LANDFORM DEVELOPMENT IN GLACIAL ENVIRONMENT

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1st Sem, Major
15.12.23

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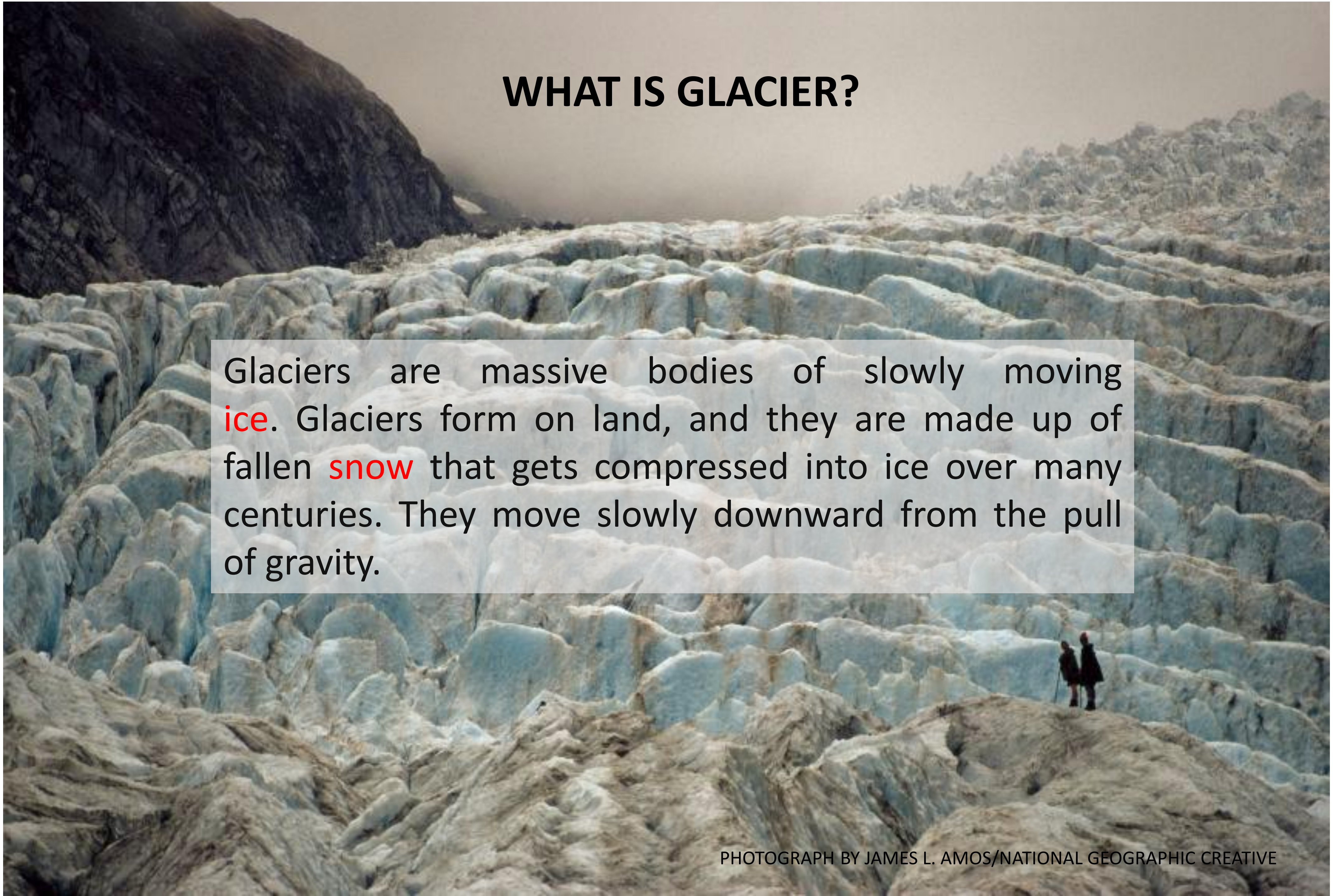
WHAT IS GLACIER?

Glaciers are massive bodies of slowly moving ice. Glaciers form on land, and they are made up of fallen snow that gets compressed into ice over many centuries. They move slowly downward from the pull of gravity.



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TYPES OF GLACIER:

1. **Ice sheet** AND **<u>ice caps</u>** i

2. **Valley glaciers** are also referred to as mountain glaciers, ice streams, or Alpine glaciers.

Firn is usually defined as snow that is at least one year old and has therefore survived one melt season, without being transformed to glacier ice.

GLACIER ICE MOVEMENT:

1. **Internal creep** is a result of the weight of overlying ice and of gravity acting down the surface slope of a glacier.
2. Alternate **compression and extension** of the ice mass in response to changes in the bedrock surface below the ice.
3. **Sliding** of the ice over bedrock.

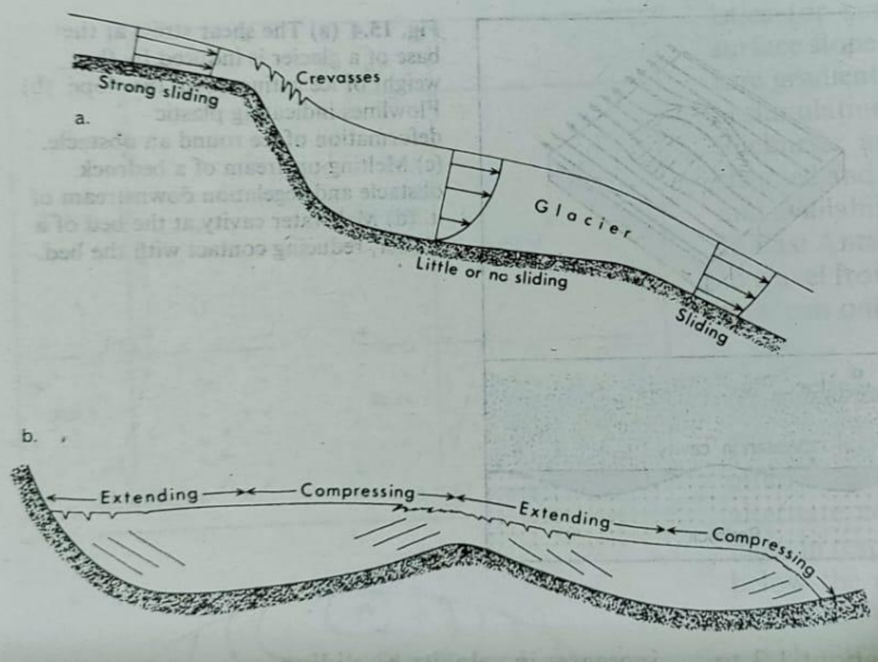


Fig. 15.5 Vertical velocity profiles within a glacier indicate the variability in the magnitude and location of the basal sliding. Creep is at a maximum a few metres above the bed and then nearly uniform to the glacier surface. (b) Location of extending and compressing flow along a glacier and the resulting surface features.

