S6 GEOGRAPHY 1(MR.LULE/MR.SEBABI)

GLACIATION

It refers to exogenic process that involves covering the earth's surface by glaciers.

A glacier is a mass of ice of limited width flowing out of a snow field on a higher ground to a lower ground under the influence of gravity. A glacier is ice in motion. Glaciers are enclosed within valley walls.

Glaciation in East Africa is confined on three mountain peaks of Kilimanjaro, Rwenzori and Kenya which rise over 4800 m above sea level. At this height, ice accumulation takes place due to a fall in temperature.

PROCESSES OF GLACIER FORMATION

Glaciers are formed when snow falls and accumulates in the valleys or basins on the land surface, this is known as **alimentation.** Successive over lying layers of snow **compress** the underlying ones. **Compaction** occurs followed by melting of ice, **refreezing** occurs and air is squeezed out by extreme compression, forming a solid impermeable glacier. **Stratification** occurs through the snow field to distinguish the annual contribution of snow.

FACTORS INFLUENCING THE FORMATION OF GLACIERS OR ICE IN EAST AFRICA.

1. **Altitude**

Areas of high altitude over 4800 m above sea level experience temperatures of about 0^0c and below. This is due to the fact that temperatures decrease with increase in altitude. The low temperatures favour the freezing of water into ice and such areas include Mt. Kenya , Mt. Kilimanjaro and Mt. Rwenzori.

2. **Precipitation**

Glaciers or ice form from the rain water or precipitation in form of snow . Rain water freezes into ice under low temperatures. The greater the precipitation, the greater the amount of glacier formation Mountain Rwenzori has the greatest volume of glacier in East Africa simply due to the highest precipitation received compared to other mountains.

3. **Nature of relief**

Ice accumulation prefers steep slopes with well developed depressions which can facilitate rapid accumulation of ice . i.e ice gets trapped in the depressions . Gentle slopes encourage ice movement at a moderate speed. Steep slopes accelerate movement of ice downwards under the influence of gravity.

4. **Relationship between rate of ice accumulation and melting of ice**.

For ice accumulation to take place, the rate of melting must be lower compared to ice accumulation rates.

5. **Periodical climatic changes.**

The occurrence of seasonal climatic changes associated with warm and cold conditions results into deglaciation and glaciation respectively.

Question:- Account for glacier formation in East Africa.

REASONS FOR THE LIMITED COVERAGEOF ICE IN EAST AFRICA

Glaciers are limited in their extent and size in East Africa because of the following;

1. **Latitudinal location**

East Africa lies astride the equator where the sun is always vertical contributing to the high temperatures that don't favour accumulation but instead accelerate the rate of ice melting leading to limited glacial coverage.

2. **Altitude**

Much of East Africa is a plateau lying below 2000 m above sea level. The snow line in East Africa is 4800 m above sea level and that is why glaciers are limited to only three mountains in East Africa i.e Rwenzori, Kenya , Kilimanjaro.

3. **Global warming**

It refers to increase in the world's temperatures and this is estimated at a rate of 2.5^0c per year mainly due to the destruction of the ozone layer. This has had an effect on the melting of ice e.g Sempe glacier on Mt. Rwenzori has greatly reduced due to increase in temperature.

4. **The lee ward effect**

Glaciers occur on the wind wardside of the mountain which experiences high rainfall. However the leeward side that experiences dry and hot descending winds have no glaciers due to no precipitation and the hot conditions that accelerate the melting of glaciers.

5. **Vulcanicity**

Most of the high mountains in East Africa that would be glaciated are volcanic in nature and thus experience warm conditions due to the hot interior. This melts off much of the glaciers on the mountains of Kenya and Kilimanjaro. It also partly explains why Mt. Rwenzori is the most glaciated.

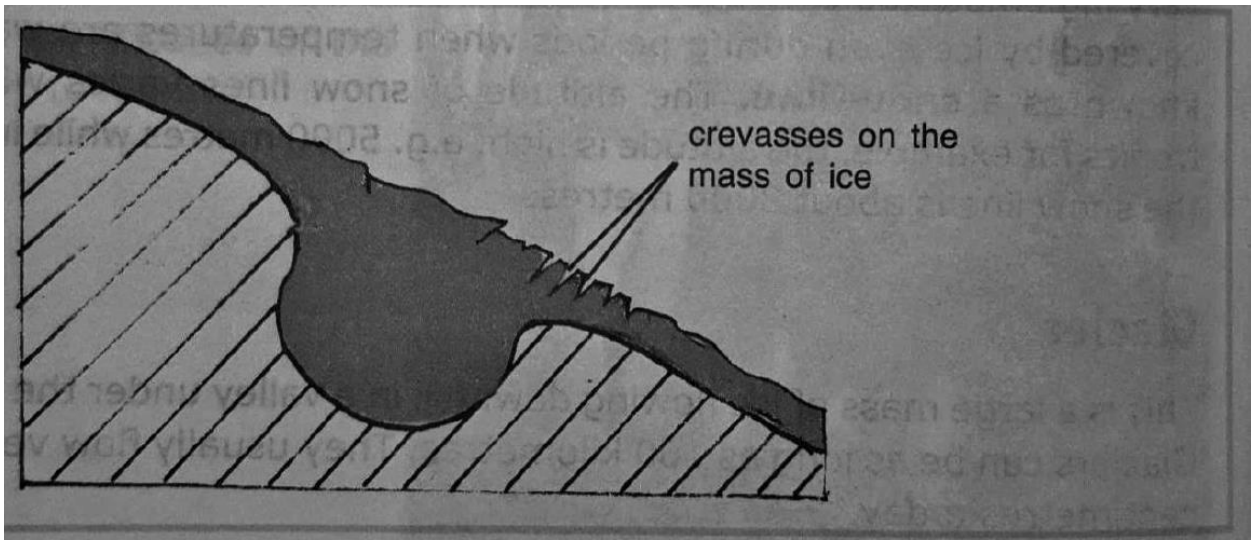
6. Much of the precipitation received in East Africa is rain not snow this limits glacier formation.

TYPES OF GLACIERS

There are mainly four types of glaciers and these include ;-

1. **Cirque/Corrie glaciers**

   These are masses of ice occupying cirques. They may flow out of the cirques feeding the valley glaciers. Cirque glaciers can be seen on Mt. Rwenzori as it receives heavy rainfall.



2. Valley glaciers

These are very large masses of ice moving down the mountain slope. These kind of glaciers usually flow in the former river valleys which are deepened, flattened and steepened by vertical and lateral ice erosion . Examples of valley glaciers are seen on Mt. Rwenzori.

