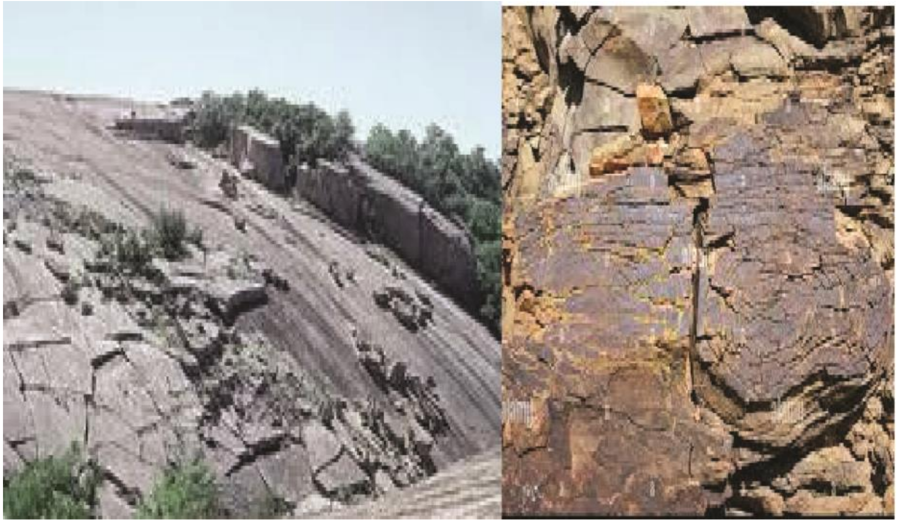
A-Level Geography paper 1 section B

1. (a) Differentiate between block disintegration and exfoliation

Block disintegration is Physical weathering process by which well jointed and well bedded rocks are broken down into smaller blocks through the process of expansion and contraction of rocks in situ. It is due to temperature changes and frost action.

In East Africa; block disintegration common in Semi-arid and arid areas such as Karamoja sub-region, Sukuma land, Turkana land etc. and on the glaciated mountains such as Kirimanjaro, Kenya and Ruwenzori ranges. Block disintegration results into regular shaped blocks

Exfoliation is a physical weathering which involves the peeling off of surface layers of exposed rock as result of alternating heating during day causing expansion and cooling at night causing contraction in Situ



Exfoliation is common in exposed homogeneous rocks in Semi- arid and arid areas such as Karamoja,

Turkana land, etc.

Exfoliation results into exfoliation domes e.g. the Bismarck rock at Mwanza.

(b) Account for the occurrence of physical weathering in East Africa.

A Candidate is expected to:

- Define physical weathering
- Identify areas of occurrence
- Identify process of physical weathering
- Explain factors for the occurrence of physical weathering while integrating specific physical weathering processes.

Physical weathering is disintegration /break down of rocks into small fragments with no change in the rocks chemical composition in situ

Physical weathering is common in Semi-arid and arid areas such *as* Karamoja, Turkana land, Central Tanzania etc. as well as glaciated mountains such *as* Kilimanjaro, Kenya and Rwenzori.

The major processes of physical weathering include;·

- **Exfoliation** which is the peeling off of surface rock layers due to heating during day causing expansion and cooling at night causing contraction.
- **Block disintegration** involves breakdown of jointed rocks into rectangular shaped blocks due to heating during day causing expansion and cooling at night causing contraction.
- **Aridity shrinkage or slaking** occurs on non-porous rocks like clay which absorbs water during

rainy season and expands, while during dry season lose water through evaporation and crack. Repeated alternative expansion and contraction eventually cause them to crumble into small elongated pieces.

The factors that cause physical weathering

- **Climate**
  - In areas of hot climate such as Turkana region in Northern Kenya, Central Tanzania, during the day it is hot, exposed rocks are heated leading to expansion of the rock, while during the night, temperatures rapidly fall leading to rapid cooling of rock resulting into contraction. Such alternate expansion and contraction of a rock lead to peeling or breaking of the rock through processes like exfoliation, granular disintegration, block disintegration etc.
  - In Semi - Arid areas such as Central Tanzania, during the short rainy season, non-porous rocks like clay absorb water and expand while during the long dry season they lose water and crack resulting into rock disintegration..
  - In Semi- Arid areas there is limited cloud cover which leads to temperature fluctuations i.e. hot/very hot during the day, cool/cold during the night leading to expansion and contraction, resulting into breakdown of rocks.
  - On high mountains of East Africa, the temperature fluctuations result into frost weathering which is the process by which water collects in cracks during the day and during the night water freezes, volume increases causing breaking of the rock
- **Nature of parent rock.**
  - **Jointed rocks** such as limestone in Turkana, Kotido and Moroto areas result into block disintegration when rocks break into rectangular blocks when heated or cooled.
  - **Mineral composition-** Rocks having different minerals absorb heat and lose heat at different rates when heated or cooled respectively resulting into granular disintegration.
  - **Color of the rock-** dark colored rocks absorb a lot of heat in Semi - Arid areas when heated leading to their disintegration.
  - **Differences in rock hardness.** Soft rocks such as limestone in semi-arid areas like Turkana, Kotido easily break down when exposed to rapid cooling and contraction due to hot temperatures during day and cold during the night.
- **Relief**
  - **Steep slopes** tend to experience to experience a lot of soil erosion that expose rocks to process of physical/mechanical weathering.
  - **Steep slopes** tend to be affected by mass wasting that expose the rock to unloading/pressure release which is in form of mechanical weathering.
- **Limited vegetation cover in semi-arid** areas like Turkana, central Tanzania, Moroto exposes the rock to extreme temperature fluctuation resulting into rapid expansion during day and rapid contraction at night leading to rock disintegration.
- **Biotic factors**
  - **Movement of heavy animals** like elephants, antelopes, zebra in Kidepo National Park lead to breaking of rocks
  - **Burrowing animals** like squirrels, Hog and insects like locust, termites destroy vegetation thus exposing rocks to physical weathering due to temperature fluctuations.
  - **Effects of plants adapted to semi-arid areas** like cactus, acacia grow strong roots into and break rocks

- **Human activities** such as quarrying cause disintegration of rock

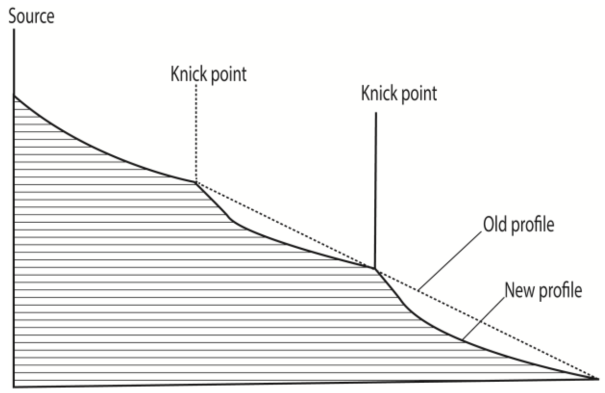
- **Time:** the longer the time the more physical weathering occurs.

2. Explain the causes and effects of river rejuvenation in East Africa
   Candidate are expected to
   Define river rejuvenation
   River rejuvenation is the renewal of the erosive activity of the river within its old valley.
   Explain the causes of river rejuvenation
   - Heavy rainfall (climate change) in the catchment areas causes increase in volume of water in the river. This increases the erosive activity resulting into rejuvenation.
   - **River capture/piracy**: As the river cuts back, it breaks into the adjacent valley and captures a nearby stream. This increases the volume of water in the pirate river channel leading to rejuvenation
   - **Regional uplift** along the river course e.g. through faulting causes a gradual steepening of the river's gradient. This increases its velocity (speed) and its erosive activity leading to rejuvenation.
   - **Isostatic and Eustatic re-adjustments.** Negative changes in the sea level (fall in sea level) create a knick point close to the coast resulting into increase in the river gradient, increased speed and its erosive activity.

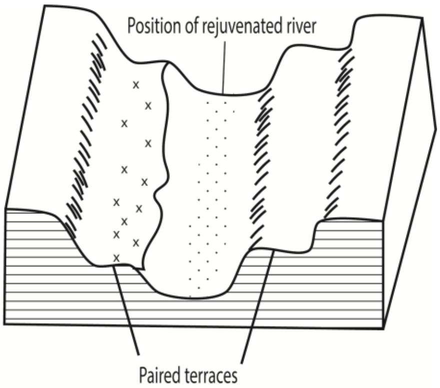
   - **Glaciation** in the ice caps and ice sheets. This reduces the amount of water reaching oceans such as the Indian Ocean. This results into a fall in the sea – level and lowering of the base-level of rivers. A steep gradient is produced and therefore, the velocity of the river and erosive load leads to an increase in the energy and erosive activity

Identify and explain, with illustrations the effects /landforms due to river rejuvenation.

- **V-knick point** is a sharp break of slope in the long profile of a river valley. It is a point in the river bed where the old river profile changes into a new river profile. Or a nick point is **part of a river or channel where there is a sharp change in channel slope, such as a waterfall or lake**.

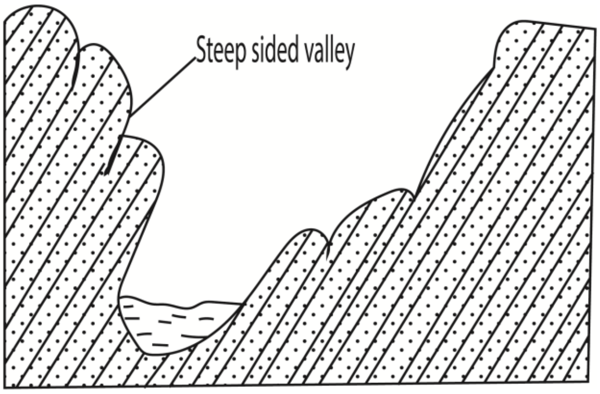


- **Valley within a valley /rejuvenated gorge.** This refers to a new valley which has been re-shaped from the old existing valley. Along rivers where rejuvenation was fairly rapid and the fall in base level quite large, the effect may produce steep sided gouge within the former valley called valley which in a valley e.g. R.Nyando

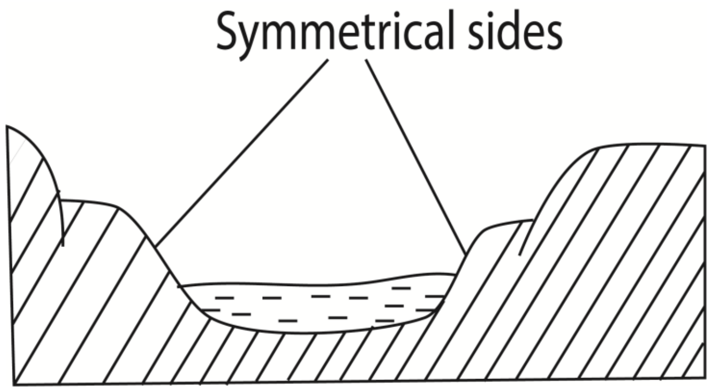


- **Stream terraces /paired terraces.** These are bench /step like strips of land found above a stream and its flood plain. They are benches cut in a rock or steps formed in sediments by deposition and subsequent erosion. Originally, the river deposited a thick section of flood plain sediments. Then the river changed from deposition to erosion and cut into its old flood plain, parts of which remain as terraces above the river .These terraces are generally of equal height and are called paired terraces e.g. R. Nyando
- **Incised meanders** .These are steep deep gorges cut into a meandering channel. They are formed when there is rapid vertical erosion of a channel within a meandering river. Th.is results to a meandering-valley with essentially no flood plains; e.g. R. Mwachin, Kombeni. Incised meanders are divided into two;

  (i) **Ingrown meanders**. This is a valley with an asymmetrical cross-profile, where one side is steeper than the other. It normally develops on more resistant rocks when vertical erosion increases, e.g. R Mubuku near the Kasese-Fort portal road, R. Manafa near Busia, along the Tororo - Mbale road.



  (ii) **Entrenched meander**. These **are** valleys with steep sided symmetrical profiles .They develop on weak reeks where there's rapid lowering of the base level



3. Accounting for the formation or glacial erosion landforms in East Africa.

Candidates are expected to define the term glaciations

Glaciation comes from the word ''glacier" which means moving large mass of ice from higher level to lower level under the influence of gravity leading to alteration of the terrain and carving out of unique features.

Candidates should identify areas where glaciers occur in East Africa namely. Mountains; Kilimanjaro, Kenya and Rwenzori

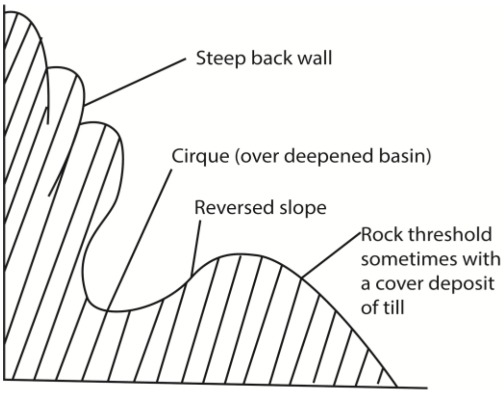
Candidates should bring out processes of glacial erosion in East Africa

- **Plucking.** Is a process by which frozen rock and any other loose fragments tear away from the rock as the glacier moves down slope. It is most effective where there are jointed rocks.
- **Abrasion.** Is the grinding process in which rock particles such as boulders and pebbles embedded in glacier are used as grinding tools to remove loose rock particles on the bottom and sides of glacial valley
- **Basal sapping**. This is the rotational slipping of ice which involves alternate freezing and thawing of water contained within cracks leading to gradual enlargement of cracks.

Landforms resulting from **glacial erosion** include

- **A cirque (corrie)** is a steep sided rock basin, semi-circular in plan cut into valley heads and mountain sides. Many are very small but some have back walls hundreds of metres high.
  - Cirques usually develop from nivation hollows. Through the process of nivation, intensive shattering of highland slopes tend to produce depressions or pre-glacial hollows where ice accumulates.
  - Wat.er freezes in the hollows and thaws or melts. There is consequently expansion and contraction that breaks the rock through the process of plucking.
  - The nivation hollows are widened by not only plucking but also abrasion which is the wearing process of the hollow using the materials embedded in ice.
  - The back walls of the hollow a.re steepened by back wall recession and it is deepened by basal sapping or rotation slipping of ice in the mountain hollow.
  - Debris is removed from the hollow by solifluction; creating a semi-circular basin known as a cirque.
  - The depression may later be filled with water to form lakes called tarns. Examples include those occupied by Lac du Speke, Lac Gris, Lac Catherine on Mt Rwenzori, Teleki tarn on Mt Kenya

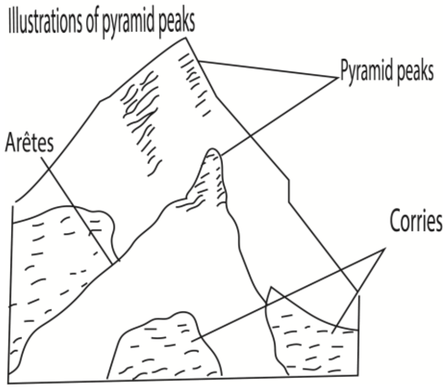
Illustration of a cirque



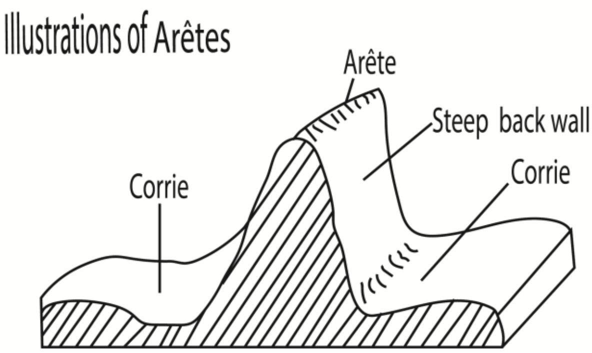
- ***A pyramidal peak***

This is a sharp rock pinnacle which is steep sided surrounded by **a** system of radiating arêtes.

- It is formed from glacial erosion where cirques are first formed and the back wall recession of two or more cirques developing into the mountain head creates a sharp rock pinnacle protruding above the ice through a system of radiating arêtes.
- Since pyramidal peaks develop from radiating arêtes, which in tum develop from cirques then processes of plucking and abrasion are important in their formation.
- Examples include Margherita peak on mountain Rwenzori.



- An **arête** is a narrow step sided rocky ridge separating two cirques.



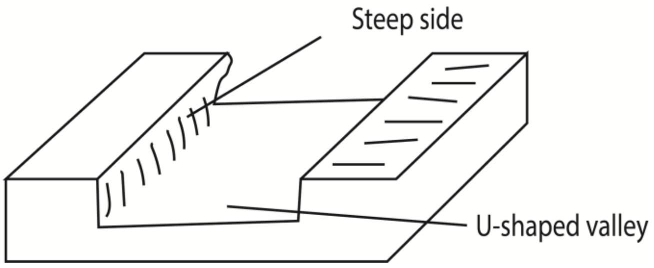
It results from the glacial erosional process of plucking and abrasion which lead to the formation of cirques The back wall recession of two adjacent cirques leads to the formation sharp ‘knife-like ridge called an arête separating two cirques. Examples are found on the foothills of Mt Rwenzori, one radiating into Bujuku Valley.

- **Glacial trough:** This is a broad bottom and steep sided U- shaped valley,

  It is formed when a river valley is filled with glacier. Plucking and abrasion help to deepen and widen the depression by vertical and lateral erosion

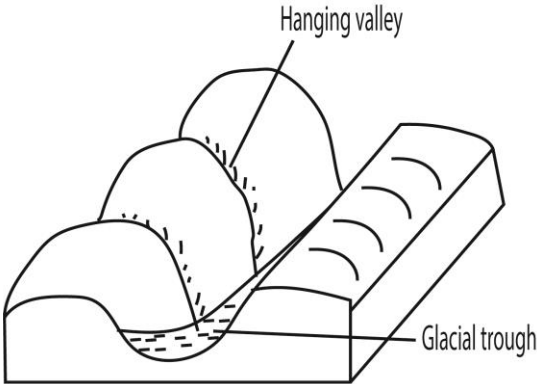
  Examples include Bujuku and Mobuku valleys on Mt Rwenzori, Gorges valley on Mt Kenya and Karanga valley on Mt Kilimanjaro.

Illustrations of Glacial trough



- **Hanging valleys.** These are tributary valleys above the main valley that descend steeply into the main valley.

  They generally form **when glacier ice deeply erodes a main or trunk valley**, leaving tributary valleys literally hanging far above the main valley floor. Tributary valleys can be seen leading to Mobuku and Bujuku on Mt Rwenzori

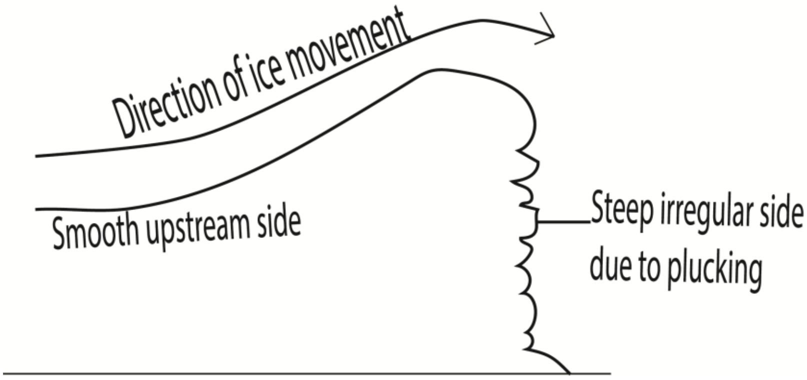


- **Rock steps.** These are rock projections in U-shaped valley .They are formed as a result of variation in rock resistance.