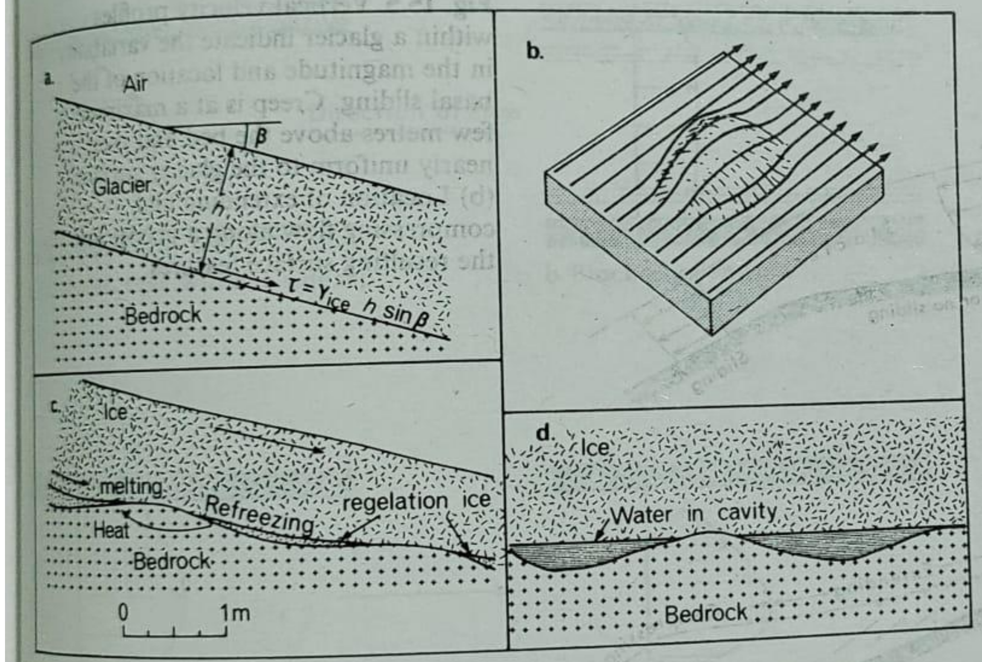


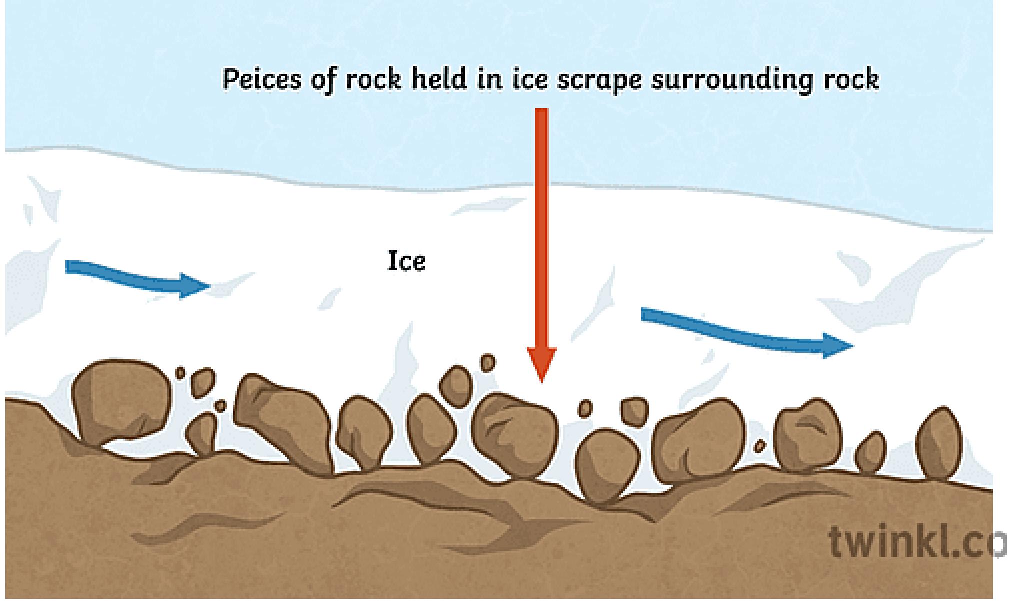
Fig. 15.4 (a) The shear stress at the base of a glacier is induced by the weight of ice acting down the slope. (b) Flowlines indicating plastic deformation of ice round an obstacle. (c) Melting upstream of a bedrock obstacle and regelation downstream of it. (d) Meltwater cavity at the bed of a glacier, reducing contact with the bed.