3. Piedmont glacier

This is an extensive sheet of ice (Glacier) extending into low lands/plains at the foot of the mountains formed by merging of several parallel valley glaciers.

4. Ice caps /Ice sheets

An ice cap is a small mass of ice, dome shaped in appearance, covering peaks of highlands. It is a smaller version of ice sheets. In East Africa ice caps are found on the Kibo peak on Mt. Kilimanjaro. On the other hand an ice sheet is an extensive continuous thick mass of ice covering the land surface e.g this can be seen in the temperate region i.e Antarctica.

THE WORK OF GLACIERS

The effect of glaciers on the land scape can be seen through erosion, transportation and deposition. Through these processes glaciers have led to land form evolution i.e the glacial erosion land forms and the glacial deposition land forms.

PROCESSES OF GLACIAL EROSION

Plucking

It is the tearing away of blocks of rocks which have become frozen into the sides or bottom of the glacier. As the ice moves it pulls part of the rock and tears it away. The process is common in the well jointed mountain rocks . I t causes more stress in the rock making the joints to enlarge and even creating new ones.

Abrasion/Corrasion

It is the wearing away of rocks under neath a glacier by scouring or grinding action of rocks embedded in a glacier. The floor is scraped , scratched , polished, creating deep grooves depending on the relative boulder hardness and that of a rock floor.

Frost shattering/Basal sapping

This is when water enters a crack during the warm day and at night freezes into ice due to a fall in temperature. Ice expands widening the cracks of the rocks and with time the rocks become loosened and detached.

Basal slip

This is erosion by which glaciers slip and slide over the underlying rock polishing and scouring the surface.

NB: The glacial erosional processes are influenced by;

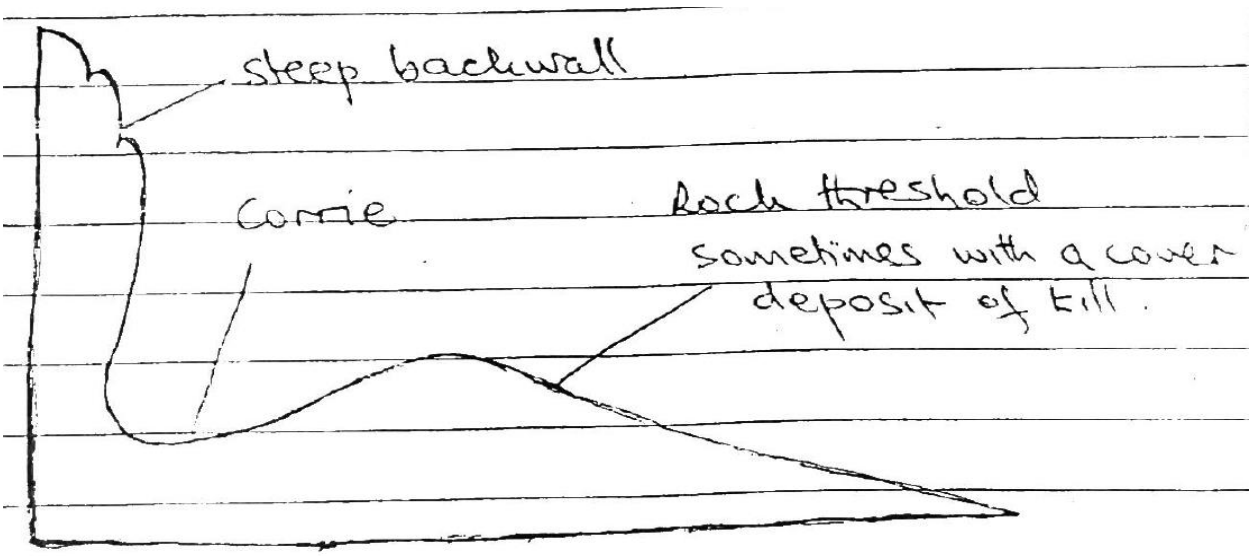
1. Resistance of the underlying rocks – more erosion where the rocks are soft and jointed
2. The speed of the glacier – the higher the speed, the higher the erosion.
3. The weight and thickness of the ice mass – the thicker and heavier of the ice mass, the faster the rate of erosion.
4. The amount of rock debris – the larger the amount of debris carried by ice the more the erosion.

GLACIAL EROSSIONAL LAND FORMS (GLACIAL UPLAND FEATURES)

1. Cirque/Corrie/Cwm

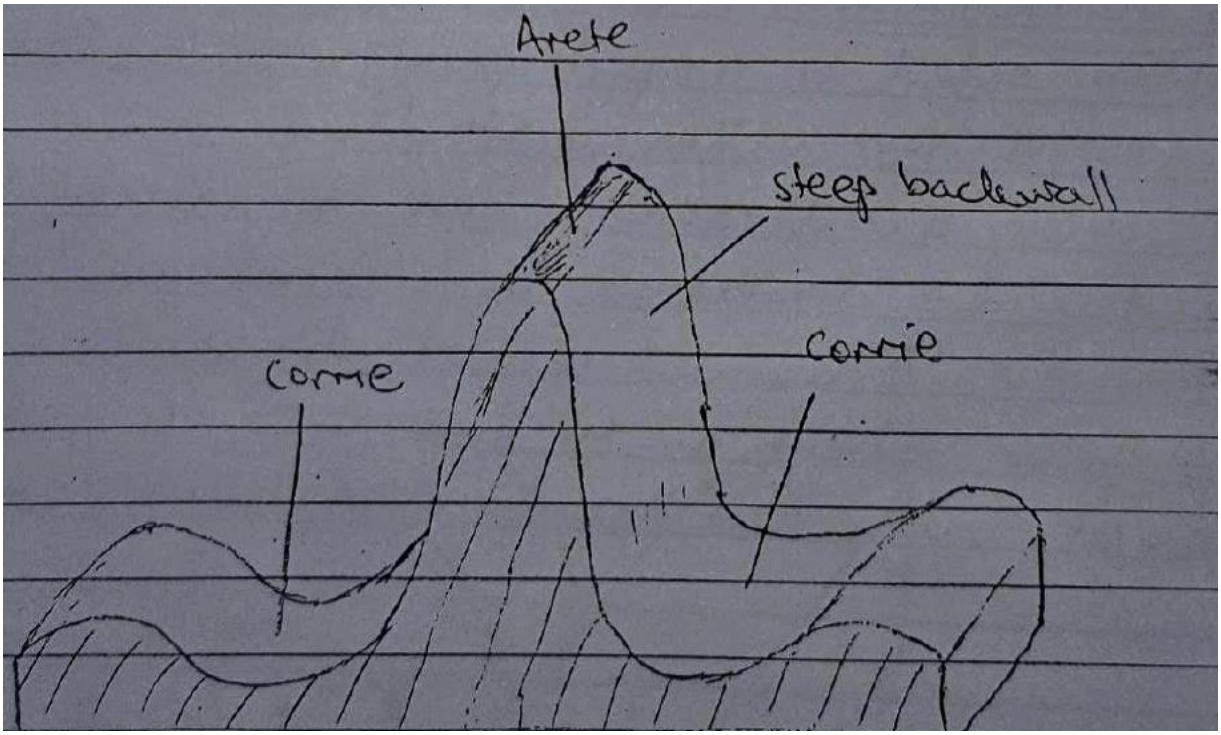
This is a steep sided arm chair shaped rock basin or semi – circular depression cut into glaciated mountain sides and valley heads. It is formed when water enters the crack and freezes breaking them down. The joints become enlarged. Abrasion drags the debris over the rock floor deepening and widening the depression.

