CHAPTER 4 ACTION OF GLACIER

Objectives

After studying this chapter, students should be able to:

- define glaciers.
- state and describe the processes of glacier erosion.
- describe highland glacial features.
- describe lowland glacial features.
- state the economic importance of glacial features to man.

4.1 Snow

When temperature is low or falls to 0^{o}c (32^{o}F) or to lower temperatures, precipitation occurs in a form called **SNOW**. Snow is a white powdery or feather-like substance that falls in winter in the temperate and frozed zones. The point where continuous snow cover disappears is called the **Snow-line.** It is the outermost limit of a more or less continuous snow cover. The area or location under permanent snow-line is called **snow-field** and is a function of altitude, latitude and relative location. Examples are found in Green land, USA and South Chile with the altitude of 610 meters. In Alaska and Southern Norway, it is 1524 meters. In the Polar Regions, the Snow Belt lie on the sea level and is permanently frozen. At Himalayan's is 4419m, in Kenya it is 5182m.

When a big ice chink of snow is gravitated to slide down a steep slope, the morning snow is known as **avalanche.** They are destructive and found in Austria and Switzerland section of Alps as well as the Rockies and Andes of America. The stratified ice found in pre-existing basins or hollows is

known as **neve** or **firn.** Also, when neve accumulation reaches a level that the ice–block, as a result of gravitational pull moves, the moving ice is called **glacier.** Moving ice mass as a result of gravitational pull is collectively known as glacier.

Processes of Glacial Action

Glaciations on the highland gives rise to **erosional** features. Thus, glacier erodes its valley by two processes: **plucking** and **abrasion**. By **plucking,** the glacier freezes the joints and bed of the underlying rocks, tears out individual block and drags them away. By **abrasion,** the glacier scratches, polishes and scours the valley floor with the debris frozen into it. These fragments are major tools of denudational processes.

Highland Glacial Features

The following features are produced by glacial erosion.

Cirque: This is the most common and probably the most striking landform in glaciated highland. It is characterized by downward movement of a glacier from its snow-covered valley. A cirque often shows a definite basin of its floor which extends forward from the headwall and terminates at a bedrock rise called **threshold.** Consequently, cirque basins are commonly sites of small cirque lakes or **tern** as they are called in British Isles. Cirque varies in plan from simple, sub circular outlines to compound ones which display many scallop. Cirque (French) is also called **kar** (German) **Cum** (welsh) **Corie** (Scotch) **botn and kjedel** (Scandinavian). They are found in Greenland (USA) and Norway.

Aretes: These are knife-edge ridges which develop at advanced stage consumed by supping process of erosion. The ridge consists of alternating sags or glacial **cols** produced by intersection of opposed cirque and

pointed peaks or **horns** which represents unreduced portion of the original mountain range. Example of horns are the matter born and Weishorn in the Alps-bordering Italy and Switzerland.

Hanging valley: Glacial troughs commonly have tributary troughs or valley joining the main trough discordantly which may be considered normal. Also, tilting of a region may steepen the gradient and accelerate the down-wearing of the main valley without a corresponding effect upon its tributaries. Faulting may also produce hanging valleys in a glaciated highland. Hanging valleys and sharp break of slopes are often sites of waterfalls in glaciated highlands as found in Lauterbrennen in Switzerland. Norway, Sierra Nevada are striking examples where hanging valleys are used for locating hydro-electricity.

Glacial troughs: Most glacial troughs were originally cut by stream valleys, but glacial action altered them such that neither in cross profile nor in long profile, do they resemble greatly stream curved valley. Trough characteristics may be scanty or lacking where glacier were not large as exemplified in during Wisconsin glaciations. Trough headwalls are likely to be most conspicuous where more than one cirque contribute to a glacial trough, hence they are notably irregular and upgraded in their long profiles. Also few exhibit the relatively smooth, concave and longitudinal feature of stream-cut valley. Descent of trough floors takes place in a series of **glacial step** or **glacial stairway.** This step is more premium. It is upper than the lower part of a trough simply because it has persisted there much longer.

Fjords and piedmont lakes: Fjords are glacial toughs eroded by ice below sea level, but a few attribute it to the great depth of sea level. It is a

feature of shorelines in high latitudes and are well developed along the coast of Norway, Green land, New Zealand, British Columbia, Alaska and Chile. The contemporary plans of some Fjords reflect joint or fault control whereas others were initially grabens. Many fjords and lakes found in Italy (Lakes Como, Mahhiore, and Lugano) and Luke McDonald in Glacier National Park are centers for tourism.