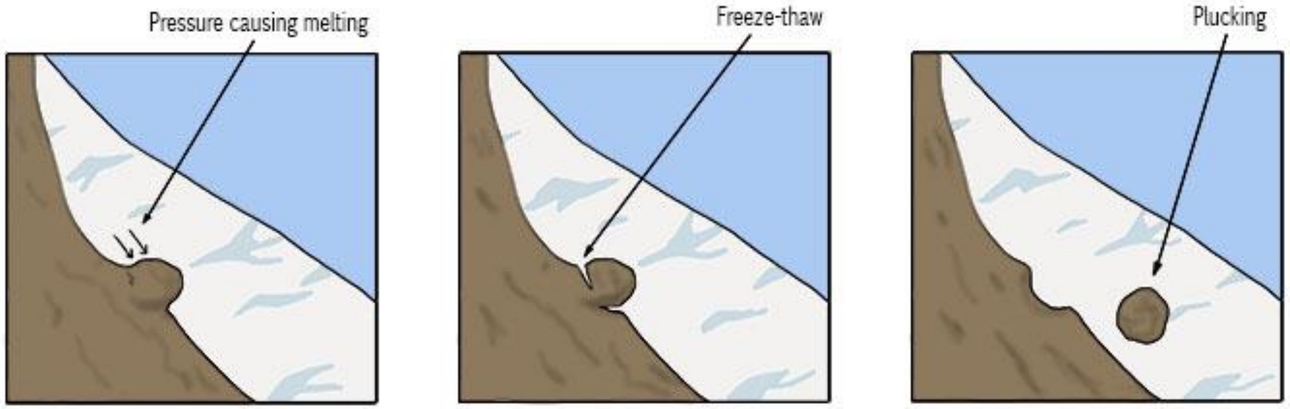
Processes of Glacial Erosion

Glacial erosion involves the removal and transport of bedrock or sediment by three main processes:

1. quarrying (also known as plucking),
2. abrasion, and
3. melt water erosion.

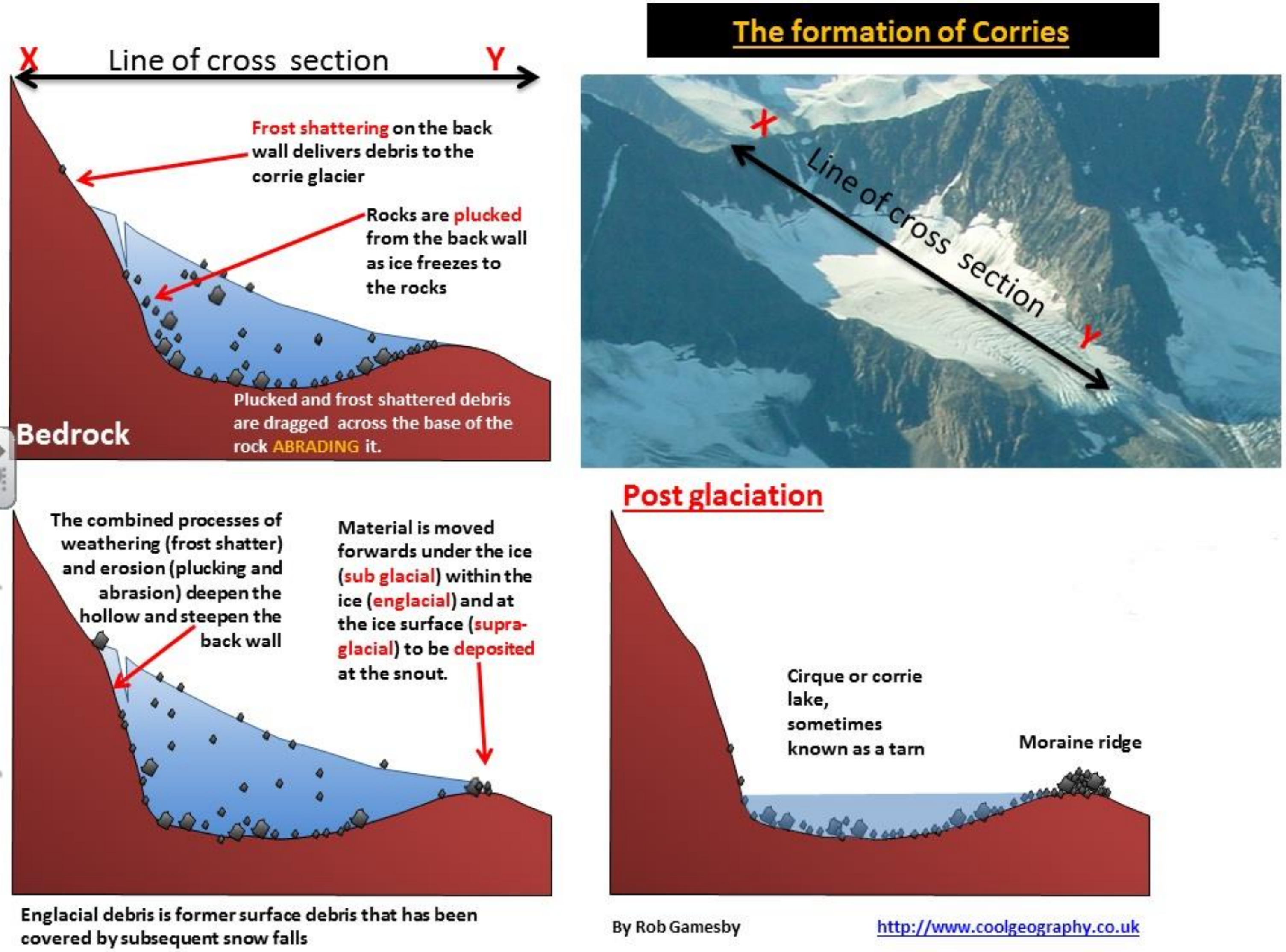
Quarrying involves two separate processes: the fracturing or crushing of bedrock beneath the glacier, and the entrainment of this fractured or crushed rock.