Back wall recession of the sides also enlarges the depression as well as steepening the cirque sides. Plucking also steepens the cirque sides. When a cirque is filled with water it forms **a tarn** (a Lake) such as L.Teleki and Mawenzi on Mt. Kenya and Kilimajaro respectively, other examples of cirques includeLac Gris, Lac du Speke , Lac Catherine ,Lac du Verte on Mt. Rwenzori.



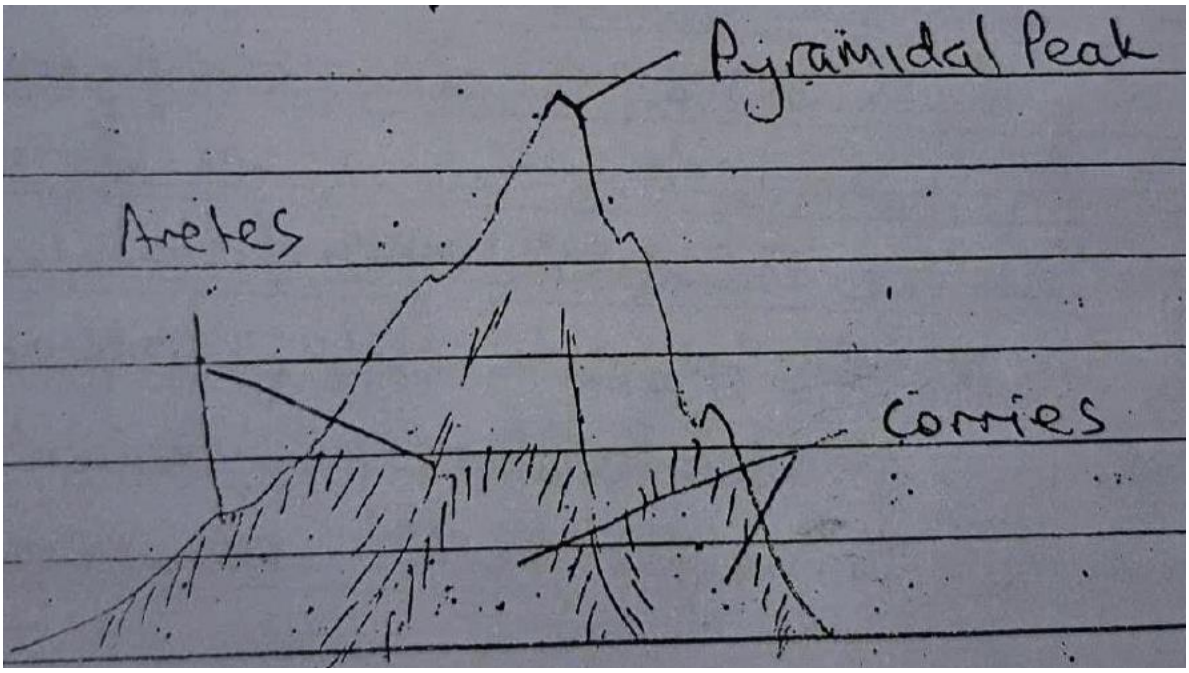
2. Arete

This is a sharp knife - like narrow ridge in between two or more cirques on a mountain side. It is formed as a result of backwall recession of two adjacent corrie sides such that they eventually meet at a ridge Plucking and abrasion assist in its formation. Aretes can be seen on Mt. Rwenzori radiating downwards into Bujuku and Mubuku valleys.