Truncated spurs: Glacial trough does conform to the original valley course, but ice streams may straighten their troughs by abrasion for spur ends and thereby produce **Truncated or faceted spurs.** Different degrees of spur truncation may be seen, varying from spur ends that have been cut off completely to partially trimmed spurs still recognizable from rocky *knobs* or *nubbins*.

Lowland Glacial Features

These are features that occur as a result of deposition of eroded materials on glaciated lowlands.

Roche Moutonnee: This is a resistant residual rock hummock. The surface is striated by ice movement. Its upstream side is soothed by **abrasion** and its down stream side is roughened by plucking, and is much steeper. The term **Roche Moutonnec** is used to describe such a feature because it resembles a sheep-skin-wig once worn as found in France. They are also found on highlands.

Crag and Tail: The outcrop of hard rock with a precipitous slope on the upstream side which protects the soft leeward slope from being completely worn down by the on-coming ice this is called **Crag.** It has a gentle tail,

strewn with the eroded rock debris. Example of **crag** and **tail** is the New castle rock of Edinburgh, Scotland.

Moraines: These comprise of rocks that are shattered by frost action, embedded in the glaciers and brought down the valley. Moraines may be distinguished, depending upon whether deposition took place at the end of, at side of or beneath an ice stream. The term **recessional moraine** has been used in the past to designate end moraine and the implication is the series of end moraines marks, successive panes in the position of a retreating ice front while others are marks by radiances. Slight oscillations of an ice front as it recedes may result in an irregular belt of knolls and basins, usually described as **knob** and **basin topography** both of which are interplay between ice-stream relationships. **Lateral Moraines** are formed along the sides of an ices stream chiefly from materials which are contributed from the valley sides above the glacier by weathering, snow sides, avalanches and other types of mass movements. Two lateral moraines are join to form a medical moraine but a medical moraine is more of a glacier feature than landform and are mostly found along glacial troughs. **Ground Moraine** is another glacial deposit which vigorously abrades and plucks its bedrock floor and deposited on the valley floor and is particularly susceptible to erosion by post glacial streams.

Drumlins: These are low rounded hills between 30m-90m above the general base level. They are arranged in rough parallel chains scattered in glaciated lowland areas. A drumlin is an oral shaped mound and is formed in three stages. First, the forced ice movements are deposited as boulder clay. Second, ice moved over the deposited boulder clay, and finally, the ice rolled over the existing boulder clay and shape it into drumlins. A landscape resulting from a series of drumlin is called **basket of eggs**

topography. Scattered drumlins are found in North America-New English, Wisconsin are as well as Germany, English, Ireland and Switzerland. Bunker Hill, with bread hill played a historic role in the revolutionary war.

Eskers: There are sinuous ridges of stratified sand and gravel which are believed to represent fillings of super glacial, en-glacial or sub-glacial or sub-glacial stream channels. They have well sorted sediments and are more common in areas of glacial stagnation in contrast to lateral moraines. Examples can be found in North Dakota (USA), Tolvajarvi (Finland) parts of Sweden and England.

Erratics: These are boulders deposited some distance away from their parent's rocks as a result of advancing glaciers and ice sheet. They often posses some distinct characteristics from the region they are deposited. As such, they are important in tracing the origin and direction of ice movement. Examples are found in Yorkshire, England where Silurian boulders are found in limestone caverns.

Outwash Plains: Outwash plains are formed where stratified sediments of sand, gravel and clay deposited by glacial action melts and water develop into an extensive plain in a low-lying region. The melted-water sort and redeposit the sediment in variety of forms from the low-hilly heath lands, such as the Lunenburg health of the North Europe plain, to undulating plains, where terraces, alluvial fans and deltaic deposits of the melt-ice streams make up the landscape.

Kames: They comprise of irregular undulating mound of stratified sand and gravel arranged in a chaotic manner. The deposition takes the form of

alternating ridges and depressions, while the latter may contain **kettle lakes** leading to the formation of **knob and kettle** topography. Examples are meres of shropshire (England) and the kettle lakes of Orkney (Scotland).

Glacial Till: This is composed of unsorted sands, clay, people, silt and land boulders. It is compacted together due to pressure in the till which is made up of clay. It is often mistaken for stratification. The presence of sand and gravel is common, thereby emphasizing fluvo-glacial deposition. Example of glacial tills are found in New England (USA) and East Anglia boulder day (England).