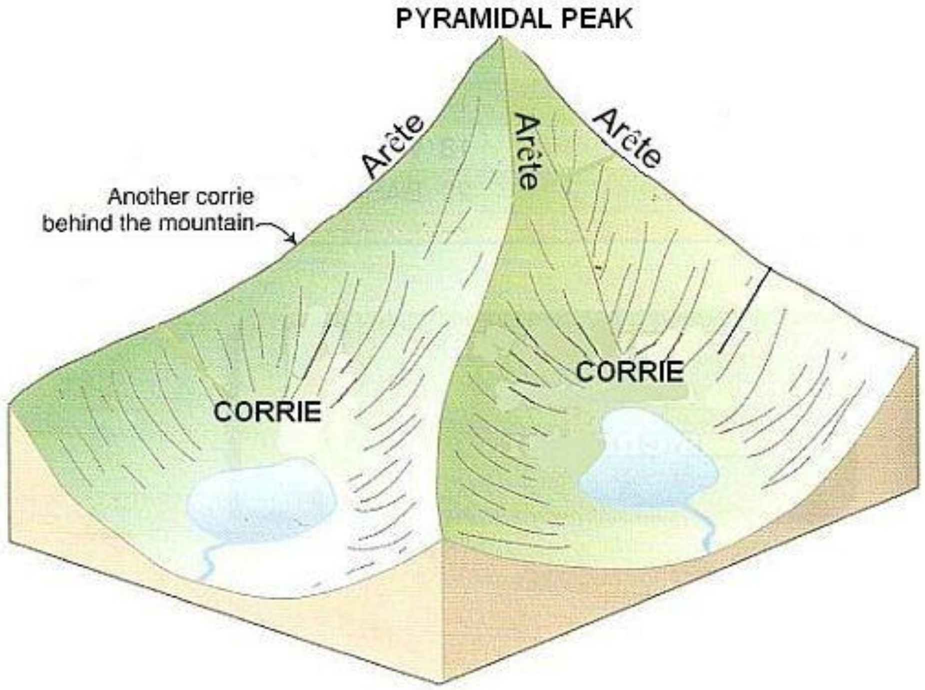




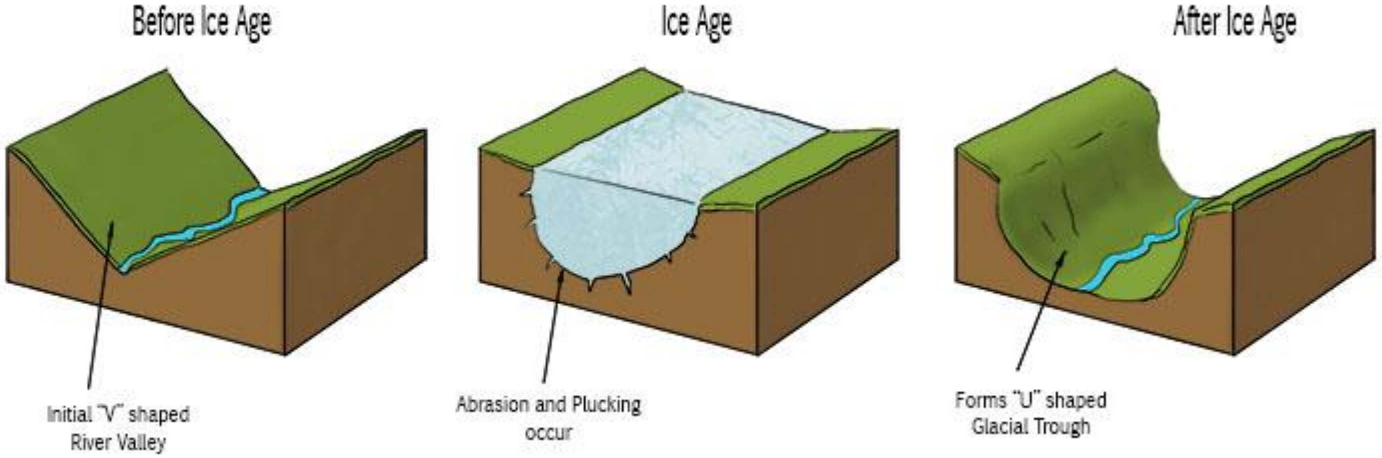
Glacial Landforms – Erosional

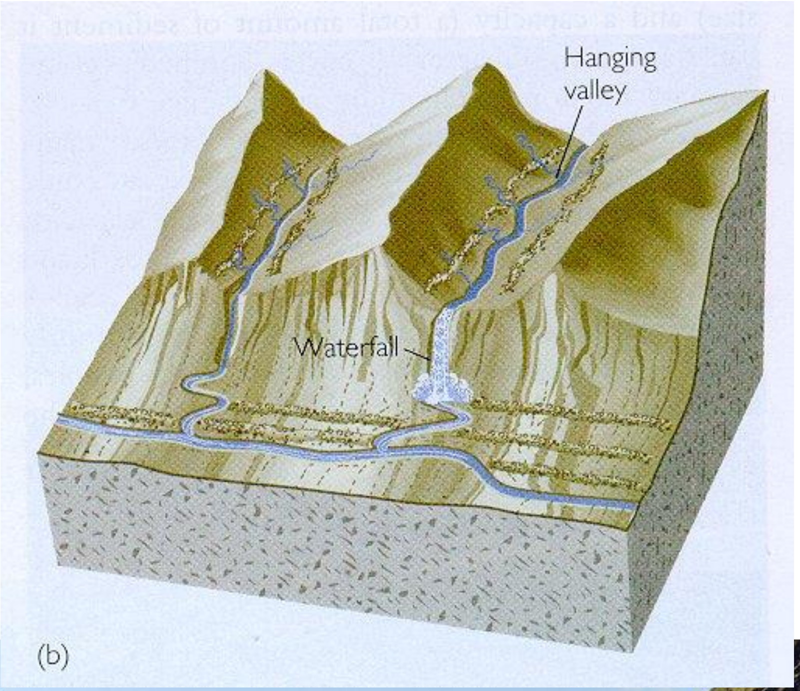
1. Corrie, Cirque, 2. Aretes and, 3. Pyramidal Peaks, 4. Nunataks