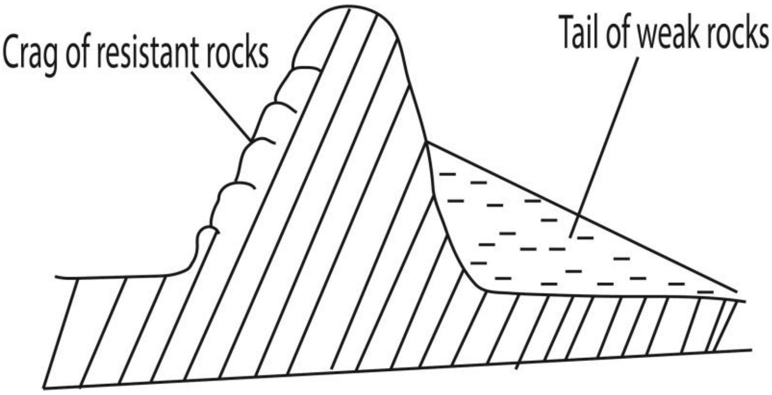
  Hare rocks resist erosion leading to rock projections in glacial trough
- **Rock Basins.** These are circular depressions in U- shaped valleys. These are formed due to unequal power of erosion due to varying thickness of ice and variation in rock resistance .They are formed where there are soft /weak/jointed rocks on floor of U- shaped valley. Examples of rock basins include those occupied by Carr lakes on Mt Kenya.

- **Roche Moutennee.** This is a gentle sloping mass of rock on upstream side and steep irregular on downstream side.

It is formed when the upstream side is smoothened by abrasion and the downstream side is affected by plucking leading to sleep jagged slope. Roche Moutennee can be seen in Mobuku valley on Mt Rwenzori and in gorges valley on Mt Kenya.



- **Crag and Tail**. This is a mass of resistant rock outcrop, steep on the up - stream side which protects the soft rocks on the leeward slope. The eroded material is deposited downstream to form an elongated tail.



- **Truncated spurs.** These are spurs with steep edges ending in the valley.
  They are formed when former interlocking spurs are affected by plucking during glacial erosion to leave steep cliff-like valley sides

4. (a) Differentiate between igneous rocks and sedimentary rocks (06marks)

Igneous rocks are fine formed rocks due to vulcanicity.

They are characterized by the following:

- They are crystalline in structure
- They do not contain fossils.
- Some are spongy in nature such as Pumice.
- Some are dark coloured such as Basalt
- They do not occur in layers/strata
- Some are acidic, basic and intermediate in chemical composition. Etc.

Examples of igneous *rocks* include; Quam, Gabbro, Pumice, Basalt, Obsidian, Dolerite, diorite etc.

WHILE,

Sedimentary rocks are rocks that are composed of particles of rocks that have been deposited in layers by water, wind or moving ice.

They are characterized by the following;

- They are stratified /occur in layers
- They contain fossil.
- They arc non crystalline in nature
- The layers are separated by bedding planes.
- The strata are either, horizontal, gently sloping or steeply dipping.

Examples include; Sandstone, mudstone, clay, rock salt; coral limestone, dolomites, soda ash, gypsum, iron ore, iron stone, etc.

(b) Explain the process responsible for the formation of igneous rocks in East Africa. (14marks)

Candidates are expected to:-

- Define igneous rocks
- Identify process of formation.
- Give origin of process
- Identify/describe the types of igneous rocks.

Igneous rocks are fire formed rocks. The main process of formation is vulcanicity. This is the process by which molten rock (magma/lava) cools down, crystallizes and solidifies either within the earth's crust to form intrusive rocks or onto the surface of the earth to form extrusive rocks.

Vulcanicity originates from the interior of the earth due to radio activity, geochemical reactions and connectivity within the mantle - a lot of heat is generated that melts the rocks in the mantle creating convective currents. These currents exert pressure on crustal rocks creating lines of weakness/ fissures through which molten rocks is either intruded or extruded.

Igneous rocks are categorized according to rate of cooling/depth and chemical composition.

According to rate of cooling and depth they include;

Plutonic rocks/ Abyssal rocks: These are formed from cooling and solidification of magma at great depth hence they are deep seated rocks.

- The intruded magma cools and solidifies extremely due to lack of contact with air leading to formation of rocks with large crystals such as granite, gabbro, diorite, synite etc.

- These rocks are found in features such as exposed batholith at Mubende, Singo etc.

Hypabyssal/intermediate rocks: These are formed from magma that cools and solidifies near the surface of the earth/shallow depth. The rate of cooling is moderate leading to formation of medium sized crystals e.g. Quartz, dolerite, porphyry, etc. They are found in features such as dykes in Turkana land etc.

Volcanic rocks/extrusive rocks are formed from fast cooling of lava extruded onto the surface of the earth due to exposure to air leading to the formation of rocks that have very small crystal e.g. obsidian, basalt, andesite, pumice etc.

- Some of the volcanic rocks are spongy in nature such as pumice due to enclosure of gases at cooling time.
- Some rocks are glassy in appearance such as obsidian.
- Some rocks are dark coloured such as Basalt.
- Volcanic rocks are mainly found in features such as volcanic mountain e.g. Elgon, lava plateaus such as Yatta etc.

Igneous rocks according to chemical composition: Magma/ lava vary in chemical composition and so has an effect on its viscosity/thickness which in turn influences the rate of cooling and the process of crystallization.

In this category the rocks include;

Acidic/felsic rocks: these have a high content of silica (65%) and 35% or less basic oxides. They are light coloured, have low density e.g. granite, diorite, Rhyolite, Andesite etc.

Intermediate rocks have moderate silica content between 55- 65% and 45-35% basic oxides. They are a mixture of mineral structure of acidic and basic e.g. poryphyites.

Bask rocks contain much mica and olivine. They are rich in iron and magnesium. They are dark coloured, dense or heavy, have low silica content between 45-55% and 55- 45% basic oxide

5. To what extent have human activities been responsible for the occurrence of landslides in East Africa. (25marks)

Candidates should define landslides as:

Landslide is a Fast/rapid/sudden movement of weathered materials of rocks from the upper to the lower slopes under the influence of gravity.

Candidates should identify highland areas in East Africa where landslides occur and they include; Kenya highlands, Kilimanjaro highland, Southern Tanzania highlands, Rwenzori highlands, Kigezi highlands, Mt Elgon etc.

Candidates should identify the various farms/types/processes of landslides.

- **Talus creep:** Movement of angular particle screes of all sizes down a moderate slope at a moderate/fast speed
- **Mudflow:** Movement of semi-liquid mud with gravels, boulders on moderate to steep slopes at a fast speed.
- **Rock slumps:** Movement of large masses of rock materials ar1d debris on over steepened slopes/cliffs/scarps/roads cuttings at a fast speed.
- **Rockslide:** Rapid movement of large masses of detached rock particles/debris rolling down at a fast speed along a slippery over steepened slope.
- **Rock fall:** Free fall of individual rocks and boulders down very steep slopes/vertical slopes at very fast speed.
- **Avalanches**: Sudden downfall of rock materials embedded in ice and snow on steep slopes.

Candidates should hen explain human activities responsible for occurrence of landslides which include:

- Construction of roads, settlements etc. in highland/hilly areas which leads to cliffs that encourage rock slump, rock fall and rock slide.
- Mining and quarrying that involves use of explosives that cause vibrations, steepening and exposing slopes triggering rock slide, rock fall, mud flows etc.
- Poor agricultural methods like up and down ploughing makes unconsolidated soils and weathered rock materials to move down slope in form of mudflow, rockslide, rock fall etc.
- Deforestation along slopes leaving the slopes bare exposing it to rain water which encourages mud flows, rock slump.
- Overstocking and overgrazing on the steep slopes loosens the rock structure leading to slumping and mud flow. This may be due to exposure of the soil/rock material and trumping of animals.
- Movement of heavy vehicles, trailers, buses and trains cause vibrations along road cuttings and steep slopes that encourage rock slump, rock fall e.g. Kabale - Kisoro road, Simu-Kapchorwa road etc.

Candidates should then bring out other factors:

Climate:

- Heavy rainfall avail water that saturates rocks and weathered material making it heavy and also lubricates the slopes resulting into mudflow, rock slump etc.
- Pounding effect of heavy rainfall destabilizes surface layers of rocks triggering movement of rocks and weathered materials under influence of gravity.
- Temperature changes that lead to alternate freezing and thawing makes the ground slippery and water made available increases weight leading to mud flows, talus creep, rock fall and avalanches.

Relief/Topography

- Very steep slopes encourage rock fall
- Over steepened scarps, cliffs and road cuttings encourage rockslide, rock slump, avalanches.
- Steep slopes encourage rock slide, mud flow and avalanches.

- Moderate to steep slopes encourage mud flow and talus creep.

Nature of the rock

- Permeable weathered rocks overlying impermeable rocks absorb water, get saturated. overloaded and lubricated encouraging mudflow and rock side and vice-versa.
- Well jointed rocks may encourage landslides in form of rock fall, rock slides, avalanches etc.
- Alternate layers of hard and soft rocks also cause landslides in form of rock slump/ rock slides etc.

Nature of the soil:

- Heavy wet massive clay soils encourage landslides when they absorb water, the weight increases, become lubricated, are much slippery thus leading to mud flow.
- Earthquakes and earth tremors cause vibrations that trigger off landslides like rock slump, rock slide, rock tall etc.
- Tectonic movements like faulting, warping create steep slopes, cliffs and escarpments that encourage rock slide, rock fall etc. While vulcanicity involving basic lava flows down slope mixed with ashes promote rock slump, mudflow.
- Over steepening of slopes as a result of undercutting at the base of river cliff/sea cliff/ Lake cliff lead to landslides like rock slump.
- Over loading/accumulation of rock debris in large masses on over steepened slopes promote landslides.
- Additional weight from materials or rain water promotes overloading hence rock slump, rock fall, mud flow.
- Living organisms like burrowing animals loosen the soil/rocks allowing water hence overloading and lubrication encouraging rock slump, rock slides and mud flow while movement of animals cause vibration that encourage rockslides, rock slump etc.

6. Explain the influence of denudational processes on the formation of lakes in East Africa

Candidates are to define the Term Lake and denudational processes.

- A lake can be defined as a body of water occupying a hollow or depression on the earth's surface.
- The term denudatlonal processes refer to the destruction/wearing down of land scape by agents of weathering; erosion and mass-wasting.

However the resultant effect of denudation is deposition of materials in an area.

Where material is eroded from; depressions are created which are later filled with water to form erosional lakes.

Agents responsible for erosion may include glaciations, rivers, and waves.

- Glacially eroded lakes; are made up of hollows created by either valley glaciers or ice sheets.

Cirque/corrie /tarn lakes; These form in arm-chair like depressions in glaciated mountains due to erosional processes-of plucking, abrasion and basal sapping which finally creates hollows that are occupied by ice-melt water to form cirque lakes e.g. Lac - du - Catherine, Speke on Mt. Rwenzori, Teleki, Hidden and hanging tarns on Mt Kenya.

Rock basin lakes: They are formed by the scouring action of an ice--sheet or a valley glacier which results in the formation of shallow hollows known as rock basins which are filled by water to form rock basin Jakes e.g. Lake Michaelson in Gorges valley on Mt. Kenya, Carr Lakes, enchanted lakes in Kenya.

Trough lakes:- It occupies an elongated hollow excavated by ice on the floor of a V - shaped valley to form ribbon lakes because of their shape. E.g. Lake Mahoma in Mubuku trough on Mt Rwenzori.

Eroded material is deposited and this influences formation of depositional lakes.

Ox-bow lakes: Is horse-shore shaped depression formed as a river meanders in a flood plain. Erosion occurs on the concave banks and deposition on the convex banks to produce sharp meander loops separated by a narrow neck of land. The neck is eventually cut through. Edges are sealed off with sediments e.g. include; on R. Tana, Rwizi, Rufigi, Malaba, Nzoia etc.

Delta lakes: These are lakes formed in Delta flood plains when alluvial deposits form levees that stop water in the river and its distributaries e.g. L. Magomeni, L. Mwananyamara in Tanzanian coast.

Lakes produced by marine deposition lagoon lakes: These are formed through long shore drift process forming bars, barrier beaches across bays which cut off part of the lake/ocean e.g. L. Nabugabo on the western shores of L. Victoria, Kaiso, Tonya lagoons on L. Albert.

Glacial depositional lakes: Marine dammed lakes. Terminal moraines are sometimes deposited across the valley where they form a ridge which dams back the flow of water e.g. Tyndall Tarn on the head or Teleki valley on Mt Kenya, Lac-Cris, Alice on Mt Rwenzori.

Mass-wasting/landslides: These are lakes contained in depressions formed as rock debris are deposited across a river valley, damming it hence forming a lake e.g. L. Bajuku on Mt. Rwenzori, L. Mbaka in Tanzania and Nyabihoko in Ntungamo.

NB: Illustrations and diagrams I Examples are required

7. To what extent was faulting responsible for the formation of relief landforms in East Africa? (25 marks)

Candidates should defi.ne the term faulting

Faulting is s the fracturing/ breaking/ rapturing/cracking of rocks due to strain and stress which subsequently leads to the dislocation and displacement of rock strata.

Faulting is caused by convectivity and radio-activity within the mantle which generates heat that melts mantle rocks; creating convection currents which exert forces on the earth's crust responsible for the formation of a wide range of features in East Africa which include rift valley, block mountains, grabens, tilt block, escarpments, fault guided valleys.

The Rift Valley

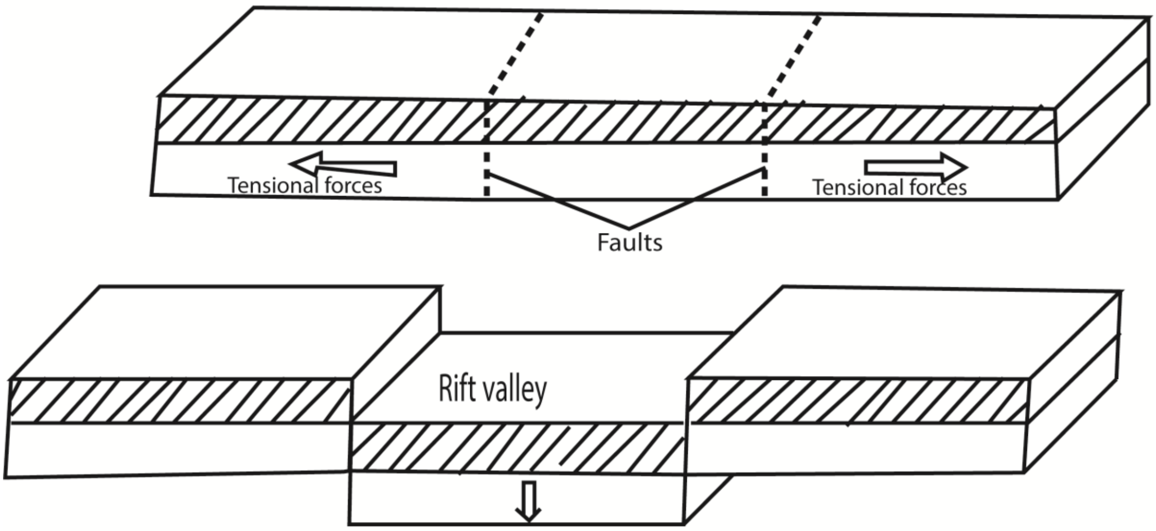
A riff valley is an elongated trough bordered by two or more inward facing fault scarps.
The rift valley in East Africa is in two arms: i.e. the Eastern arm and Western arm
The formation of the rift valley has been explained three theories:-

- The Tension force theory by Gregory
- The compression force by Wayland
- Vertical displacement theory by Dixey

NB: *Candidates is required to choose only one theory to explain the formation of the rift valley with relevant illustrations*

Tension theory by J. W. Gregory

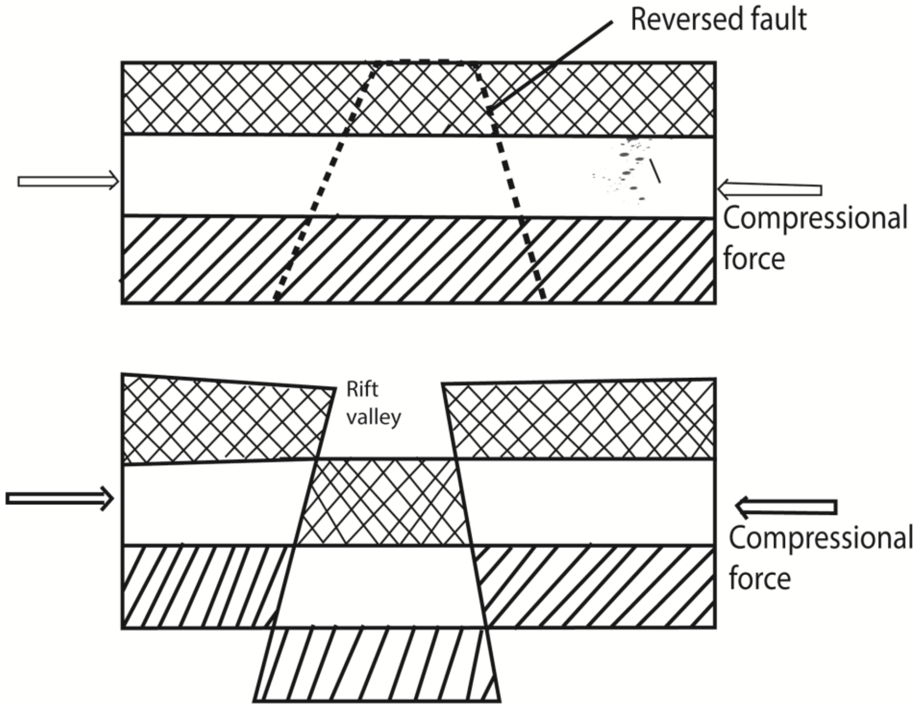
- The radio-active and convective currents produced tension forces within the earth crust.
- Tension forces acted/ pulled apart/ in opposite directions.
- Normal faults were produced, displacing rock strata.
- Side blocks were separated from the middle block, which was later lowered/ sunk under its own weight forming a rift valley with gentle slopes.
- Erosion and mass wasting modified the slopes.
- The theory is more applicable to the Eastern Kenya Rift valley (Gregory Rift).



Compression force theory by1:,J. Wayland

- That strain developed in the East Africa crust as compressional forces pushed/moved in the same directions (convergent).

- Reversed faults were produced.
- The side blocks were forced to over-ride (up thrust), hanging above the central block. The central block thus formed rift valley with steep/ sharp edges.
- The sharp edges were later modified by erosion and mass wasting.
- The theory is more relevant to Western arm of the East African Rift Valley, especially the Albertine Rift valley.

