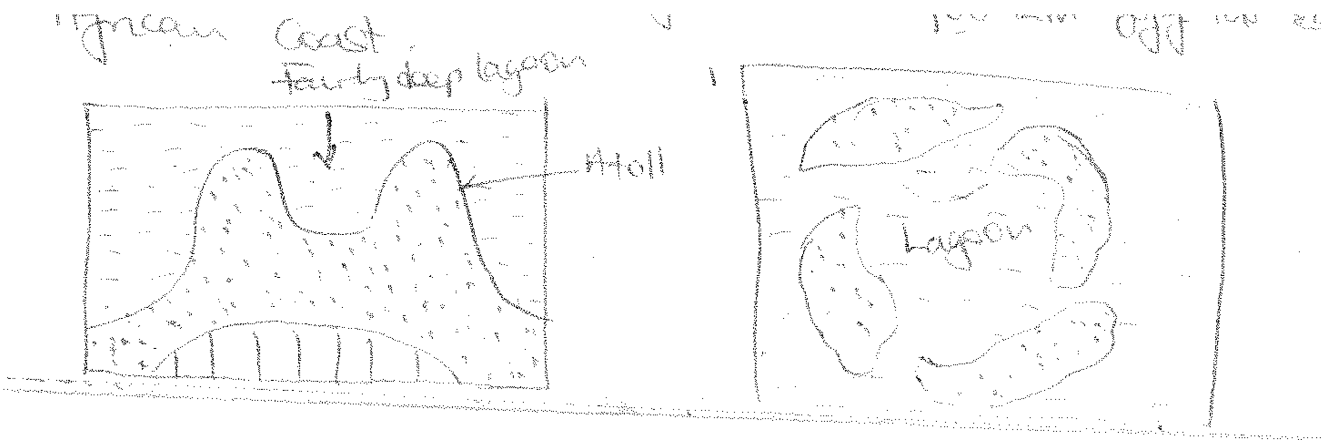
These are usually circular /horse shoe shaped. They are often found in the middle of oceans.

They are not connected to the coast.

They surround a fairly deep lagoon but generally broken in pieces by narrow channel inlets.

Examples include, Chumbe Island near Zanzibar, Shimon in Southern Kenya and Aldabara reef located 700km off the coast of East Africa.

Diagram:



13.4 THEORIES OF FORMATION OF CORAL REEFS

There is no problem about the origin and growth of fringing reefs. They grow from land towards the sea.

However, there is a problem attached to the origin of barrier and atoll reefs that grow up from great depth such as 29000 – 30,000 feet, yet coral can only grow from 60m deep. The depth is far below the level at which coral can grow.

Three theories to explain the origin of atoll and barrier reefs have been advanced by Darwin, Murray and Daly.

13.5DARWIN'S THEORY OF SUBSIDENCE

Darwin states that the growth of atoll and barrier reefs is due to subsidence of land masses.

He suggests that initially volcanic activity led to the formation of a volcanic cone / island due to the accumulation of magma along a vent in the ocean.

Polyps colonized the Flanks/edges of a volcanic cone/island and as they died their skeletons accumulated on the volcanic platform. They were eventually compacted, compressed and cemented into a hard rock called a fringing reef.

The volcanic island gradually / slowly subsided as a result of isostatic i.e. readjustment which followed the eruption.

However, the fringing reefs on the flanks of the volcanic cone continued to grow upwards and outwards keeping pace with the subsidence of the volcano.

Such a subsidence increased the water depth beyond the level at which coral polyps can grow/survive.

Coral polyps subsequently died while some tried to grow to keep pace with the changes in the water depth.

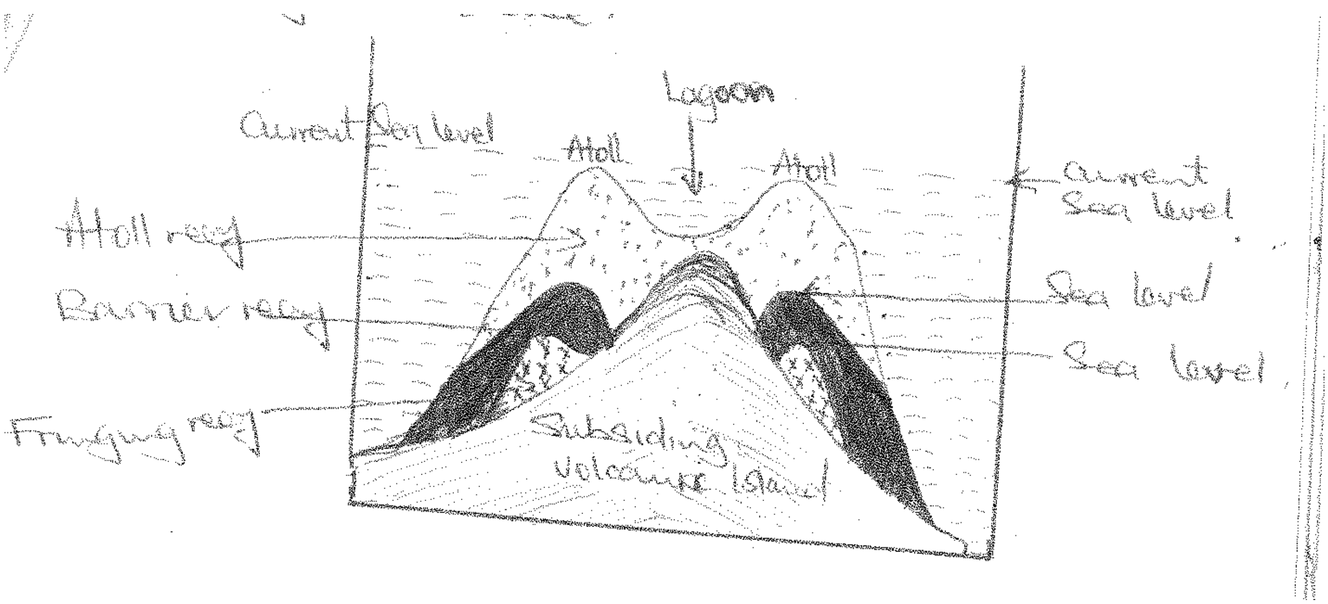
Since coral / growth is more concentrated on the out side of the reef where food is plenty, a big rim will be formed.

On the other hand the inner side of the reef becomes increasingly deeper and wider as the reef becomes bigger and the coast of the volcano subsides further. At this point, a fringing reef has turned into a barrier reef.

Finally with continued subsidence of the volcanic cone, there will come a time when it is only the coral which is visible, the volcanic cone being completely submerged. This visible coral will form a ring of coral reefs with no island in the middle. This becomes an atoll.

Note: The transformation took place because the upward accumulation of corals was able to keep pace with the rate of subsidence of the volcano and maintain itself at the water surface.

Diagram:



FACTS TO SUPPORT DARWIN'S THEORY

- Some coasts within close proximity to barrier and atoll reefs reveal features of submergence like rias and estuaries e.g. the East African coast and at the same time, atoll and barrier roots are found in the Indian Ocean close to the coast of East Africa.
- There is presence of volcanic island off the East African coast in the Indian Ocean and yet there is atoll and barrier reefs.
- There are also other features caused by submergence e.g. mud flats at Mombasa and Dalmatian coastline near Pemba.

FACTS DISAPROVING DARWIN'S THEORY

- Some atolls and barrier reefs occur near coasts that have been uplifted and where no signs of subsidence are apparent yet he bases his theory on subsidence.
- In some borings i.e. digging down the ocean floor, no volcanic rocks were found on Bikini Island, sedimentary rocks were found instead.
- The theory does not explain why some corals are found at great depth of over 1000m where coral polyps cannot survive.

13.6 MURRAY'S THEORY OF ANTECEDENT

Murray assumed the existence of a stable submarine platform on which pelagic deposits were deposited upto a depth of not more than 60m after which coral grew.

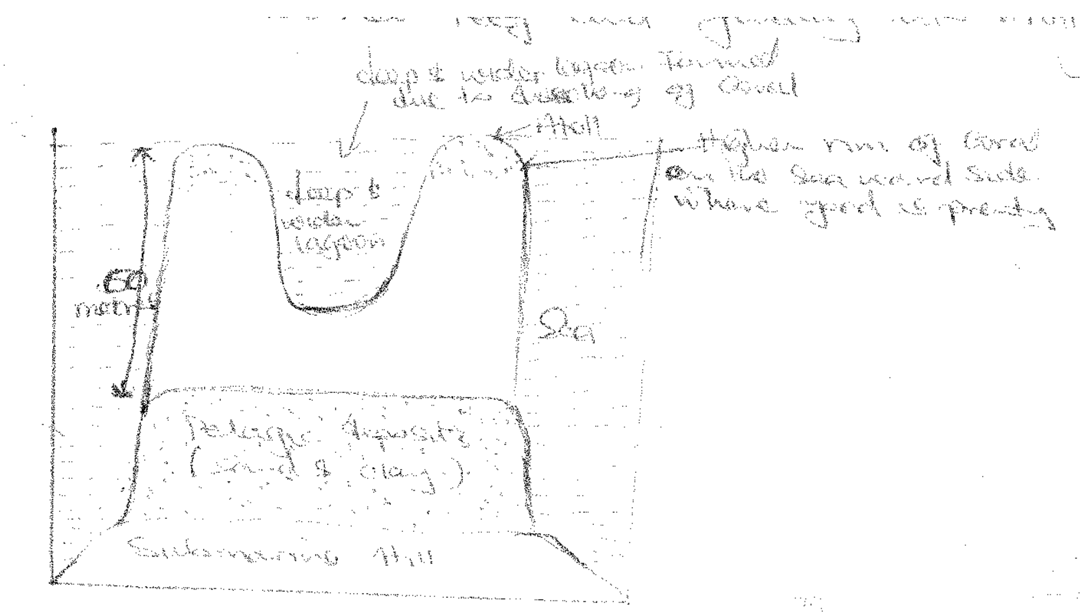
Barrier and atoll reefs began life / formation on these platform / submarine hills as fringing reefs by glowing upwards and outwards.

As the reefs grew upwards and outwards it was pounded by waves so that masses of coral fragments accumulated on the sea ward side where they were commented into hard rocks to form barrier reefs.

The corals on the inner side died due to lack of food and their skeletons become dissolved such that a deeper and wider lagoon is formed inside the reef to form an atoll.

In the process, the fringing reef transformed into a barrier reef and finally into an atoll.

Diagram



FACTS TO SUPPORT MURRAY'S THEORY

- Fragments of coral do exist in the lagoons between reefs.
- Through boring, sediments were found underneath at a depth of 2000ft down the Bikini island. This is in line with Murray's theory.
- The steepness of the reef is greater on the seaward side than on the leeward side.
- Atolls have been established to rest on truncated volcanic cones as was suggested by Murray e.g. at Aldabara.
- Existence of fringing and barrier reefs on Mayotte islands between Madagascar and Mozambique.
- Presence of atolls around Aldabara.
- More pronounced coral growth on the seaward side than the leeward side.

WEAKNESSES OF THE THEORY

- Coral reefs are too hard to be worn down as suggested by Murray.
- Sand accumulates very slowly and it is unlikely that it would form a platform moreover with the necessary steepness.

- The theory does not explain the great thickness of the corals.
- The lagoons enclosed by atoll and barrier reefs are too big that it would be difficult for water to dissolve a hard rock to this depth.

13.7 DALY'S DEGLACIATION THEORY

He based his theory on sea level changes.

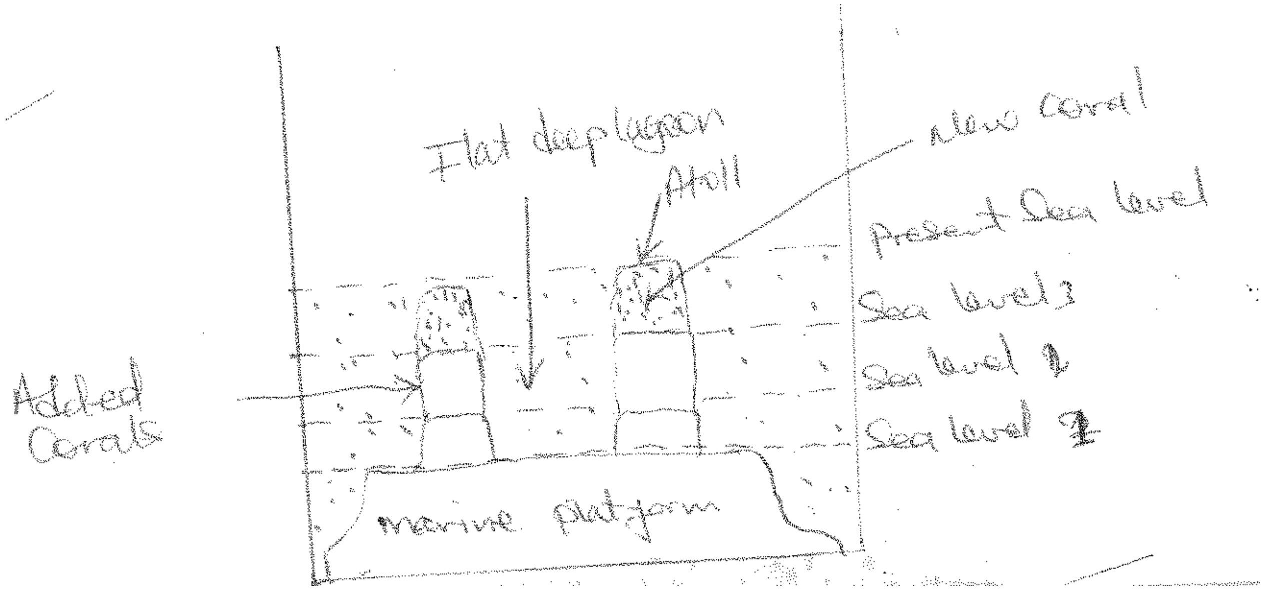
He suggested that the level of the sea was greatly lowered during the cold glacial times and therefore periglacial coral reefs and other islands were eroded by waves to the sea level of that time. This produced flat or gently sloping surfaces.

Coral polyps colonized these platforms to form fringing reefs when the temperatures of the sea increased and ice sheets slowly returned their melt water to the oceans causing a rise in the sea level.

The deglaciation which led to a rise in the sea level made the fringing reefs continue to grow upwards and outwards thus transforming into barrier reefs and finally into atoll reefs when the hills were completely submerged.

The transformation took place because the upward and outward growth of coral was able to keep pace with the rate in the rise of the sea level and maintained themselves at the water surface.

