GLACIERS

Of all the water near the surface of the earth, only about 2 % is on the land as glacier ice.

Even this small fraction is enough to cover entirely one continent ANTARCTICA an most of the largest island GREENLAND with ice to an average of 2.2 km (over 4 miles) over Antarctica and 1.5 km over Greenland.

Glaciers are an important storage in the earth's hydrologic system. Almost ¾ of the earth's fresh water is locked up in polar sheets.

At present time about 10 % of the earth's area is ice covered.

An additional 20 % has been ice covered repeatedly during glaciations of the Pleistocene Epoch, much of it as recently as 15,000 to 20,000 years ago.

Glaciations has been the dominant factor in shaping the present landscape of North America northward of the Ohio and Missouri rivers and of Eurasia northward of a line from Dublin eastward through Berlin to Moscow, and beyond the Urals.

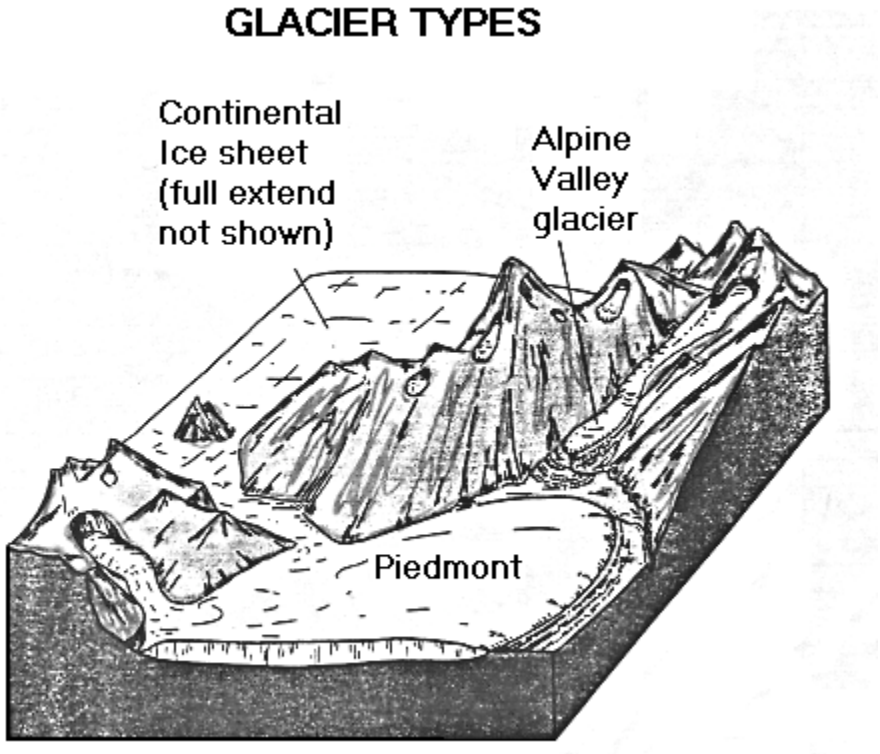
In addition mountains and plateaus in all latitudes have been glaciated to an altitude of 1000 to 1500 m lower than the present showline.

GLACIER.

Mass of moving ice that forms on land, formed by recrystallization of snow.

Slowly moving ice sheets . (The movement of a glacier may be a nearly imperceptible (20 m/year [65 m/year] to 10 km per year ; 30 m (100 ft) per day. Moves under its own weight.

Like a huge conveyor belt for rocks.



There are <u>two main</u> types of glaciers

<u>ALPINE (VALLEY or MOUNTAIN) GLACIERS</u>.	Confined to a pre-exiting stream valley in mountainous terrains (River of ice) .They occur at higher elevations. Exist in western mountains of the United States (as well as Alaska) in Western Canada, in the Andes, in South America, the Alps of Europe, in the Himalayas of Asia, and in other high mountains of the word. Most of the estimated 70,000 to 200,000 glaciers in the word today are Alpine Glaciers
PIEDMONT GLACIERS.	Forms when two or more valley glaciers emerge from their valleys, spread out and form a broad sheet on the lowlands at the base of a mountain. Coalescing alpine glaciers along major slope breaks. They form a single broad mass. Relatively rare. MALASPINA GLACIER, Alaska
<u>CONTINENTAL GLACIERS (ICE SHEETS)</u>.	Cover large land areas (> 50,000 km^2) They are not confined by the topography (not confined to valleys). They spread out in all directions with little regard to the topography. Not fed by tributaries. ANTARCTICA, GREENLAND (considered by some as an **ICE CAP**. Smaller than an ice sheet). They are fewer in number but collectively contain more ice. They make up 99 % of all the glacier ice on the world. ANTARCTICA (cover 48 contiguous state; depths of 3 km (2 miles).
	* The ARCTIC POLAR ICE MASS is not a true glacier as is not based on land.