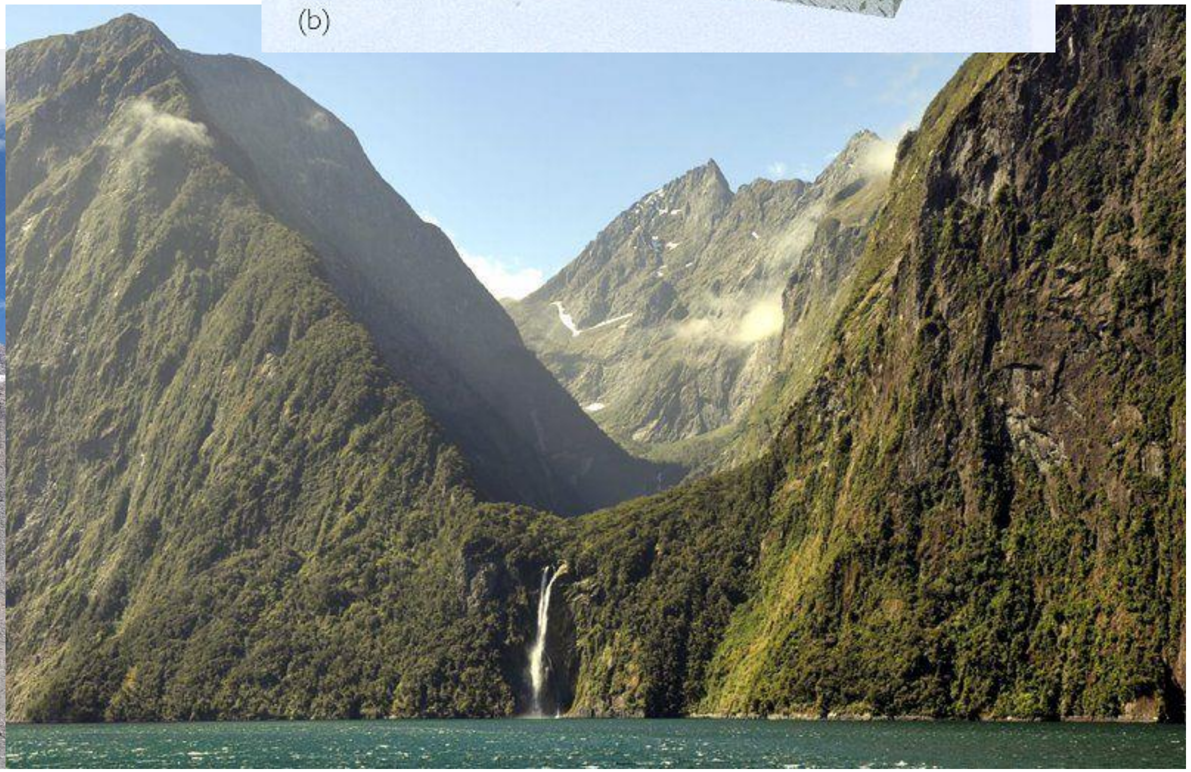




5. U shaped glacial Troughs , 6. Hanging Valley



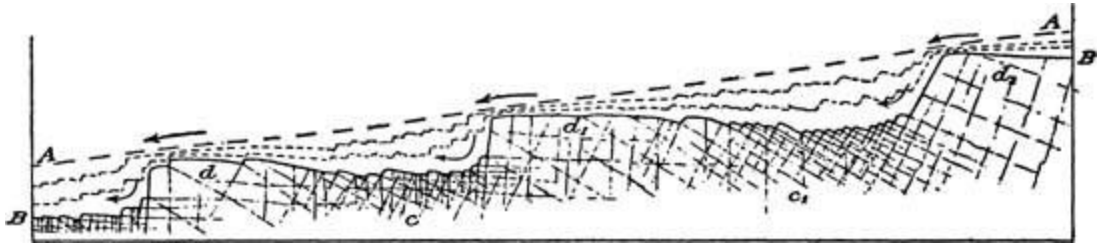




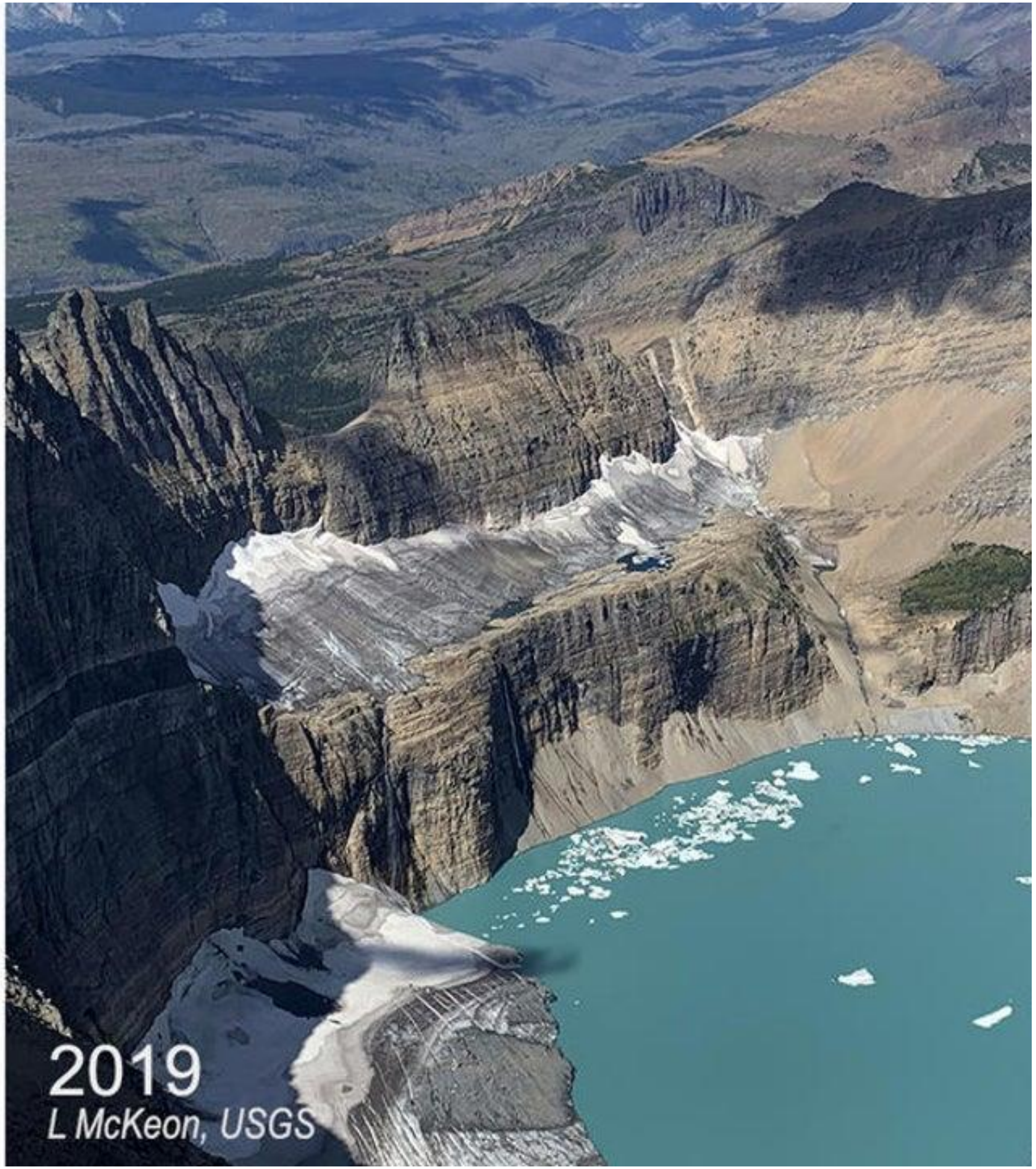
7. Changu Lake, Sikkim, example of a Corrie Lake