Diagram



FACTS TO SUPPORT DALY'S THEORY

- The great depth at which coral is formed through boring is explained because it is believed that corals grow on top of dead coral.
- Coral can grow upwards at a ratio of 1 foot per 10 years. This means that it would keep pace with the rise of the sea level.
- Features of glaciation have been formed e.g. fiords and yet some of the coral island are found in the Pacific Ocean.
- It was discovered that we have had four ice ages. So the level of the sea has therefore gone up and down four times.
- During all these sea level changes, coral would have happened as suggested by Daly. Moreover most of the evidences through boring seem to be in favour of changes in the sea level.
- Atoll reefs are very steep and this is explained by Daly's theory since sediments would accumulate at such steep angels.

FACTS DISPPROVING DALY'S THEORY

- Scientists have discovered that coral reefs are not easily eroded. They are eroded at a rate of 2mm per 10 years. It is therefore not possible that sub-marine wave cut platforms would be formed.

Questions:

1. Examine the relevance of Daly's theory in understanding the origin of coral landforms.

Approach:
- Define coral landforms.
- Conditions
- Process
- Types of coral reefs.
- Describe Daly's theory.
- Explain the facts to support the theory

2. Assess the relevance of Darwin's theory in understanding the origin of coral landforms.

Approach:
- Define coral landforms.
- Conditions.
- Processe.
- Types.
- Describe Darwn's theory.
- Explain facts to support his theory.
- Explain the facts disapproving his theory.

14.0 WAVE ACTION

Waves are undulations or ripples on the surface of the sea caused by the blowing of wind across the water.

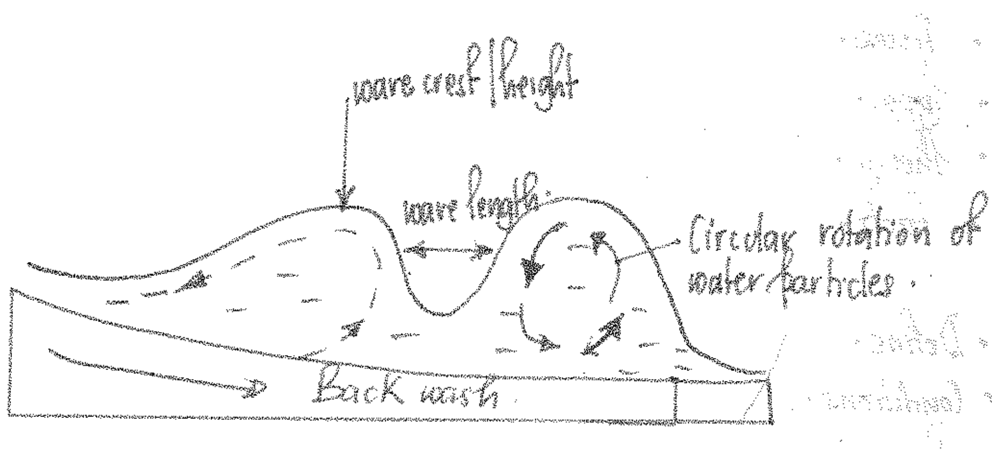
Waves are generated by wind form when there is friction between moving wind and water surface. This friction causes the circular movement of water particles which move vertically towards the coast as waves.

Waves can also be caused by marine earthquakes (Tsunamies) large submarines moving ships, large whales, and marine volcanic eruptions e.t.c.

When a wave enters shallow water, its top falls forward and its water is thrown forward.

The water thrown up the beach by the breaking waves is called a Swash while the retreat of the water back to the sea is called a back wash.

The drift of materials carried by waves along the coast as a result of waves breaking at an angle is called long shore drift.

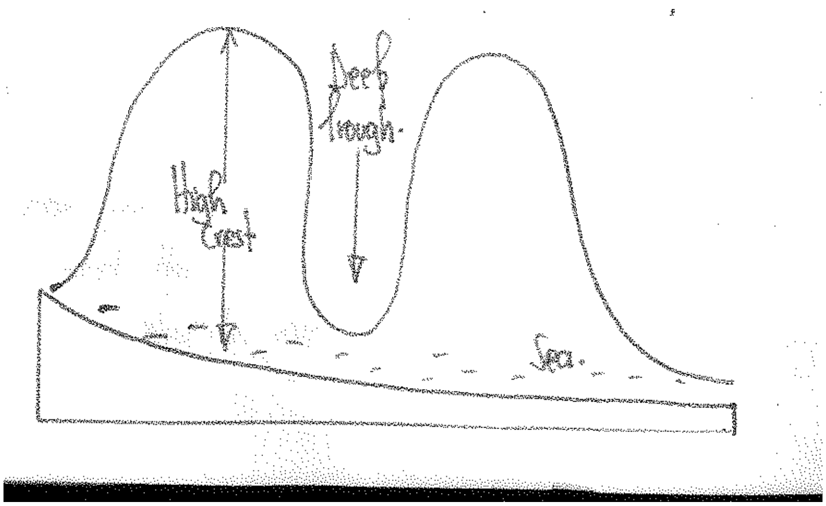


14.1 TYPES OF WAVES

(1) Destructive waves

These are waves that have a strong back wash and weak swash. They are generated by strong winds. These waves remove pebbles and sands from the coast and lead to the erosion of the coast. They have a frequency of 13 – 15 waves per minute.

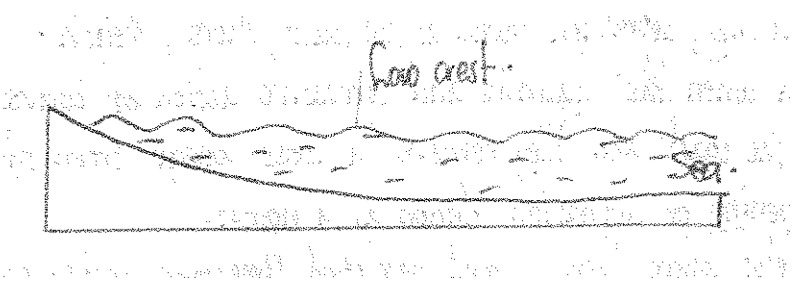
<u>Diagram:</u>



(2) Constructive waves

These are waves which have a strong swash and a weak back wash, generated by weak winds and have a low frequency of 8 waves per minute. They lead to deposition along the coast.

Diagram:



14.2 EROSIVE WORK OF WAVES

Waves erode the coast through several ways / processes like;

(1) Mechanical action / Abrasion / Corrasive action

Boulders, pebbles and sands are thrown with force by the breaking waves against the coast and these cause under cutting and rock break up leading to the formation of various landforms and rock break up leading to the formation of various landforms.

(2) Hydraulic action

Water thrown against the cliff face by the breaking waves causes air in the cracks and crevaces to become suddenly compressed. When the waves retreat, the air expands often explosively. This action causes the rocks to shutter as the cracks become enlarged and extended. Wave water also has a beating action on the coast which leads to rock break up.

(3) Solution / corrosion

This is a process which involves discharging soluble rock into a solution especially soluble rocks like limestone.

(4) Attrition

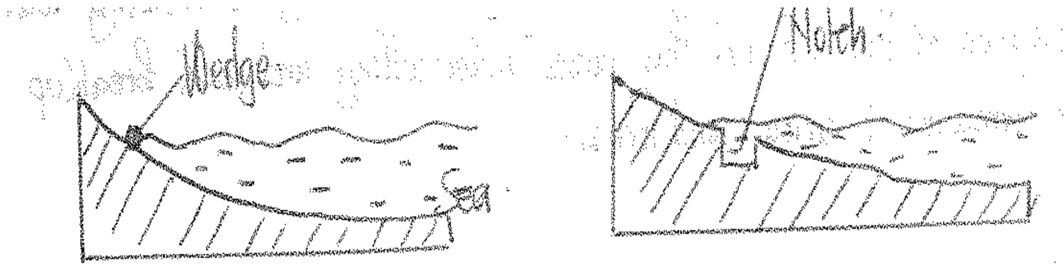
This is a process where boulders pebbles e.t.c. rub against each other and bigger particles reduce in size.

14.3 FEATURES PRODUCED BY WAVE ACTION

(1) Notch

This is a small opening / depression found at the coast shore / beach. It is formed when hydraulic and corrosion action of waves lead to the under cutting of the coast and they remove a loose wedge from the coast and form a small opening or depression known as a Notch. Notches also develop where there are well developed limestone rocks which have been removed by chemical action (solution of waves). The limestone is dissolved by the wave salty waters. Where the dissolution has occurred and rocks are turned into a solution there remains a small opening or depression called a Notch.

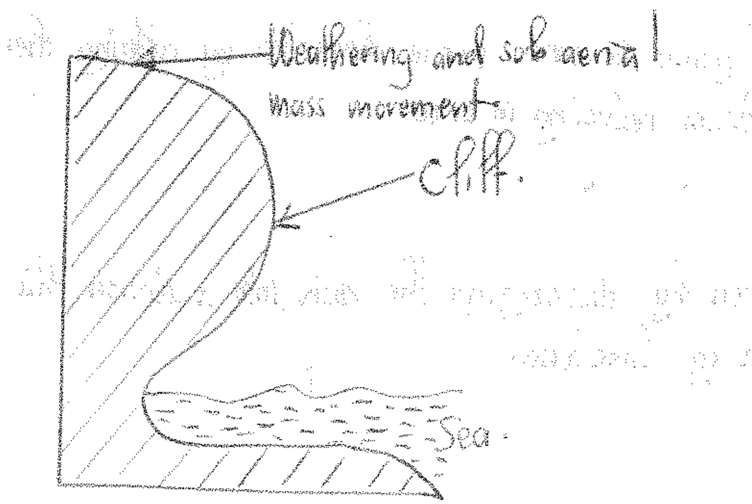
(i) Before erosion (ii) After erosion



(2) Cliff

Is a steep rock face along the coast. The continued undercutting by hydraulic and corrosion action of waves in the Notch combined with sub-aerial mass movement and weathering which causes the upper part to collapse. The steep rock face formed is known as a cliff.

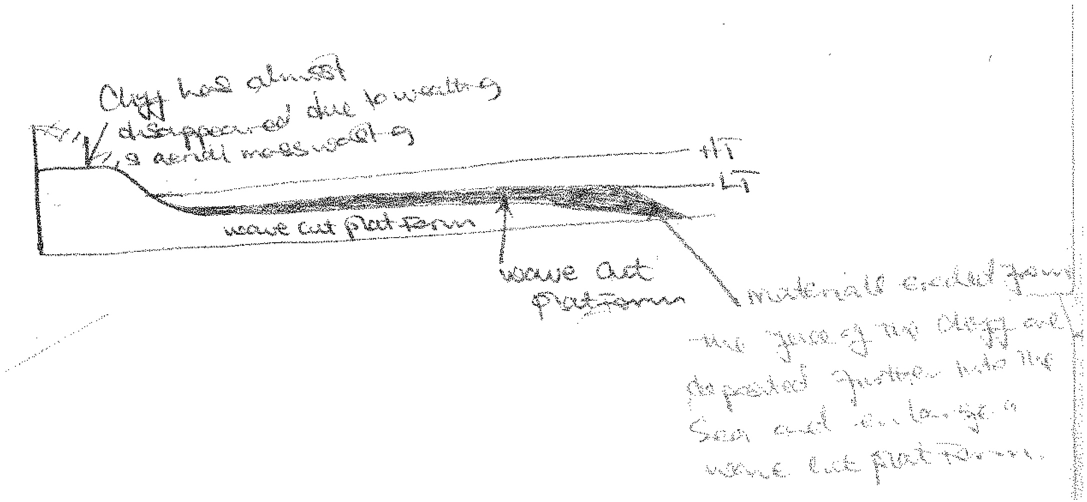
Diagram:



(3) Wave cut platform

Is the flat low-lying piece of land found at the coast. It is formed when a cliff retreats to form a bench like feature through the grinding action / corrasive action of materials swept to and from the coast by the breaking waves. They are visible at low tide and covered by water at high tide e.g. south of Mombasa.

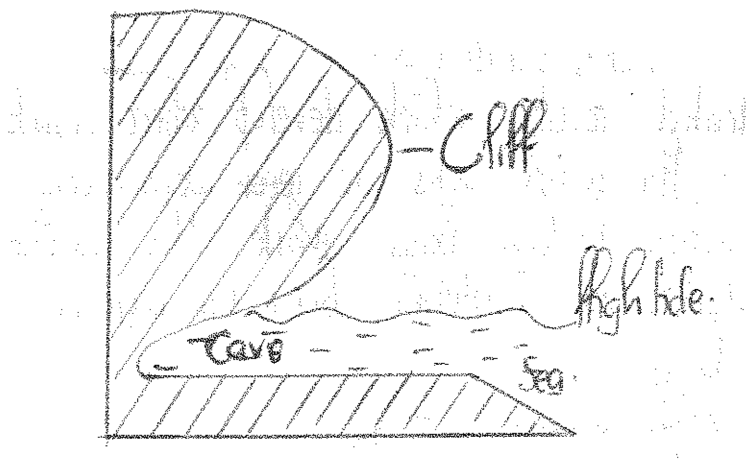
Diagram:



(4) Caves

A cave is a horizontal cylindrical hole at the base of the cliff formed by the hydraulic action of waves enlarging an initial crack (joint in the rock) the impact of the breaking waves by the hydraulic action exerts enormous pressure in the rock joints causing air in the cracks to be suddenly compressed. When water retreats, the air expands explosively. The expansion gradually loosens the rocks and enlarge the cracks. The boulders pebble thrown with force at the base of the cliff also lead to under cutting and rock break up through corrosive action. There is a cave at Lutembe beach. Resort beach in Entebbe at Mombasa e.t.c.

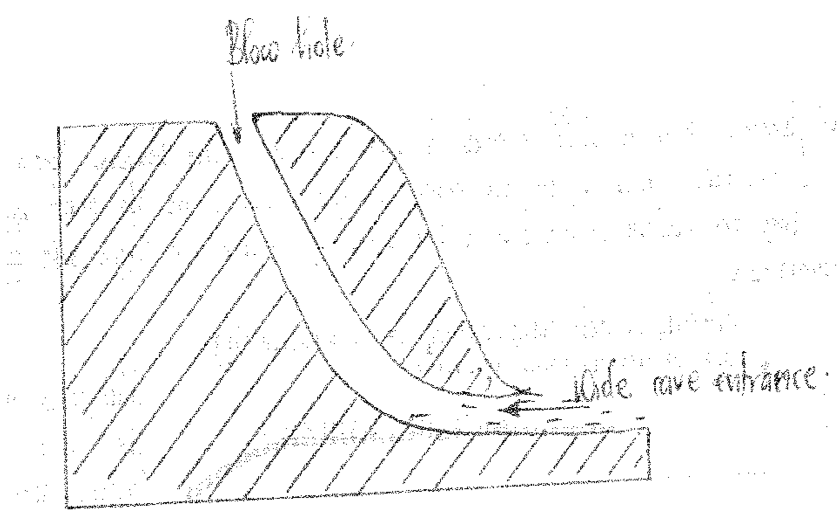
Diagram:



(5) Blow hole

Is a vertical cylindrical hole which extends from the end of the cave to the top of the cliff. It is formed from the hydraulic force of waves spurting high into the air and weaken the joints in the cave roof so much that a vertical tunnel connecting the cave with the cliff top known as a blow hole is formed e.g. near Botanical gardens in Entebbe and Kasenyi fish landing site.