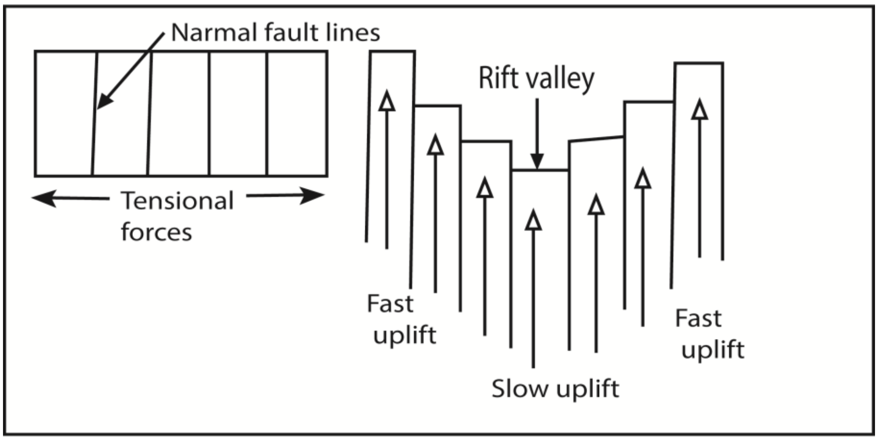


Other theories include:

- ***Differential uplift theory***

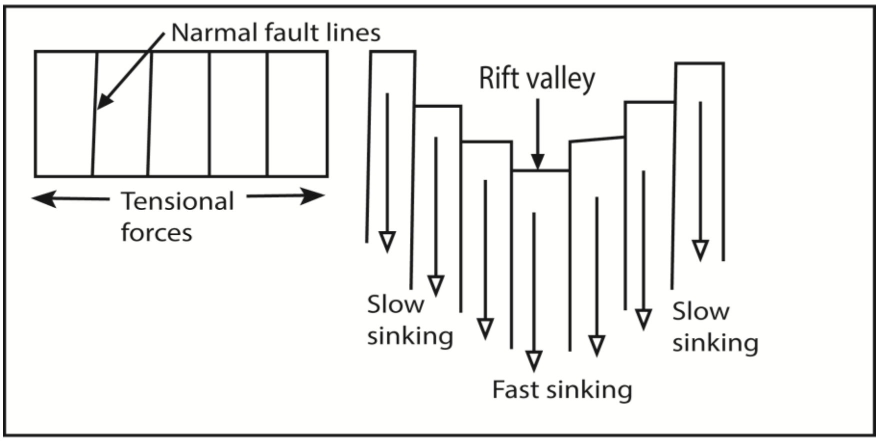
- Dealt with the Nairobi part of the E t African Rift valley of Kenya that is step faulted.
- That there was a period of general uplift of part of the East African Crust .
- It led to the formation of several parallel fault-lines.
- Blocks on either side of the central block rose faster as the middle lagged behind in stages.
- At each stage, a mass or of block formed a terrace·
- Examples include Kendang scar near Nairobi appearing as several terraces rising from the Rift Valley floor.
- The gap in the middle of terraces formed the rift valley.
- Diagrammatic illustration of differential uplift

Differential rift theory



- ***Relative Sinking (subsidence theory)***
  - Just like in differential uplift theory, there was extensive faulting in East Africa which created multiple parallel faults.
  - Within the mantle / interior of the earth, there is intense heat originating from radioactivity and geochemical reactions.
  - The heat melts down the interior rocks and they begin to move in form of convective currents upwards towards the crustal plates.
  - When they become colder and therefore heavy, they sink or flow back down in the mantle and as they do so they exert a drag force which pull the crustal blocks downwards thus sagging of crustal blocks along each fault.
  - The central blocks sagged more than those or, the extreme ends to form a step or terraced rift valley

Relative sinking theory

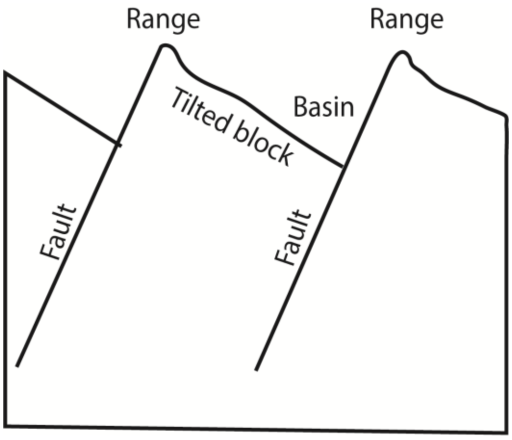


Tilt block land scape

This is upland of inclined crustal block

It has angular inclined ridges and depressions formed by multiple faulting and vertical movements which displaced the faulted crustal blocks at different rates *to* & series of tilted faulted blocks.

Examples are Aberdare ranges in Kenya, Kichwamba in Uganda etc.



BLOCK MOUNTAIN OR HORST

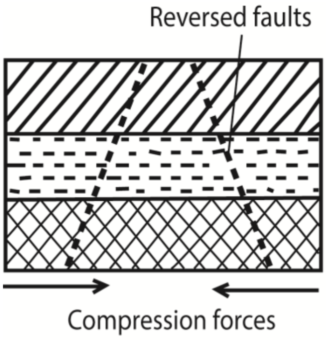
A block mountain is an upland bordered by fault scarps on either side. Examples of the Block Mountains are Rwenzori ranges in Uganda, Usambara, Pare in Tanzania.
The formation of Block Mountains is explained by three theories:

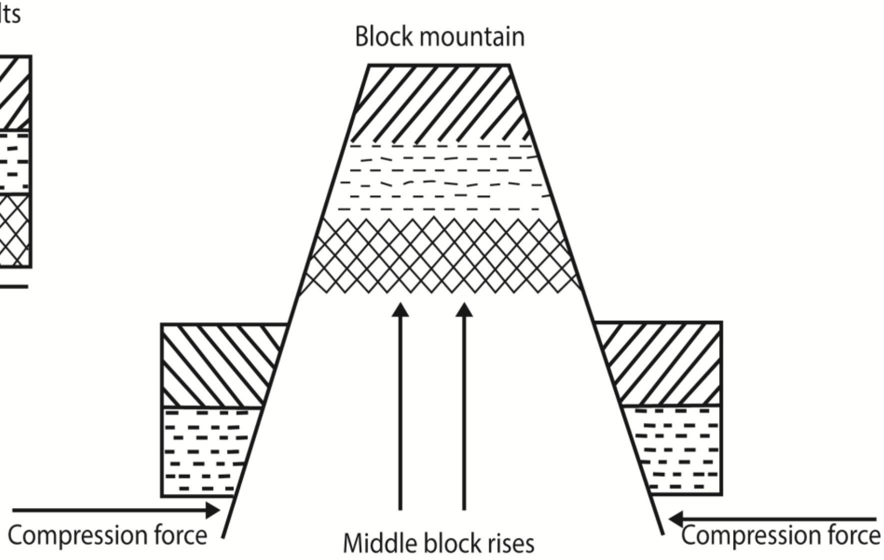
- The compression force theory by Wayland
- The Tension force theory by Gregory
- Vertical displacement theory by Dixey

NB: Candidates should choose only one theory to explain the formation of a Horst with relevant diagrams

Formation of a block mountain by compression forces

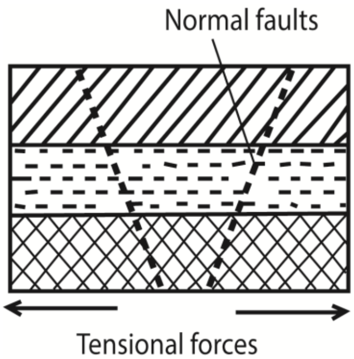
- Compression forces pushed a crystal block of land on either sides resulting into stressing hence the development of reversed fault lines.
- The fault lines divided the crystal block into three parts.
- As the action of compression forces continued the middle/ central block was thrust upwards above the two adjacent blocks/ surrounding blocks to form a block mountain.
- This is illustrated as shown below:

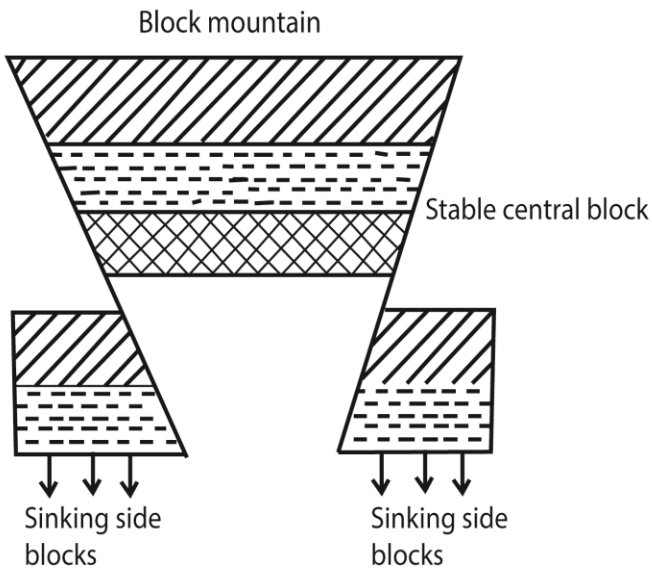




Formation of a block mountain by tension forces

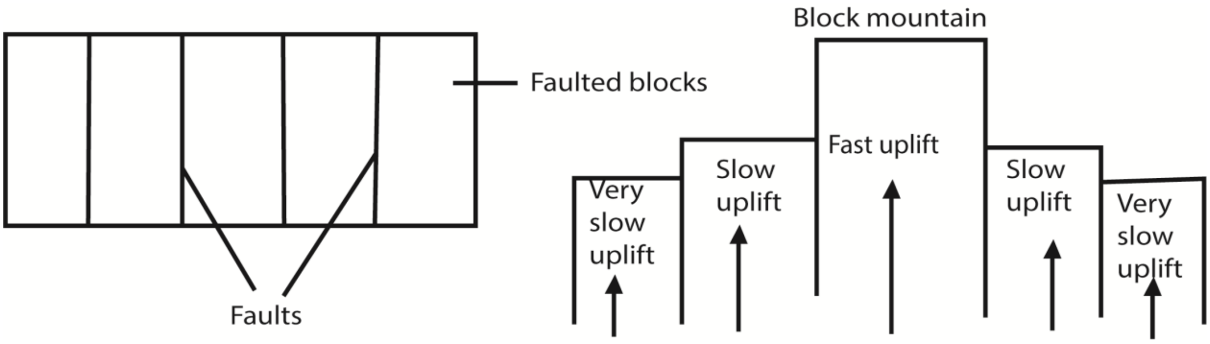
- Tension forces act on the earth's crust by pulling in opposite direction from each other.
- This is when convectional currents move horizontally in different directions hence the development of parallel normal faults in the crust.
- The faults divide the crust into three parts.
- The continued tension forces lead to the subsidence (sinking) of the side blocks.
- The middle block remains stable high above the side blocks as a block mountain





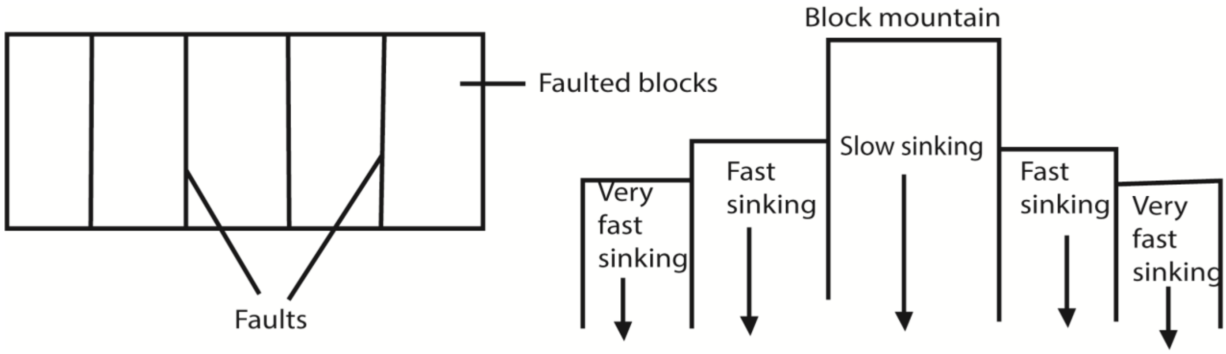
Formation of a block mountain by differential uplift theory;

- This is due to multiple faulting which forms series of crystal blocks of varying sizes and densities
- When the forces of uplift acted on the crystal blocks with varying strength.
- Uplift force was strongest on the central blocks; they were forced to rise higher to from peaks of the horst.
- The side blocks did not rise high enough but formed the sides of the horst in stages as illustrated below;



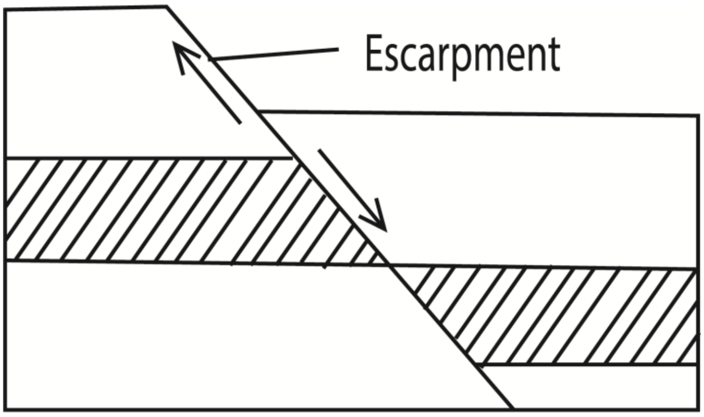
Formation by relative sinking;

- When faulted blocks experienced sinking which was not uniform. The side blocks sank faster than the central block.
- The central block remained relatively higher to form the peak of the horn as illustrated below;



Fault scarps/ fault escarpments.

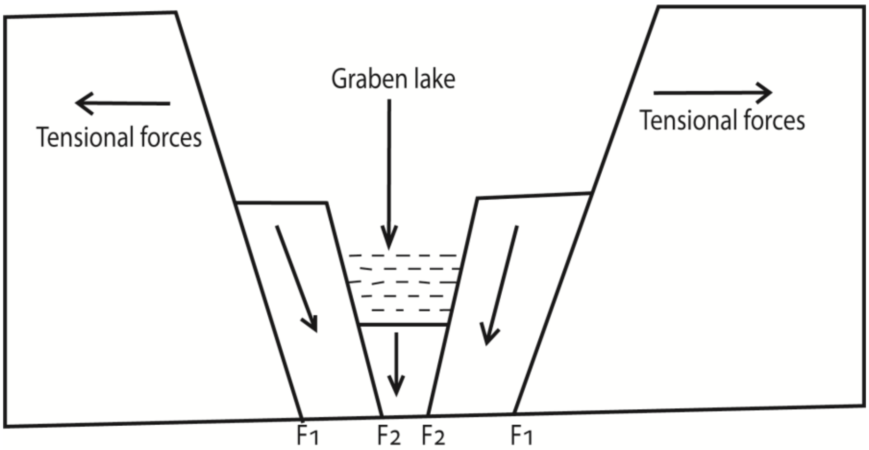
It's a steep slope along a fault formed when one block along the fault line is thrown up and the other own thrust e.g. Butiaba, Kicwamba in Uganda and Mau Escarpments in Kenya, Manyara, Elgeyo, Chunga etc.



Grabens

These are narrow , regular shaped and deep depressions on the floor of the rift valley formed as a result of secondary faulting.

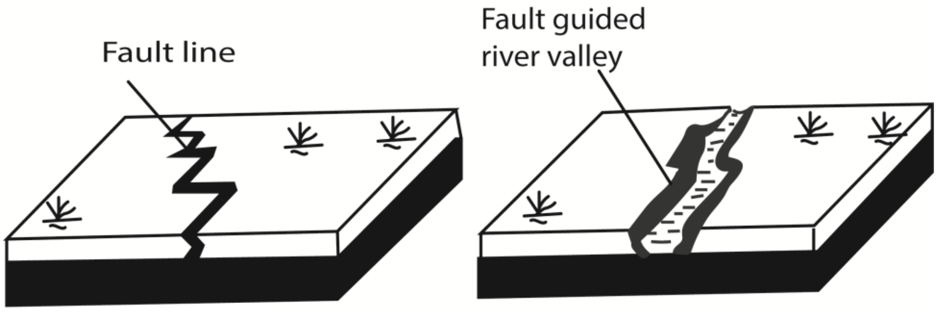
Secondary faulting led to the formation of secondary normal faults and subsequent displacement of rock blocks to the formation of Grabens e.g. Grabens occupied by Lake Tanganyika, Turkana, Albert, Edward etc.



Fault guided valleys

Fault guided valleys are faulted valleys found along single faults where the fault zone is crushed susceptible to weathering and erosion.

Fault guided valley



Examples of fault guided valleys are River Aswa in Nonhem Uganda, Kerio Valley between Eigeyo Escarpment and Kamasiya Ridge in Kenya.

The candidates should then identify other processes which have led to formation of relief land forms in East Africa

Vulcanicity is the process through which molten rock /magma, gases and liquids are either ejected on to the earth's, surface orinjected into the earth's crust through lines of weakness leading to formation of extrusive volcanic features and intrusive volcanic features

The extrusive **volcanic features** consist of

- Composite volcanoes e.g. Mt. Kilimanjaro,
- Ash/cindercones e.g. TeJeki, Nabuyatom,
- Cunulo domes e.g.Mt. Ntunbi in Tanzania,
- Shield volcanoes/basalt domes e.g Marsabit,
- Lava plateaus e.g. Laikipia, Uasin Gishu
- Calderas e.g. Ngorongoro
- Explosion craters e.g. L. Karwe.

The Intrusive vulcanicity has led to formation of the following landforms after exposure of intrusive features by denudational processes

- Batholith with resistant rocks are exposed to form inselbergs, low hills e.g. in Mubende,
- Less resistant B1&1olithsform Arenas e.g. Rubanda in Kabale.
- Dykes with resistant rocks are exposed to form ridges e.g Parabong ridge, while dykes with soft rocks are worn out to form linear trenches e.g. near L. Turkana,
- Sills form flat toped hills.

Warping:- The **up-warping and down warping led to formation of** plateaus and basins respectively e.g. L. Kyoga and Victoria basins. ·

Coastal uplift - Has led to formation of raised beaches, raised cliffs, raised wave, cut platforms and exposed caves. .

Coastal subsidence: -Has led to formation of Rias, Dalmatia islands, estuaries, mudflats etc. formed due to Isostatic re - adjustment

- **Weathering:**
  - Chemical weathering has produced landforms in karst regions i.e. stalactites, stalagmites, caves pillars
  - Physical chemical weathering has led to formation of exfoliation domes, rectangular rock blocks etc.
- **Glaciation has led to formation of**
  - Erosional landforms like cirques, pyramidal peaks, hanging valleys, glacial troughs, Arêtes
  - Depositional land forms e.g. hill plains, Eskers, drumlins, moraines etc.
- Rivers have led to formation of:
  - Erosional landforms e.g. valleys, plunge pools, Georges, Interlocking spars etc.
  - Depositional landforms e.g. flood plains, braiding, slip - off slopes etc.
- Wave action has led to formation of
  - Erosional landforms e.g. like notches, caves, blow holes, goes, headlands, bays etc.
  - Depositional land forms e.g. beaches, spits, bars, tombolo etc.
  - Sea depositing of coral polyps skeletons building coral reefs.

8. Account for the occurrence of mechanical weathering in East Africa. (25 marks)

The candidates are expected to define the term Mechanical weathering

Mechanical weathering is the process that involves disintegration or breakdown of rocks into smaller fragments without any chemical changes in the composition of the rock.