ALPINE GLACIERS

DURING GLACIATION
Glaciers form networks.
Smaller ==> **TRIBUTARIES** join larger **MASTER, MAIN, and TRUNK**.
Tributary ices does not mix with the master ice flows as distinct unit

EROSIONAL LANDFORMS of ALPINE GLACIERS

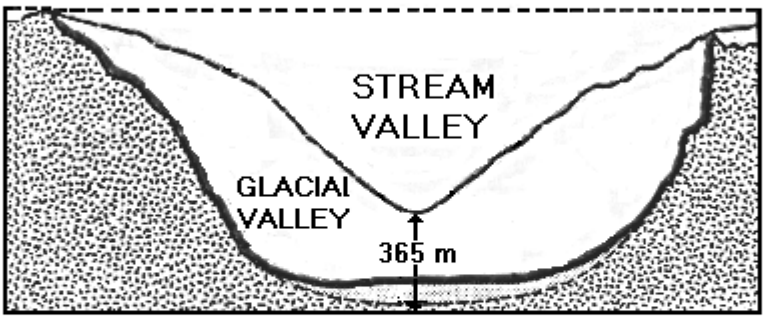
Glaciers produce spectacularly rugged topography

GLACIAL VALLEYS	The enormous quantity of moving ice and erode the valley as much as 600 m below the original level. Erosion widens preexisting stream valley, The valley becomes straight (the glacier cannot easily turn as a river (higher viscosity) U-SHAPED in cross section. Several hundred meters deep. Reduction of drainage divides.
HANGING VALLEYS	Formed where tributary glaciers once joined the master glacier, and waterfall cascade from them to the main valley floor. The thicker a glacier is the more erosive force it excerpts on the valley floor valley beneath and the more bedrock is ground away. For this reason a large master glacier erodes downward more rapidly and carves a deeper valley than do the smaller tributaries that join them, After the glacier disappears (recedes, melts) tributaries remain as a HANGING VALLEY above the main valley
CIRQUES	Bowl-shaped depressions that represent original areas of snow accumulation. S Steep side Located at head of a glacial valley
HORNS	Triangular-shaped mountain peak found near the head of a glacial valley. Formed where several cirques merge.
COL RIDGE	A sharp-edged or saddle-shaped pass in a mountain range, formed by the headward erosion of two opposite oriented cirques. Individual horns may be joined by a narrow ridges
ARETES	Narrow, rugged divide between two parallel glacial valleys.
GLACIAL LAKES	**TARNS** Form in basins left by alpine glacial scouring . Lakes contained in cirques
	PATTERN NOSTER SUCCESSION. Glacial lakes that

	occur in a step-wise sequence down an alpine glacial valley

ALPINE GLACIER

EROSIONAL FEATURES

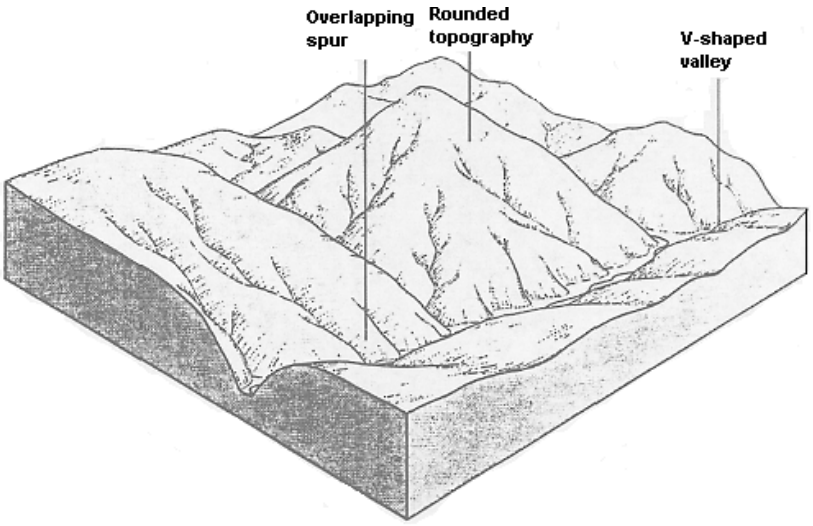


Glacial modification of river valleys

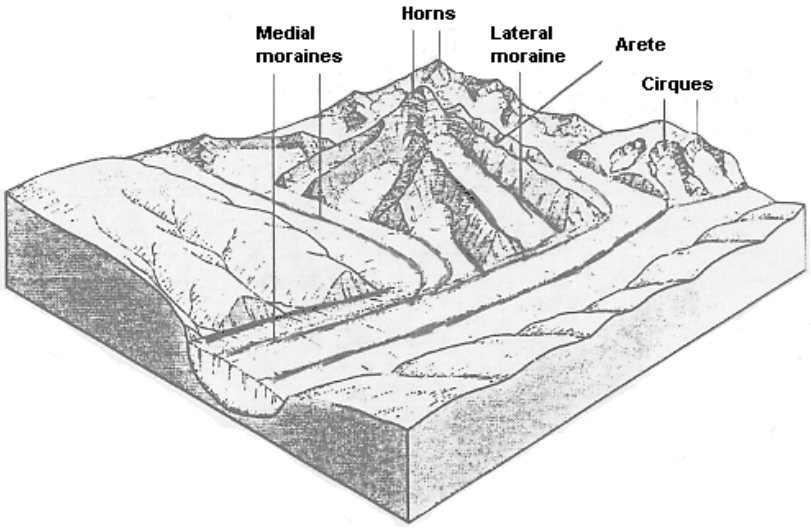
STREAM VALLLEY — **"V" SHAPED IN CROSS SECTION**