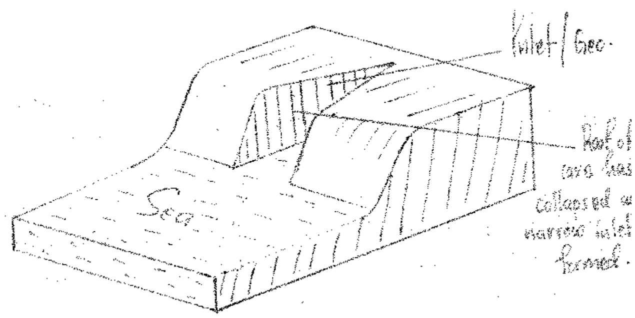
<u>Diagram:</u>



(6) Geo

This is a long narrow sea inlet along the coast. It is formed when there is further erosion by hydraulic and corrosive actions of waves which forces the cave roof to collapse to form a long narrow gorge like inlet known as a geo e.g. at Kasenyi.

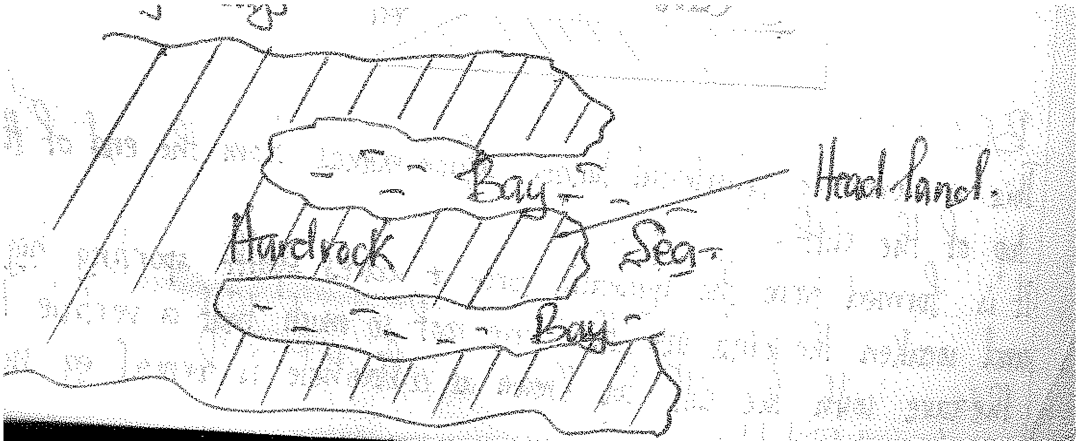
Diagram:



(5) Bays and headlands

These are indented coasts where headlands refer to projection of the land into the sea and bays refer to the projections of the sea into the coast. They develop along costs where resistant and weak rocks alternate. The weak rocks are worn away by hydraulic and corrosive action of waves to form bays while the resistant rocks stand up as headlands and remain projecting into the sea e.g. Entebbe peninsular region has headlands flanked by bays.

Diagram:



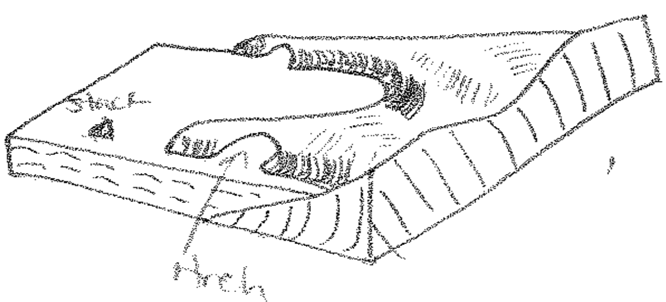
Qn. Account for the formation of a stump.

Approach:

- Identify a stump as a wave erosive feature.
- Describe wave erosional processes.
- Indicate that the stump forms in a series of stage beginning with:
  - Cliffs develop on the sides of a headland.
  - Then caves at the base of the cliff on the headlands.
  - Then arches, then stack and lastly stump.

Arches

An arch is a horizontal cylindrical tunnel which develops in a headland. They are formed when two caves develop back to back by the hydraulic and corrosive action of waves on a headland which ultimately join forming a tunnel through the headland known as an arch.



Stack

Is a piece of rock standing prommently into the water opposite a headland.

Its formed when hydraulic and corrosive action erode the roof of the arch and it finally collapses such that the end of the headland is separated from the main headland which stands up in the water and it is called a stack.

Stump

Is a worn down piece of rock standing prominently into and under the water opposite a headland but can be visible during low tide. Formed when a stack is worn down by the hydraulic and abrasive actions of waves.

Examples of bays and headlands; stacks, arches and stumps exist at Kasenyi fish landing site e.t.c.

14.4 WAVE DEPOSITIONAL FEATURES

Wave deposition occurs through the process of long shore drift.

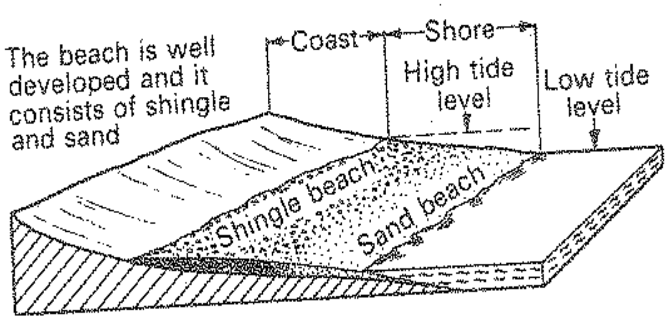
It's a process through which materials are moved by the swash and back wash in a zigzag manner. It occurs where the waves break obliquely and the swash deposits the material. The back wash retreats at right angles at the shore. Eventually the deposits accumulate to form wave depositional features.

BEACH

A beach is a gently sloping platform along the coast or shore composed of accumulated deposits of sand, shingle and pebbles.

Beaches can be sandy, stony beaches and shingle beaches. Beaches are formed through the process of the long shore drift where waves deposit sand, shingle and pebbles along the coast to form a gently sloping platform between the high tide and low tide e.g. Gaba beach, Lido beach.

Diagram



TYPES OF BEACHES

(1) Bay head beach

It is a crescent of sand and shingle formed between two headlands by the long shore drift. Such as the Lido beach at Entebbe, Nyali beach at Mombasa, Lutembe beach e.t.c.

(2) Barrier beach

This is a long sand ridge parallel to the coast and separate by a lagoon. It is formed where waves break some distance from the coast.

(3) Storm beach

This is formed where strong waves deposit coarse materials several metres above the water level during times of storms.

(4) Beach berms

Is a beach ridge formed on the upper part of some beaches. It is formed by the deposition of sand and shingle in areas with steep profiles along the shore. They accumulate at the furthest limit of the wave action.

(5)Beach cusps

Are projections of sand and shingle forming a cone shaped apex pointing seawards. They are formed by eddres with a powerful swash. Scouring coarse materials in the depressions. They are separated by shallow indentations that face seaward e.g. at Mombasa.

SPITS

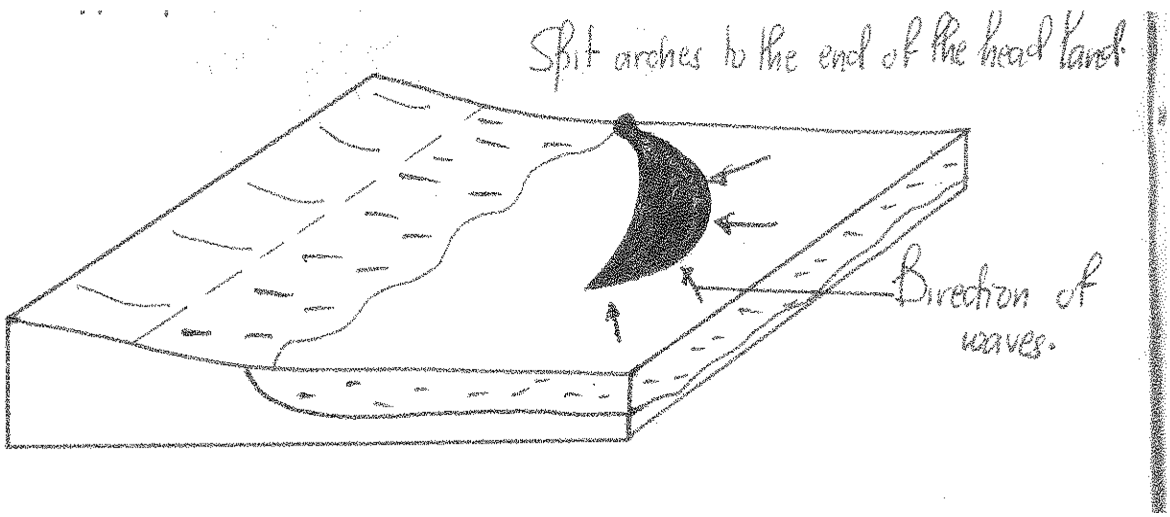
A spit is a low narrow ridge of sand and pebbles joined to the coast at one end with the other end terminating into the sea. It is formed by the process of the long shore drift in areas around headlands, where sand, shingle and pebbles are deposited growing outwards and glares into the bay.

Waves swaying obliquely into the bay hit the materials being deposited and therefore the ends of the spits become hooked or curved.

(1) Hooked / Curved spits

This is formed where waves approach a spit from several directions depositing materials at right angles, causing it to curve towards the sea as it grows e.g. at Kibanga on L. Victoria at Buikwe and Tonya point on L. Albert.

Diagram:



(2) Cuspate spit

This is formed where spits develop from opposite headlands and converge at their apex where spits begin formation from a headland and keeps on curving until it becomes attached to the shore / head land again.

BAR

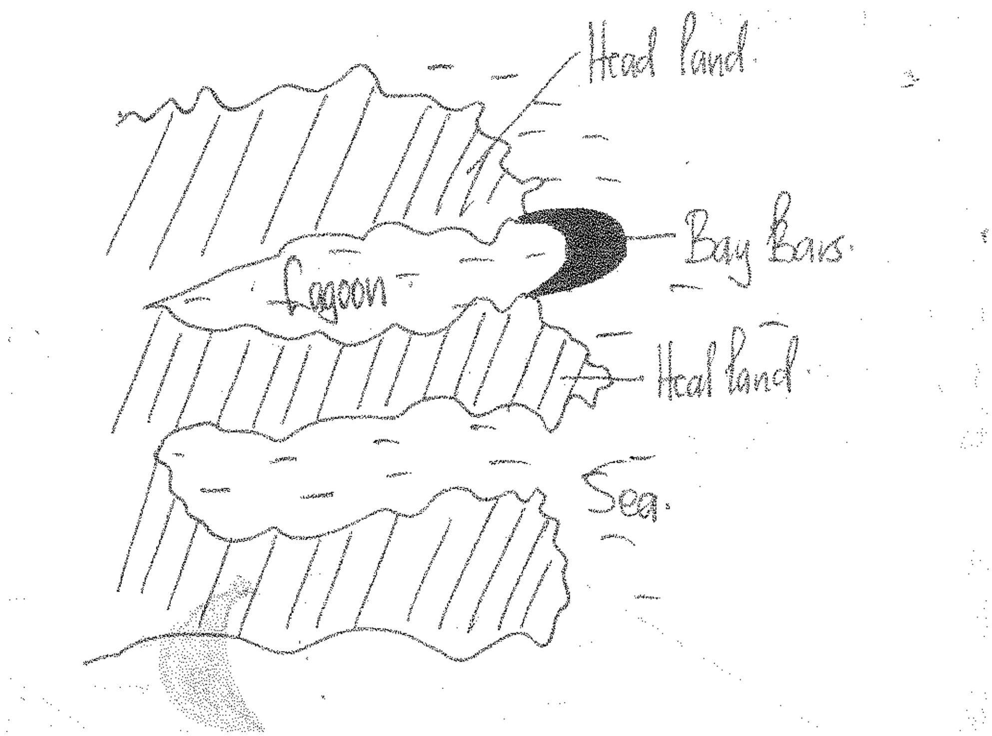
A bar is a low narrow ridge of sand and shingle. They are formed through the process of the long shore drift when the breaking waves deposit sand materials off shore parallel to the coast or across a bay enclosing a lagoon.

TYPES OF BARS

(1) Bay Bar

These are formed when deposition of materials begin from a headland as a spit, ultimately stretches across a bay to the next headland. They are normally broken into by tides and are therefore are not always continuous.
They enclose a lagoon e.g. Lake Nabugabo.

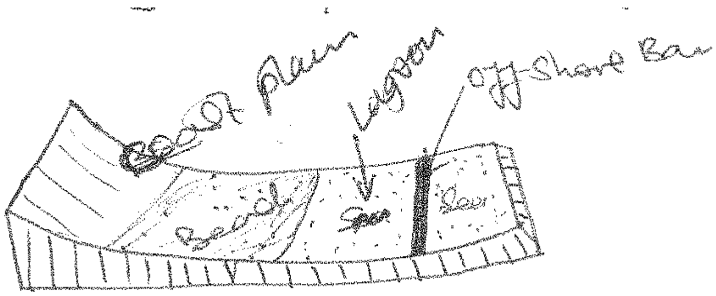
Diagram:



OFF SHORE BAR

It is formed when materials are deposited far away on very gently sloping coast where the continental shelf extends into the sea. The waves transporting the material break at a distance before reaching the coast thus depositing the material forming on offshore bar.