Mechanical weathering occurs under the conditions of temperature fluctuations which may lead to alternate heating and cooling or freezing and thawing as well as by biotic factors like the action of roots of plants or activities of living organisms that break the rock into rock fragments without changing mineral composition of the rock.
The areas in East Africa where physical weathering dominate include:-Central Tanzania, North Eastern Kenya around Turkana, North-Eastern Uganda in Kaabong, Moroto, Kotindo districts and on upper slopes of high mountains of East Africa like Kilimanjaro, Rwenzori and Kenya at an altitude above 4500m

Physical weathering processes that dominate East Africa include

- **Exfoliation** which is the peeling off of surface layers of the rock as a result of differential expansion of the surface layers of the rock due to alternate heating and cooling.
- **Block disintegration** which is the breakdown of rock into rectangular shaped blocks when jointed rocks are heated or cooled leading to expansion or contraction.
- **Granular disintegration** which is the breakdown of rocks into grains due to differential

heating and cooling.
- **Salt crystallization** which is process where saline solutions in rock cracks and joints begin to crystallize causing stress on the rock resulting into its disintegration.
- **Aridity shrinkage** which is the process by which non porous rocks like clay which absorbs water in the rainy season and expand while during the dry season they lose water and crack leading to their disintegration.
- Action of roots of plants that break the rock into rock fragments.
- Unloading/ pressure release while is the process by which newly exposed rock due to mass wasting expand and break due to release of weight caused by pressure.

Candidates should bring out factors for occurrence of mechanical weathering in East Africa

- **Climate**
  - In areas of hot climate such as Turkana region in Northern Kenya, Central Tanzania during the day it is hot, exposed rocks are heated leading to expansion of the rock, while during the night temperatures rapidly fall leading to rapid cooling of rock resulting into contraction. Such alternate expansion and contraction of the rock lead to peeling or breaking of the rock through a process like exfoliation, granular disintegration, block disintegration etc.
  - In Semi - Arid areas such as Central Tanzania, during the short rainy season, non-porous rocks like clay absorb water and expand while during the long dry season they lose water and crack resulting into rock disintegration.
  - In Semi- Area areas there is limited cloud cover which leads to temperature fluctuations i.e. hot/very hot during the day, cool/cold during the night leading to expansion and contraction, resulting into breakdown of rock .
  - On high mountains of East Africa, the temperature fluctuations result into frost weathering which is the process by which water collects in cracks during the day and during the night water freezes, volume increases causing breaking of the rock
- **Nature of rock.**
  - Jointed rocks such as limestone in Turkana, Kotido and Moroto areas result into block disintegration where rocks break into regular blocks when heated and cooled
  - Mineral composition- Rocks having different minerals absorb heat and loose heat at different rate, when heated or cooled respectively resulting into granular disintegration.
  - Colour of the rock- dark coloured rocks absorb a lot of heat in Semi - Arid areas when heated leading to their disintegration.
  - Differences in rock hardness: Soft rocks such as limestone in semi-arid areas like Turkana, Kotido easily break d own when exposed to rapid cooling and contraction due to bot temperatures during day and cold during the night
- **Relief:**
  - Steep slopes tend to experience a lot of soil erosion that expose the rock to process of physical/mechanical weathering
  - Steep slopes tend to be affected by mass wasting that expose the rock to unloading/

pressure release which is a form of mechanical weathering

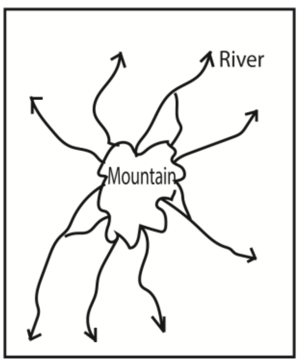
- **Limited vegetation cover** in semi-arid areas like Turkana, Central Tanzania, Moroto exposes the rock to extreme temperatures (hot during day and very cold during night) resulting into rapid expansion and contraction of the rock leading to disintegration.
- **Biotic factors:**
  - Movement of heavy animals like elephants, antelopes, zebras in Kidepo National Park help to break the rock into small particles.
  - Burrowing animals such as squirrels, Hog and insects like locusts, termites, ants destroy the limited vegetation thus exposing the rock to physical weathering processes like exfoliation due to temperature extremes.
  - Effect of plants that are adapted to semi-arid conditions. Such plants like the cacti, acacia and the baobab grow very long roots that t penetrate deeper underground breaking the nearby rocks. Some plants such as thorn bush grow on rocky surfaces in Turkana and Kaabong thus creating cracks which eventually widen and disintegrate into regular blocks.
- **Human** activities like mining and quarrying for example gold extractions in Kotido involves excavations and break down of rocks into smaller pieces. Overgrazing by pastoral tribes in Turkana, Kotido exposes the rock surface to extreme temperatures leading to expansion and contraction resulting into rock disintegration
- **Time:** The more the time, the more the mechanical weathering and rock disintegration. Over time new rock surfaces are exposed to mechanical weathering.

9. (a) Distinguish between radial and dendritic drainage patterns. (10 marks)

Radial drainage pattern

This is a drainage pattern where several rivers originate from the same source/ central point and flow outwards to different directions down the flanks of dome or cone- shaped hill/ mountain/ upland.

Radial pattern



Process of Formation/ causes of radial drainage

- Presence of a dome or cone shaped highland such as a volcanic cone/mountain or highland provides the source of the rivers. .
- Nature of the slope. Radial drainage is greatly controlled by the presence of steep slope which

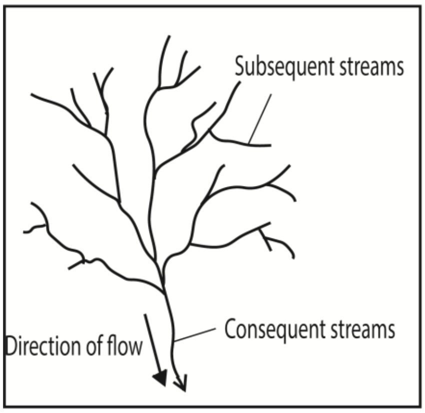
accelerates downward movement and erosion of rocks to create channels along which the rivers flow.

- High precipitation in the catchment area in form of rainfall, snow or the melting of glaciers is important for the development of radial drainage pattern. Such precipitation provides a constant supply of water needed for the development of the rivers.
- Exampl.es of Radial drainage patterns are found on Mt Elgon where Rivers Sironko, Manafwa, Sipi, Namatala, etc.; on Mt.Rwenzori where R. Mubulru, Nyamugasani, Lume and Ruanoli originate. It's also found on Mt Kenya, Kilimanjaro and Meru.

Dendritic drainage pattern:

- This is a drainage pattern where the main river and its tributaries resemble a structure of a tree or a leaf. It's a tree-like pattern where tributaries converge on the main stream from many directions and usually join the main river at an acute angle i.e. less than 90°.
- Examples are found on R.Rufigi,. Victoria Nile,. R. Malagalasi, Ruvuma, in. Tanzania and River Nyando, Congo, R. Nzoia, Kagera, Katonga, Aswa, Okok, Mara etc.

Dendritic drainage pattern



Conditions for development of dendritic drainage pattern are:

- They develop in areas with uniform rock structure and hardness (homogenous rocks). Such patterns are common on the crystalline granitic rocks. It enables the rivers to erode with minimum effort.
- Dendritic pattern also develop on gently dipping/ sloping landscape of sedimentary strata. Each tributary flows in a valley proportional to its size or volume of water and maintains its flow.
- Dendritic pattern develop in regions which receives heavy and reliable rainfall. That's why it's most prominent in the equatorial / tropical regions where there is heavy and reliable rainfall to support the development of multiple tributaries.
- In relation to slope, all the consequent and subsequent streams flow in the direction of the initial slope of the area over which the area was established ·
- Dendritic drainage pattern develops in a common large catchment area. The multiple tributaries cover a larger catchment area.
- Dendritic pattern develops on gently sloping areas where the entire major streams (Consequent) and subsequent (minor) streams flow in the direction of the initial slope of the area over which the pattern was established.

- Consequent streams develop head ward erosion and minor (subsequent) streams develop in the similar manner and join the main tributaries to complete the pattern.

(b) Explain the influence of rock structure on the development of drainage patterns in East Africa. (15marks)

Candidates should briefly describe rock structure as entailing aspects of rock hardness, rock jointing, rock dip, stratification, mineralogical composition, homogeneity, rock heterogeneity etc.

The nature of the rock structure has influenced development of different drainage patterns in many ways. These include:

- Jointed and faulted rocks have influenced development of rectilinear or Trellis drainage patterns. This is a pattern which displays a rectilinear shape with tributaries joining, the main stream at approximately right angles (90°). It develops in areas of alternate soft and hard rocks demarcated by joints and lie at approximately right angles to the general slope downwards which the main river (Consequent) stream flows. The soft rock bands are eroded by head ward erosion while the hard rocks resist. Presence of joints along the rocks facilitates quick head ward erosion in that the river flow is guided by the fault lines or joints.

  Examples occur on R. Mayanja- Kato, Wasswa in Kichwamba, R. Aworanga, Pager, Aswa, Tiva and Galana,

- Alternate bands of soft and hard rocks side by side influence development of Parallel drainage pattern, This is a drainage pattern where rivers flow by the side of each other but with limited chances of joining one another hence the name parallel. Examples are found in western Uganda where R. Nkusi and R. Hoima flow parallel to **each other before joining L. Albert. In Kenya they are found in the Aberdare ranges and west of Mau ranges** where tributaries of River Athi such as R. Nairobi, Thirika, Komu and Ruiru flow parallel to each other. 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.

- Homogeneous ot crystalline igneous rocks influence development of dendritic and radial patterns. Dendritic is a drainage pattern where the main river and its tributaries resemble a structure of a tree *or* a leaf. It's a tree-like pattern where tributaries converge on the main stream from many directions and usually join the main river at an acute angle i.e. less than 90°.

  Example are found on R. Rufigi, Victoria Nile, R. Malagalasi. Ruvuma in Tanzania and River Nyando. They develop on areas with uniform rock/structure and hardness {Homogenous rocks). Uniformity of the rock structure enables the rivers to erode any region with minimum effort thus creating a variety of tributaries.

- Difference in rock hardness (Heterogeneous rocks) occurring in alternate belts of hard and soft rocks lying at right angle to the slope influence development of Trellis pattern. This is pattern which displays a rectilinear shape with tributaries joining the main stream at approximately right angles (90°). Examples occurs on R. Mayanja- Kato, Wasswa in Kichwamba. R-. A woranga & Pager. The soft rocks are eroded through head ward erosion to create river channels while the bard rocks resist erosion resulting into trellis pattern.

- Steeply dipping rock encourage development of radial drainage pattern especially if it is on a dome shaped upland e.g. on Mt. Suswa in Kenya.

10. Explain the influence of tectonic movements on the formation of highlands in East Africa (25 marks)

Candidates are expected to take note of the following approach.

Give the definition of highlands

Identify examples of highlands in E. Africa

Definition of tectonic movements.

Origin of such movements.

Explain role of tectonic movements 0n the formation of ***highlands*** *in E. Africa*

A highland is a raised area or upland which is above 1500m above sea level

- The major highlands in Uganda include: Kigezi highlands, the Rwenzori mountain ranges, Mt. Elgon, Mt. Moroto, Bunyaruguru and Buhweju highlands, etc.
- In Kenya, the highlands include: Mt. Kenya, Abardare ranges, Mau ranges, _
- In **Tanzania**, the highlands include: Mt. Kilimanjaro, the Southern highlands (Kipengere), Usambara, Pare, Uluguru, Meru, etc.

Tectonic movements are differential movements of the earth's crust which are lateral or vertical, rapid or slow within the earth's crust

Tectonic movements originate from the Mantle due to radioactivity, Geochemical and geophysical reaction which generate heat and pressure which melt the rocks in the Mantle forming convectional currents which develop within the molten rocks that produce tensional, compressional and vertical forces.

These forces lead to processes of faulting, vulcanicity and warping.

In E. Africa, highlands have been formed as a result of faulting, vulcanicity and up warping.

Faulting: - The fracturing and subsequent displacement rocks of the earth's. This led to formation of Block Mountains (Horsts) and tilt blocks.

Block Mountain or Horst

A block mountain is an upland bordered by two or more fault scarps on either side. Examples of the Block Mountains are Rwenzori ranges in Uganda, Usambara, Pare in Tanzania.

The formation of block mountains is explained by three theories:-

- The compression force theory by Wayland

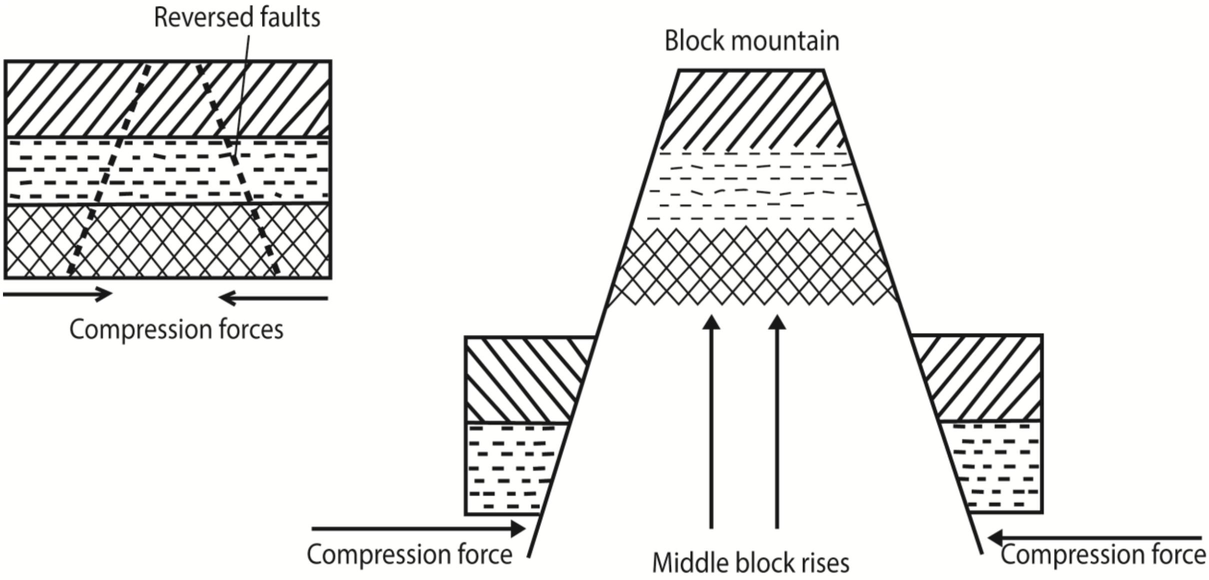
- The Tension force theory by Gregory
- Vertical displacement theory by Dixey

NB: Candidates, may choose any two theories to explain the formation of a Horst with relevant diagrams

Formation of a block mountain by compression forces

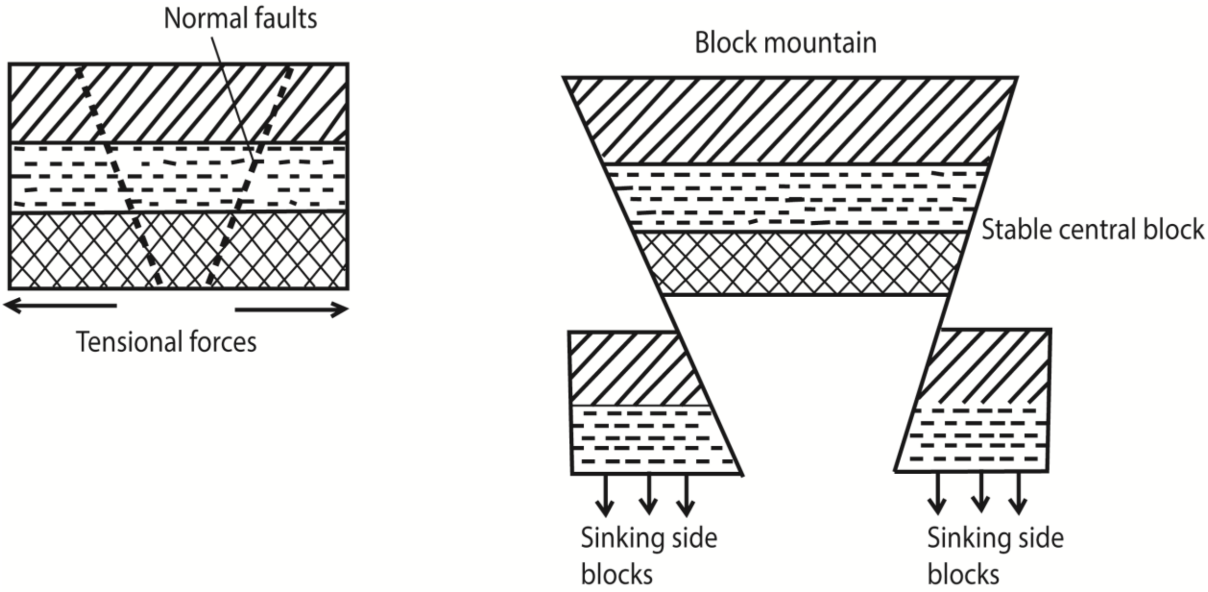
- Compression forces pushed a crystal block of land on either sides resulting into stressing hence the development of reversed fault lines.
- The fault lines divided the crystal block into three parts.
- As the action of compression forces continued the middle/ central block was thrust upwards above the two adjacent blocks/ surrounding blocks to form a block mountain.

This is illustrated as shown below;



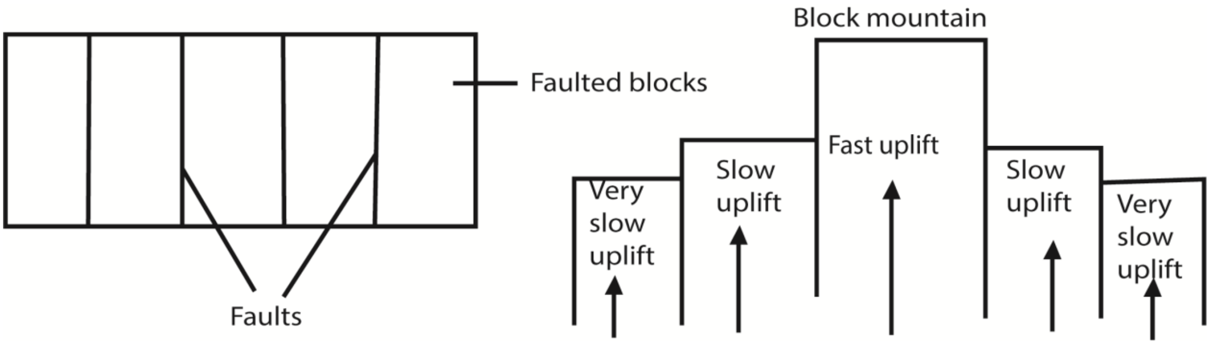
Formation of a block mountain by tension forces

- Tension forces act on the earth crust by pulling in opposite direction from each other.'
- This is when convectional currents move horizontally in different directions hence the development of parallel normal faults in the crust.
- The faults divide the crust into three parts.
- The continued tension forces lead to the subsidence (sinking) of the side blocks.
- The middle block remains stable high above the side blocks as a block mountain.



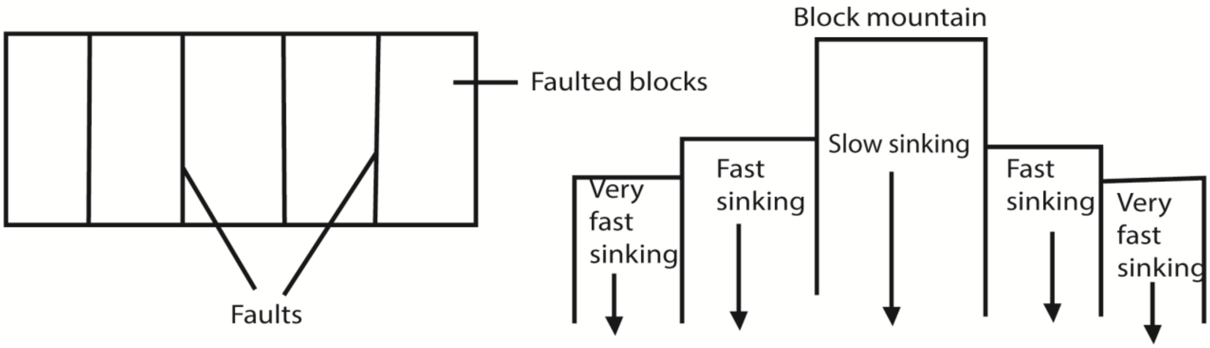
Formation of a block mountain by differential uplift theory:

- This is due to multiple faulting which forms series of crystal blocks of varying sizes and density
- When the forces of uplift acted on the crystal blocks with varying strength.
- Uplift forces was strongest on the central blocks, they were forced to rise higher to from peaks of the horst.
- The side blocks did not rise high enough but formed the sides of the horst in in stages as illustrated below.