GLACIAL VALLEY — **"U" SHAPED IN CROSS SECTION**

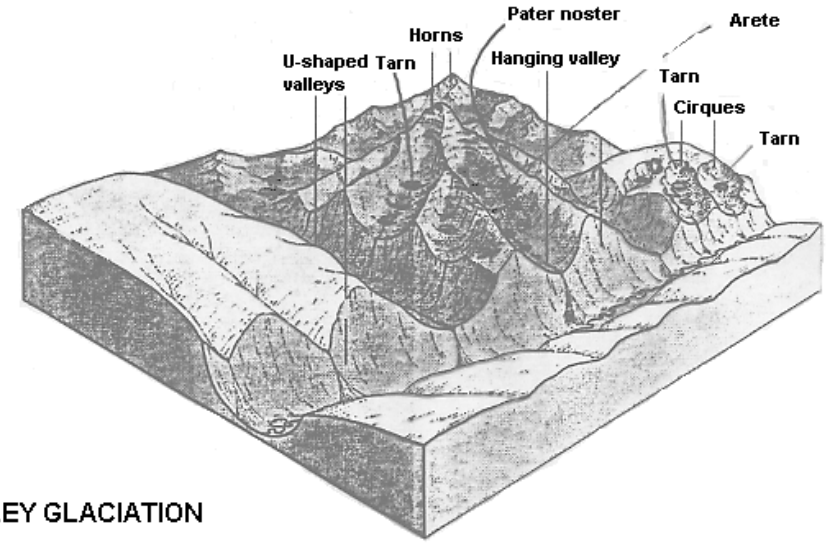
PREGLACIATION
Topograaphy before glaciation is characterized by V-shaped stream valleys. Overlapping spurs, and rounded hills.



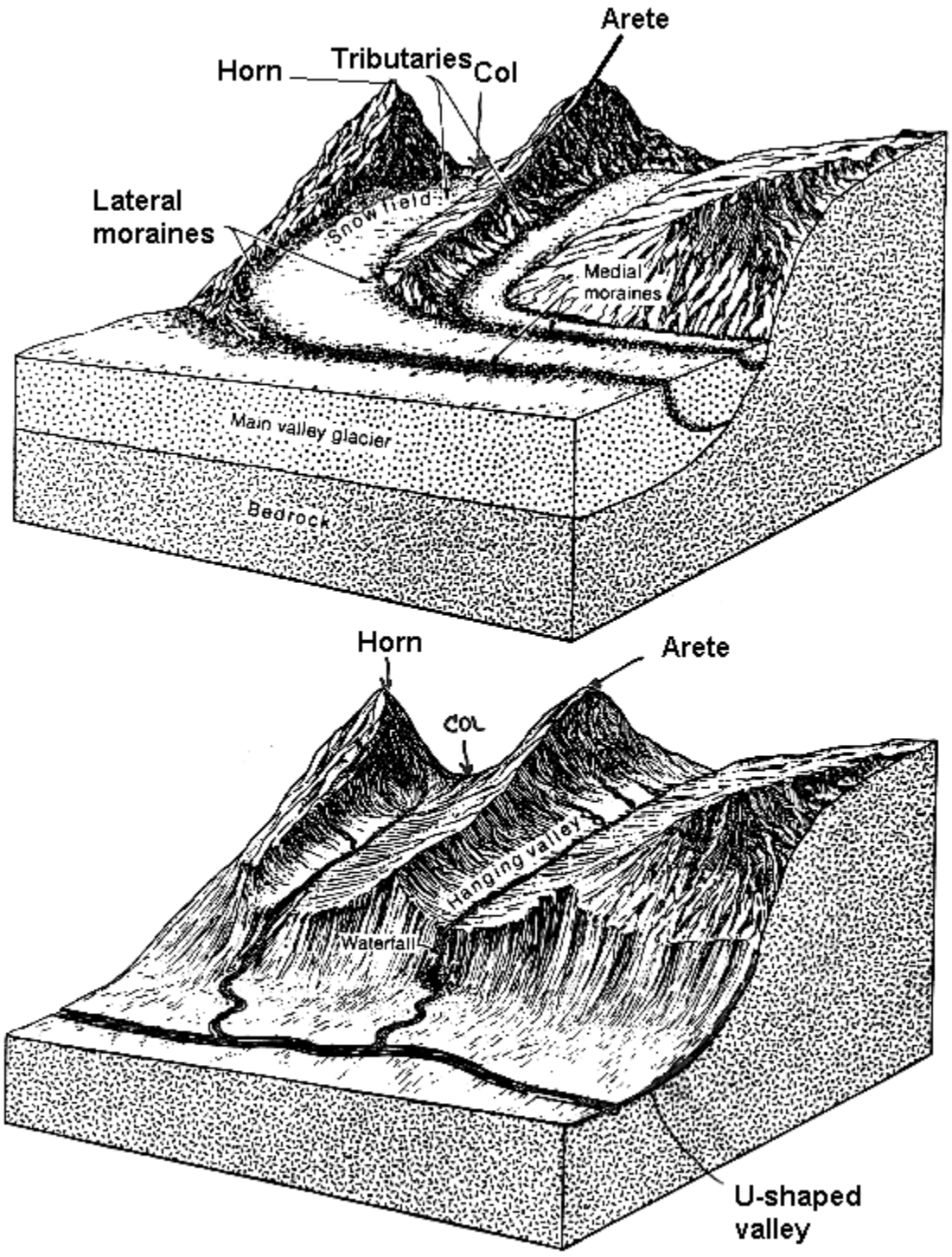
GLACIATION.
Valley glaciers develop from snowfield in the high peaks and expand down stream valleys. Major glaciers thus have a network of tributaries that follows the drainage system.