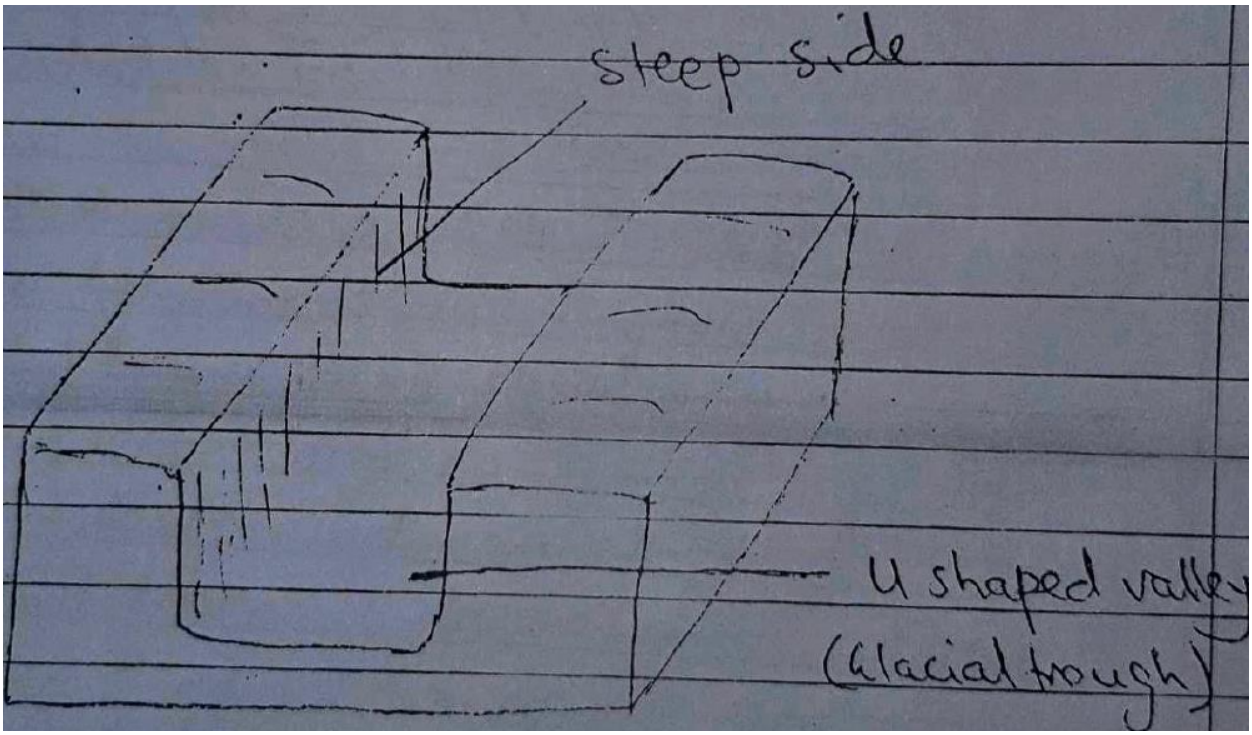
3. Pyramidal peak/Horn

It is a sharp steep sided jagged mountain top surrounded by a number of cirques and radiating aretes. It is formed as a result of backwall recession of two or more cirques from all sides of the mountain . Pyramidal peaks become formed and sharpened by plucking, abrasion and frost shattering e.g include Mawenzi , Kibo peaks on Mt. Kilimanjaro , Nelion peak , Piggot point on mt Kenya, Margherita and Stanley on Mt. Rwenzori.



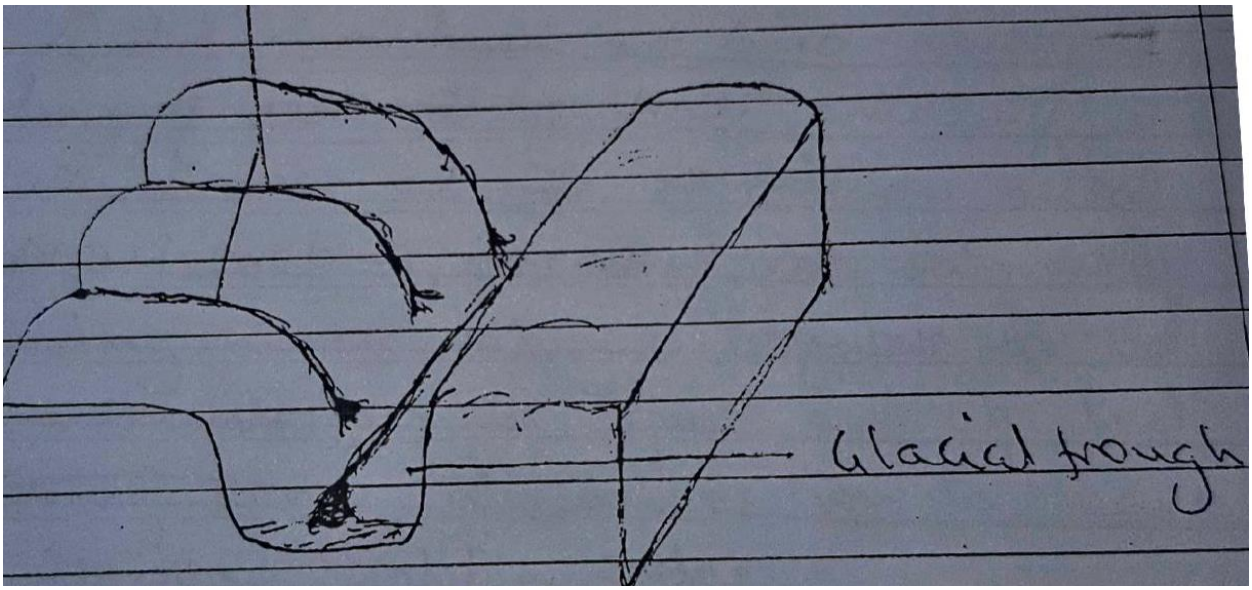
4. Glacial trough/U- shaped valley

These are broad flat floored and steep sided valleys with a U – shaped cross profile. They are formed when abrasion plucking , frost shattering are subjected to former river valleys leading to lateral and vertical erosion which widens and deepens the valleys respectively to form a trough . e.g include Bujuku , Mubuku , Kamusoso valleys along Mt. Rwenzori, Karanga valley on Mt. Kirimanjaro , Teleki valley on Mt. Kenya.



5. Hanging valleys

These are short , narrow and V- shaped tributary valleys of the main U - shaped valleys, joining the U – shaped valleys at vertical slopes, forming water falls at these points. They are formed when tributary valleys are occupied by small volumes of glacial ice compared to the main valley. As a result the main valley is over deepened by abrasion and plucking leaving tributary valleys at a higher level , hence the name **hanging valley**. Examples include the little Nithi river valley as it joins the main Nithi river valley on Mt. Kenya , tributary valleys leading to Mobuku and Bujuku valleys on Mt. Rwenzori.

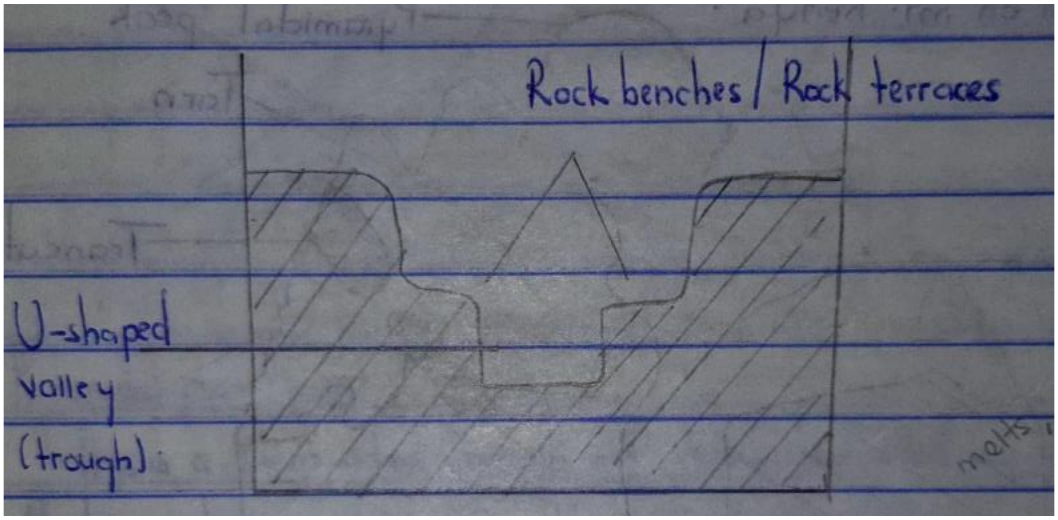


6. Truncated spurs

These are spurs with steep edges ending in the valley . They are formed when former interlocking spurs lower ends projecting into the valleys are laterally eroded due to plucking and abrasion creating steep cliff like valley sides. Examples can be seen at Bujuku , Mubuku valleys on Mt. Rwenzori ,Teleki valley on Mt. Kenya.