9. A **paternoster lake** is one of a series of glacial lakes connected by a single stream or a braided stream system.

8. Glacial stairways: Long profile of a glacial trough: it is characterized by alternating rock bars (riegels) and rock basins, giving the impression of a stairway. The structure is attributed to variations in the erosive power of ice, or to the influence of rock jointing.




1938
TJ Hileman, GNP Archives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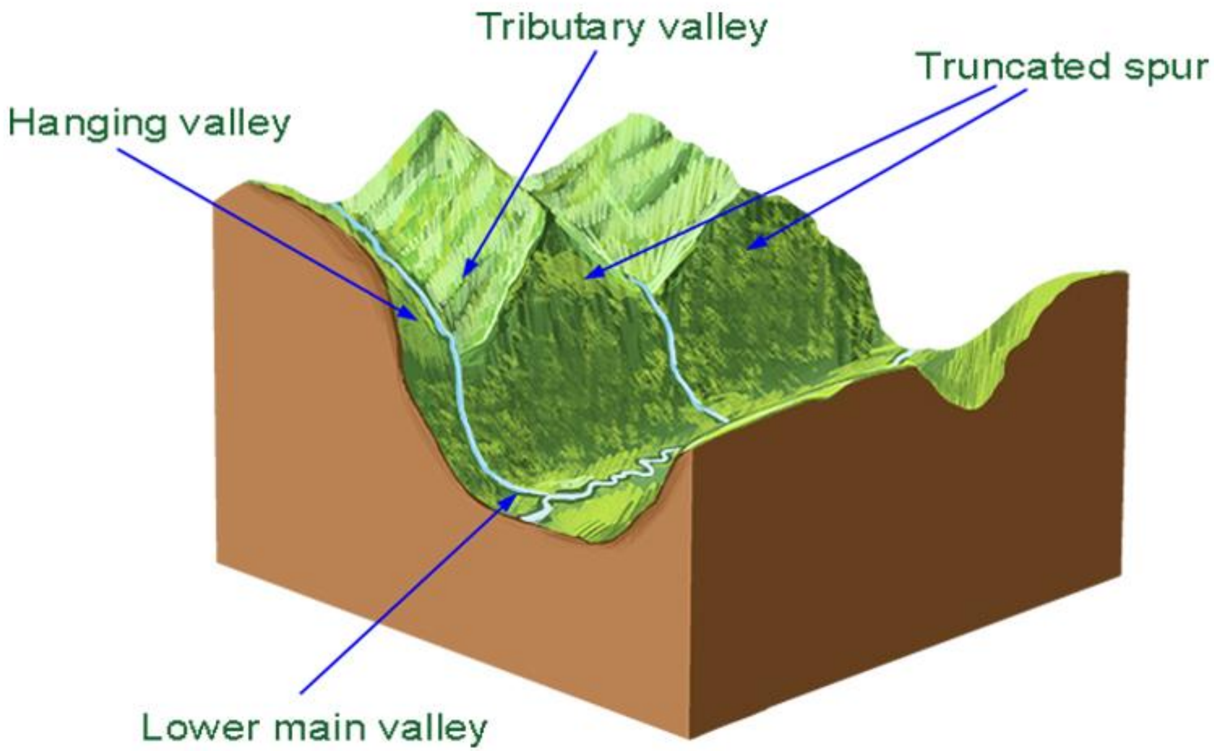
10. **Truncated spurs** are rounded areas of land which have been cut off when glaciers move through the main valley. It occurs when the glacier is unable to past the interlocking spurs and so simply cuts through them by processes of erosion. They are often round at the top but steep at the bottom.



11. Roche moutonnée

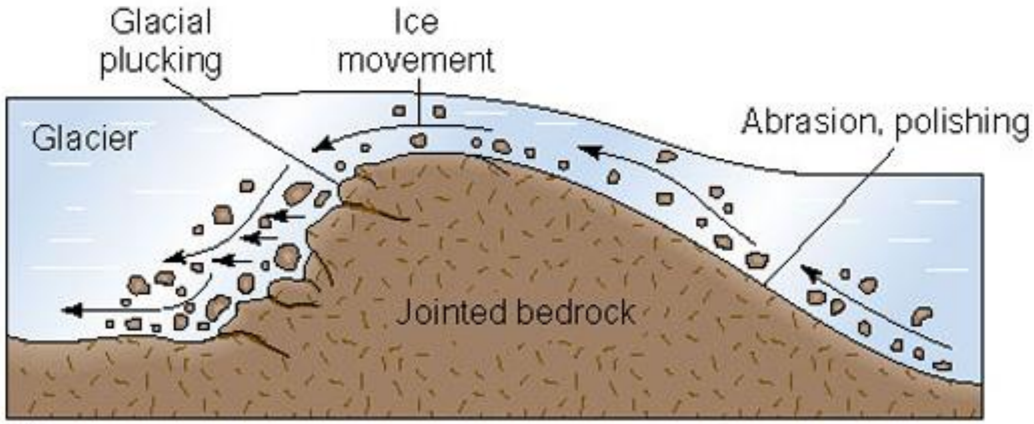
•Basically, a resistant residual rock hummock or mound, striated by the ice movement.