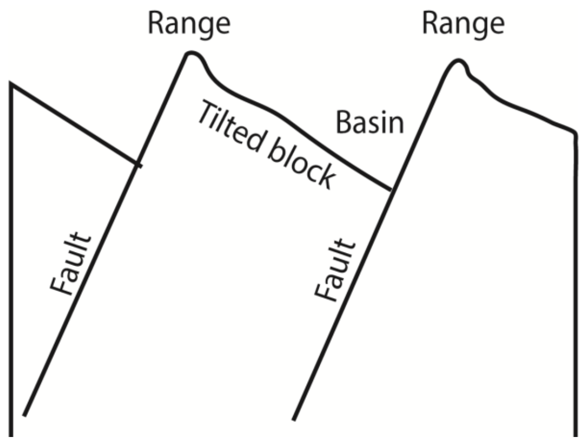
Formation by relative sinking;

- This is due to multiple faulting which forms series of crystal blocks of varying sizes and density
- When faulted blocks experienced sinking which was not uniform. The side blocks sank faster than the central block.
- Toe central block remained relatively higher to form the peak of the horst as illustrated below;



A tilt block landscape

This is upland of inclined crustal blocks It is formed as a result of compression or Tension forces which led to the formation of parallel fault lines. This was followed by a general uplift of the faulted regions. The uplift was not uniform on neither sides of the fault blocks such that one side rose higher than the other to form a tilt block for example, the abaredare ranges in Kenya, Mt. Rwenzori slopes at Kichwamba etc.



Highlands due to Vulcanicity*:*

***Vulcanicity is** a total process through which ashes, gases and molten magma (rocks) is ejected **and** deposited on to the earth's surface thus forming extrusive volcanic land forms.*

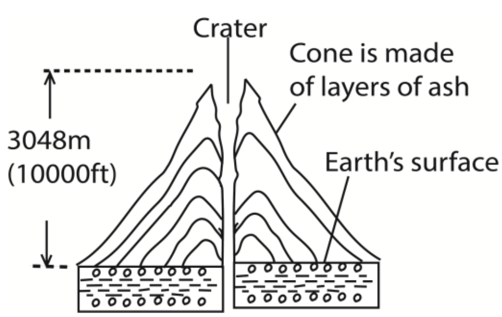
The highlands in E. Africa as **a** result of vulcanicity include:

In Uganda, Mt. Elgon, Kigezi highlands, Mt. Moroto, Tororo plug, etc.
In Kenya; Kenya highlands which include Mt. Kenya

In Tanzania, the Southern highlands, Mt. Kilimanjaro, Meru, etc.

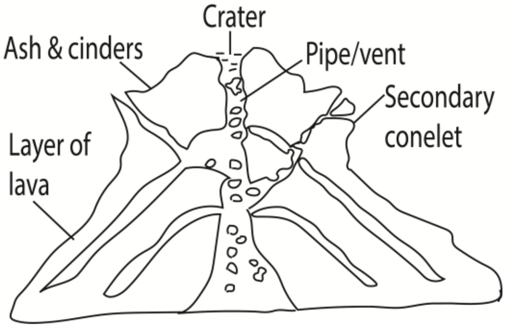
The highlands formed by vulcanicity include the following;

- ***Ash* and cinder cones.**
  These are small steep sided hills usually less than 200m in height formed by very violent eruption. Violent eruption brew lava into very many fragments of various sizes with ash being smaller than cinder. These are blown in the atmosphere and later laid down around the central vent in layers of ash and cinder. Each layer represents a phase in eruption. It's the accumulation of these layers of ash and cinder that forms these hills. Such hills frequently occur in groups and near large volcanoes. Examples of such are Teleki, Likaiyu, Nabuyatom and some are found south of L. Turkana in Kenya. In Kisoro they include Muganza. Sagitwe, Bisalo, etc.



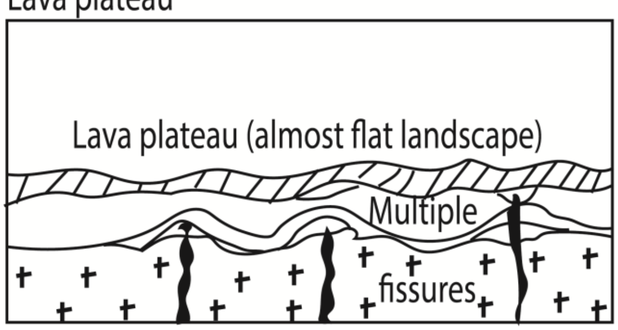
- **Composite cones / strato volcanoes.**
  These are usually large volcanic cones with fairly steep slopes. They are made of alternate layers of ash and lava ejected through a central vent over a long period of time. Each layer of lava over ash represents a phase of eruption. They are called strato volcanoes because they constitute strata \ layers of ash and lava. Eruptions that gave birth to strato volcanoes are very explosive due to contents in magma. Each eruption phase begins with great violence and explosion releasing a lot of ash which accumulate around the vent. This is later covered by a layer of lava when the eruption relaxes. After formation, magma solidifies and therefore blocks the central vent. Secondary eruption may blow up the solidified magma in the vent and the top of the cone leaving behind a funnel shaped depression called a crater. Examples of composite cones/ strato volcanoes are Mt. Kilimanjaro, Meru, Mt Mubabura on Uganda - Rwanda border

Composite/strato volcanoes



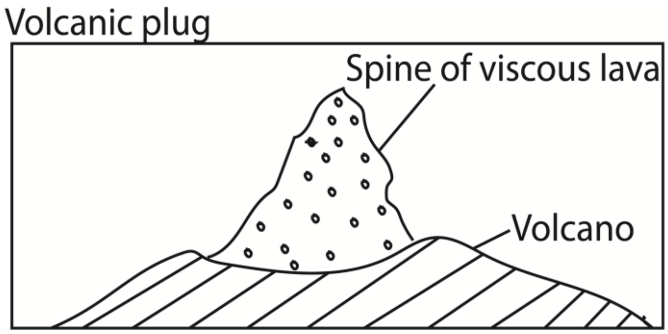
- **Lava plateaus**
  A lava plateau is upland with more or less monotonous relief and formed by different or successive layers of lava. It's formed by a quiet eruption where basic and therefore fluid lava flows out through several fissures in the earth crust and spreads out over a long distance covering any original valleys and hills on the landscape before solidifying as a sheet of basalt. Repeated fissure eruptions lead to the building of thick and high plateau which may reach 6000feet high. Examples include the Laikipia plateau on the eastern slopes of the Aberadare ranges in in Kenya, Yatta plateau, Kisoro lava plateau, etc.

Lava plateau

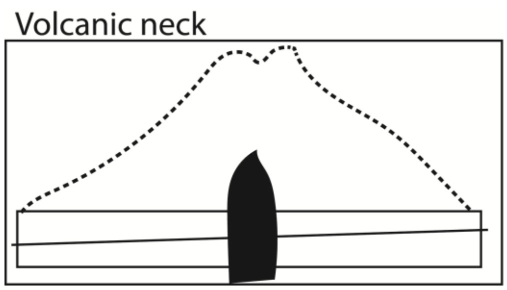


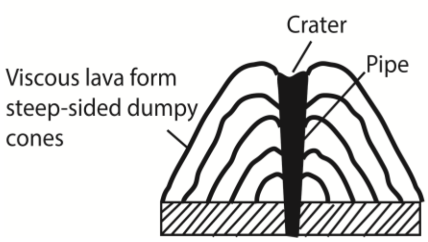
- **Volcanic plug.**
  These are very steep sided volcanic features that stand out prominently above the ground. Volcanic

plug is formed by a very explosive eruption where viscous magma is extruded out as a rigid cylindrical mass amidst clouds of hot ash and cinders.



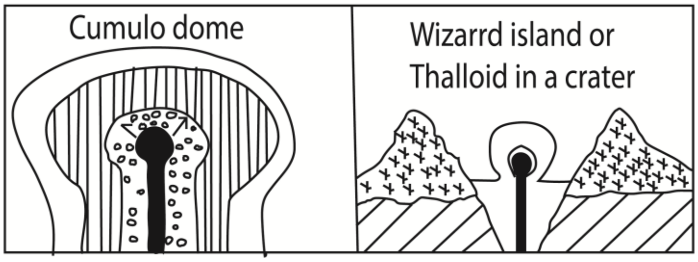
- **Volcanic neck.** This was formed when lava solidified in the vent of a volcano and later exposed by the erosion of the surrounding cone. Besides the volcanic neck, differential erosion may also reveal resistant dykes which have solidified in fissures of the original cone. Examples include; Mawenzi peak on Mt. Kilimanjaro, Batian and Nelion peaks on Mt Kenya, etc.





- **Cumulo domes.** This is a circular or round volcanic feature deep rooted in the earth crust. It's formed when volcanic activity builds up a volcanic dome / ball of viscous magma ejected at low pressure. The surface quickly hardens while the interior is still fluid. Further uprising within the already hardened layer forces the dome to expand forming a more-or-less rounded feature called a cumulo dome. When it forms into a crater, it is called a Thalloid or wizard Island. Examples are Ntumbi cumulo dome in Tanzania, Gombe and Nakasongola domes in Uganda. In Kenya, they are found in the Tsavo National Park, Thalloids are found in a Caldera on top of Mt Rungwe in Tanzania.

Cumulo and Thalloids



- **Some** other highlands in E. Africa are due to up warping: Up warping led to general uplift of the rift valley shoulders to form uplands e.g. Bunyaruguru and Buhweju among others.

11. (a) Distinguish between aggradation and degradation (05marks)

Aggradation is an exogenic process which involves the building up or deposition and accumulation of unconsolidated materials by marine or fluvial process in low land areas or valleys.

- Agents of deposition include rivers, waves, tidal currents, glacier/ice-sheets and wind
- The deposited materials include: sand, silt, mud, boulders, pebbles, etc.

Degradation refers to the gradual lowering/ destruction of the landscape through the work of weathering, mass - wasting and erosion.

Agents involved in the denudation process include: rivers, waves, glaciers/ ice - sheets, wind, Etc.

The materials that are carried away include: pebbles, silt, sand, boulders, Etc.

(b) Explain the Davisian cycle of land evolution (20 marks)

The Davisian cycle of land form evolution also referred to as t e geomorphic cycle or Erosional cycle was proposed by William Morris Davis

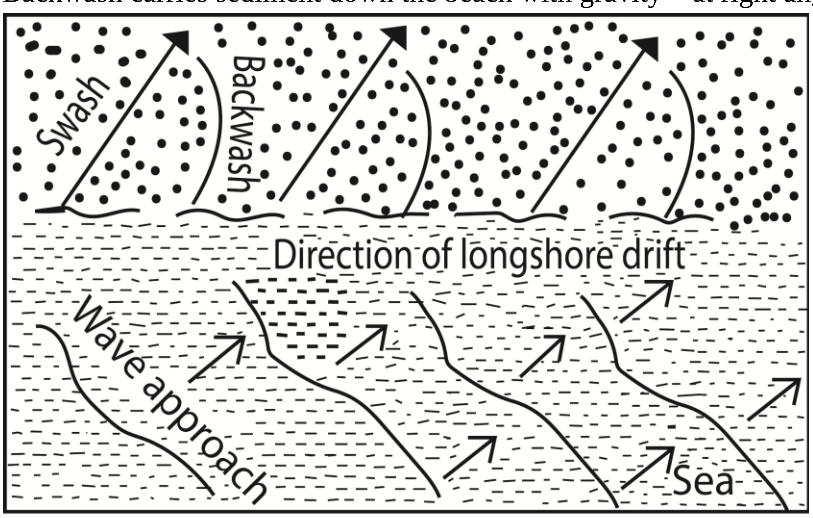
- He observed that the physical landscape undergoes modification as a result of the nature the agencies in an orderly progressive sequence or stages- e.g. youthful, mature and old / senile stage.
- Slopes evolve towards a level surface that returns to their point of origin.
- The cycle begins with uplift leading to building of highlands/uplands due to earth movements or orogenic processes.
- The uplift bas to be simple and fast/ rapid enough that it does fast/rapid enough that it does not experience significant erosion during this phase.
- The uplifted land then undergoes the cycle of erosion/ down cutting by rivers, glaciers, wind and the weathering processes.
- Rivers at this stage (i.e. Youthful) deepen their valleys through vertical erosion, flow at high speed forming V-shaped valleys.
- As the process continues the relief decreases, slopes and valleys become more gentle.
- Lateral erosion becomes more dominant and valleys become relatively broadened (U-shaped) due to reduced gradient This is the mature stage of slope development

- With continued erosion and deposition the relief later becomes relatively smooth and flood plains begin to develop the land form evolution reaches the old/ senile stage.
- Rivers then deposit the eroded materials from the youthful and mature stages.
- Deposition results into meandering as the relief becomes more gentle/ flatter.
- Lowland finally develops and Davis calls this a peneplain or a level surface.
- When the peneplain stage is achieved uplift occurs so that the cycle starts again, hence a return to a level or point of origin.
- The Davisian cycle therefore clearly points out the value of structure, process and time/ stage in land form
- evolution.

12. To what extent has longshore drift influenced the development of depositional features in East Africa? (25marks)

Candidates are expected to define the term longshore drift, talk about constructive waves, give the landforms that result from longshore drift then bring out other factors.

- **Longshore drift** is the movement of sediments/eroded materials along a coast by waves that approach at an angle to the shore but then the swash recedes directly away from it
- Waves approach the coast at an angle. Swash carries sediment up the beach at an angle. Backwash carries sediment down the beach with gravity – at right angles to the beach.



Depositional landforms formed by longshore drift include

- **Beach** is a gently sloping strip of land along the coastline covered products of weathering and erosion such as sand, pebbles, rock and seashell fragments. The different types of beaches include
  - **Barrier beach** is a narrow and elongated ridge of sand deposits approximately parallel to the shoreline separated from it by a lagoon. It is formed on gently sloping Coastlines by longshore drift waves. Materials are deposited under water as off shore sand bars appear above high tide, wave action gradually moves the deposited material to the mainland as barrier beaches.

- **Beach Cusps.** Series of small horn-shaped projections separated by shallow indentations that Point Sea wards. Formed by eddies of powerful swash that scours coarser materials in the depression.
- A **Bayhead beach** is a type of **beach** that is crescent shaped and has developed at the head or back of a bay between two headlands by constructive waves e.g. Lido beach at Entebbe
- **Beach rock** is a friable to well-cemented sedimentary rock that consists of a variable mixture of gravel, sand and silt-sized sediment that is cemented with carbonate minerals and has formed along a shoreline e.g. found at Lutembe beach along L. Victoria

- **Beach Berms** is ridge like features formed by larger material that accumulates at furthest limit of Swash action. Develop on beaches when Swash is stronger than back wash e.g. Lutembe Beach, Lido etc.
- **Beach Bars:** Ridges of sand, Mud, gravel and shingle deposited off shore parallel to the coast formed on gently sloping coast/irregular shoreline.

  Formation is attributed to either waves which drift materials along the shore or backwash combing materials directly down the beach.

  Similarly the long breaking waves cause sand grains to more sea ward resulting into accumulation of material on the submerged line known a break Point bar. Repeated processes form a bar behind which develops a lagoon, mud flats & marshes.

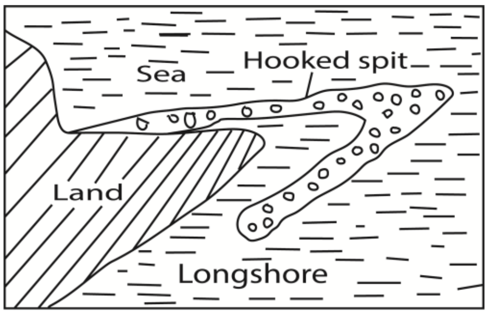
Types of Bars include:

- **Off Shore Bars:** These are long ridges of sand and shingle deposited along a coast separated from the coast by a lagoon formed by waves breaking some distance offshore where the continental shelf is shallow leading to formation of a submarine bar that is slowly built upwards through continued deposition of material.
- **Fore shore Sand Bar:** A bar formed by constant accumulation of sand causing offshore bars to rise above the water surface. ,
- **Bay Bar:** A bar which extends across a bay forms when a spit continues to grow length wise from one headland towards another. Link the two headlands enclosing a lagoon e.g. at Nabugabo bay.
- **Barrier Island:** A bar which gradually moves inland by wave attack and encloses the area of shallow water (sounds) and have no connection to the mainland.

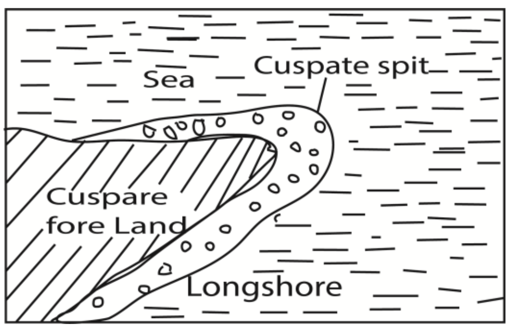
- **Spit; Spit** is a long narrow ridge of sand, shingle or pebbles in a linear form joined to the land at one end with the other end projecting into the sea or across the estuary.
  It grows out from the coastline due to the effect of the long shore drift, often at a location where the line of the coast changes direction, usually at the mouth of an estuary or delta e.g. Kaiso spit and Tonya spit on L Albert.

Types of Spits include:

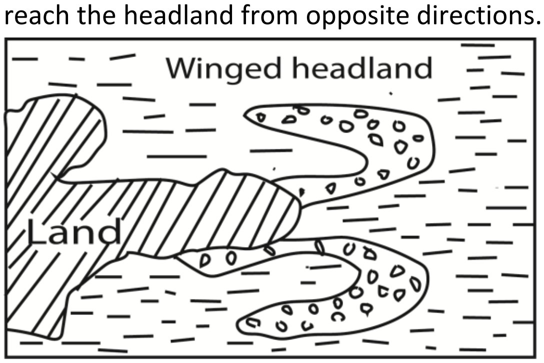
- **Hooked Spit** is a long narrow ridge of sand, shingle or pebbles joined to the land on one side with hooked end projecting into the sea or estuary. Formed by waves moving obliquely to the shore tending to swing around the end of the spit or waves approaching the shore from several directions force the open part of the spit to bend or curve. The deep water off the spit allows wave refraction to curve hence forming a hooked spit e.g. at Kibanga.



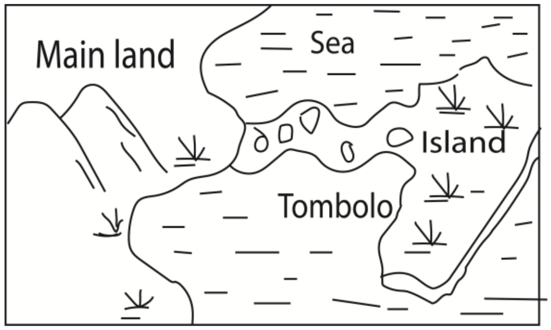
- **Cuspate Spit** applies to *two* spit converging offshore. It is also a recurving of a simple spit until it becomes attached to the shore at both ends.