Diagram:



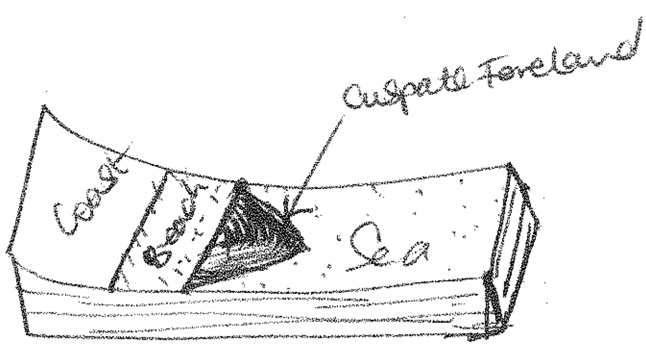
FORE SHORE BAR

This is formed by the constant accumulation of sand causing the bar to rise above the water surface.

CUSPATE FORELAND

Is a triangular shaped deposit of sand and shingle projecting seawards. It is formed by the converging of two spits which enclose a lagoon and this lagoon is later filled with sand and shingle and may later be colonized by vegetation. A cuspate foreland may later be enlarged by addition of materials (gravel, shingle and sand) to form beach cusps.

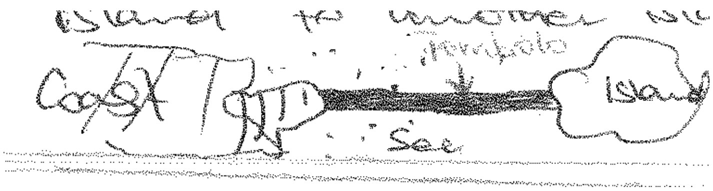
Diagram:



TOMBOLO

Is a low narrow ridge connecting the coast to an island or one island to another. It is formed when the deposition of sand begins from a headland as a spit, glares into the sea up to an island. There used to be a tombolo joining Bukakata in Masaka to Lambu Island.

Diagram:



MUD FLATS

These are platforms of mud. They are formed as a result of the long shore drift of waves transporting and depositing mud and silt which form low-lying platforms of mud known as mudflats.

Examples exist in Mombasa.

Qn. Examine the influence of long shore drift on landform development in East Africa.

Approach:

- Define long shore drift.
- Account for the formation of wave depositional features.

15.0 SEA LEVEL CHANGES / EUSTATISM

15.1 Eustatic movements / Eustatism

This refers to the world wide rise or fall in the level of the sea relative to that of land. These changes are due to tectonic movements; massive melting of Glaciers e.t.c. these changes can be positive in the form of submergence or can be negative in form of emergency.

15.2 Isostatic movements

These refer to the rise of fall of the sea level in relation to the land on a local / minor scale. The changes are due to local earth movements and they affect particular coasts or are from isostatic adjustments due to unloading or loading of the coast. They also involve positive movements in form of submergence and negative movements in form of emergency.

15.3 CAUSES OF A RISE IN THE SEA LEVEL / SUBMERGENCE OF COASTLINES / TRANSGRESSION

(1) Deglaciation

This is the melting of glaciers. After the Pleistocene period, large masses of glaciers melted releasing large amounts of water which drained into the sea hence contributing to a rise in the sea level.

(2) Sedimentation

The presence of many rivers flowing into seas, oceans and lakes which carry large quantities of sediments and deposit them on the sea floor, displace the waters upwards hence contributing to a rise in the sea level e.g. R. Rufigi and Tana in the Indian Ocean.

(3) Climatic changes

Climatic changes resulting into increased rainfall lead to the rise in the sea level e.g. 1960's in Uganda long heavy rains led to the most lakes rising and submergence of ports.

(4) Rise in sea temperatures

When the sea temperatures rise, water molecules expand which causes the positive movements in the sea level. The increased temperatures may be due to volcanic activities on the sea bed.

(5) Earth movements

Uplifting of the sea bed displaces the sea water upwards hence causing a rise in the sea level. Subsidence along the coast causes the land to go down and the water level goes up e.g. the local sinking at Kirindini (Mombasa) contributed to a rise in the level of the sea relative to the level of land.

(6) **Presence of many rivers and streams** discharging their water in the seas also leads to the rise in the sea level.

(7) Global warming

Due to the current trend in the green house affect world temperatures are increasing. This leads to melting of permanent snow which release large amounts of water into the sea and oceans.

(8) Isostacy

This involves the wearing away (down) of continental land masses by weathering and erosion which leads to a fall in the level of land relative to that of the sea leads to a rise in the sea level relative to that of land.

(9) Contraction of sea floors

Some geologists have suggested that the earth is contracting which means that the sea floors are also contracting leading to reduced volumes of the ocean basins.

This automatically leads to the rise in the sea level.

(10) Human activities

Like dumping of rubbish, sewage, gabbage, construction of piers and hotels in water have led to the rise in the sea level. This involves the dumping of thousands tonnes of hard core stones, soils and sewage in water which forces the water to be displaced upwards hence a rise in the sea level.

15.4 CAUSES OF A FALL IN THE SEA LEVEL / NEGATIVE CHANGES (EMERGENCY OF COAST LINES) / REGRESSION

(1) Glaciation

Refers to the formation of large masses of ice; large quantities of water are locked up in form of ice masses resulting into a fall in the sea level.

(2) Global warming

This has resulted into increased temperatures and depletion of the ozone layer due to the increase in carbon compounds in the atmosphere hence leading to direct heating of the earth surface leading to excessive evaporation hence a fall in the sea level.

(3) Drought

Abnormal prolonged shortages of rainfall have resulted into no water being discharged in oceans and high evaporation rates hence leading to a fall in the sea level.

(4) Isostacy

The rising of the coastal land relative to the sea leads to a fall in the sea level. This could be due to deposition at the coast by rivers e.t.c. leads to a fall in the sea level.

(5) Earth movements

Warping or faulting on the sea bed creates depressions there which makes the waters withdraw from the coastal area to fill the newly created depressions on the sea bed.

This leads to a fall in the sea level whereas uplifting along the coast leads to the rise of land relative to that of the sea hence contributing to a fall in the sea base level.

(6) **Presence of many streams/rivers** drawing water from the sea / lakes drain them hence leading to a reduction in the water levels.

(7) Human activities

Like using too much water from lakes and seas for irrigation, damming of rivers for domestic use, which are the sources of water for the seas and lakes leads to a fall in the sea level.

Note: Any movement including a rise in the land relative to that of the sea is described as negative movements of the sea level and leads to emergency of coastlines.

The sinking of land relative to the sea is called a positive movement of the sea base level and leads to the submergence of the coast line.

There are therefore two basic types of coasts i.e. submerged coasts and emerged coasts. Each of these coasts can be divided into highlands and low land coasts.

15.6 LANDFORMS RESULTING FROM SEA LEVEL CHANGES ON A HIGHLAND COAST

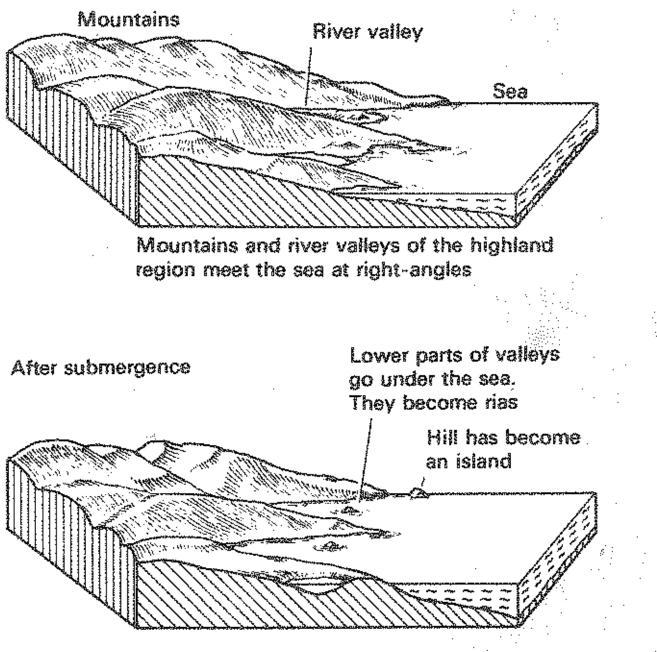
(1) RIAS

A ria is a submerged river valley on the highland coast. Its funnel shaped, wider and deeper seawards and narrower and shallower landward.

It's formed when the lower part of the river valley is submerged during the rise in sea level e.g. R. Mtwala, Tanga, Dar-es-Saalam and Lamu in Tanzania and along the southern shores of Lake Victoria near Mwanza.

(i) Before submergence

Diagram



(2) FIORDS

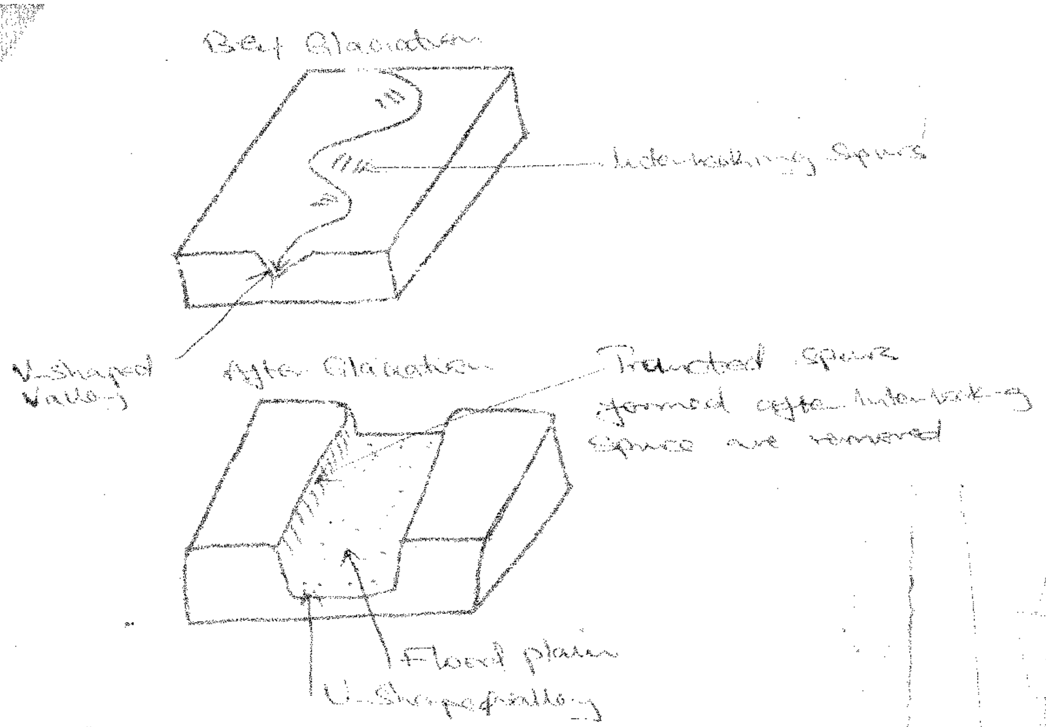
A fiord is a drowned glaciated river valley on a highland coast.

Before glaciation, a river is winding between interlocking spurs but when the valley is filled with glaciers, the interlocking spurs are eroded and the river valley is changed from a V-profile to a U-shaped profile and has hanging valleys and truncated spurs, shallow seawards and deeper landwards. The valleys are excessively steep sided because of glacial erosion when such a valley is drowned to rise sea level, forms a fiord. They form good sheltered harbours and examples exist in Sweden and Norway.

Formation of fiords

(i) Before glaciation (ii) After glaciation

Diagram ***Diagram***

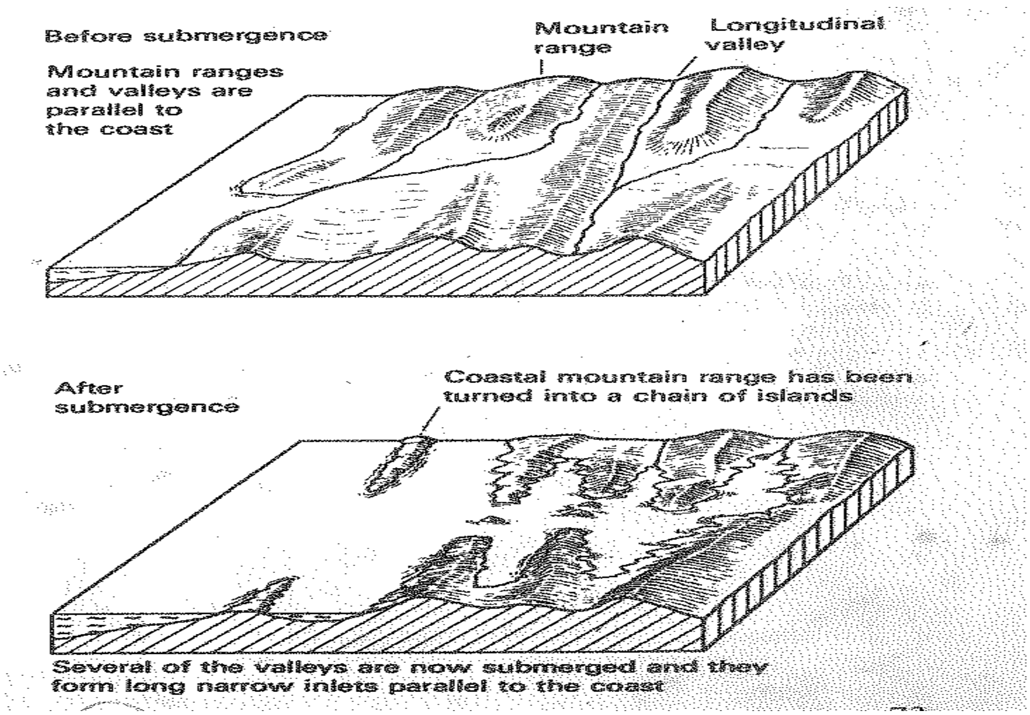


(3) LONGITUDINAL / DALMATIAN COAST

These are submerged tops of hills / mountains / highlands lying broadly parallel to the coast. It's formed when highland regions whose vallies and mountains are parallel to the coast are submerged during the rise in the sea level.

Highlands appear as a chain of islands called Dalmatian coasts while the drowned valleys form sounds e.g. the smith sounds on the shores of Lake Victoria in Mwanza, Bumbuli hills, south of Bukoba on L. Victoria.

Diagram



(4) PENINSULAR

This is an extensive piece of land projecting into the sea. It's formed when highlands are at right angles to the coast and the valleys are submerged, leaving the land projecting into the sea e.g. Entebbe and Mombasa peninsular.

(5) ISLAND

Is a piece of land surrounded by water in a sea lake or ocean. It's formed when a highland region is submerged and the parts which are not covered by water form islands e.g. Ssese island, Kome in L. Victoria.

15.7 SUBMERGED FEATURES ON LOW LAND COAST

(1) ESTUARIES

These are submerged / drowned river valleys on a low land coast. They have a V-shaped cross profile pointing land ward e.g. the mouth of R. Rufigi, Wani along the East African coast, Mombasa and Kibanga on L. Victoria in Buikwe.