POSTGLACIATION
Broad, deep, U-shaped valleys are the most characteristic landform developed by valley glaciation. Cirques , horns, and aretes are glacial features that create spectacular scenery in the highlands. Hanging valleys, often with high waterfalls, occur where tributaries enter the main valley.



LANDFORMS DEVELOPED BY VALLEY GLACIATION

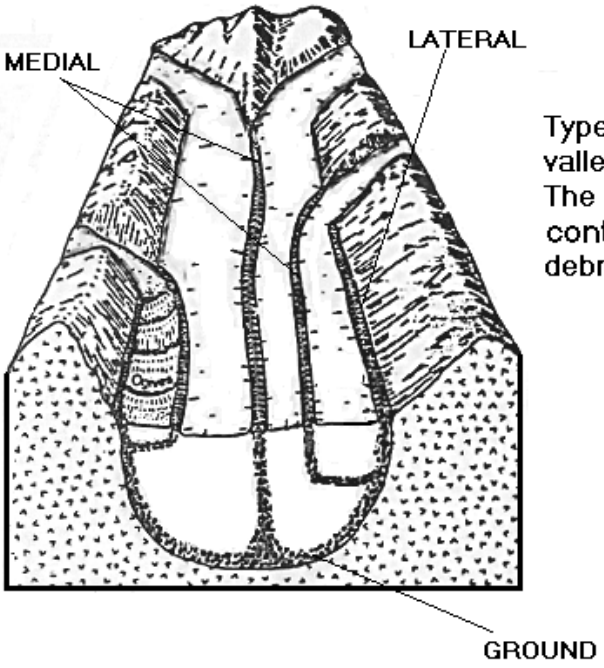

Arete
Horn
Tributaries
Col
Lateral moraines
Snow field
Medial moraines
Main valley glacier
Bedrock
Horn
Arete
Col
Hanging valley
Waterfall
U-shaped valley

DEPOSITIONAL LANDFORMS of ALPINE GLACIERS

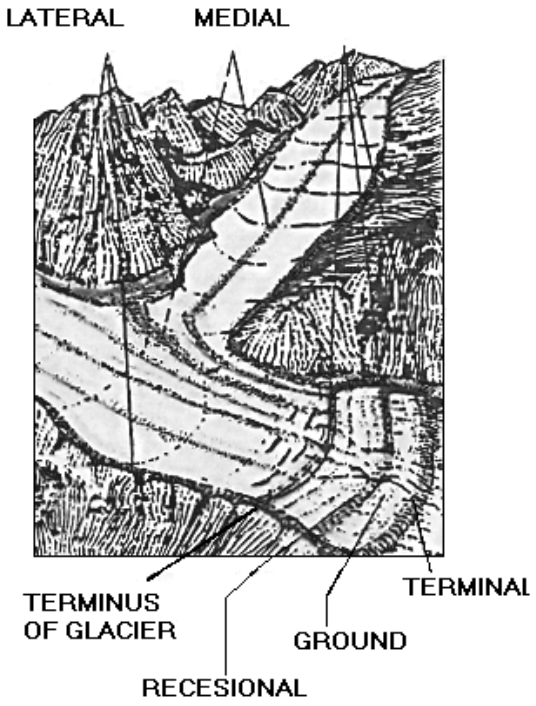
MORAINES Redistributed debris. **Till** (Poorly sorted angular) ===> **Tillite** Because ice is solid, it transports sediments with equal efficiency regardless of particle size. Lies in the lowlands where the glacier finally melted	**LATERAL**. Formed by debris eroded from the walls of a valley glacier and transported along the margin of the glacier.
	MEDIAL. Formed at the confluence of two valley glaciers where tributary glaciers come together. (Indication of direction of ice flow)
	END OR TERMINAL. Represent the farthest advance of the glacier. During melting, surface debris and sediment carried within an alpine glacier are deposited along the **TERMINUS** (lower edge of a glacier)**.**
OUTWASH PLAIN	Formed by **fine-grained sediments** that were **transported by melt-water streams**. Deposited outward from the glacier terminus. Generally flat area. They may be locally enclosed by moraine deposits to form temporary lakes

