SOURAV SIR'S CLASSES

Geological Work of Glaciers

(Part-4)

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Transportation and Deposition by Valley Glaciers

Glacial drift- Glacial drift includes all rock material (clay, silt, sand, gravel, boulders) transported by a glacier and deposited directly by or from the ice, or by running water (i.e. glacial streams) emanating from a glacier. They may be of two types-

a) Unsorted and unstratified deposits (called as tills)
b) Stratified deposits (called as the glacio-fluvial deposits).

I) Unstratified Deposits

1. Till / Boulder –Clay- Materials that are laid down directly or reworked by a glacier and consists of mainly unsorted, coarser to finer sized clasts (or grains) mostly angular in outline are called as till. Typically, it is a mixture of rock fragments and boulders in a fine-grained sandy or muddy matrix (non-stratified drift). The exact composition of any particular till, however, depends on the materials available to the glacier at the time of deposition. When the unsorted materials carried by glacier are deposited en-mass and are compacted to form large sized boulders that consists of variable clast sized, it is called as boulder-clay.

2. Moraines & Tillites- A moraine is any accumulation of unconsolidated debris, sometimes referred to as glacial till, that occurs in both currently and formerly glaciated regions, and that has been previously carried along by a glacier or ice sheet. Consolidated moraines are called as tillites.

- **Types of Moraines**

I) **Moving Moraines**- They are of 3 types

1) Surface Moraines- They are of two types-

a) Lateral Moraines
b) Medial Moraines
2) Englacial Moraines
3) Ground or Sub-glacial Moraines

II) Stationary Moraines- They are of 2 types-

1) Terminal Moraines
2) Recessional Moraines

3) Erratic Blocks- Erratic blocks are glacier-transported rock fragment that differs from the local bedrock in composition. Erratics may be embedded in till deposits or occur on the ground surface and may range in size from pebbles to huge boulders. They are of following types-

a) Perched Blocks- Perched block are the mushroom- shaped rock (sometimes called as the pedestal rock) are formed when large sized boulder transported by glacial ice are balanced on a pinnacle or slender rock or another boulder and they mostly rests in some precarious position.
b) Pocking and Logging Stones- These are erratic blocks that are delicately balanced in a precarious position on the bedrock.
c) Boulder Train- A boulder train consists of rock fragments of boulder size (greater than 10 inches or 256 mm) arranged in the alignment of ice-flow, usually in a row or fan.

II. Stratified / Glaciofluvial Deposits

1. Outwash Plains and Valley Trains- Outwash, deposit of sand and gravel carried by running water from the melting ice of a glacier and laid down in stratified deposits. An outwash may attain a thickness of 100 m (328 feet) at the edge of a glacier, although the thickness is usually much less; it may also extend many kilometres in length. For example, outwash deposits from the Wisconsin Glaciation can be traced to the mouth of the Mississippi River, 1,120 km (700 miles) from the nearest glacial terminus.

The sheet of outwash may be pitted with undrained kettles or dissected by postglacial streams. Alluvial fan deposits are common features in outwash pains. Outwash plains are commonly cross-bedded with units of alternating grain size. The ordinarily gentle slope causes the larger material to be dropped nearest to the glacier, while the smaller grain sizes are spread over greater distances. Striated pebbles are uncommon because the striations are worn away during transport. Outwashes are the largest of the glacialfluvio deposits and provide a considerable source of windblown material. When confined within valley walls, the outwash deposit is known as a valley train.

3. Eskers / Osser / Oss- Eskers are ridges made of sands and gravels, deposited by glacial meltwater flowing through tunnels within and underneath glaciers, or through meltwater channels on top of glaciers. Over time, the channel or tunnel gets filled up with sediments. As the ice retreats, the sediments are left behind as a ridge in the landscape. Eskers are important, because they can tell us about how ice sheets and glaciers behaved. They can tell us about meltwater, and help us reconstruct the former ice surface, and the orientation of the glacier's snout.

4. Kames; Kames Terraces and Kettles – Kame are mound-like hill of poorly sorted drift, mostly sand and gravel, deposited at or near the terminus of a glacier.

Kame terraces are frequently found along the side of a glacial valley and are stratified deposits of meltwater streams flowing between the ice and the adjacent valley side. These kame terraces tend to look like long, flat benches, with many pits on the surface made by kettles.

Kettle, also called kettle hole are depression in a glacial outwash drift made by the melting of a detached mass of glacial ice that became wholly or partly buried. The occurrence of these stranded ice masses is thought to be the result of gradual accumulation of outwash atop the irregular glacier terminus. When filled with water they are called kettle lakes. Most kettles are circular in shape because melting blocks of ice tend to become rounded; distorted or branching depressions may result from extremely irregular ice masses.

Erosional Features Produced By Continental Ice-Sheets

1. Chatter Marks and Crescentic Gouges - Chatter mark are small, curved fracture found on glaciated rock surfaces. They occur mainly on hard, brittle rocks such as granite and are formed under a glacier by the pressure and impact of boulders moved along by irregular rolling or sliding. The resulting pattern of impacts has been likened to the "chatter" of a carpenter's chisel slipping along the surface of a piece of

wood. They are convexed towards upstream direction. Chatter marks are commonly arranged in nested series, with the orientation of the fractures at right angles to the direction of glacial movement.

The crescentic gouge are formed on bedrock surface and formed due to the removal of a chip of rock by rock fragments present with ice layers. They occur in a series of curved cracks that are convexed towards the downstream direction.

The curvature in case of chatter marks are opposite to those of crescentic gouges. Both marks represents glacier flow direction.

2. Roches Moutonnees- Roches moutonnées are asymmetric bedrock bumps or hills with a gently sloping and abraded upglacier (stoss) face and a steep-sided, quarried (or plucked) downglacier (lee) face that is typically blunter. They are found typical in both valley and continental glaciers.

3. Crag and Tail- A Crag and Tail consists of a large mass of resistant rock on the STOSS (upslope side) and a gently sloping tail (on the LEE side) of less resistant rock. This is a geological formation caused by the passage of a glacier over an area of hard rock and softer rock.

Depositional Features Produced By Continental Ice-Sheets

1. Moraines- Three types of moraines are found in continental glaciers-
    a) Terminal moraines
    b) Recessional moraines
    c) Ground moraines
2. Knob and Kettle- These are landforms consisting of irregularly shaped hill or mound composed of sand, gravel, and till with intermittent depressed hollows thar are called as knob and kettle structures. They are commonly associated with end moraine.
3. Interlobate moraines- When two end moraines coaleases to form a larger lobate- shaped single moraine, it is called as interlobate moraines.

4. Drumlins- Drumlins are features similar to roches moutonnées that are bedrock knobs or hills completely streamlined due to the glacial abrasion and plucking action. But unlike the roches moutonnées, the drumlims are characterized with steep stoss sides and gently sloping lee sides.

The stoss side is at the upstream side and lee-side is at the downstream side. In other words drumlims shows features opposite to that of roches moutonnées.

5. Glacio-lacustrine Deposits- Varves- A varve is simply defined as: an annual sediment layer. A rhythmic sequence of sediments deposited in annual cycles in glacial lakes. Light-colored, coarse summer grains are deposited by rapid melting of the glacier. The summer layers grade upward to layers of finer, dark winter grains of clay minerals or organic material that are deposited slowly from suspension in quiet water while streams and lakes are icebound. Varves are useful to the study of geochronology because they can be counted to determine the absolute age of some Pleistocene rocks of glacial origin.