(2) CREEKS

These are drowned river valleys on a low land coast but they are smaller and tidal than Estuaries e.g. Mtwapa creeks along the East African coast, Makupa along Mombasa Kenya coast.

(3) FIARDS

These are submerged glaciated river valleys on a low land coast. Their profiles are broader with U-shaped cross profile examples are evident in south East Sweden.

(4) MUD FLATS

These are plat forms / deposits of fine silt, mud from drowned river valleys deposited by waves during the rise in sea level. They are usually colonized by vegetation to form mangrove swamps / marshes e.g. along the East African coast. Such deposits may enclose lagoons.

15.8 EMERGED FEATURES ON A HIGHLAND COAST

(1) RAISED BEACHES

When the level of sea falls, a new beach is formed at a lower level. The original beach left high above the present zone of wave deposition is referred to as a raised beach e.g. Timbuani, Diani, Shimon along the East African coast, Lutembe beach, Kasenyi beach e.t.c.

(2) RAISED CLIFFS

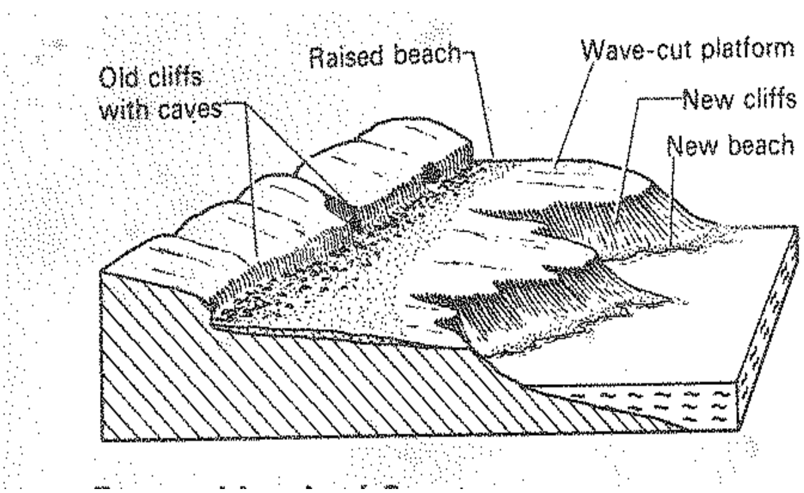
When the level of the sea falls, a new cliff is created at the lower level of wave erosion. The original cliff is left high above the present level of the sea and it's referred to as a raised cliff e.g. at Lamu and Malindi on the Tanzania coast.

(3) RAISED CAVE

The cave which was formed by hydraulic and corrosive action of waves before the fall in the sea level is left high after a fall in sea level as a new cave forms at the current sea level.

Raised cliff, Raised beach, raised cave are illustrated below

Diagram



(4) RAISED RIVER TERRACES

When the level of the sea falls, a river renews it's under cutting hence rejuvenated in order to reach the new base level, features of rejuvenation are thus formed. The first set of terraces are found at high elevation compared to the level of water in the sea where the drop in sea level produces another pair of terraces.

Examples occur in Lutembe near Lake Victoria.

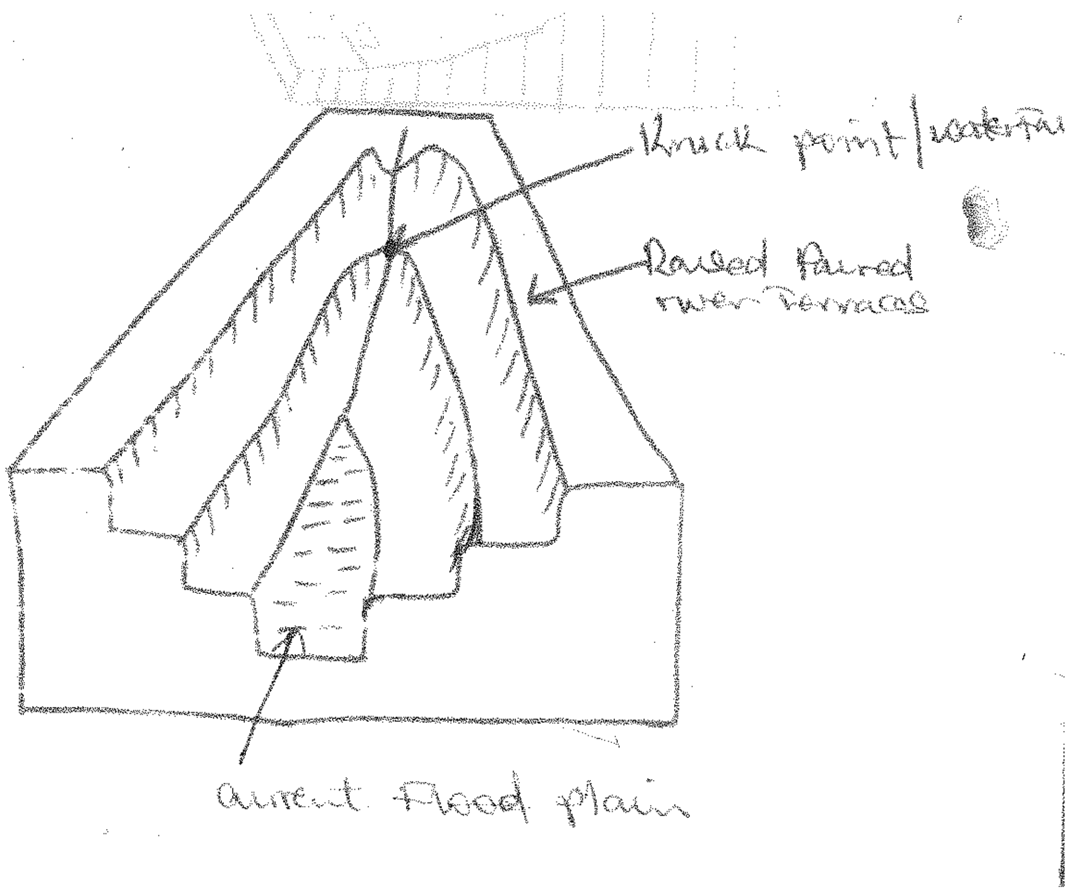
(5) KNICK POINT

This refers to the sharp change in the gradient of the slope along which the river flows.

Formed when a fall in the sea level is followed by river rejuvenation which leads to excessive under cutting of the valley floor (renewed vertical erosion) in order to reach the new base level which creates a sharp break in the gradient of the slope to form a knick point.

Knick point

Diagram:



(6) VALLEY WITHIN A VALLEY

It's formed when renewed vertical under cutting of the river creates a new valley on the floor of the original valley after a fall in sea level.

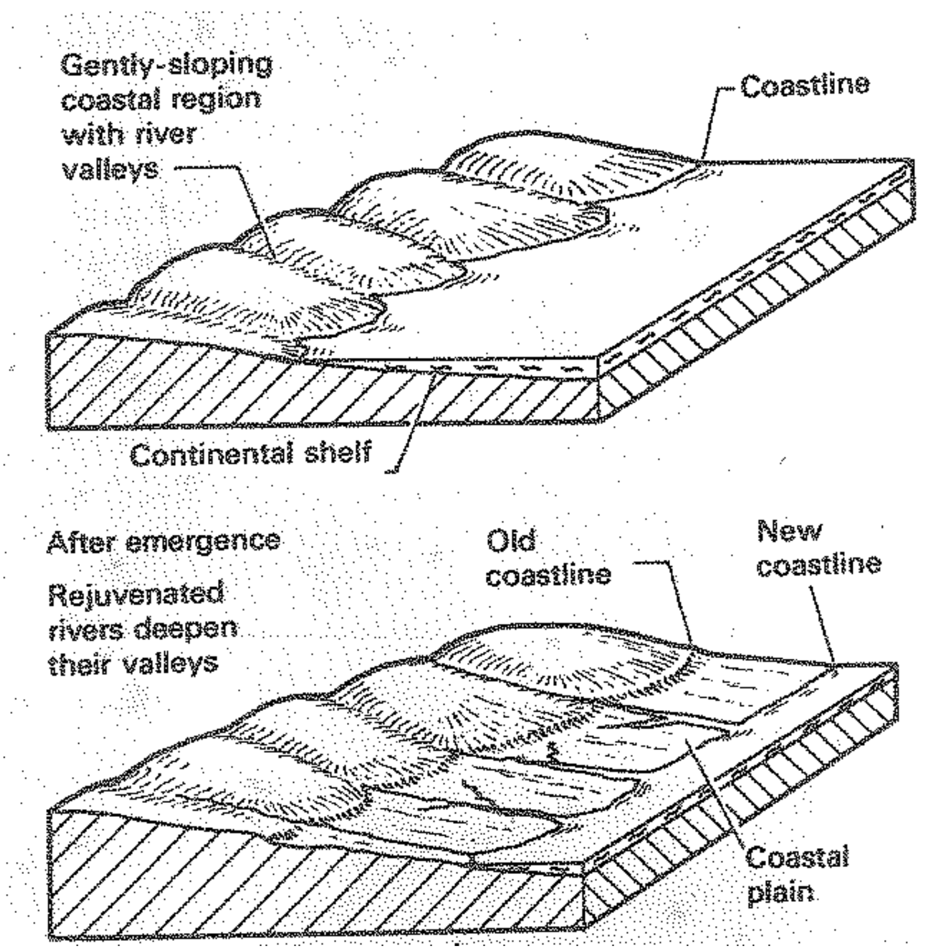
Valley within a valley

15.9 EMERGED FEATURES ON A LOW LAND COAST

(1) COASTAL PLAIN

Is an extensive low-lying piece of land boardering the sea.

Formed when part of the continental shelf emerges from the sea due to the fall in the sea level. Examples are found at the north East coast of the Gulf of Mexico and south west of U.S.A.



16.0 RIVER ACTION

A river is a mass of water flowing over the land surface from its source to its mouth in a defined direction.

(1) River source

This is a place from which a river begins to flow e.g. a lake, spring, melting glaciers, swamps or a region of steady rainfall e.g. R. Congo.

(2) Rivers mouth

This is a place where the river ends e.g. Lake, ocean, swamp.

(3) River's catchment area / long profile of a river.

This refers to all the areas drained by a river and its tributaries from its source to its mouth. **OR**;

The long distance covered by a river from its source to the mouth which is divided into 3 stages namely, youthful, maturity and old stage.

(4) Cross profile of a river

Refers to the vertical section through the river valley from one bank to the other.

(5) Divide / water shade

This is a highland area separating one river system from another.

(6) River regime

Refers to seasonal variations in the volume of water in a river valley. The volume is high during the rainy season and the volume is low in dry season.

A river course / profile is divided into 3 stages namely youthful, middle and old stage. In each of these stages a river does certain activities and therefore characterized by different features.

16.1 WORK OF A RIVER

Rivers are major agents of land sculpture or moulding of land. A river is therefore both a constructive and destructive agent of the earth's surface. As a river flows, it erodes thus destroying, transports and deposits materials thus constructing the earth's surface.

The materials transported by a river are known as its load.

16.2 RIVER EROSIONAL PROCESSES

A river erodes its channel through several processes e,g.:-

(1) Hydraulic Action

Erosion caused by the pounding force of moving water. Through this action, loose material is removed by the force of water alone. This type of erosion tends to make river banks curve.

(2) Abbrasion / Corrasion

Mechanical wearing away of the river channel by the impact of the grinding action of materials carried by the river at the river floor.

(3) Solution / corrosion

Process where river dissolves soluble rocks like rock salt.

(4) Attrition

Erosion of materials or load that is being carried by the river which rub against each other thus reducing in size and the softer the rock, the easier it's eroded by attrition.

16.3 JUVENILE / YOUTHFUL STAGE / TORRENT / UPPER COUSE

Characteristics of a river in the youthful stage and its valley / Torrent state / upper course / juvenile

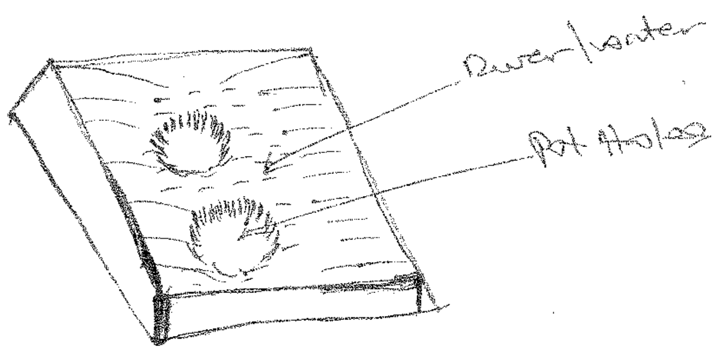
- A river flows very swiftly / high velocity due to the steep gradient.
- A river flows onto a steep gradient because of the steep slopes.
- Vertical erosion is very pronounced due to the rolling stones (abrasion).
- Lateral erosion is absent / very minimal because the river concentrates all its energy to vertical erosion.
- The river valley is V-shaped and narrow due to vertical erosion and minimal lateral erosion.
- The river flows in a winding manner avoiding any resistant rock out crops on the way resulting into interlocking spurs.
- Water falls, plunge pools, e.t.c. occur when the bend of the river becomes stiff.

16.4 FEATURES FORMED IN THE YOUTHFUL STAGE

(1) Potholes

These are circular depressions on the river bed formed when water of a fast flowing river swirls if the bed is un even and the stone carried by the moving river cuts circular depression on the river bed. These gradually deepen and are called potholes.

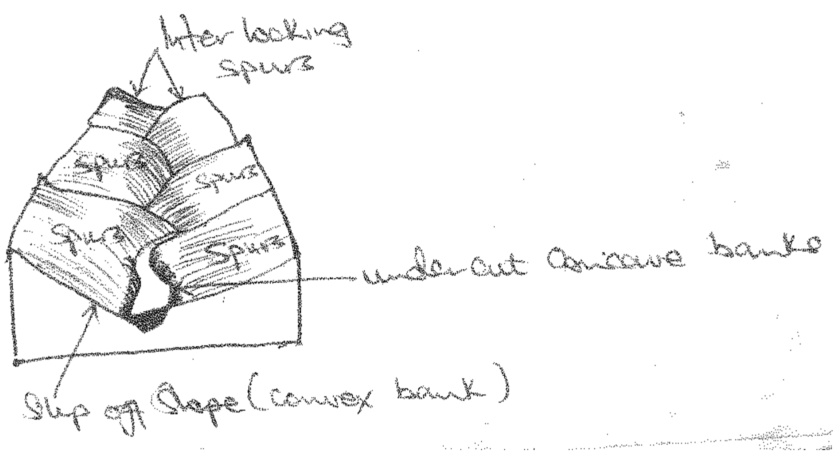
Diagram:



(2) Interlocking spurs

River features in a highland area where a river flows through a series of highlands, twists and turns around to avoid resistant rock obstacles. It's formed as a result of a river's vertical erosion through hydraulic and abrasion action rapidly deepening the river and the river twists and turns around obstacles of hard rocks. Erosion is more pronounced on the concave banks of the river which form interlocking spurs to interlock. Eroded materials from the concave banks are deposited on the convex banks where there is no or little erosion this makes the convex banks form gentle slopes of slip off slopes.