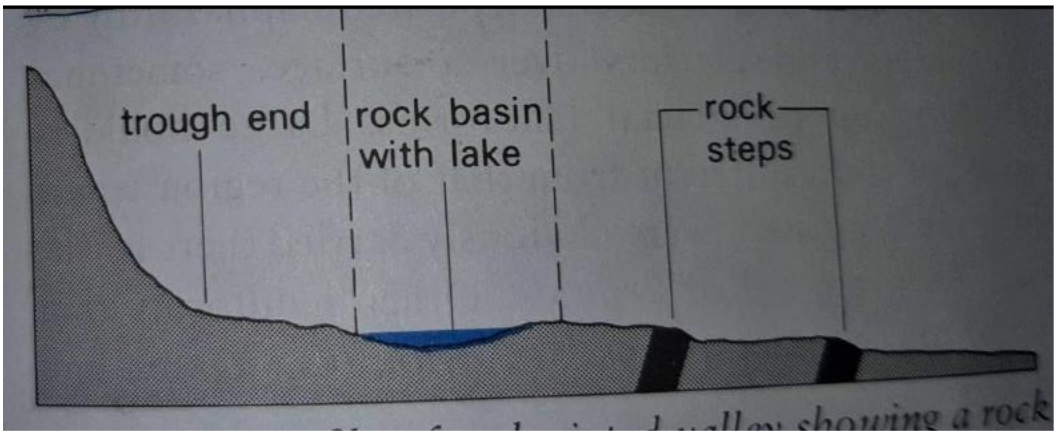
7. Rock benches/Rock terraces

These are terrace like features lined above the steep walls of the valley. The upper slopes of the river valley are less affected by glaciation while the valley below is more eroded by glaciers. As the glacier melts, the initial slopes remain as benches or terraces. E.g the Gorges valley on Mt. Kenya.



8. Rock basin

This is an irregular and circular depression in the floor of the U – shaped valley formed by differential glacial erosion of the less resistant bed rock through abrasion, plucking and frost shattering. Rock basins usually develop where tributary glaciers join the main valley and cause more glacial erosion leading to the formation of a **hollow**. If the rock basin gets filled up with water, it forms a lake (Rock basin lakes) e.g Michealson basin , Carr lakes on Mt. Kenya .



9. ROCK STEPS

These are hard rock projections in a glacial U- shaped valley formed as a result of differential erosion due to difference in rock resistance and variation in the glacier thickness. The increased ice in the main valley makes it possible to cut deep in the valley, creating step like features known as rock steps e.g the Vivienne falls on Mt. Kenya.

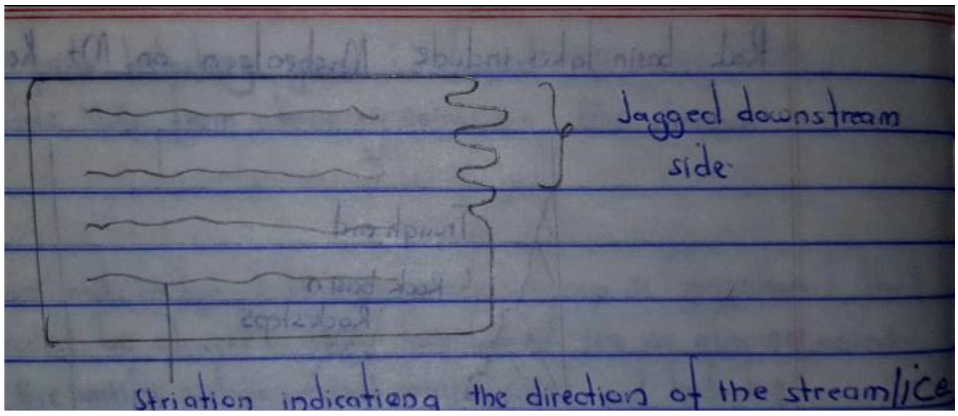
(As illustrated in the above diagram)

10.Trough end

This is a steep wall of a rock which forms an abrupt end of the glacial valley above which we have several circques. As the glacier straightens the valley, it also deepens it where several glaciers join forming a much larger and bigger glacier. The extra weight of the glacier promotes greater downward erosion that deepens the valley further to form a troughend. (As illustrated above)

11.Striations

These are long, straight and parallel scratches or gouges cut into the rock surfaces by glacial abrasion as the glacier moves down stream. Finer sediments embedded in the glacier further scour and polish the rock surfaces to form these striations. Strations usually indicate the direction of ice movement. Examples can be seen along Mubuku valley on Mt. Rwenzori.



12.Crag and tail

This is a mass of resistant rock out crop with its upstream steepened by abrasion and its downstream side of soft rocks elongated due to being protected by hard rocks from erosion. Some times, the 'tail' forms from the downstream deposition of the eroded materials.