ALPINE MORAINES

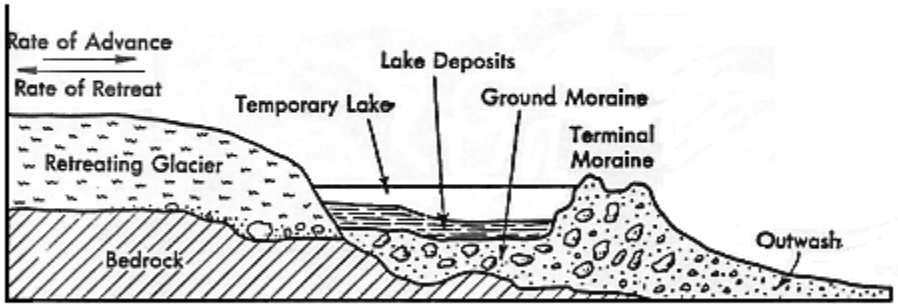
DEPOSITIONAL FEATURES



Types and locations of valley glacier MORAINES
The volume and continuity of englacial debris is exaggerated.

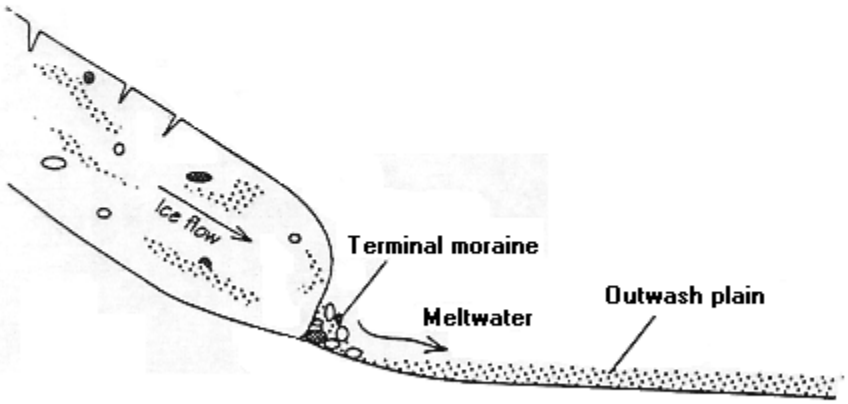


MORAINES



ALPINE MORAINES

DEPOSITIONAL FEATURES



OUTWASH PLAIN

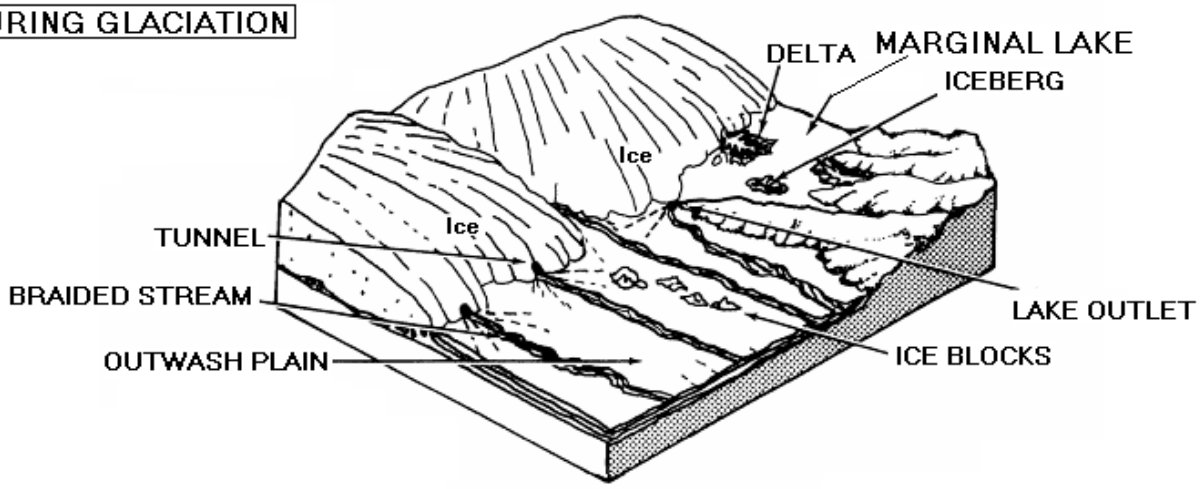
CONTINENTAL GLACIERS

Extensive ice sheets (several thousands of feet thick) ANTARCTICA (GREENLAND).
Originate in areas of high rates of snow fall.
ICE = Compacted and recrystallized snow.
Powerful erosional agent