Diagram:



(3) Water fall

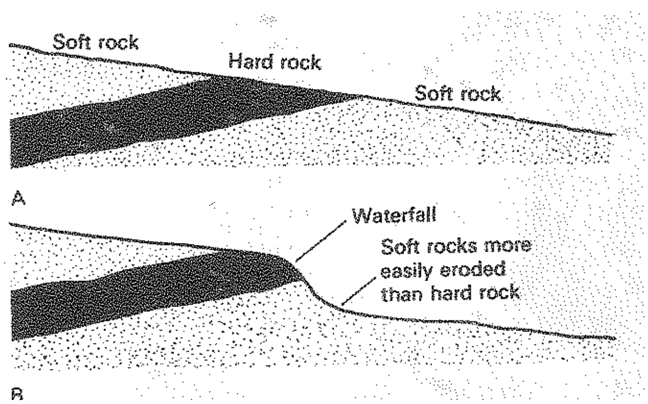
This is a sharp change in the gradient of the slope over which a river flows i.e. from a high elevation to a sudden low elevation.

Waterfalls are of two types i.e. those caused by rock differentials in hardness into which the river is cutting and those caused by an uplift and faulting, larva flows and landslides.

(a) Waterfalls due to rock differentials.

When a layer of hard rock lies across a river's course, the soft rocks on the downstream side are more quickly eroded by abrasion and hydraulic action than the hard rock. The river bed is thus steepened when it crosses the hard rock and a waterfall develops e.g. Bujagali, Owen falls, Ssezibwa falls, Sippi falls.

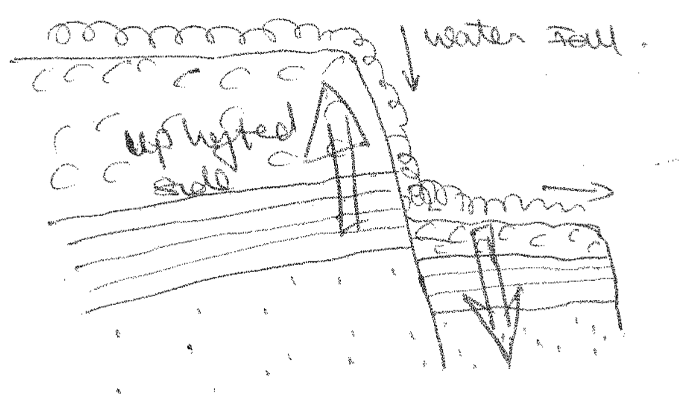
Diagram:



(b) Water falls due to uplift / faulting.

When faulting occurs across a river channel this is followed by vertical displacement of rocks along the fault line where one block is uplifted and the other one sinks. A water fall is formed where a river flows from a suddenly high to a low elevation e.g. Murchison falls.

Diagram:



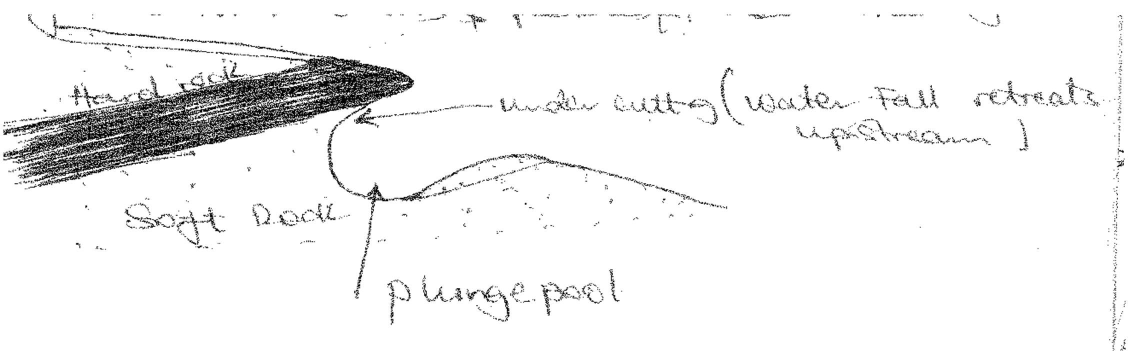
A PLUNGE POOL

A narrow or broad depression formed at the base of a water fall, formed as a result of the enlargement of a pot hole at the base of a water fall due to the progressive drilling or grinding of the valley floor by the hydraulic and abrasion action of water.

CONDITIONS FOR THE FORMATION OF A PLUNGE POOL

- Large volumes of water which increases the rivers competence.
- Steep gradient resulting into high erosive power of a river due to velocity.
- Large amounts of abrasive materials like boulders to swirl and grind the bed.
- Difference in rock resistance in rock resistance in that the river flows from a hard rock to a soft rock thus drilling and deepening the softer rock.
- Examples are found along R. Sezibwa at Sezibwa falls, Sipi falls, Kizizi falls and upper Tana River.

Diagram:



GORGES

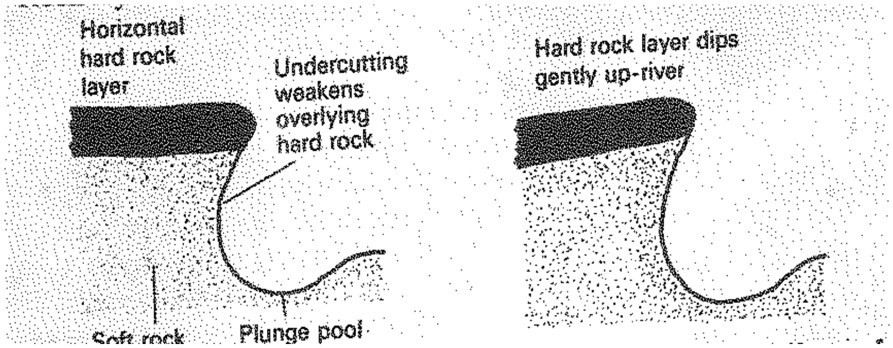
A gorge is a steep sided narrow deep river valley which develops at a point of a water fall.

Gorges are formed as a result of;

(a) Retreatment of a water fall

It's formed when a water fall retreats upstream e.g. at Victoria Falls on R. Zambezi e.t.c. This retreatment is done by the hydraulic and abrasion action of the river waters and stones carried by the river.

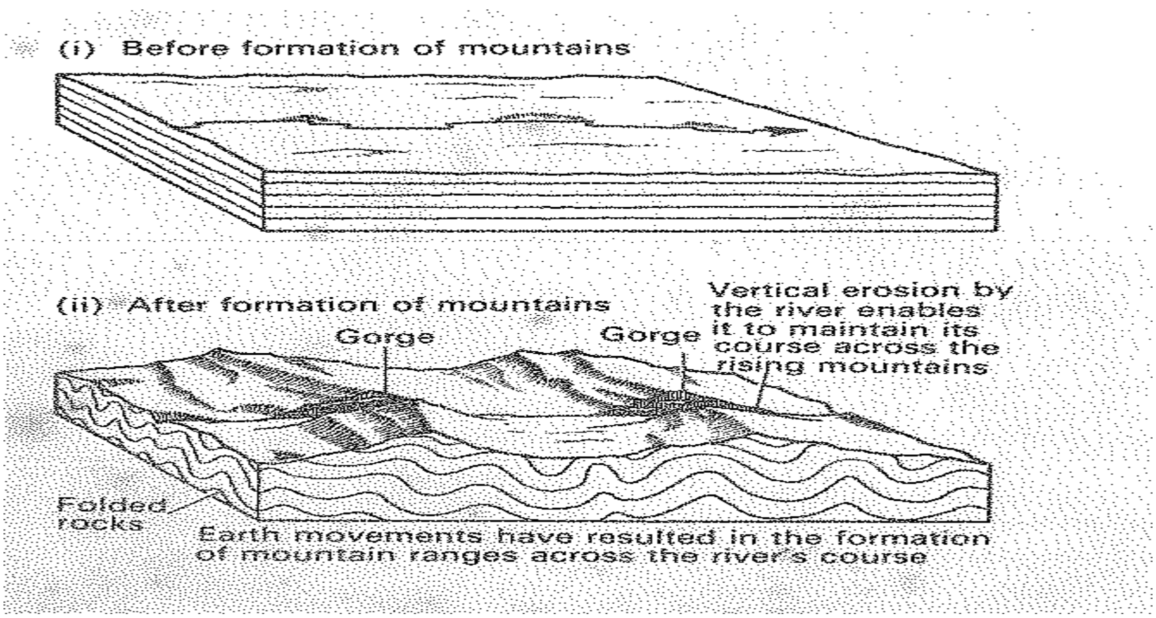
Diagram:



(b) A gorge may also be formed when a river maintains its course across a belt of land that has been uplifted due to the pronounced under cutting through hydraulic and abrasion action.

(i) Before uplifting (ii) After uplifting

Diagram:



Examples of Gorges include:-

- The Great Ruha Gorge on R. Ruha in Tanzania.
- Murchison falls on R. Nile.
- Sabaloka and Batoka on R. Nile in Sudan.
- Rupata Gorge in Mozambique
- Manambolo Gorge in Madagasca

MAIN CAUSES OF GORGES

When a water fall retreats up stream as it erodes vertically it will create a Gorge. It's common when retreatment is at a water fall e.g. Batoka Gorge and Victoria fall on

R. Zambezi.

A gorge may be cut by fast flowing river especially when a rock on which it flows is very soft. It's common at a point where rejuvenation has taken place, increasing the erosive force e.g. in Sudan such gorge is super imposed at Sabaleka Gorge where R. Nile has excessively eroded a volcanic ash leaving behind a super imposed Gorge.

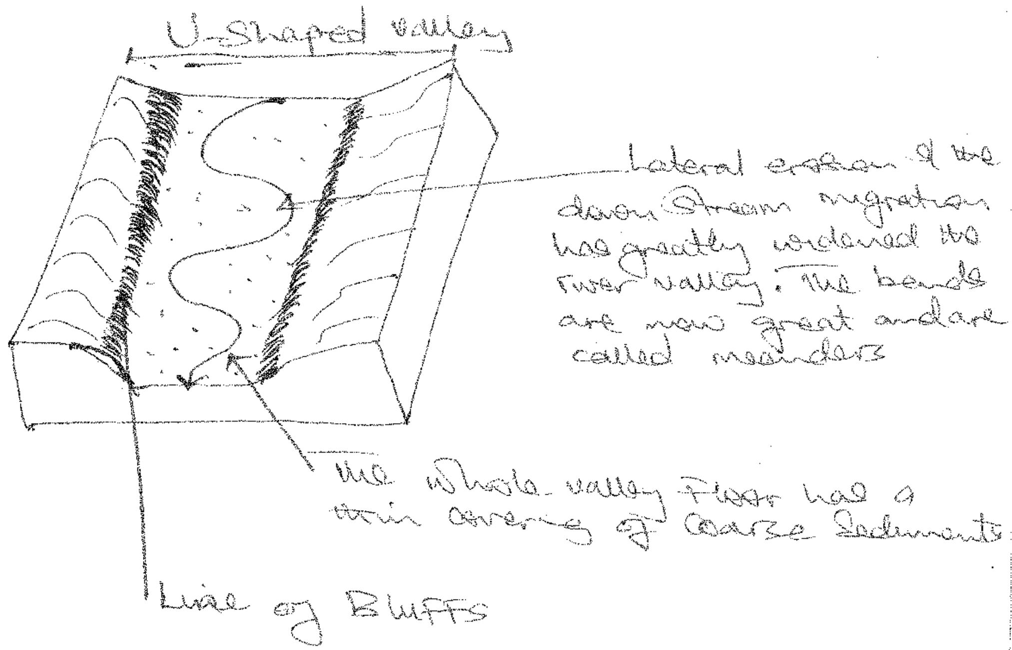
Sometimes there is continuous rise of landscape but a river continues to erode vertically at the previous rate. In this case, an antecedent Gorge will develop at point of uplift as illustrated above.

16.5 MIDDLE STAGE / MATURITY STAGE OF A RIVER

Characteristics:-

- A river flows on a reduced gradient due to the Gentle slope on which it flows.
- The velocity of the river is reduced i.e. it's not swift as in the youthful stage.
- Both vertical and lateral erosion are pronounced.
- The valley becomes U-shaped due to increased lateral erosion.
- The river valley floor is wide and by the time the river is nearing the old stage, the valley floor is covered by a layer of sediments.
- Spurs are removed by lateral erosion and their remains form a line of bluffs on each side of the valley floor.
- River bends are pronounced which form meanders.
- The concave banks of meanders stand as cliffs while the convex bank slopes gently as slip off slopes.

Illustration:



MEANDERS

This is a pronounced bend of a river.

CAUSES OF RIVER MEANDERS

(1) Coriolis force

River meander following the rotation of the earth. As the earth rotates, coriolis force forces rivers to lose their normal trend. This greatly affects rivers at the poles.

(2) Obstacles across river channels

The presence of obstacles of resistant rock out crops across a river channel may force a river to meander as it monouvers its way down valley avoiding the resistant out crop of rocks.

Obstacles along river valleys may force rivers to meander in their youthful stage, forcing them to develop interlocking spurs along river profiles.

(3) River deposition

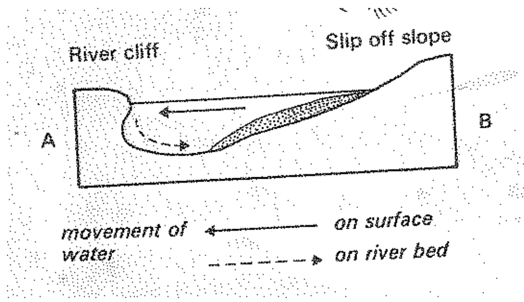
When the angle of the slope reduces from the steep surface to an undulating landscape, the speed of the water in the river valley is greatly reduced and the river may be forced to meander in the 2nd and 3rd stages of the river.