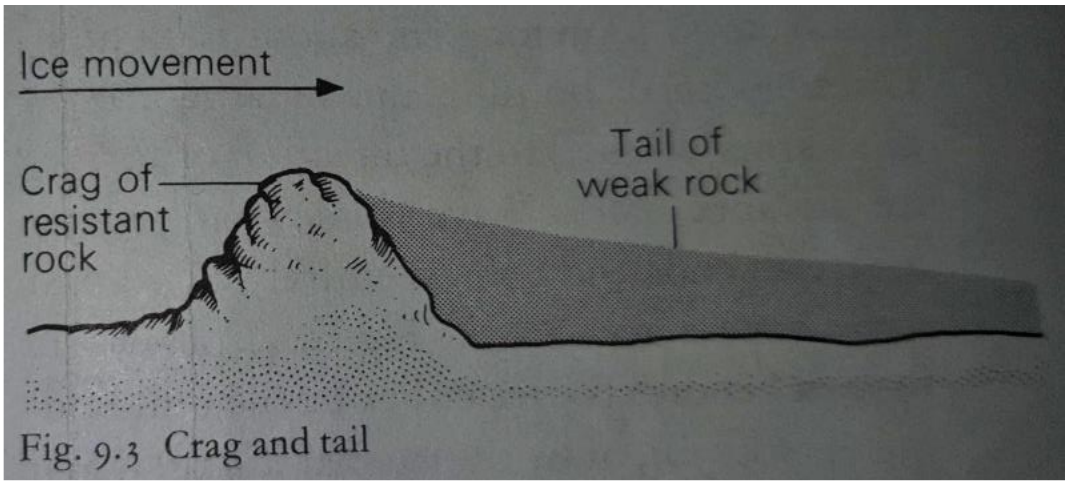


Fig. 9.3 Crag and tail

13.Roche moutonnee

These are rock masses, glacially molded with a smooth, gently sloping upstream smoothened by abrasion. The down stream is steep and rough due to plucking e.gs can be seen in Mubuku valley along Mt. Rwenzori, along the Gorges valley near the snout of lenana glacier on Mt. Kenya.

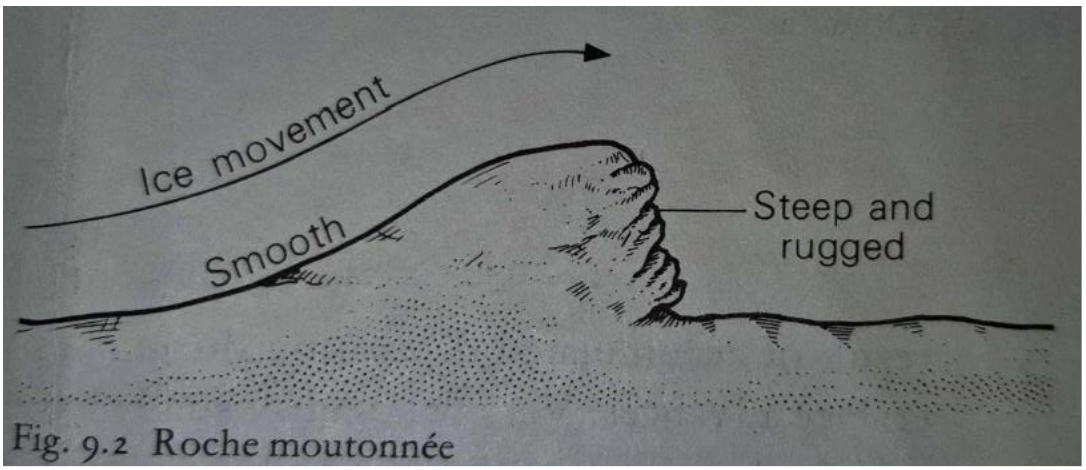


Fig. 9.2 Roche moutonnée

Questions

1. Account for the formation of glacial erosional landforms in East Africa.
2. Account for the formation of the upland glacial land forms in East Africa.
3. Describe the processes responsible for the formation of the glacial erosional land forms in East Africa.

GLACIAL DEPOSITIONAL LANDFORMS (LOW LAND GLACIAL FEATURES)

These are formed when glaciers transport the eroded rock materials or any other materials and deposit them in the low lying areas.

Glacial depositional land forms are mainly found in the lower slopes of the mountains i.e the valleys / low land areas .

The glacial depositional features are subdivided into two types;

Those resulting from deposition by ice (Till) and those deposited by melt water (fluvial – Glacial features)

LAND FORMS

Moraine

Moraine refers to the rock debris that is eroded by flowing ice from the sides and base of the valley and deposited in lowlying areas. Moraines are large and small fragments that are detached , transported and deposited when ice loses its capacity to transport the material. The types of moraine include;

(i) Terminal moraine

It is a ridge like feature formed by accumulation of unsorted fragments of all sizes extending across the country rock as a belt of low hills by many kilometers.

It is formed by extensive deposition along the snout of an ice sheet and may cover a reasonable distance and height of 50 m . It builds up when a glacier is static. At this point there is a balance between the amount of ice coming and the ice melting away. Melting ice carries away materials which are finally laid down beyond the terminal moraines as outwash moraines . e.g can be seen in the low lying areas of Rwenzori e.g Bujuku, Mubuku valley's .

(ii) Lateral moraine

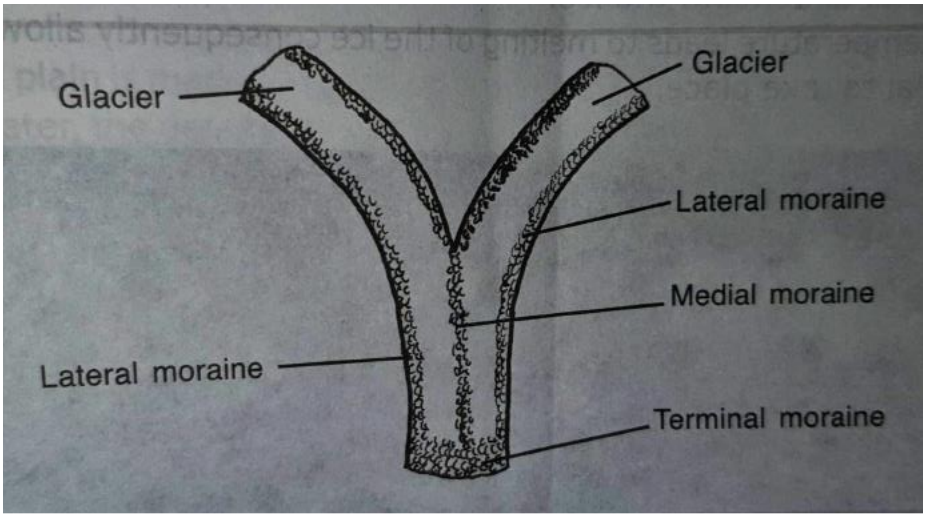
This is an elongated ridge of moraine formed along the valley glacier sides. The deposition is as a result of friction between the moraine and the valley sides.

(iii) Medial moraine

When two glaciers meet, the lateral moraines of the inner sides of both glaciers are joined to form medial moraine. Medial moraine forms at the centre of the glacier when a glacier retreats and drops its moraine.