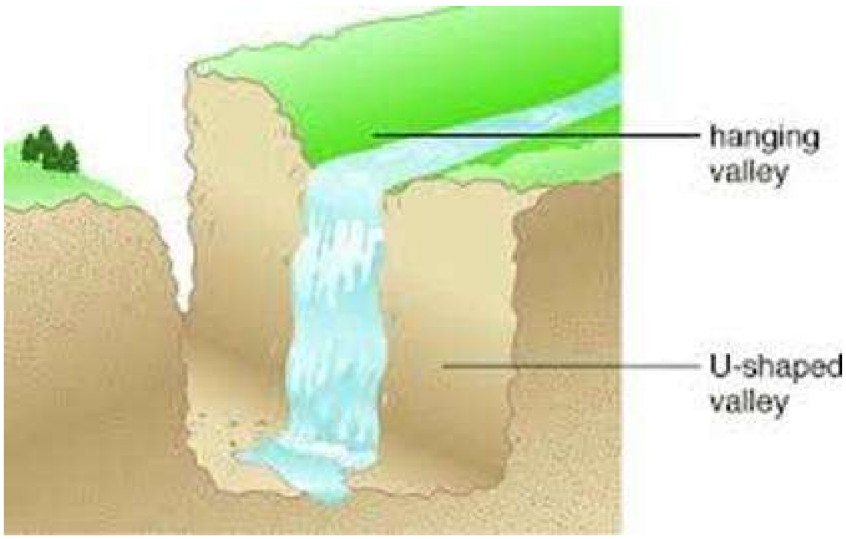

Fig. 4.2: Profile section of a glacial trough

Economic Importance of Glacial Landforms

Glacial landforms are important in the following ways:

1. It serves as a center for tourist attraction and health resort. Examples include lakes of alps and mountains in Swiss.

2. Glacial landforms such as drumlins serve as a historic places where reference and researches can be made e.g. Bunker Hill and Breads Hill noted as active areas during the revolutionary wars.
3. Hanging valleys and other glaciated highlands provide best site for generating hydro-electricity. Thus in turn enhances socio-economic development.
4. Pleistocene glacial lakes provide best means of inland transportation and communication e.g. Great Lakes of North America.
5. Out-wash plains, kames and eskers serve as sources of sands and gravels for building and road construction purposes.
6. Agricultural purposes: Glaciated lowland when eventually dried up has the former beds covered with thick layers of fertile alluvium that are used for agricultural purposes e.g. the rich Red river valley of Canada.

Summary

- A mass of moving ice due of gravitational pull is called glacier.
- Highland erosion occurs through the process of plucking and abrasion. Features produced include: cirque, aretes, hanging valley, glacial troughs, fjords and piedmont.
- Lowland glacier features are formed as a result of deposition and they include: moraines, drumlins, eskers, erratic, kames.
- Glacier landforms are important to man as they serve as tourist centres, research purposes, hydroelectric power, etc.

Objective Questions

1. When temperature is low or falls to 0^0C (32^0F) or to lower temperatures, precipitation occurs in a form called

A. rain. B. hail. C. dew. D. snow.

2. Glaciation on highland gives rise to _____ features.
   A. depositional. B. erosional. C. sedimentational. D. deltaic.
3. Glacier erodes its valley by two processes _____ and _____.
   A. corrosion and corrosion. B. depositional and sedimentational.
   C. plucking and abrasion. D. corrosion and abrasion.
4. The following features are produced by glacial erosion except
   A. cirque. B. arêtes. C. hanging valley. D. moraines.
5. Drumlin is a feature that occurs as a result of
   A. lowland glacial features. B. highland glacial features. C. sedimendation features. D. corrosion.
6. Under the force of gravity the ice may move downslope and become channeled into already existing valleys. Ice moving in this way is known as
   A. ice movement. B. water. C. river. D. glacier.
7. By _____ the glacier scratches, scrapes, polishes and scours the valley floor with the debris frozen into it.
   A. attrition B. deflation C. abrasion D. valleys
8. _____ are made up of the pieces of rock that are shattered by frost action and brought down the valley.
   A. Moraines B. Rock floor C. Ice sheets D. Abrasion
9. An unsorted glacial deposit comprising a range of eroded materials is called
   A. glacial till B. kames C. erratic D. eskers
10. The following features are produced by glacial deposition except
    A. moraines B. crag and tail C. boulder clay D. erratic

Essay Questions

1. Explain why glaciations in the uplands produced erosional features while glaciations in the lowland produced depositional features?
2. Discuss the appearance and formation of any two of he following features moraines, eskers, Marques, outwash plains and hanging valleys?
3. Highlight five economic importance of glacial landforms to man?
4. The following lowland glacial features are all, infact, small ridges, but are quite different in their process of formation: roche, moutonnee, drumlin, esker, crag and tail, kames. State which of them are of erosional or depositional nature.
5. Distinguish between valley glaciers and continental ice sheets.