TYPES OF MEANDERS

(1) In-grown incised meanders.

These are under cut meanders composed of alternating steep sides with undercut slopes facing gentle sides of slip-off slopes.

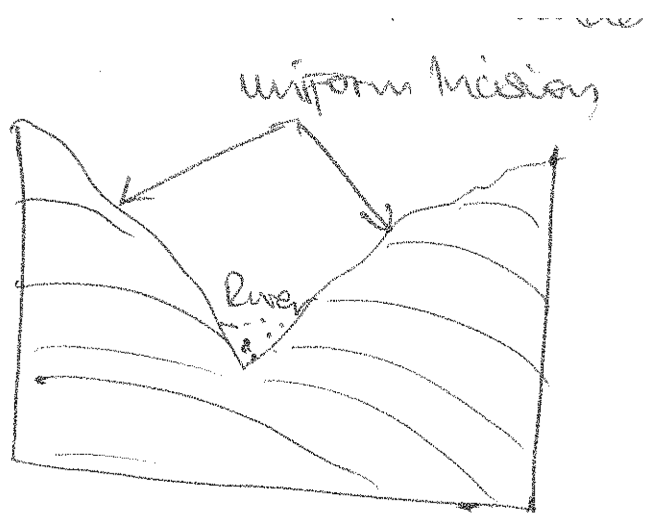
They often develop on rocks of uniform resistance to erosion where the base level falls gradually. As a result in-grown include meanders are of a symmetrical profile. (not uniform) e.g R.Mwachi North West of Mombasa and R.Umzimukulu and R.Rwizi.



(2) Entrenched meanders

These are steep sided with symmetrical cross profile.
It develops on weak rocks where the base level falls quickly as a result of rapid vertical incision eg R.Mangani, R.Mtavuna, R.Mkomazi and R.Mpanga have entrenched meanders.

Intrenched meander (diagram)



16.6 OLD STAGE/ SENILE/LOWER COURSE PLAIN COURSE

Characteristics

- The valley is U-shaped which gained its shape from the middle stage.
- The gradiently is totally reduced. Hence the river is flowing sluggishly/slowly.
- The river is braided.
- River bends are very pronounced and in fact, the river is characterized by numerous meanders eg on R.Ruizi in Mbarara.
- The valley floor is totally covered with a layer of sediments.

16.7 FEATURES FORMED.

1. **Flood plain**.

   Is a lap lying swampy plain covered with alluvial deposits of sands, silts, gravel and muds.

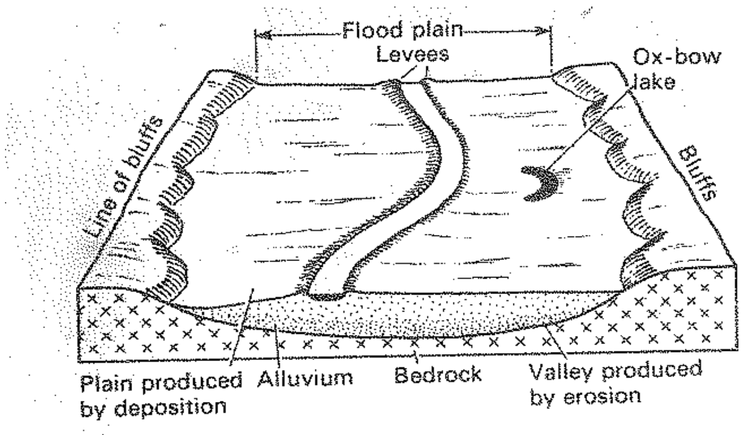
   Formation

   Its formation begins during the maturity stage. The whole valley floor is ultimately widened by lateral erosion which is affected by meanders migrating down stream.

   Active deposition begins to take place during maturity and the whole valley floor is ultimately affected as meanders wonder across it.

   When the age of maturity reached, the river begins to over flow its banks and it deposits five suits and muds on the valley floor. This is the final stage in the formation of a flood plain.

   Diagram

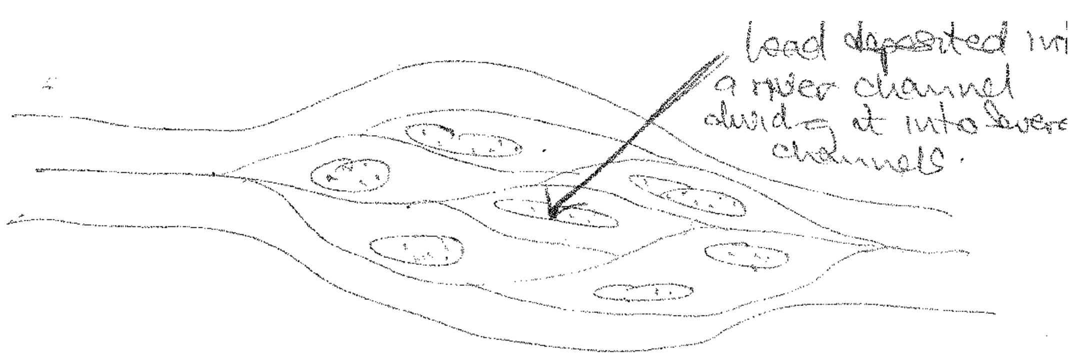


Examples of flood plains are seen on R. Ruizi, Semuliki, Nzoia and Nile in Egypt and Sudan.

Characteristic features of flood plain

1. **River Braids**
   The river carriers a heavy load some of which is deposited on its bed. This may produce mounds which divide the river channel into several channels. When this happens, the river is said to be braided.

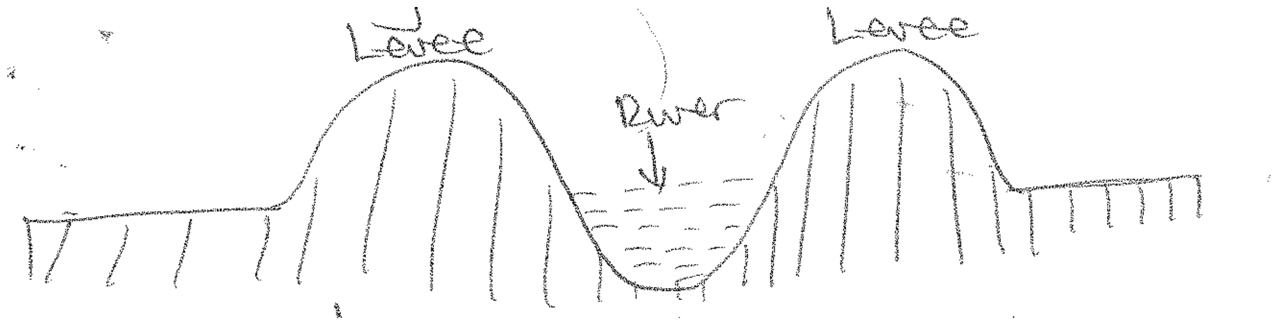
   Diagram



2. **Levees**
   These refer to the pronounced banks of a river which develop onto a flood plain.

   They are formed as a result of a river building up its banks by depositing alliumium along side it.

   Diagram

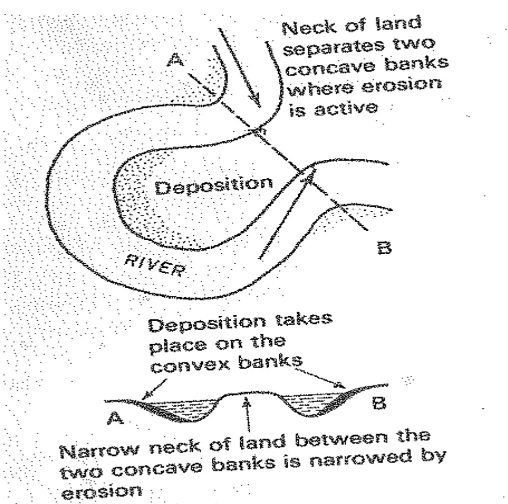


3. **Deffered/post poned junction**
   This occurs when the tributary is unable to join the main river because of the levees so that the junction is postponed eg R.Yazoo, a tributary of R. Mississippi flows for a long distance on parallels to the Mississippi river before it is able to join it.

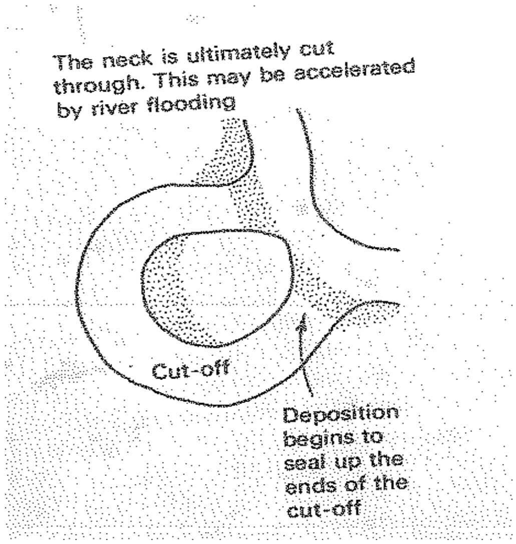
4. **Ox-Bow Lakes**
   These lakes are formed where there is an acute meander with a narrow neck of land separating two concave banks which are being cut.

   The neck is ultimately cut through. This is always accelerated by river flooding deposition begins to seal up the ends of the cut-off to form ox-bow lakes.

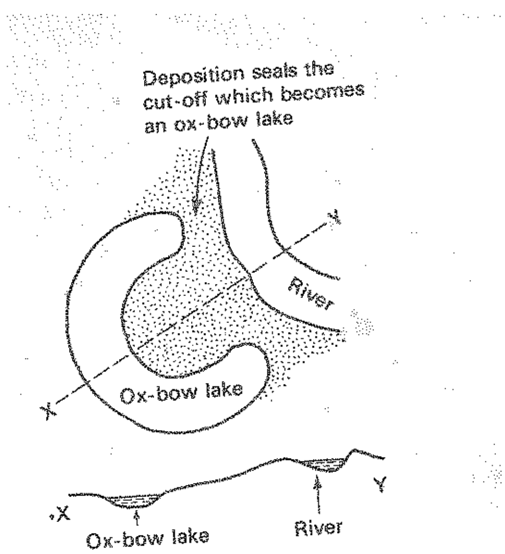
   Stage 1 diagram



   Stage 2 diagram



Stage 3 diagram



Note

Deposition along the convex banks increases after the formation of the ox-bow lake, the river bed and banks are steadily raised by the deposition and ultimately the river lies above the level of the ox-bow lake.

16.8 DELTAS

A delta is a large flat low lying swampy plain characterized by the presence of deposited material, distributeries, small lakes and lagoons and vegetation.

A delta usually has a triangular shapes formed at the mouth of a river as it enters a sea or lake or ocean.

CONDITIONS FOR THE FORMATION OF DELTAS

Before a delta is formed, the following conditions must be met:-

1. Active vertical and lateral erosion in the upper course of a river to provide extensive sediments to be deposited and form deltes.

2. The cost should be sheltered preferably tideless allowing deposited materials to stay and pile up.

3. The sea adjoining the delta should be shallow or else the load disappears in deep waters.

4. There should be no large lake in the river’s course to filter off the sediments.

5. There should be no strong currents running at right angles to the river’s mouth, washing away the sediments.

6. The velocity of the river must be too low as to allow deposition in the river’s mouth.

7. Rivers load must be deposited faster than can be removed by the action of tides and currents.

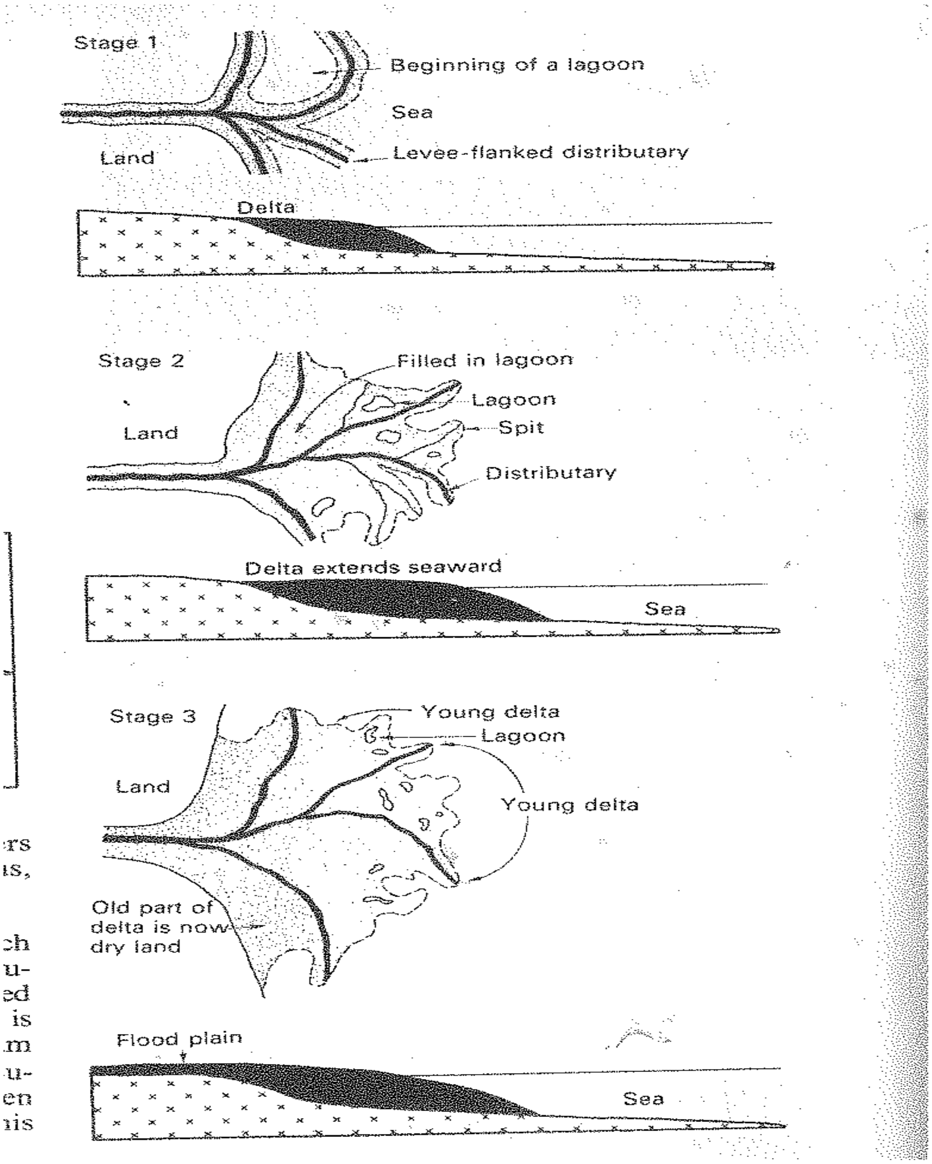
FORMATION OF DELTAS

- ✓ A large load and because of low river velocity, is deposited near the river’s mouth.