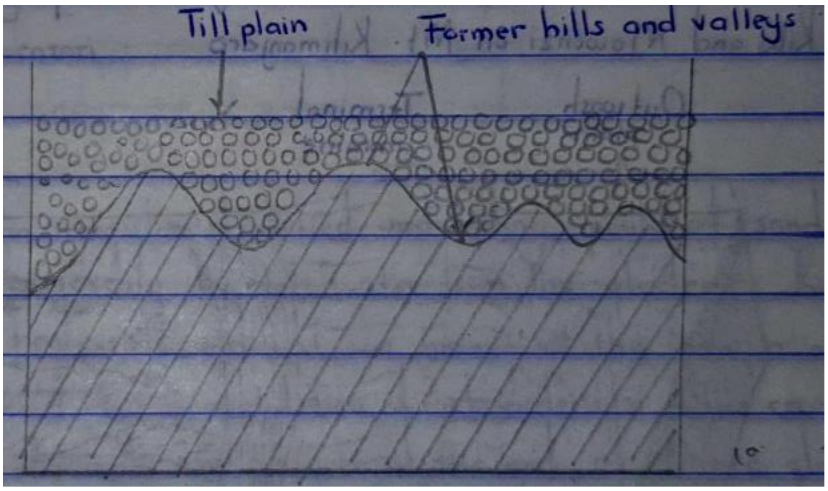
(iv) Basal moraine/Ground moraine

It is formed when the moraine is deposited at the bed of the glacier. It is composed of mainly fine glacial moraine dropped by retreating ice. Ground moraine covers almost the whole width of the valley.



2. **Till plain**

This is an extensive area of monotonous relief (uniform or leveled) which is relatively flat. It is formed when thick layers of moraine are deposited in a once grooved area to form a generally flat plain . e.g can be seen at the floor of Bujuku – Mubuku valleys , Teleki valleys of Mt. Kenya .



3.. **Drumlins**

It is a low rounded smooth, elongated hill of moraine parallel to the direction of ice movement . It is usually up to 1 km long and about 100 m high . It is formed by large deposition of moraines resulting from increased friction between moraine and the solid ground rock forcing the moraine to collect in the uneven mounds under the ice. Most drumlins have steeper upstream ends, made up of tills. Drumlins are smoothened and rounded by ice. They may occur in groups or swarms . Examples can be seen in Teleki valley on Mt. Kenya , Bujuku – Mubuku valleys in the glaciated low lands of Mt. Rwenzori etc.

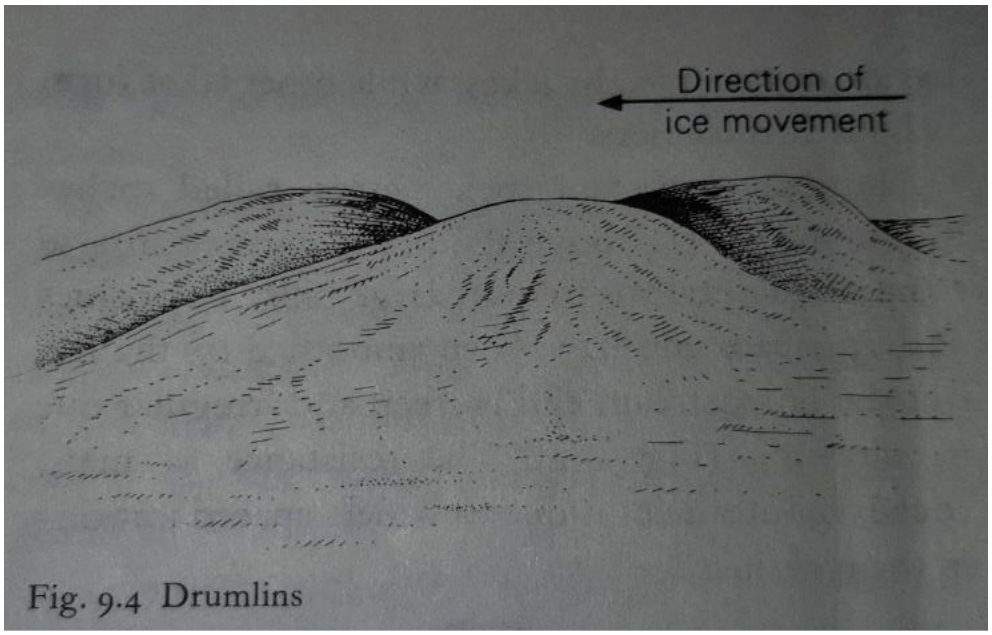
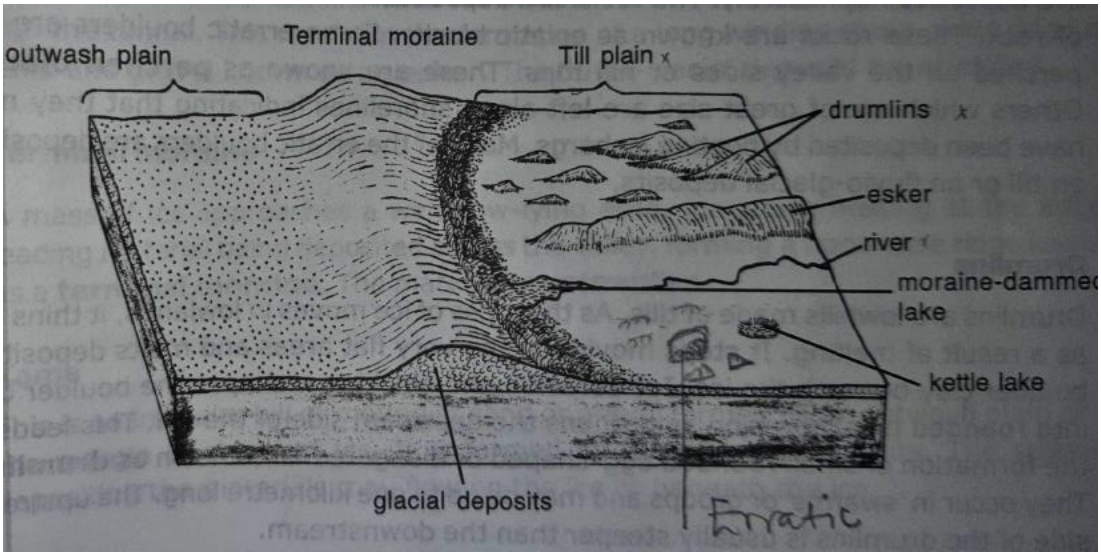


Fig. 9.4 Drumlins

4.. **Outwash plain**

This is a wide gently sloping plain composed of unevenly deposited sand and gravel by ice beyond the terminal moraine. Heavy and coarser materials are dropped first and finer materials last. Outwash plains may be about 50 m in thickness . e.g can be seen in Mubuku – Bujuku valleys on Mt. Rwenzori between Kibo and Mawenzi on Mt. Kilimanjaro.