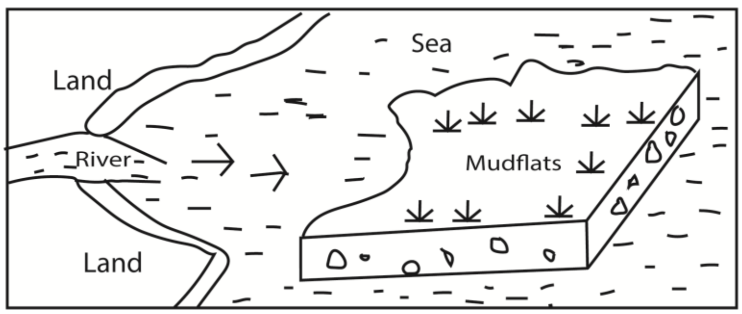
- **Cuspate foreland** is a triangular shaped deposit of sand, shingle projecting sea wards formed by convergence to one apex of two separate curved spits broadly at right angles or by two sets of constructive waves, the enclosed water is filled with deposits then colonized by vegetation leading to a cuspate foreland, e.g at Tonya point.
- **Winged headlands:** These are spits attached at both sides of the headland. They develop when spits develop at both sides of the headland. This occurs when waves / longshore drift reach the headland from opposite directions.



- **Tombolo** is a ridge/ bar of sand or shingle joining an island to the mainland or joining an island to an island. When the longshore drift operates between an island and the mainland, sediments may gradually be laid down in that in that zone. Deposition may start on one end of the mainland linking the two up. E.g.Bukakata-Lambu islands.



- **Mudflats:** Platforms of mud, silt and other forms of alluvium along gentle is especially in bays & estuaries. They develop when rivers & waves deposit material along gentle coasts especially in bays and estuaries between high and low tides e.g. near Tanga, mouth of R. Rufigi.



Candidates are expected to make an evaluation and bring other factors like:

- Wind direction which should be on shore such that material is carried and deposited by on-shore wind along the shoreline.
- Availability ofweathered and eroded materials that are transported by constructive waves and deposited at the coast to form various landforms e.g. beaches.
- Presence of a relative shallow continental shelf to form the base upon which material is deposited.
- Presence of organic deposits/corals due to deposition and accumulation of dead polyps.
- Nature of the coastline i.e. gently sloping allows deposition & accumulation of material leading to formation of depositional coastal features.
- Human activities e.g. dumping of industrial wastes at the coast/ shoreline, soil and rock boulders to construct piers etc.
- River deposition at the mouth forming deltas.

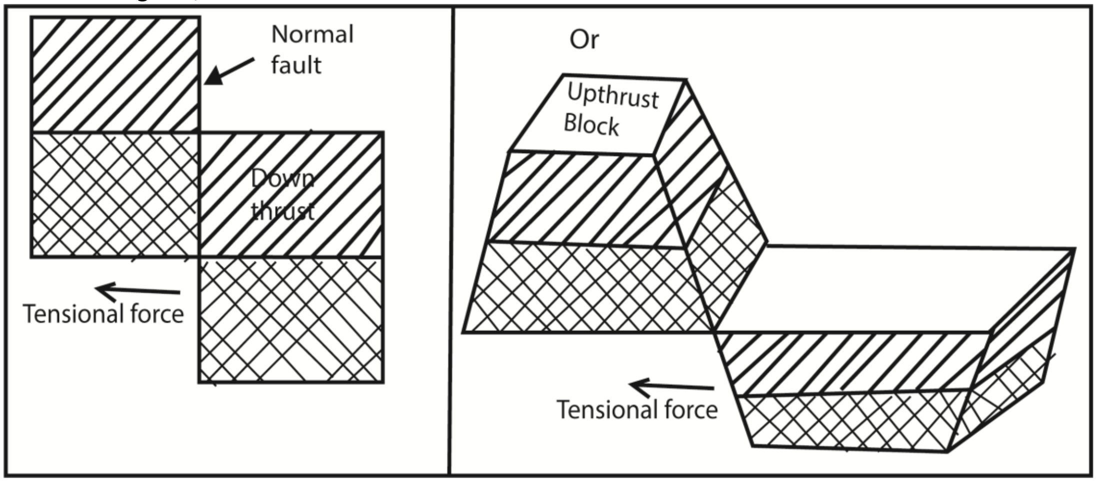
NB: Conclusion should be drawn

Diagrams should be drawn where applicable.

13. (a) Differentiate between normal faults and reversed faults. (06marks)

Normal faults

- They result from tensional forces pulling apart the earth's crust in opposite directions
- Diagram/illustration of normal fault can be either vertical or inclined as shown below.

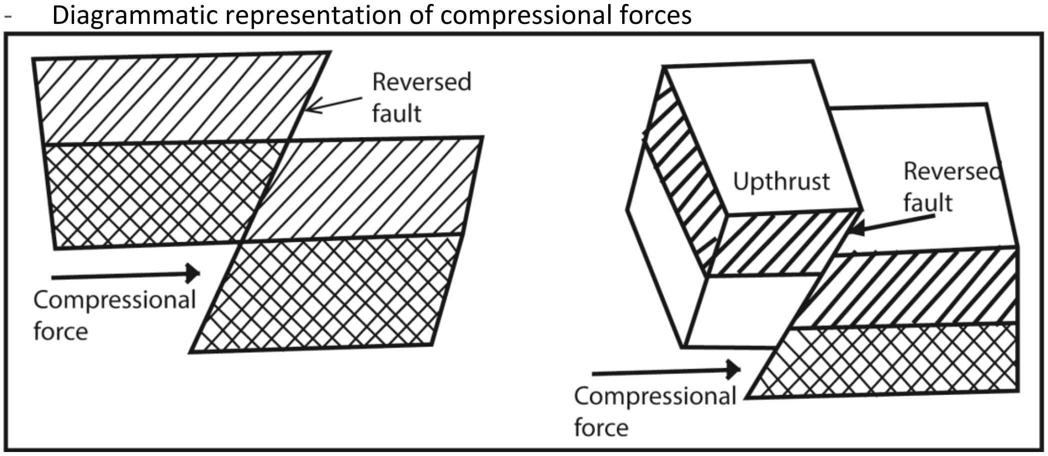


- Example of normal faults are in Eastern Rift valley section i.e. Elgeyo, Mau, Rukura etc.

While

Reversed faults

- Are due to compressional forces pushing/moving in the same direction, the rocks of the earth crust causing fracturing and displacement of the blocks.
- Diagrammatic representation of compressional forces



- Examples of reversed faults are found in the western Rift valley section i.e. Albertine Rift valley of Uganda.

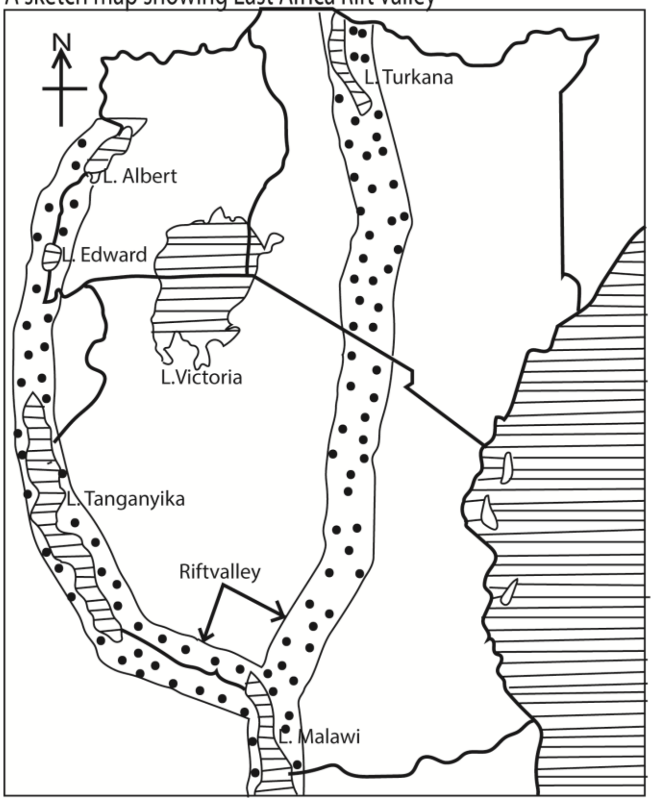
(b) Account for the formation of the East African rift valley. (19marks)

Candidates are expected to define a Rift Valley .

As an elongated trough or depression bordered or surrounded by in- facing fault scarps along more or less parallel faults.

Areas covered by the East African Rift Valley should be identified by either description or with the help of a sketch map. i.e. Eastern and Western arms/ section in Kenya, Uganda and Tanzania

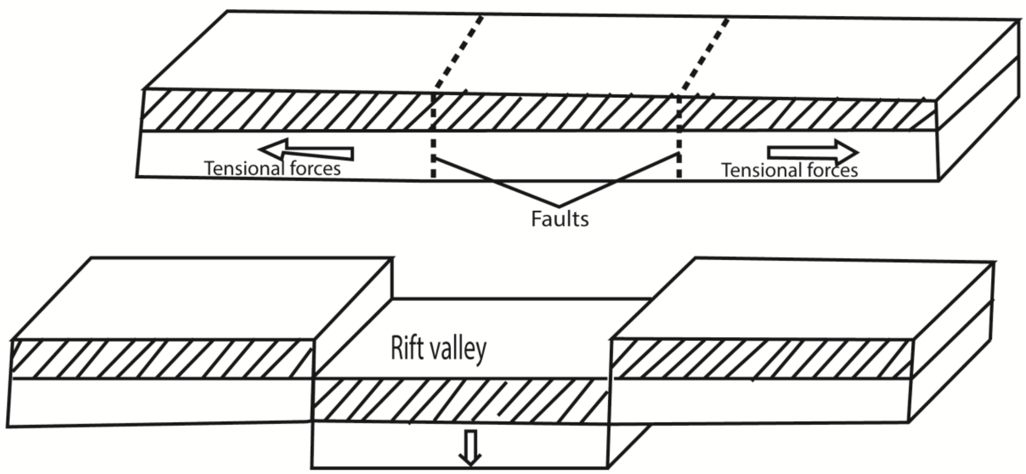
A sketch map showing East Africa Rift valley



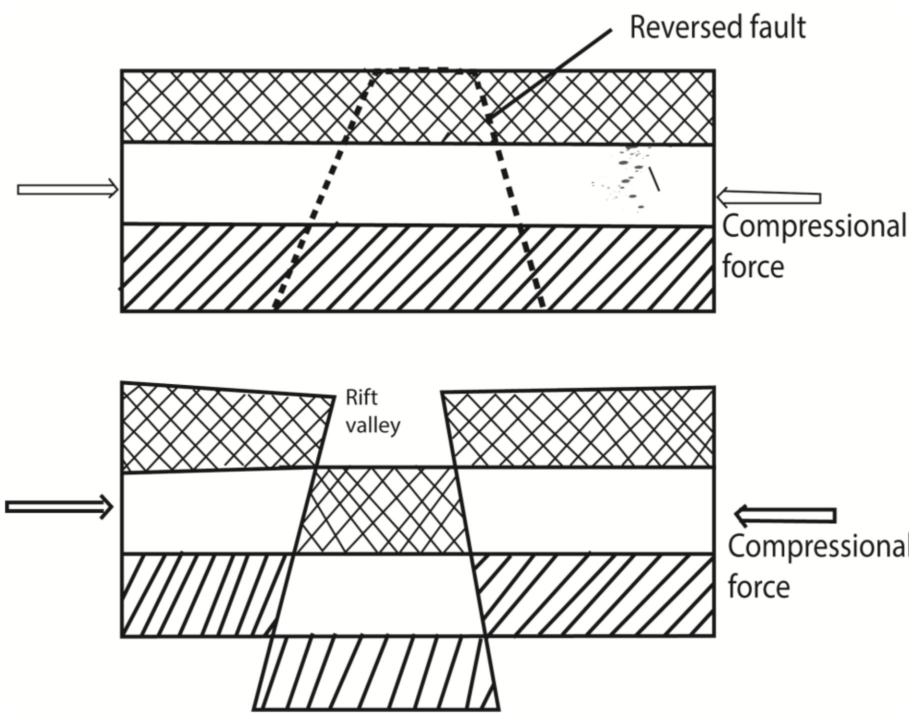
The origin of the Rift valley formation *is* still more of debate i.e. it involves many theories related to radio-active and gee-chemical reactions within the interior of the earth crust hence convective currents producing tensional, compressional, horizontal and vertical differential forces causing faulting i.e. fracturing and displacement of the earth crust along fault lines:

The major theories include

- **Tensional theory by J.W Gregory**
  - That radio-active and convective currents produced tensional forces within the earth crust.
  - Tensional forces acted / pulled apart/ in opposite directions.
  - Normal faults were produced, displacing rock strata.
  - Side blocks were separated from the middle block, which was later lowered/ sunk under its own weight, forming a rift valley with gentle slopes.
  - Erosion and mass **wasting** modified the slopes.
  - The theory is more applicable to the Eastern Kenya Rift valley (Gregory Rift).



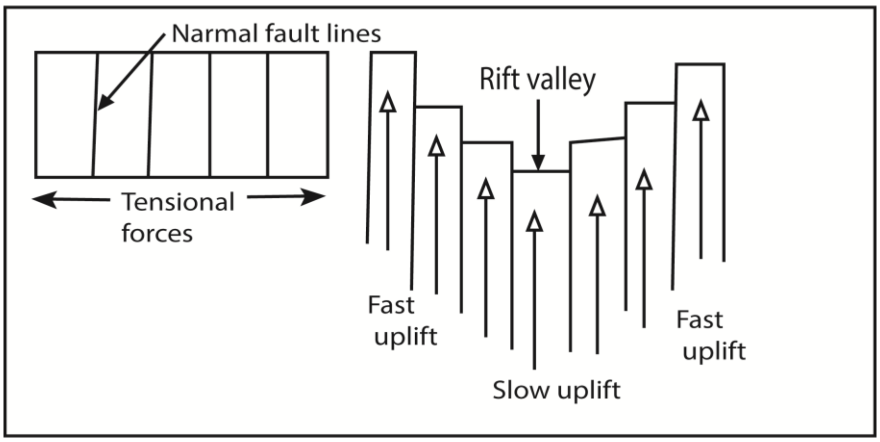
- **Compression force theory by E.J Wayland**
  - That strain developed in the East Africa crust as compressional forces pushed/moved in the same directions (convergent).
  - Reversed faults were produced.
  - The side blocks were forced to over-ride (up thrust), hanging above the central block. The central block thus formed rift valley with steep/ sharp edges.
  - The sharp edges were later modified by erosion and mass wasting.
  - The theory is more relevant to Western arm of the East African Rift Valley, especially the Albertine Rift valley.



- **Differential uplift theory**
  - Dealt with the Nairobi part of the East African Rift valley of Kenya that is step faulted.

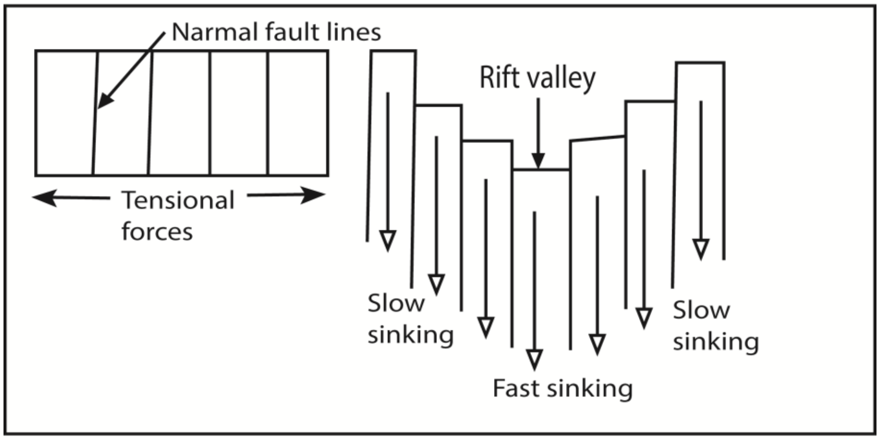
- That there was a period of general uplift of part of the East African Crust.
- It led to the formation of several parallel fault-lines.
- Blocks on either side of the central block rose faster as the middle lagged behind in stages.
- At each stage, a mass or of block formed a terrace·
- Examples include Kendang scar near Nairobi appearing as several terraces rising from the Rift Valley floor.
- The gap in the middle of terraces formed the rift valley.
- Diagrammatic illustration of differential uplift

Differential rift theory



- **Relative Sinking (subsidence theory)**
  - Just like in differential uplift theory, there was extensive faulting in East Africa which created multiple parallel faults.
  - Within the mantle / interior of the earth, there is intense heat originating from radioactivity and geochemical reactions.
  - The heat melts down the interior rocks and they begin to move in form of convective currents upwards towards the crustal plates.
  - When they become colder and therefore heavy, they sink or flow back down in the mantle and as they do so they exert a drag force which pull the crustal blocks downwards thus sagging of crustal blocks along each fault.
  - The central blocks sagged more than those or, the extreme ends to form a step or terraced rift valley

Relative sinking theory



14. To what extent does the nature of materials ejected influence the formation of volcanic relief land forms (25marks)

Candidates should define volcanic relief land reforms as features formed as a result of the ejection of Liquid, Solid or Gaseous materials on the surface of the Earth.

They should then describe the nature of materials ejected and the associated relief land forms, i.e.

- The liquid materials ejected consist of molten magma which reaches the surface as lava:
- Some Lavas{Acidic) contain much Silica, with a high melting point, very viscous and solidify rapidly building high-steep sided cones or may solidify in the vent causing recurrent explosive eruptions. The resultant land reforms include:- . .
  - Cumulo domese.g. Ntumhi in Tanzania.
  - Volcanic plug/ plug domes e.g. Mt.Kenya.
  - Co mposite volcanoes e.g. Kilimanjaro
- Where the Lava is basic i.e. poor in silica but rich in Iron and magnesium materials, it flows for a considerable distance before solidifying producing flatter cones of greater diameter. It is associated with the formation of:-
  - Basaltic domes/ shield volcanoes e.g. Nyamulagira- part of the Virunga ranges.
  - Lava plateaus/ plains e.g. Kisoro, Yatta, Kapiti, Nyabondo etc.
- Gaseous compounds emitted during eruption include sulphur, carbon dioxide and chloride etc. including steam. The gases inter - react generating great heat within the lava. This affects the ra te of cooling, lava flow and the shape and type of volcanic landform formed.
- Solid materials generally known as tephra are ejected during a series of eruptions. These may include fragments of country rocks; angular fragments of solidified lava and finer materials such as Scoria, Pumice, Cinders, Dust and Ash.
- Gaseous and solid materials are ejected during violent emptions producing the following relief land reforms·-
  - Ash and Cinder cones I Scoria cones e.g. Shozi, Sagitwe in Kisoro, Teleki and Likaiyu in Kenya etc.
  - Strato/ composite volcanoes e.g. Kilimanjaro, Muhavura

- Calderas e.g. Napak, Longonot, Menengai, Suswa etc.
- Explosion craters e.g. Katwe, Nyamunuka, Nyangu etc. in low lying areas and mountain craters e.g. Muhavura crater. Kilimanjaro crater. Shozi crater etc.

However, other factors which bring about volcanic relief landforms should be cited e.g.