- ✓ There is coagulation of fine materials mixing with salty sea water.

- ✓ The deposited materials sediments block the existing river channels causing new distributeries to form and with the growth of vegetation, distributeries are encouraged to form.
- ✓ Spits and bars together with lagoons are formed.
- ✓ The levees of the rivers extend into the sea via distributeries.
- ✓ Lagoons get filled with sediments and become swampy.
- ✓ Deltas thus take a solid appearance.
- ✓ Plants colonise the older/upper delta and its height eventually raised swamps disappear leaving a dry delta.
- ✓ Older parts of the delta eventually become part of the flood plain.

Diagrams illustrating formation of deltas



TYPES OF DELTAS

1. **Arcuate delta**
   These are formed of coarse and fine sediments such as gravel and sand. They are triangular in shape or they have a shape of an inverted cone and many distributeries eg. R.Niger and Nile deltas.

2. **Estuarine Deltas**
   These are built by rivers depositing material in a submerged river mouth. Sand banks are formed with several distributeries winding around them.

They take the shape of an estuary eg R. Congo between Boma and Banana ports before it reaches the ocean.

3. **Birds foot digitate deltas**
   These are formed by rivers carrying very fine materials/suit into water where wave energy is too low to remove it.

   There are a few long distributeries boarded by levees eg. R. Omo in Ethiopia as it enters Lake Turkana.

IMPORTANCE OF DELTAS

- ✓ Deltas provide fertile alluvial soils which can support agriculture eg wet rice growing.
- ✓ They are good geographical features which attract tourists.
- ✓ Encourage fishing because they are rich in plunktons.
- ✓ Deltas provide raw materials for hand craft industry e.g papyrus and clay for the ceramics industry etc.
- ✓ Deltas may encourage alluvial mining (place mining)
- ✓ In case of estuary deltas, they can be good sites for the construction of parts and harbours.
- ✓ Study and research.

Disadvantages

- ✓ They may hinder the development of parts and harbours as well as inland transport because rivers channels across them are very shallow due to continuous silting.
- ✓ Deltas often lead to floods of the land scape adjacent to them. As a result, they may intervene with settlement, construction of roads and railways and may encourage the spread of bilharzia and other water born diseases.

Question

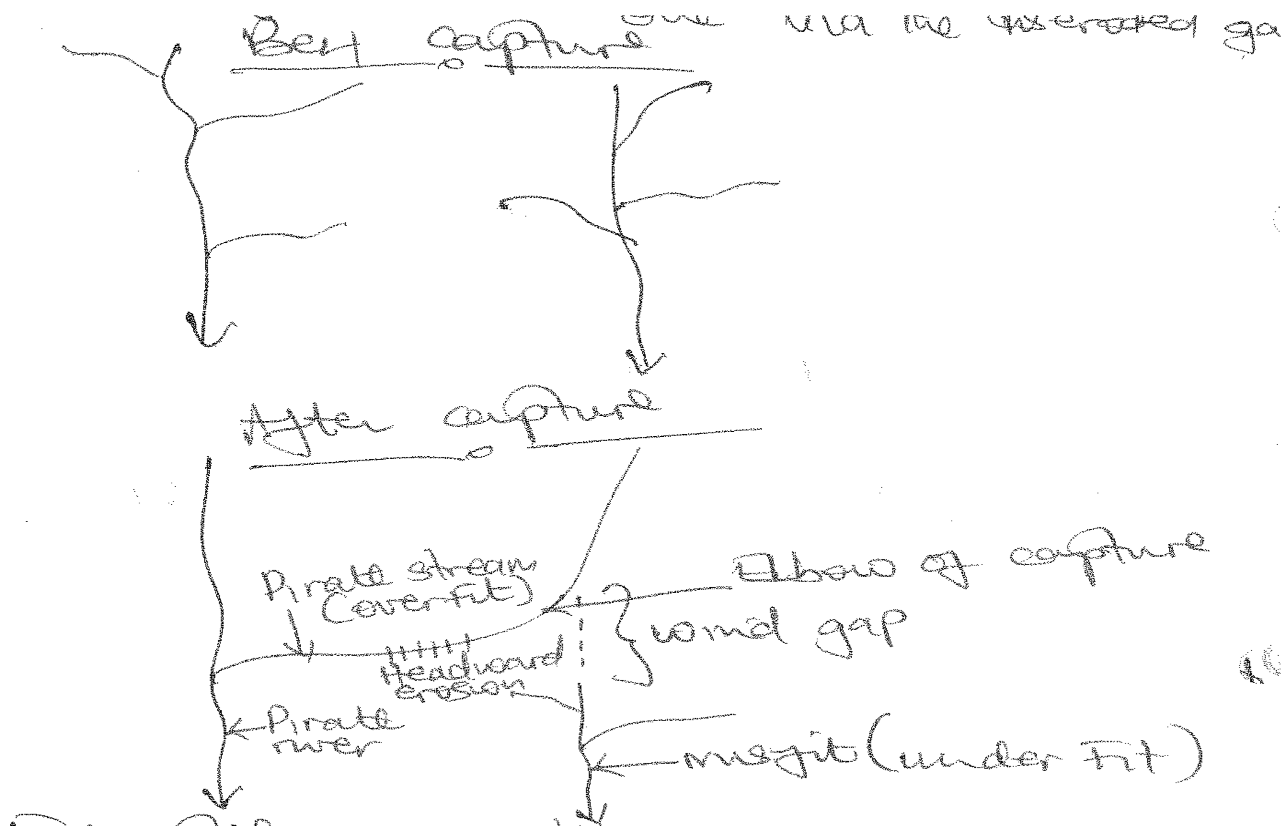
(a) Distinguish between deltas and estuaries.

(b) Account for the formation of deltas.

16.9 RIVER CAPT URE

Is the process where by one river course is diverted into a system of an adjscent powerful river which is able to cradle into the valley more rapidily than its weaker neighbor.

When one river becomes more powerful than its neighbor, it will erode backward at a quicker rate than the weaker river.
Eventually the stronger river will divert the waters of the weak one via the diseroded gap.



Examples of capture include
Tiva capture in Eastern Kenya where lower Tiva captured upper Tiva, a former tributary of R. Galana, R. Aswa captured R. Ruizi captured R.Shanga, R.Wasa captured R. Nyaboroga in fortportal.

CAUSES OF RIVER CAPTURE

1. **Differences in stream power/energy for vertical erosion**, where one powerful river and a less powerful one are flowing adjacent to each other on homogeneous rocks. The more powerfuls river erodes its bed faster by headward erosion and captures waters of another eg R.Nile captured the waters of rivers Tochi, Okole and Arocha in this way.

2. **Differences in rock hardness**, A river flowing over soft rocks deeply cuts its valley by head ward erosion into the valley of one flowing over hard rocks capturing it. River Wasa flowing on soft rocks captured river Nyaboroga in Fort portal.

3. **Earth movements** eg uplift and down warp along the course of one river may lead to river capture. A river flowing over a down warped channel, may extend its valley by headward erosion and captures the waters of an adjacent weaker river flowing over an uplifted channel. Reversed rivers of Rwizi, Katonga, Captured weaker adjacent rivers (streams) when Western Uganda was uplifted.

4. **Influence of river rejuvenation due to changes in sea base level**. A rejuvenated river eroding along a steeper gradient may extend its valley into that of a weaker adjacent river.

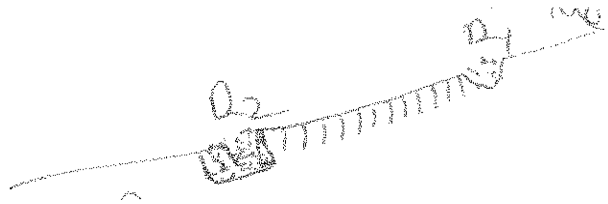
5. Gradient/nature of slope where a capturing river/stream is flowing over a steeper slope than its victim eg. R.Zambezi.

6. **Rock jointing**, where the capturing river is flowing over well jointed rocks, is able to deepen its valley, while the captured river is on massive rocks.

7. **Volumes of water possed by the rivers**. The capturing river may have more water than its victim and so will have greater ability to erode than its neighbor/victim. Ie greater head ward erosion eg the Volta than its victim.

8. **A difference in the altitude / base level** eg R. Zambezi. This is when two more rivers are a bit near each other but when one has got a higher level of water. Hence it will go on eroding the soil which separates both rivers. Time will come when it will pull the water of the river with the lower base level.

Diagram



River 2 erodes the shaded part to pull the water of 2.1 hence capturing it.

LAND FORM FEATURES FORMED DUE TO RIVER CAPTURE

1. **Elbow of capture**
   This is a marked bond formed at a point where the head waters of the captured stream flow into the capturing tributary. It is a right angled bond.

2. **Wind gap**
   This is a dry valley of the beheaded stream below the point of capture. The floor of this valley is normally lined with alluvial deposits or gravel.

3. **Misfit**
   This is the valley of the beheaded stream which having lost its head waters, will be reduced in volume, causing it to appear too small for its valley.

4. **Incised valley / Gorge**
   Under cutting of the pirate river near the point of capture due to increased water volume produces a steep and deep valley / rejuvenated valley / Gorge.

5. **Formation of knick points**
   This is a sharp break in the slope created near the point of capture due to rejuvenation. Water slows down steeply on this knick point resulting into a water fall.

6. **Pirate river / stream**
   This is a river, through headward erosion, that captures waters of another nearby river.

7. **Over fit stream / river**
   Is the river that appears too big for its present valley due to increased volume of water from the captured river stream.

16.10 REJUVINATION

Refers to the renewed erosive activity in a river valley. It is a situation where vertical and lateral erosion are increased and a river's ability to carry its load is increased and at the same time the spread of the river flow is increased.

CAUSES OF RIVER REJUVINATION

1. Climatic changes ie increased rainfall which increases the water discharge in a river valley which increases the river energy. This outcome atically leads to renewal of the river's erosive capacity.

2. River capture. This adds more water in the pirate stream river which increases its erosive capacity due to the increased speed and volume of water eg lower Twa captured upper Tiva river in Kenya.

3. Negative movement of the sea ie where there is a fall in the sea base level, this steepens a rivers gradient, forcing it to flow very fast, causing renewed erosion. In this case, a river is rejuvenated.

4. Earth movement also cause river rejuvination. An uplift or upwarping along a river's course, leads to steepened river gradient. This leads to fast movement of water, hence increased erosion.

5. Changes in the nature of the basement rock is also responsible for rejuvination. When a river which was originally flowing over a hard resistant rock, approaches a soft rock, its erosive power is renewed. It erodes away much of the soft rock, thus, deepening and widening it's channel.

6. An increase in water discharge which increases the rivers volume, speed and erosive capacity. This may be due to; melting of lee caps and tributaries joining the main river.

7. Decrease in the load of a river. As it enters a swamp, it deposits the head there. After there, its speed is increased and it renews its erosive capacity / rejuvinated.

8. Existence of obstacles in a river course passes the obstacles, it is rejuvinated.

9. Human activities like daming construction of dams across rivers, holds back water in the reservoir behind, but at the same time, when the water is released in the turbines flows out with a high speed. Thus rejuvenating the river's erosive power. Thus dams along river Nile from Jinja to Egypt, cause its rejuvination.

EFFECTS OF REJUVINATION ON THE LAND SCAPE

1. **Formation of paired river terraces.**
   These are steps or bench like structures cut in the side of a river valley and covered with gravels and alluvials deposits.

   They are formed when a river renews its erosive capacity / down cutting leading to a fall in the base level.

   The parts of the flood plain are not removed after rejuvination. They remain on the valley sides as illustrated below.

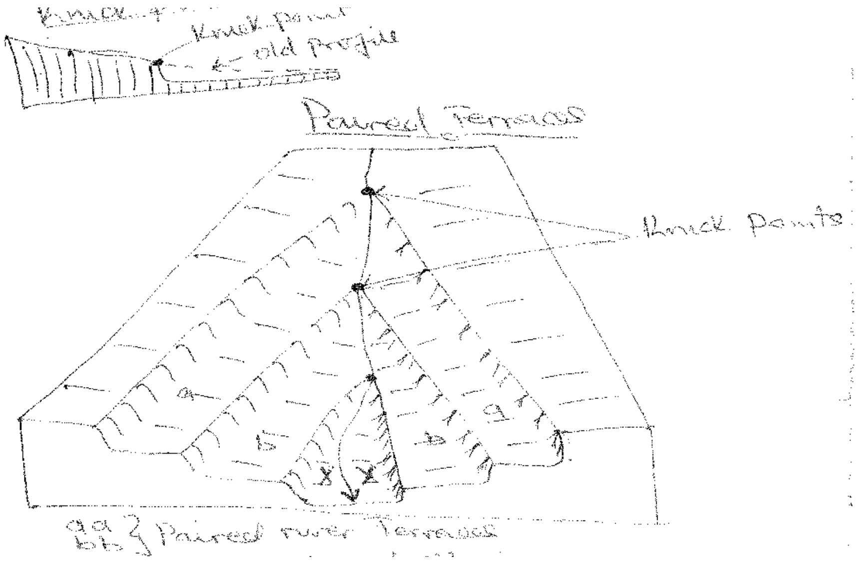
   Examples include Birim valley near Kibi in Ghana, along river Ngaila and Nyando in Kenya, Mpanga, Rwizi, Kafu rivers.

2. **Formation of knick points**
   A kinck point is break of shape in the long profile of a river valley. It marks the point where rejuvination started.

   A knick points may result from increase in discharge of a river due to river capture.

   They are associated with water falls. Eg Charlot knick point on R. Orugu in Sierra Leon and Burthurst knick point on R. Congo and Mt. Mwachi in Kenya.

   Knick points diagrams



3. **Formation of incised meanders**

An incised meander is a curved bend of a river that has been under cut / incised into the land surface so that now a river winds between steep valley walls.

Incised meanders result from rejuvination of an already meandering river eg R.Mwachi in Kenya. Type are ingrown and intrenched incised meanders.

Note
Refer to meanders notes for diagrams and formation.

4. Valley within valley

A long river where rejuvination was fairly rapid and a fall in base level quite large, the effect is the production of a steep-sided rejuvinated gorge.

Examples are along R. Mpanga near Arubaho in Fortportal, R. Semuliki and R. Nyando.