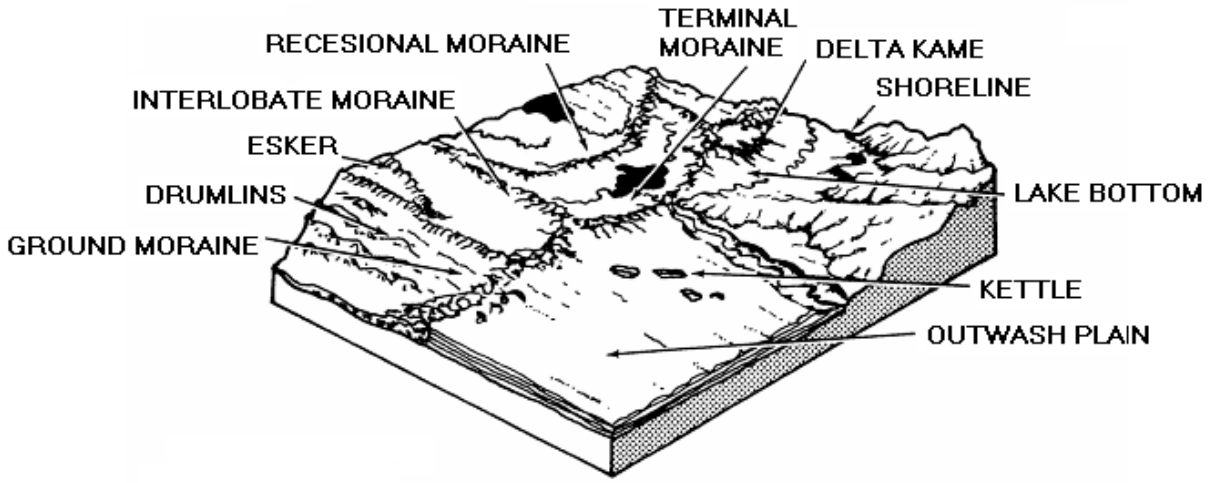
EROSIONAL and DEPOSTIONAL LANDFORM FORMED BY CONTINENTAL GLACIATION

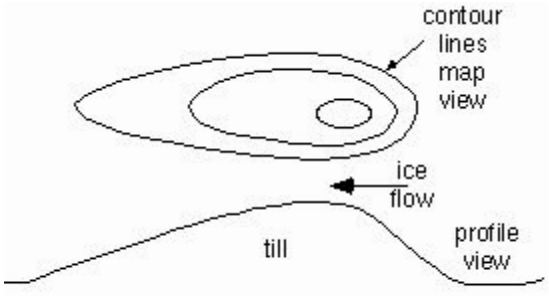
MORAINES Accumulation of rock material (till) that has been carried or deposited by a glacier.	**END OR TERMINAL** Perpendicular to the front of the glacier. Marks the maximum extent of a glacier margin. Represent the greatest advance. (less than 100 m high and extend tens of kms.
	GROUND Widespread drift with a relatively smooth surface topography consisting of gently undulating knolls and shallow closed depressions. The **debris scattered irregularly over the surface upon which the ice had formerly rested**
OUTWASH PLAINS	Located outward from the terminus. Where most fine-grained glacial sediment is transported by meltwater streams. Relatively flat area. Poorly developed drainage and extensive swamp and marsh are typical of areas where continental glaciation has occurred
KETTLES **KETTLE LAKES**	Depression formed where partially buried ice blocks have melted. If the depression intersects the water table a small lake will form. ((Upper Midwest of US)
DRUMLINS Boston MA. Central Near Syracuse NY, Eastern and Southern WI, Michigan, Minnesota, Parts of Southern Canada. Iceland	Elliptical asymmetrical hills or mounds. Several hundred yards or meters long oriented in the direction of the original ice flow. Stream lined iced molded forms The longitudinal profile of a drumlin characteristically shows a steep side on the end from which the ice was coming and a more gentler slope on the downstream direction from which the glacial ice advanced. They are reshaped ground moraines probably produce by an ice sheet overriding and reshaping a deposit of till left by an earlier glacial advance
ESKERS (Glacio-fluvial)	Sinuous ridge. A Long winding structure, like a sinuous railroad embankment. Result from sediment (sand and gravel) deposited on the floor of a formed ice tunnel. Alternatively interpreted to be formed as the deposits in meltwater ice channels in the surface..
KAME TERRACES (Glacio-fluvial)	Formed by sediments deposited within meltwater stream, that flow on a glacier surface. After glacial recession
KAMES	Short steep-sided mounds