•Its upstream or stoss side is smoothened by abrasion & its downward or leeward side is roughened by plucking & is much steeper.

•It is believed that plucking may have occurred on the leeward side due to a reduction in pressure of the glacier moving over the stoss slope

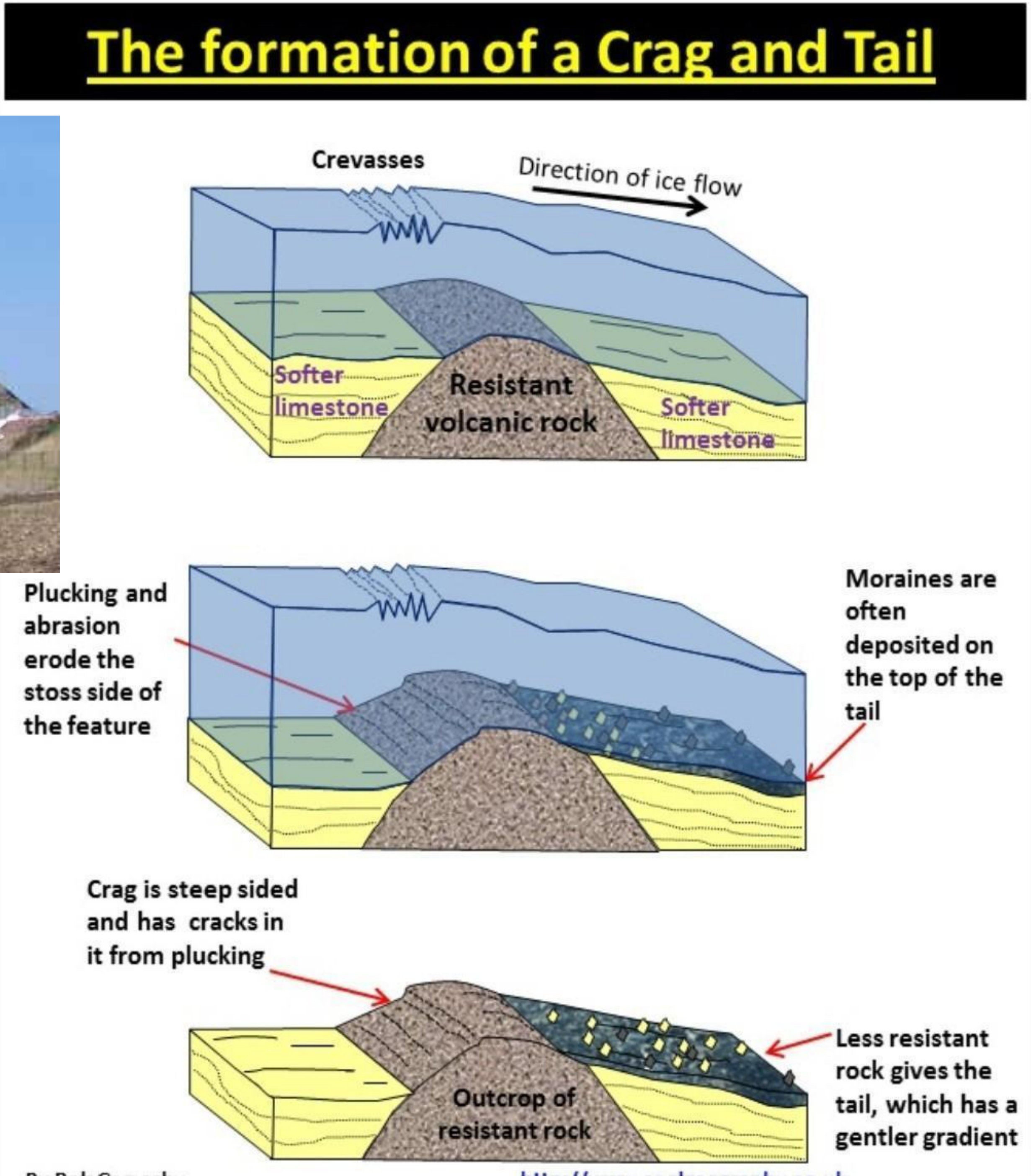
•Therefore providing the opportunity for water to refreeze on the lee side and pluck the rock away.

(a)