- *Nature of passage/ vent.*
  - Central or single vent leads to the formation of steep sided cones e.g. plugs and composite volcanoes.
  - Numerous fissures tend to produce gently sloping cones, usually low in height with a large base e.g. basaltic domes and lava plateaus.
  - Fault lines provides passages for the formation of volcanic cones e.g. Suswa, Longonot etc.
  -
- *Number /times of emissions.*
  - Successive eruptions lead to complex composite volcanoes, basaltic domes etc.
  - Simple/ single eruptions lead to formation of small cones.

15. Describe the landforms resulting from chemical weathering in East Africa. (25 marks)

- Candidates should define chemical weathering as the decomposition/decay/rotting of rocks at or near the earth surface. It occurs in situ (one place).
- Candidates should identify conditions favouring chemical weathering. These include:
  - Heavy rainfall and high humidity to avail water to act as a medium of chemical reactions.
  - Hot temperatures to accelerate the rate of chemical reactions.
  - Presence of atmospheric gases like oxygen, carbon dioxide and mineral compounds.
- Candidates should identify areas where chemical weathering is common. e.g.
  - Lake Victoria basin like Jinja, Mwanz.a, Kisumu.
  - Nyakasura area in Western Uganda.
  - East African coast e.g. Mombasa. Dar es Salaam.
- Candidates should describe land forms due to chemical weathering in East Africa.

  NB; - Candidates should bring out processes of chemical weathering like carbonation, solution, Oxidation but these processes may be integrated with explanation of landforms

  - Candidates may bring out illustrations and local examples

Stalactite and stalagmite

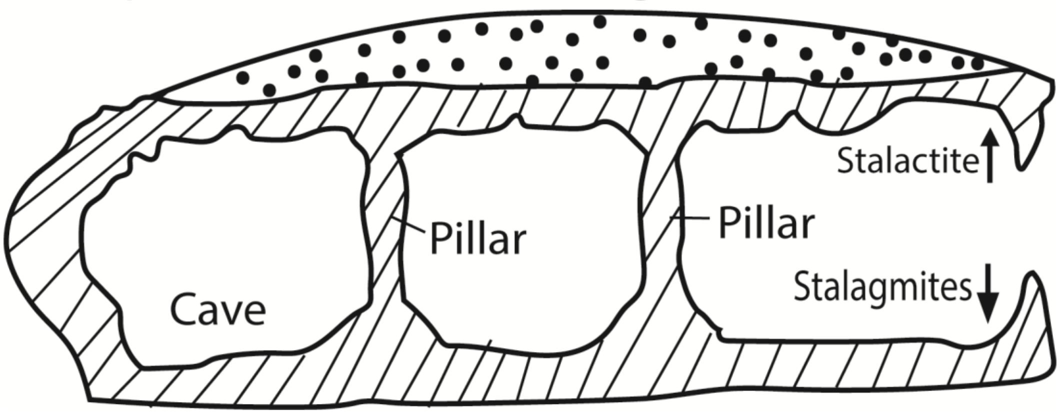
These are formed through carbonation. Rain water combines with carbon dioxide in the atmosphere to form weak carbonic acid which dissolves calcium carbonate to form calcium bi carbonate. When solution reaches underground cave, calcium carbonate is deposited on roof of the cave to form stalagmite e.g. at Nyakasura in Western Uganda.

Pillars.

These are vertical stands of calcium carbonate formed in underground caves when stalactites and stalagmites continue to grow towards each other and eventually join. Examples arc found at Nyakasura and Tanga.

Caves: a cave is a natural underground space. It is formed when there is chemical dissolution of limestone or dolomite. The rock is dissolved by **natural** acid in ground water that seeps through the bedding planes, faults and joints.

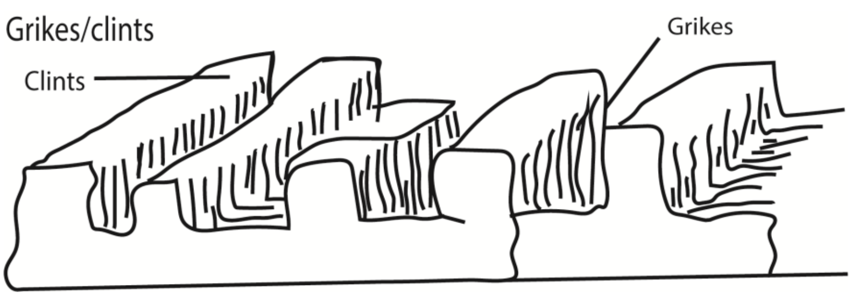
Cave, pillars,stalactite and stalagmites



Grikes and Clints

Grikes are hollows or depressions while Clints are ridges formed as a result of carbonation. They formed in limestone areas with rocks of different chemical composition. Lime stone is dissolved by acidic rain to form depressions/ hollows called Grikes while dissolved rocks form ridges called Clints/ Limestone pavement.

Grikes/clints



Sink/roles

A sinkhole is a natural depression or hole in earth's surface formed when limestone is dissolved. It is formed through the processes of removal of soluble rock by percolating water and the collapse of roof cave.

Dolines*:* these are larger than sinkholes. These are shallow circular depressions formed either by solution of the surface lime stone or by collapse of underlying caves. In latter case they are called collapse doline.

Polje. This is an elongated basin having a flat floor and steep walls. The poljes are formed by coalescence of several sinkholes when being formed through carbonation and solution. In some poljes, small residual hills known as hums are formed.

Limestone gorge is deep steep-sided valley formed when acid rain seeps into the cracks in limestone rocks or when a larger river erodes/ weathers soft limestone rocks by solution.

Duricrust is a hard crust (layer) found on the surface formed from mineral precipitation i.e. deposition of insoluble materials from a solution. The most common in East Africa is lateritic duricrust formed when the weathered layer become impregnated with iron solution due to leaching. On removal of top layer laterite hardens into duricrust like on flat topped hills of Buganda/ laterite terms·. ,- -·.,·_

Tors are landforms created by chemical weathering of a rock along joints followed by removal of the weathered material

16. To what extent has relief influenced the development of drainage patterns in East Africa? (25marks)
Candidates should define the term drainage pattern

Drainage pattern is s the layout/plan or arrangement made by a river and its tributaries on the landscape (Drainage basin) over which it flows.

Candidates should identify and describe the various drainage patterns that exist in East Africa as:

- **Radial drainage pattern -** A pattern in which rivers and their tributaries flow from a common peak/dome shaped structure various directions like the spokes of a bicycle wheel. It is common in dome shaped uplands like mountain Elgon, Mgahinga etc.
- **Dendritic drainage pattern -** a pattern where rivers and their tributaries create a tree like plan/layout, with tributaries joining the main stream from many directions at more or less acute angles. It's the most, common type of drainage pattern in East Africa, such as river Apwac in Kalongo area, Tana river, rive: Namatale etc.
- **Rectangular drainage pattern (Trellis) -** a pattern where the main stream takes sharp, more or less rectangular bends and tributaries join it at more or less right angles such as river pager and tributaries, river Athi, river Mayanja, river Kato-Wasswa in Mityana-Mubende area etc.
- **Centripetal pattern -** where rivers flow from the rims of surrounding higher areas (Basin) into a common depression where there is a lake or Swamp such as lake Victoria and Kyoga,

lake Baringo etc.

- **Annular pattern -** where streams join at sharp angles arranged in a series of curves around dissected uplands, craters / calderas such as Ngorongoro, Bukigai area (hill) in Bududa etc.
- **Parallel pattern -** where streams and their tributaries flow down slope more or less parallel to each other such as nver Nkusi and Hoima on the other Butiaba scarp, river Rukoki, chalanga and Kamulikwizi in Kassese area.
- **Barbed/ hooked pattern -** a pattern where stream tributaries flow in opposite direction to the main river, before joining it at more or less acute angles to form a hooked or barbed pattern. This pattern is associated with drainage reversal as is the case of river Katonga, Kafu, Kagcra etc.

Candidates should explain the extent to which relief has led to the development of the above mentioned drainage patterns in East Africa as:

The existence of relief has influenced the development of various drainage patterns in many ways and these include:

- Steep slopes on volcanic cones such as Mt Susisa in Kenya, Mt Elgon etc. favor the development of radial drainage pattern. The steep slopes accelerate down ward movement of water and erosion of rocks to create channels along which rivers flow. Steep slopes such as escarpments lead to parallel drainage patterns.
- Gently dipping slopes favor the development of dendritic pattern. Gently sloping areas encourage the dendritic drainage where the consequent (major) and subsequent (minor) streams flow in the direction of the initial slope over which the pattern was established such as river Malagarasi Victoria Nile, Rufiji etc.
- Existence of hills separated by inside valleys lead to the development of trellised drainage as seen from Mayanja Kato and Wasswa in Mityana-Mubende area.

Candidates should explain the other factors which equally influence the development of drainage Patterns in East Africa such as:

Rock nature/ structure

- Jointed/ faulted rocks have encouraged the development of rectilinear/ trellis drainage patterns as seen on river Mayanja-Kato and Wasswa, pager, Awa and Galana.
- Alternate soft and hard rocks demarcated by joints almost at right angles to the general slope encourage trellis drainage patterns.
- Soft and hard rocks lying side by side encourage the development of parallel drainage pattern, where rivers flow by side of each other but with limited chances of joining e.g. river Nkusi and river Hoima.
- Homogeneously uniform/crystalline igneous rocks lead to the development of dendritic patterns, radial patterns. Uniform rocks enable the rivers to erode uniformly creating a variety of tributaries.

Tectonism has encouraged me development of drainage patterns in East Africa;

- Warping- Areas affected by up warping and down warping such as the Victoria-Kyoga basin/depression, which later encouraged several rivers from different directions to flow into the basin, formed centripetal, drainage pattern.
- Faulting encouraged the formations of joints and faultlines which later promoted the formation of rectilinear/rectangular or parallel patterns.
- River capture system encourages the development of drainage pattern over time especially where a strong river arrests the water of a weak neighboring river, into its own channels. This

encourages the development of barbed/ hooked drainage patterns, Dendritic patterns etc.

- Climate in form of reliable rainfall equally accounts for the development of drainage patterns in East Africa. Existence of reliable rainfall in a drainage basin/catchment area is necessary to support the evolution and continued existence of a river and its tributaries which may form several patterns like radial, trellis, dendritic etc.

Much as relief plays a significant role in a drainage pattern development, it does not do so in isolation, other factors are also at work.

N.B: Candidates should draw diagrams to illustrate their answers where appropriate and local examples may be sighted to support their answers.

17. Examine the relevance of Wegner's theory of continental drift in explaining the present day position of continents. (25marks)

- *Candidates are expected to define continental drift as the movement of continental landmasses/blocks relative to one another (away, towards or alongside), across the surface of the earth to their present locations/positions to form continents such as Africa, North and South America, Asia, Europe etc. and ocean basin.*
- *Candidates are expected to men on Wegner's assumptions as:*
  - Wegner's theory is based on the rifting and drifting of continents.
  - Wegner's theory assumed that there was one giant **Sialic** landmass (super continent) known as Pangaea, which was located in the south near the present day South Pole, surrounded by a huge expanse of water (Ocean) known as **Panthalasa.**
  - During the Precambrian period (Permian times about 250million years) Pangaea begun rifting and drifting northwards.
  - Pangaea cracked and broke into land masses i.e. Laurasia and Gondwanaland were separated by a narrow sea of Tethys (universal sea).
  - At about l35million years ago, Gondwanaland and Laurasia drifted north wards leading to the closure of the Tethys Sea in the East .
  - Laurasia split into North America, Eurasia and Green land, Iceland while Gondwanaland split into Africa, South America, India, Austria and Antarctica.
  - During the drifting the Oceans between the continental blocks became wider, forming the present day ocean basins like Atlantic, pacific etc.
  - In the North, Eurasia drifted East wards.
  - In the South, Africa moved to attain its present locations astride the equator.
  - India drifted northwards to join Eurasia. South drifted Eastwards, away from Antarctica about 65million years ago.

- *Relevancy* of Wegner's theory
  - Jigsaw/Visual fit of continents. There is a close fitting (Jigsaw puzzle) of the continental coastlines across the Atlantic ocean i.e. the East coast of South America and West coast of Africa have good visual fit (ach fit into one another) not only at the surface but also at 2000m deep.
  - Geometric fit of continents. The west coastline of Africa and the Eastern coastline of South America fit almost exactly on each other if rotated at an angle of 57^0 with rotational point 40^0N and 30^0West.
  - Matching geological/similarity in rocks and rocks bearing minerals which appear continuous. E.g. Africa and South America have rocks with a convincing boundary joined between Accra and Saolouis in Brazil, the coal bearing rocks of Eurasia and North America (the Appalachiana). The gold bearing rocks of West Africa (Ghana) and South America (Guyana).
  - Similar oil beds. Oil beds in Brazil are similar to those of Angola in Africa.
  - Matching orogenic zones/belts. The alignment of the belts of fold mountains matches across the joint of Africa and America e.g. folded ranges in Falkland Islands and Argentina are similar in age and structure to those of the south west cape of South Africa-the cape

ranges.

- Glacial evidence (Dwyka Tillite) thick deposits of tillite (fossilized glacial moraine) in Eastern Brazil, Paraguay and Argentina, are exactly like those of south Africa and Australia implying that the continents at one time were near or too close to each other.
- Similar sedimentary Basins. A long part of North Eastern Brazil coast, South Nigeria and Cameroon, similar sedimentary rocks sequences exist and the low beds of that basin match exactly on both continents.
- Similarity in plant and animal species in Australia and south Africa; Africa And south America
- Palaeomagnetic evidence in India, Australia, South America, the magnetic properties in the magnetized rocks no longer point in the north-south direction as it should be suggesting that during the course of drifting, rocks were twisted and changed direction.
- Existence of laterites in North America and Europe proves that these continents experienced tropical climatic conditions for laterites to form
- Existence of coral reefs in the Green land, Britain, North America and yet coral reefs form in hot climatic conditions.
- Salt evaporites/beds in cold parts of U.S.A, Britain, Germany and Russia yet salt evaporites occur in tropics
- Proximity of continental land masses to the North Pole than in South Pole.

18. Describe the weathering processes taking place in the Lake Victoria basin of East Africa. (25marks)

Candidates are expected to

- Define weathering
- Give the climatic conditions/characteristics of Lake Victoria basin
- Identify the types of weathering processes taking place in the Lake victoria Basin and describe how they take place.

- Weathering is the integration/breaking and decomposition/decay/rotting of rocks in situ or near the earth's surface
- Lake Victoria Basin is located in the Southern/South-Eastern part of Uganda, South-western Kenya and Northern Tanzania including the Islands such as Kalangala (or draw a location map of Lake Victoria Basin)
- Lake Victoria Basin has the following major climatic conditions which influence weathering process
    - Heavy rainfall is received (i.e. between 2000- 2500mm)
    - Rainfall is double maxima/bimodal/two seasonal peaks
    - It is received throughout the year with no distinct dry season
    - Temperatures are uniformly hot through the year (i.e. between 24^0C-27^0C) the diurnal temperature range is small between 2-3^0C.
    - Relative humidity is usually high of 80% dense cloud cover experienced.

The above climatic conditions have led to the dominance of chemical weathering processes which include the following:

- **Solution.**

This is where soluble mineral components in rocks are dissolved by water e.g. rock salts are carried in solution leaving behind joints, cracks/widened hollows in rocks.

- **Oxidation.**

This is the reaction between oxygen and mineral components in rocks such as iron, aluminum facilitated by the hot temperatures and existence of water. This has led to the formation of laterites for example on the flat-topped hills of Buganda, Rocks containing Iron (ferrous state) change to ferric state.

- **Hydrolysis.**

This is the reaction between the hydrogen ions from water and mineral ions from rocks to form new compounds. It the major process in of decomposition of feldspars in igneous rocks e.g. granites.

- **Carbonation**.

This involves rain water dissolving atmospheric carbon dioxide to producing carbonic acid This reacts with calcium and magnesium carbonates in the rocks to form, new compounds.

- **Hydration.**

Is a process in which certain minerals absorb water and expand causing internal stress and fracturing of the rock. Examples include the conversion of hematite to limonite, mica in sedimentary rocks like sandstone.

- **Spheroidal weathering.**

Is the swelling/expansion of the outer shell of a rock mass by penetration of water forcing them to peel successively away and loosen.

- **Reduction.**

Also known as gleying occurs in swampy/water logged areas at the shores of lake Victoria. It involves anaerobic bacteria absorbing the limited oxygen leaving behind hydrogen that reacts with the rocks to form new compounds i.e. the clay rich rocks turn into blue greyish colour.

- **Biological weathering.**
    - Plants use their roots to extract nutrients from rocks and therefore cause a change in the composition of those rocks . Also the decaying of plants and animals results in the formation of humus, which mixes with rain water and forms humic acid that further decomposes rocks.
    - The roots of plants/trees can force apart joints and cracks in rocks as they grow and enlarge
    - Human activities have led to disintegration/decay of rocks such as quarrying, application of fertilizers, garbage/sewage disposal, industrialization etc.
    - Burrowing animals such as rodents also break surface *rocks* as they create passages in rocks

through which water vapour, gases pass to react chemically with rocks.

- Bacteria existing in leguminous plants absorb nitrogen to produce nitric acid which reacts with parent rock to form new compounds.

However physical weathering processes also occur in the lake Victoria Basin especially the South Western shores in Uganda and North Western shores in Tanzania where the following climatic conditions exist.

- Low and seasonal rainfall, long dry seasons, hot temperature, large temperature range.
- The above conditions have led to the following physical weathering processes:

- **Exfoliation.**

Is the peeling of surface layers of exposed rocks as a result of alternating heating and cooling. This causes the outer layer of the rock to expand during day because of hot temperatures and contract at night due to low temperatures. This causes rock stress and strain shattering the surface rock layers. For example the Bismarck rock at Mwanza.

- Block disintegration. Is the breaking of homogeneous jointed rocks into blocks due to alternating heating and cooling.
- Granular disintegration; Is the breaking up of heterogeneous rocks into smaller grains due to alternating heating and cooling. The different mineral components in the rocks expand and contract at different rates causing stress and strain leading to disintegration.

19. Explain the influence of earth movements on the formation of lakes in East Africa. (25marks)

Candidates should define a lake as a hollow in the Earth's surface filled by water

- Lakes in East Africa differ in permanency, salinity, shape, size and depth.

  Earth movements are differential movements of the Earth's crust which are caused by internal/endogenic/diastrophic forces. They may be slow or rapid, lateral or vertical. Result from convective currents in the mantle that cause tension, compression, Earth quakes, isostatic re-adjustment etc.

Candidates should identify earth movements which cause lake formation e.g. coastal warping, faulting and folding. These movements cause hollows which are then filled with water to form lakes.

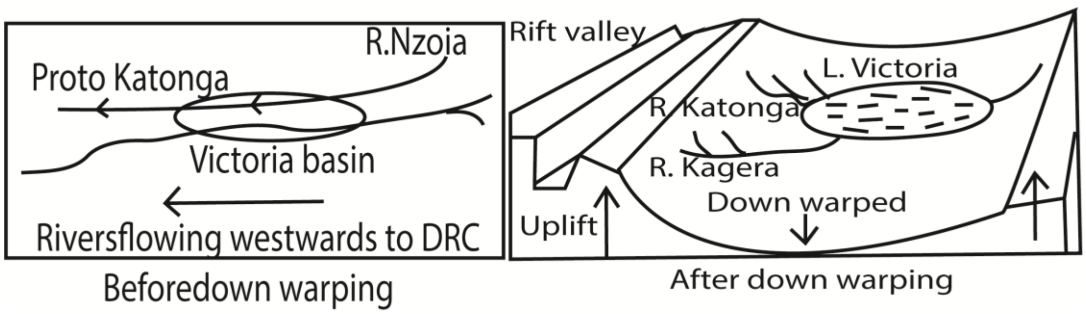
Coastal warping

The extensive downward and upward movement of the crust led to formation of depressions and uplands. Down warping occurred in central and South Eastern Uganda to form depressions occupied by lakes Victoria, Kyoga, Wamala and Nakivale.