5… **Erratics**

These are blocks of rocks of varying sizes that are deposited by glaciers. Erratics are composed of materials that are different from the region where they are deposited. The rocks or blocks are uprooted from one region, transported for along distance and finally deposited by ice in another region . e.g in Bujuku , Kamusaso valleys in the low lands of Mt. Rwenzori, along the valley of Nithi river in Kenya mountain

Diagrams as illustrated above.

6.. **Eskers**

These are long narrow winding steep sided ridges of sand and gravel lying parallel to the direction of the ice movement formed by glacial deposition. Eskers are formed at the bed of glacier tunnels and at the glacier terminal. When the flow becomes sluggish, deposition occurs. E.g can be found on Teleki valley, Gorges valley on Mt. Kenya.

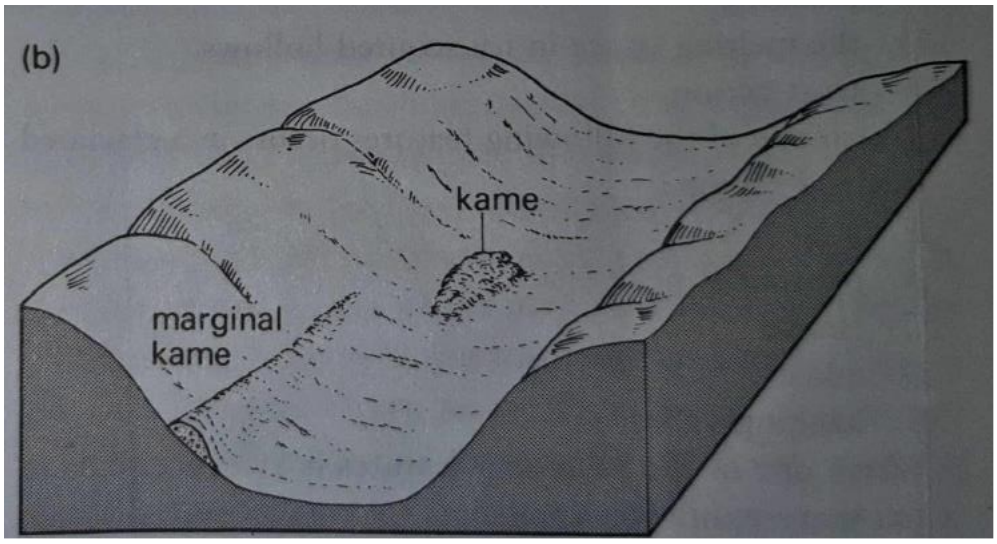
Illustration in the above diagram

7.. **Kettle hole**

These are circular depressions formed when stagnant ice block enclosed within the moraine melts . The depression left behind may get filled up with water to form a kettle lake e.g L.Mahoma near Mubuku and Bujuku valleys on Mt. Rwenzori.

8.. **Kame**

This is an irregular, stratified undulating mound of sand and gravel deposited unevenly by melt water from the glaciers. Kames are ice contact features found at the margin of stagnant ice. Kames form from accumulation of rock materials in the cracks on the surface. E.g can be seen at the end of Moore glacier on Mt. Rwenzori.



9.. **Kame terrace**

This is a narrow , flat topped ,Terrace like ridge of sand and gravel formed along the valley side, it has signs of collapse at the outer edge. Kame terraces are formed by the deposition of sand and gravel in the depressions held between the ice front and an adjacent upland. When the ice melts, the deposit at the edge of the ice slump down forming Kame terraces. Examples can be seen in Kamusoso valley along Rwenzori, Hobbley valley on Mt. Kenya.

10.. **Moraine dammed lake** (refer to Lakes)

IMPORTANCE OF GLACIATED REGIONS

- Water falls at the hanging valleys are potential sites of hydroelectric power generation which is used for domestic and industrial purposes e.g at Vivienne falls on Mt. Kenya.
- The unique beautiful scenery such as aretes, pyramidal peaks, cirques, hanging valley's attract tourists and this earns foreign exchange to the region
- The lakes and rivers in the glaciated regions are sources of water for domestic, agricultural and industrial purposes e.g R. Mubuku and R.Nyamwamba on Mt. Rwenzori supplying water to plantations and Kilembe mines respectively, R. Tana on Mt. Kenya supplies water to irrigation schemes.
- The moraines deposited contain sand and gravel which can be extracted for building and construction purposes.
- The boulder clay plains in the glaciated low lands are some times very fertile and suitable for arable arming e.g Mubuku valley in the lower lands of Mt. Rwenzori.
- Glaciated areas act as recreation and sports centres e.g mountain climbing on Mt. Rwenzori.
- The U – shaped valleys form natural route ways in the mountainous areas e.g Kasese – Kilembe route following the Nyamwamba glacial trough in Western Uganda.

- Rivers and lakes formed due to glacial actions in such areas act as fishing grounds, providing proteins to the local community and as well as sources of income to the people.
- Glacial erosion exposes valuable minerals which becomes easy to be exploited.
- The melt water from streams and lakes may act as micro climate modifiers through formation of rainfall and lowering temperatures of the region.
- Glacial features are used for study and research by students and other researchers .

Negatives

- Glaciers as they move down hill lead to extensive loss of property and lives e.g in the low lands of Mt. Rwenzori.
- Extensive areas of land are sometimes turned into myriads of lakes by moraine deposits and such land scape limits development in terms of transport and agriculture.
- Many outwash plains contain infertile sand which gives rise to extensive areas of waste land , land which is unsuitable for agriculture.
- The marshy and swampy low lands resulting from moraine deposition are conducive for mosquito breeding which cause malaria to man.
- The upland slopes remain infertile as the top most soils are removed, this is unsuitable for cultivation .
- Flooding of rivers like Nyamwamba due to added melt ice causes damage to the surrounding areas e.g in the late 1990s and 2014 in Kasese led to destruction of roads , crop fields and settlements.
- Glaciated areas offer hardships in infrastructure construction such as roads over valleys or rivers associated with glaciation .

Questions.

1. Examine the evidence of glaciation in East Africa.
2. (a)Account for the limited glaciation in East Africa.
   (b)Describe the features formed by glacial activities.
3. Explain the formation of the following glaciation features.
4. Describe the processes responsible for the development of land forms associated with glacial troughs in East Africa.
5. Account for glacial formation in East Africa.

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