DURING GLACIATION

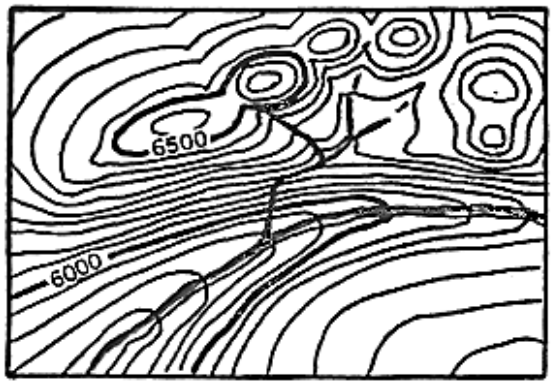


FOLLOWING RETREAT

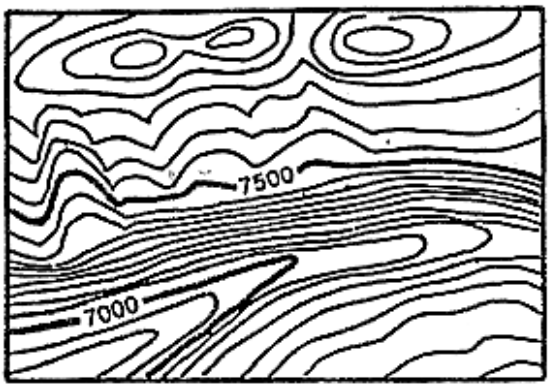




MAP AND PROFILE OF A DRUMLIN

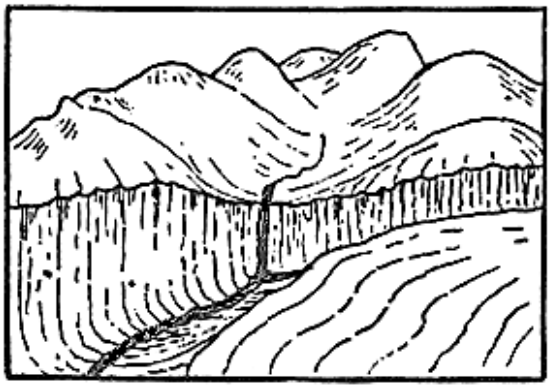


HANGING VALLEY (CONTOURS)

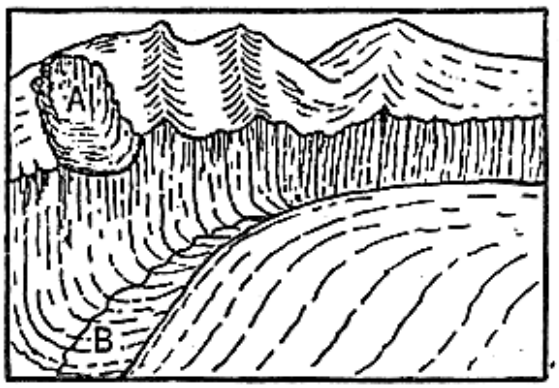


CIRQUE AND TROUGH (CONTOURS)