- Before warping took place, land in central Uganda was sloping to the West and rivers like Katonga, Kagera, Rwizi, Kafu were flowing to the west.

- During warping, Eastern and Western Uganda were up warped while central Uganda down warped forming basins.

- After warping, rivers reversed their flow eastwards; emptying their waters into the basins to form lakes Victoria and Kyoga.
  Diagram(s) to illustrate river flows



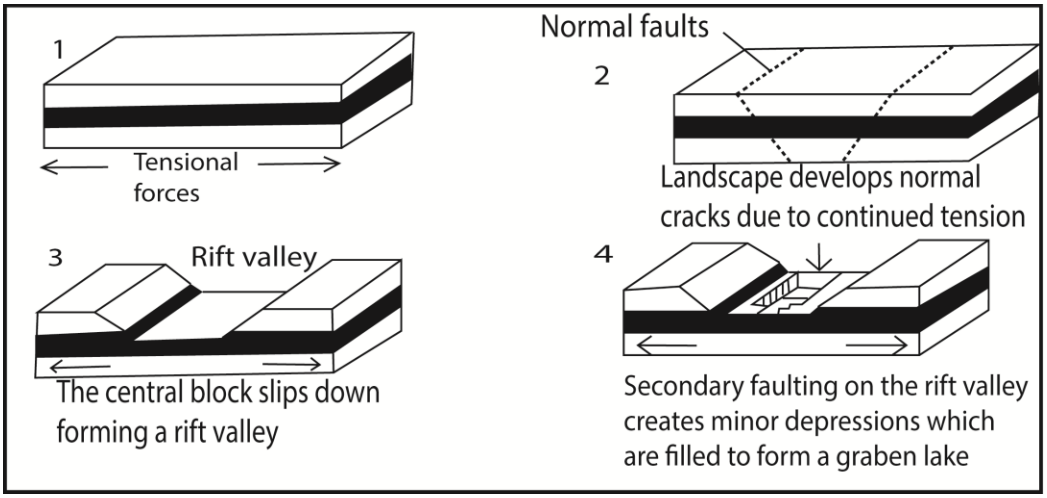
- The formed lakes are shallow in depth, having fresh water, irregular outlines/shore lines and extensive swamps around them bays/headland.

Faulting

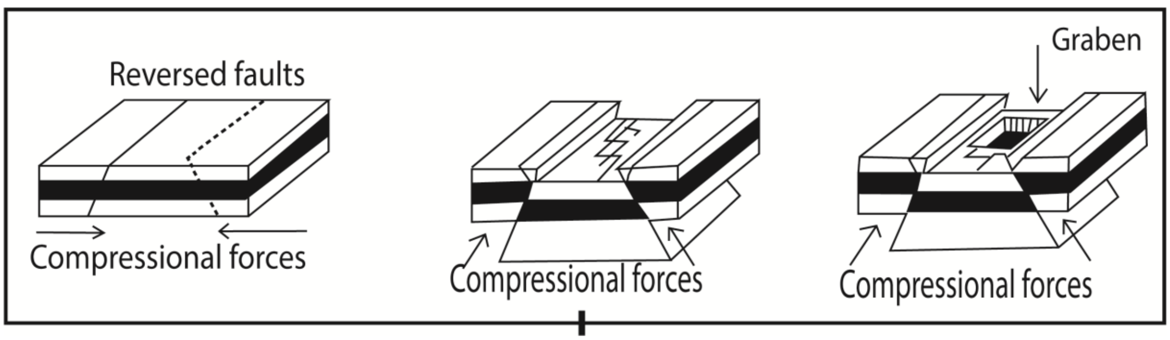
The breaking and subsequent displacement of crustal rocks by forces of tension or compression led to the formation of following types of lakes:

- Grabens are hollow lakes/Rift valley lakes found in rift valley floor occupying graben hollow. Grabens result from forces of tension, compression forces. E.g. Albert, Tanganyika, Edward, George, Natron, Eyasi etc.

According to tensional forces
- Radioactive and convective currents from the mantle caused lines of weakness.
- Normal faults were created in the crust.
- Displacement occurred in the crust forming the rift valley.
- Secondary faulting took place in the rift valley to form grabens.
- Formed grabens were later occupied by water to from rivers, rain to form lakes.



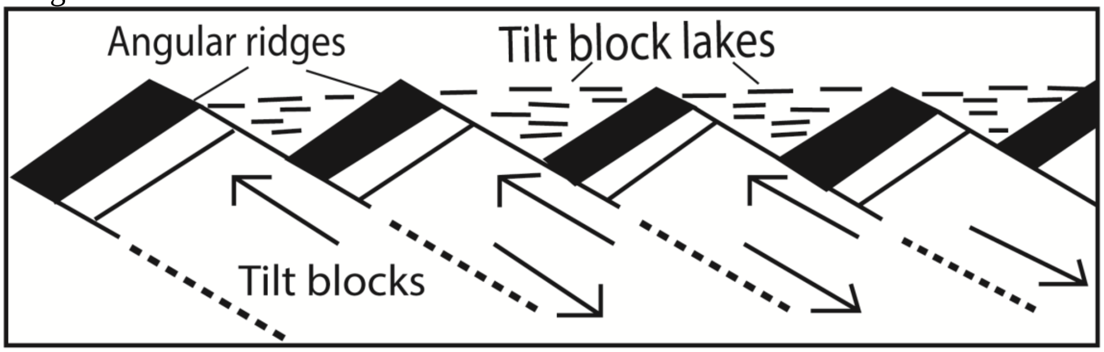
According to compressional forces
- Radioactive and convective currents from the crust produced lines of weaknesses.
- Reversed faults were formed in the crust
- Crustal displacement occurred to form the rift valleys
- Secondary faulting took place in the rift valley forming grabens.
- The formed grabens were occupied by water from rivers, rain to form lakes.



- The formed lakes are characterized by being narrow, elongated and deep with steep bank , taking shape of the grabens.
- Examples include lakes; Albert, Tanganyika, Turkana, Edward etc.

Tilt block lakes occupy depressions between tilted uplands/ridges.
- Tension and compression forces led to formation of several parallel faults dividing up the crust into several blocks.
- Faulted landscape was then subjected to uplift or sinking at different rates and then tilting in one direction forming angular ridges and depressions.
- Water from rain /rivers fill the depressions to form a lake(s) e.g. Lake olbolossat in Aberdares in Kenya.

Diagrammatic illustration



20. (a)Account for the occurrence of sea level changes. (10marks)

- Candidates should define the term "sea-level changes" as a rise or fall in the level of the sea relative to the land or the vertical movement of land relative to the sea. Sea level changes are also referred to as Eustatic changes.
- Candidates should identify and explain the causes of sea - level changes.

Rainfall/precipitation; Increased rainfall/ precipitation (Pluviation) in the upstream areas leads to a rise in sea-level relative to the lands while reduced rainfall, characterized by drought (dessication) leads to fall in the sea-level relative to the land.

Temperature; reduced temperatures/ low temperatures (such as in winter) causes contraction of water molecules in water bodies leading to a fall in sea-level relative to the land while increase in temperature (say due to vulcanicity) causes expansion of water leading increase in volume.

Glaciation and de-glaciation; De-glaciation which involves ice melting due to increased temperatures leads to a rise in sea-level relative to the land whereas glaciation/formation of ice involves freezing of water on high mountains and polar Regions. This leads to a fall in sea - level relative to the land.

Sedimentation; Deposition of sediments in ocean basins displaces water upwards, leading to a rise in sea - level relative to the land. E.g. Rivers such as Rufigi and Tana deposit a lot of alluvium into the sea. This displaces some water and after a number of years it leads to a rise in sea level

Rivers; the water deposited (poured) into the sea by rivers such as **the** Nile in Mediterranean, Tana into the Indian Ocean **lead** to a rise in **the sea** level

Reaction of hydrogen and oxygen; it's believed that hydrogen atoms from the sun often enter the earth's atmosphere and when they combine with oxygen in the ozone layer, rainfall is formed which enters into the sea to raise its level

Drought; prolonged drought leads to excessive evaporation leading to a fall in the sea level, East Africa for example has been experiencing prolonged drought and reduced rains for the last 50 years. This has led to a fall in the water level of the Indian Ocean and Lake Victoria exposing many features which were once submerged.

Global warming is another cause for rise in sea level. It involves a rise in temperature leading to melting of ice and snow from mountains like the Hi Malaya, Rwenzori, Mt. Kenya and Kilimanjaro. Such water moves down into oceans through rivers.

Human activities like dumping of sewage, garbage, construction of artificial piers and Hotels on water have all led to a rise in the sea level. Over the world thousands of tones in form of hardcore stones and soils are deposited in the sea especially near: beaches to construct Hotels. In Uganda Speke Resort hotel at Munyonyo was partly constructed in Lake Victoria through a similar process.

Tectonic movements. These include warping, faulting, vulcanicity etc.

- **Warping** - up warp of coastal areas and down warp of ocean basins led to fall in sea level while down warping of coastal areas and up warping of ocean basins led to a rise in sea-level/base level,
- **Plate-divergence** causes expansion of ocean basins leading to a fall in sea level while contraction of ocean basins due to plate convergence leads to a rise in sea-level/base-level.
- **Vulcanicity**. Volcanism at contractive plate boundaries and subduction zones displaces water upwards, hence a rise in sea-level relative to the land.
- **Isostatic re-adjustments;**. Addition of sediments/ loading on continental areas. This causes sinking slowly of continents, hence a rise in sea level. Isostatic uplift of land mass occurs due to ice melting, leading to a fall in sea-level.

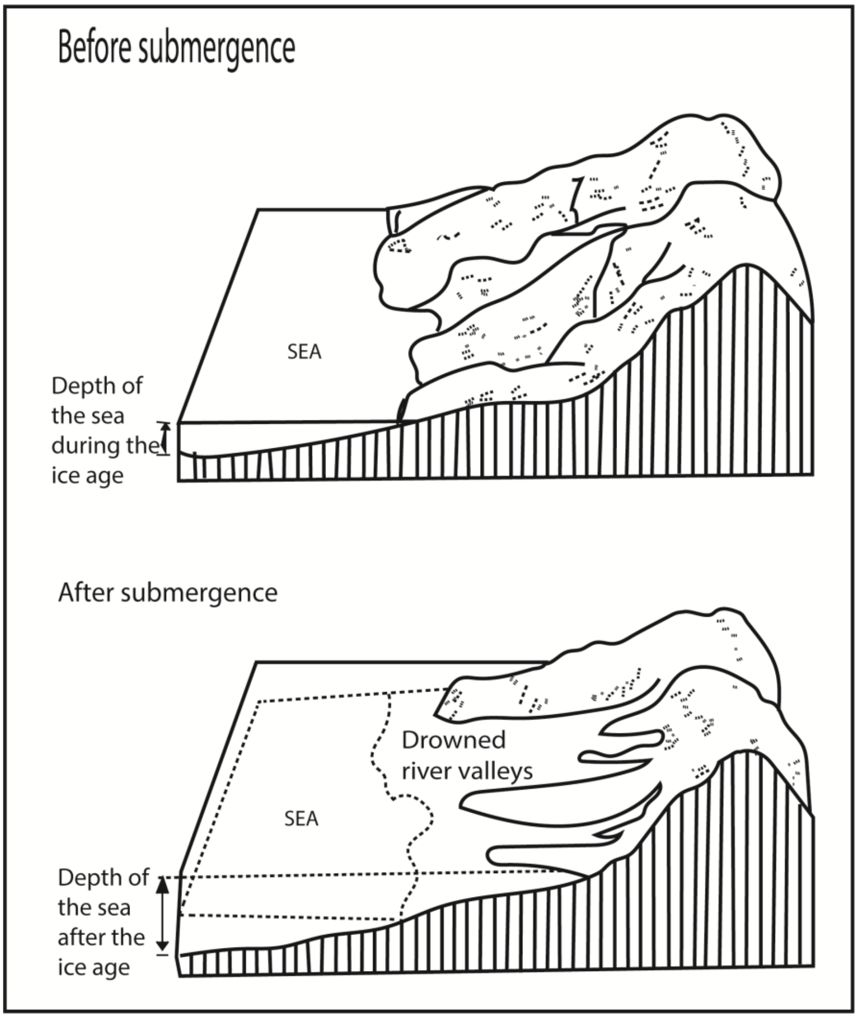
(b) Describe the landforms resulting from a rise in sea level. (15marks)

Candidates should identify the land forms resulting from a rise in sea-level, describe their formation with illustrations. These landforms are in two categories i.e. those that form in highland coastal areas and lowland coastal areas.

(i) Highland coastal areas.

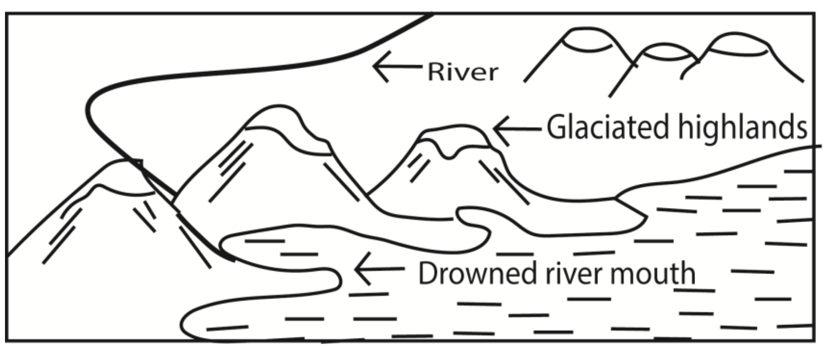
- **Rias**. These are funnel shaped drowned river valley mouths. They are V- shaped in cross profile and progressively deepen sea-wands. They form in highland coastal areas where hills and river valleys meet the sea approximately at right angles. They form when the Sea-level raises leading to submergence of river valleys at the Sea Examples are found at Mombasa, Dar-es-salaam, Mtwara etc.

Diagrammatic illustration of Ria coast



- **Fjords.** These are submerged U-shaped glacial troughs. They are deep elongated and have hanging valleys and truncated spurs. They form in highland coastal areas which are affected by glaciation where glaciers erode pre-glacial valleys through plucking and abrasion. The pre-glacial valleys are deepened, widened and lengthened, transforming formerly V-shaped valleys to a U-shaped cross profile. They are deeper downwards. When drowned due to a rise in sea-level fjords are formed.
  Examples include: at the coastal areas of Norway, British Colombia, Chile etc.

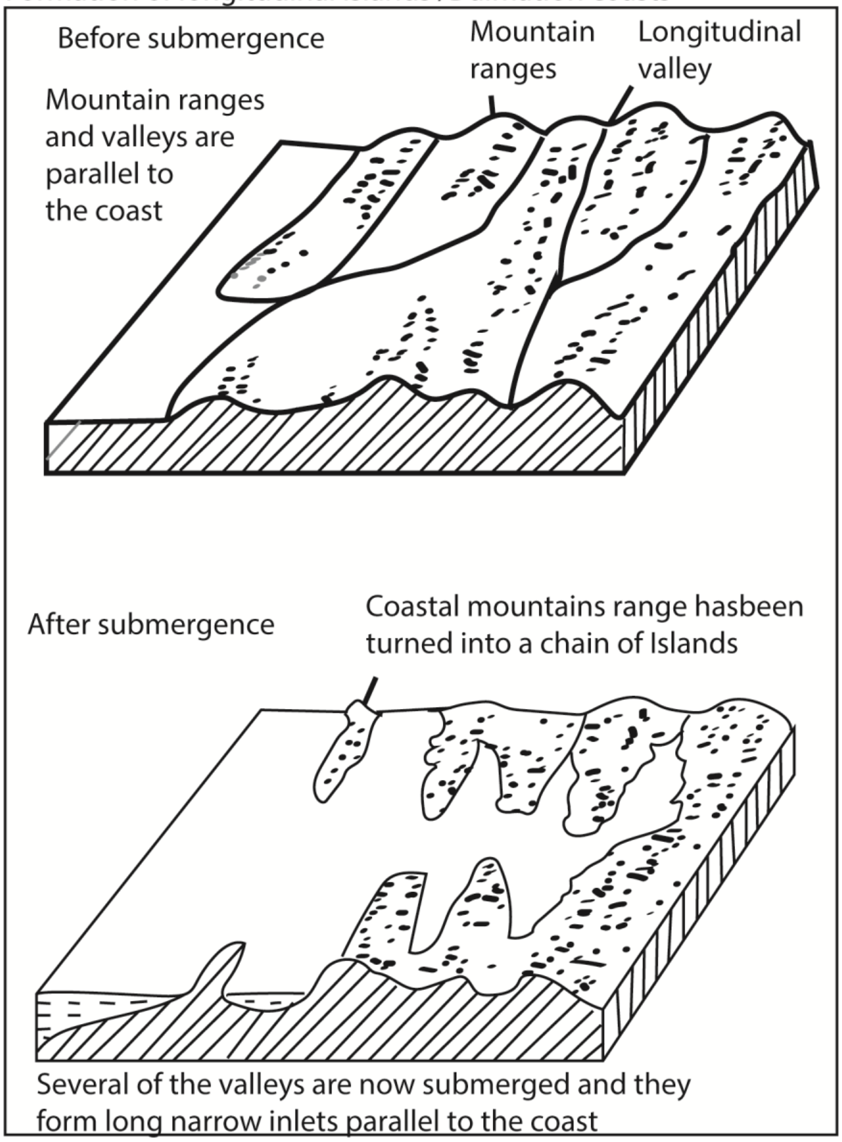
Diagrammatic illustration of fjorded coastline



- **Longitudinal Islands/Dalmation coasts. These** are straight and regular coasts, characterized by bays, sounds, where former valleys exist and peninsular and islands in areas of former hills. They form when highlands, ridges, river valleys run parallel to the coast. As the Sea - level rises, valleys are flooded and hills become chains of Islands running parallel to the coast. The resulting drowned hills are separated by parallel narrow inlets or valleys called sounds. Examples are found in Pemba, Zanzibar, Serbia, Crotia etc.

Diagrammatic illustration of longitudinal islands

Formation of longitudinal Islands /Dalmation coasts



Peninsulas are pieces of land projecting seawards (headlands) between bays. Valleys are drowned leaving highlands projecting sea-wards. Examples include, Entebbe peninsular, Mweya peninsular etc.

(ii) Submerged landforms in lowland coasts include.

Estuaries. These are drowned/ submerged river valleys with a V-shaped cross-profile pointing land wards. They form where former valleys meet the coast more-lose at right angles. They are similar to Rias, except that they are wider and deeper. Estuaries form when the sea-level rises along a low land coast causing the sea to penetrate inland along river valleys. Examples include, Rufigi, Kibanga, Mombasa, Congo Estuaries, Estuary of Fiver themes (UK) etc.

Creeks. These are narrow inlets formed by submergence of **small** streams e.g. Kilifi, Makupa, Chacke - Chacke etc.

Fiards. These are formed in low land glaciated coastal areas. They are similar to Fjords except that their profiles are broader. They have a U-shaped cross-profile e.g. in South Eastern Sweden.

Mud flats. Are platform of fine silt and alluvium of rivers. Sediments are deposited in shallow water, either behind shingle, bars, sand spits or **shelter apart** of estuaries and bays. Examples of Mudflats can be found at Mombasa, Lamu, Tonya etc.