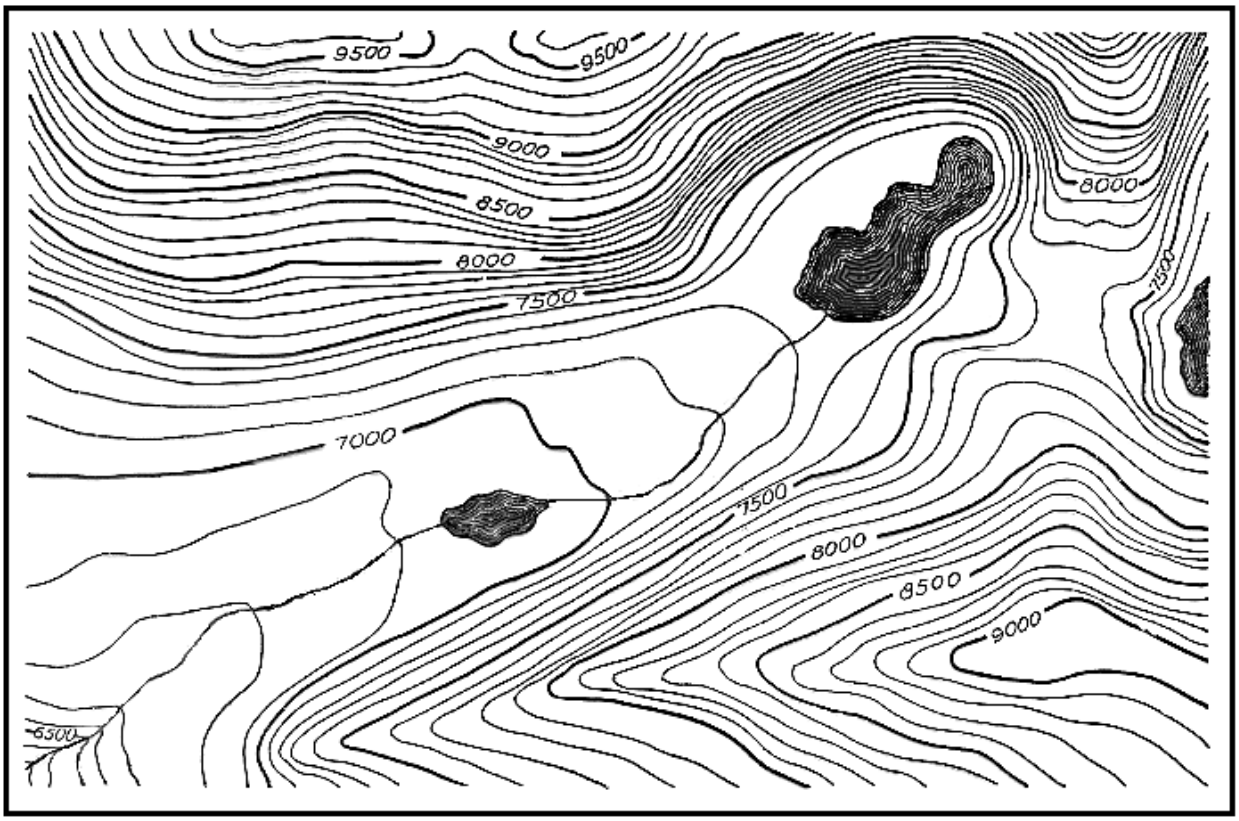
↳ LOOPED SHAPED PATTERN



HANGING VALLEY



(A) CIRQUE (B) GLACIAL (TROUGH) VALLEY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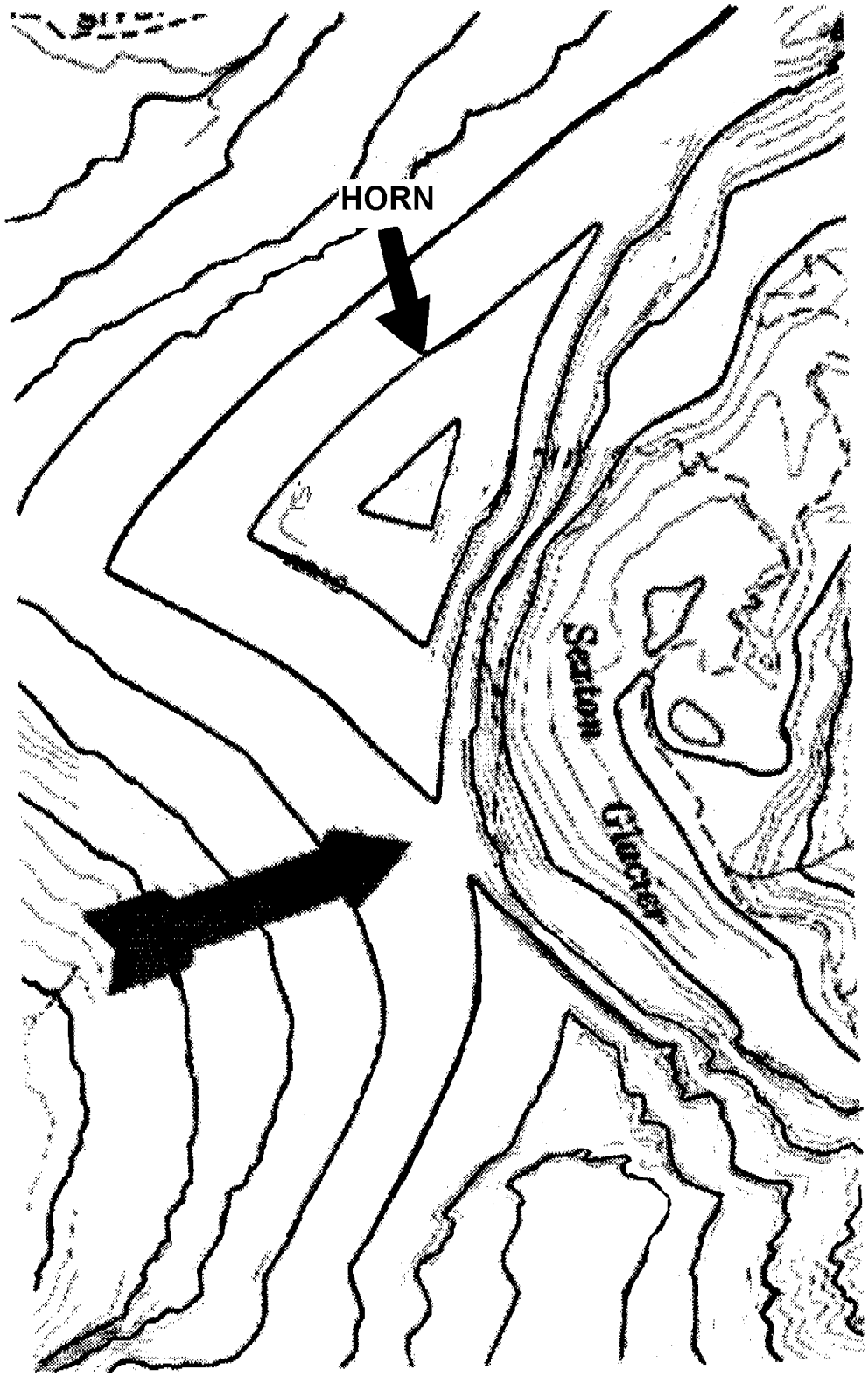
HORN
Saskum Glacier