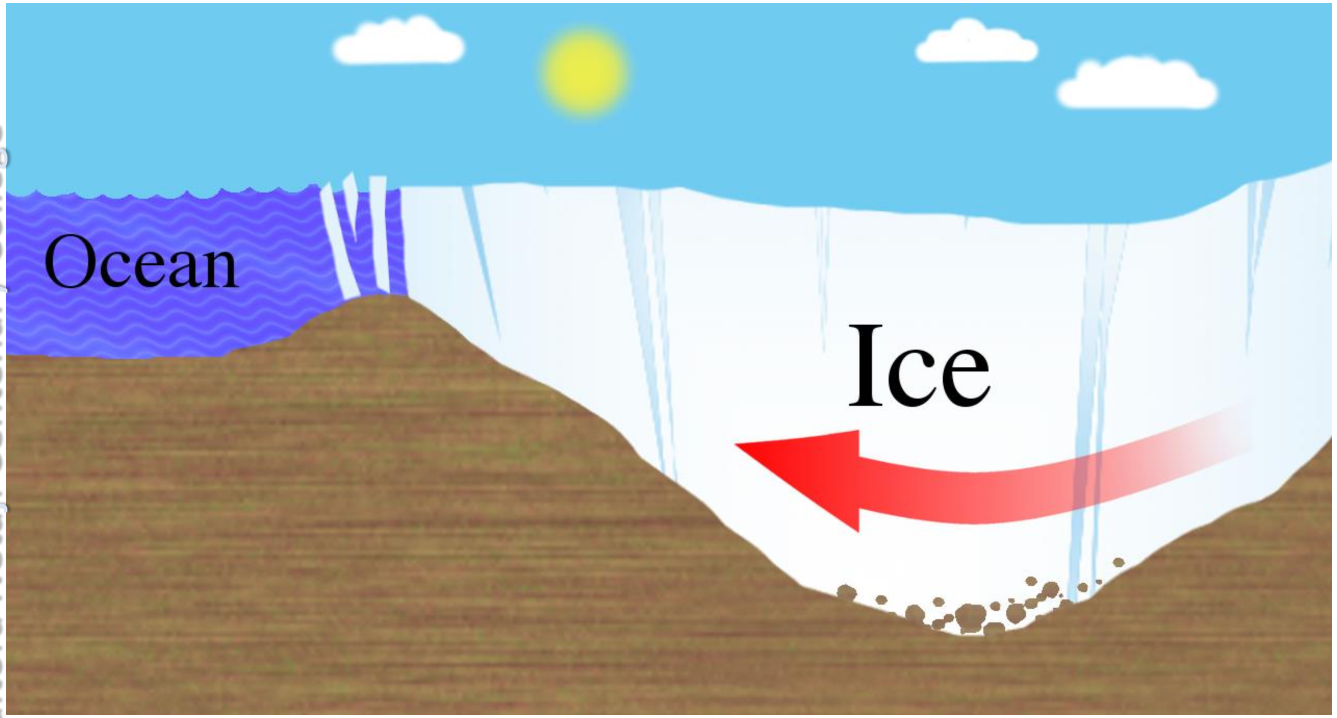


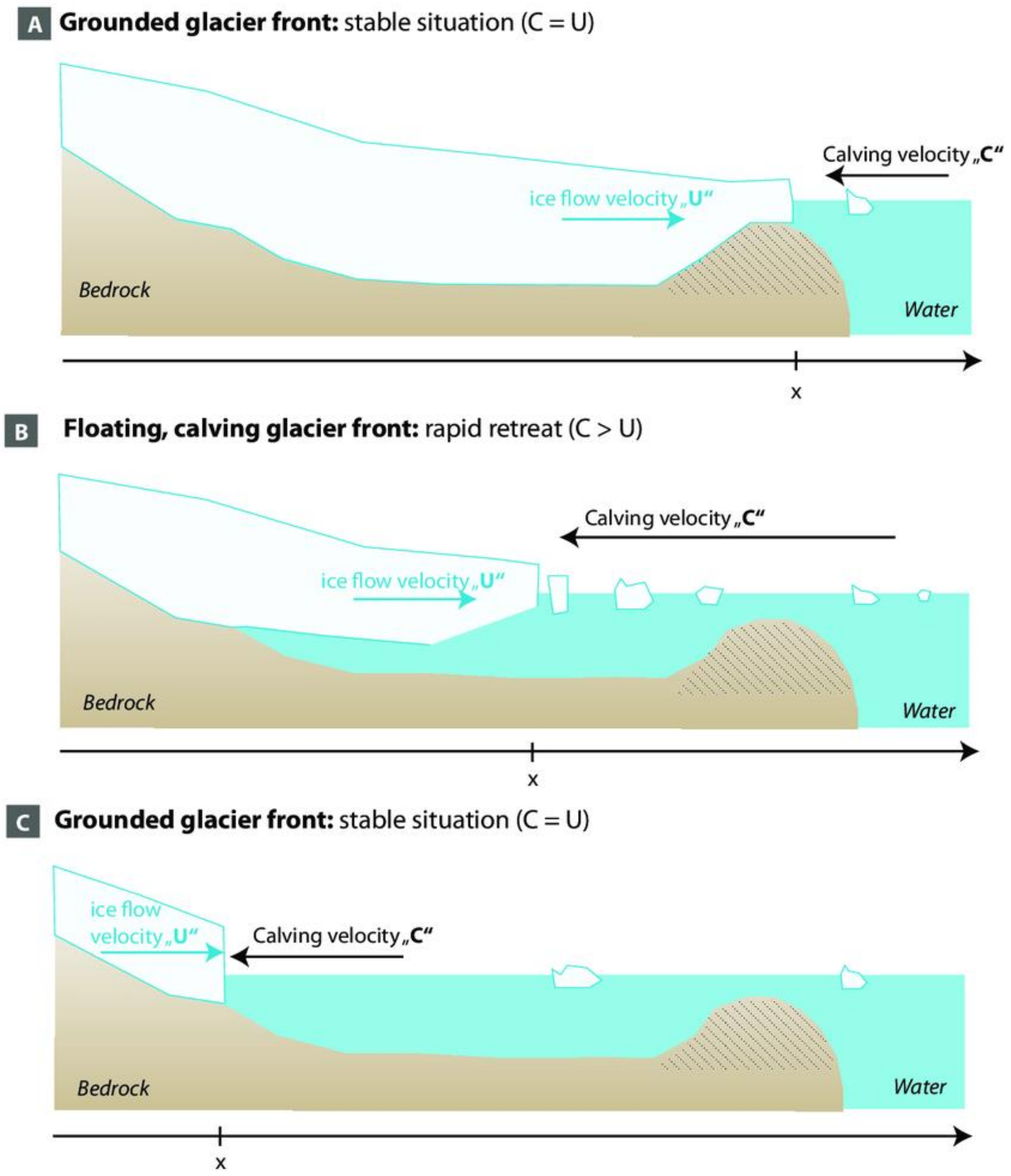
(b)

12. Crag and tail



13. Fjord, long narrow arm of the sea, commonly extending far inland, that results from marine inundation of a glaciated valley. Many fjords are astonishingly deep; Sogn Fjord in Norway is 1,308 m (4,290 feet) deep, and Canal Messier in Chile is 1,270 m (4,167 feet). The great depth of these submerged valleys, extending thousands of feet below sea level, is compatible only with a glacial origin. It is assumed that the enormous, thick glaciers that formed in these valleys were so heavy that they could erode the bottom of the valley far below sea level before they floated in the ocean water. After the glaciers melted, the waters of the sea invaded the valleys. Fjords commonly are deeper in their middle and upper reaches than at the seaward end.

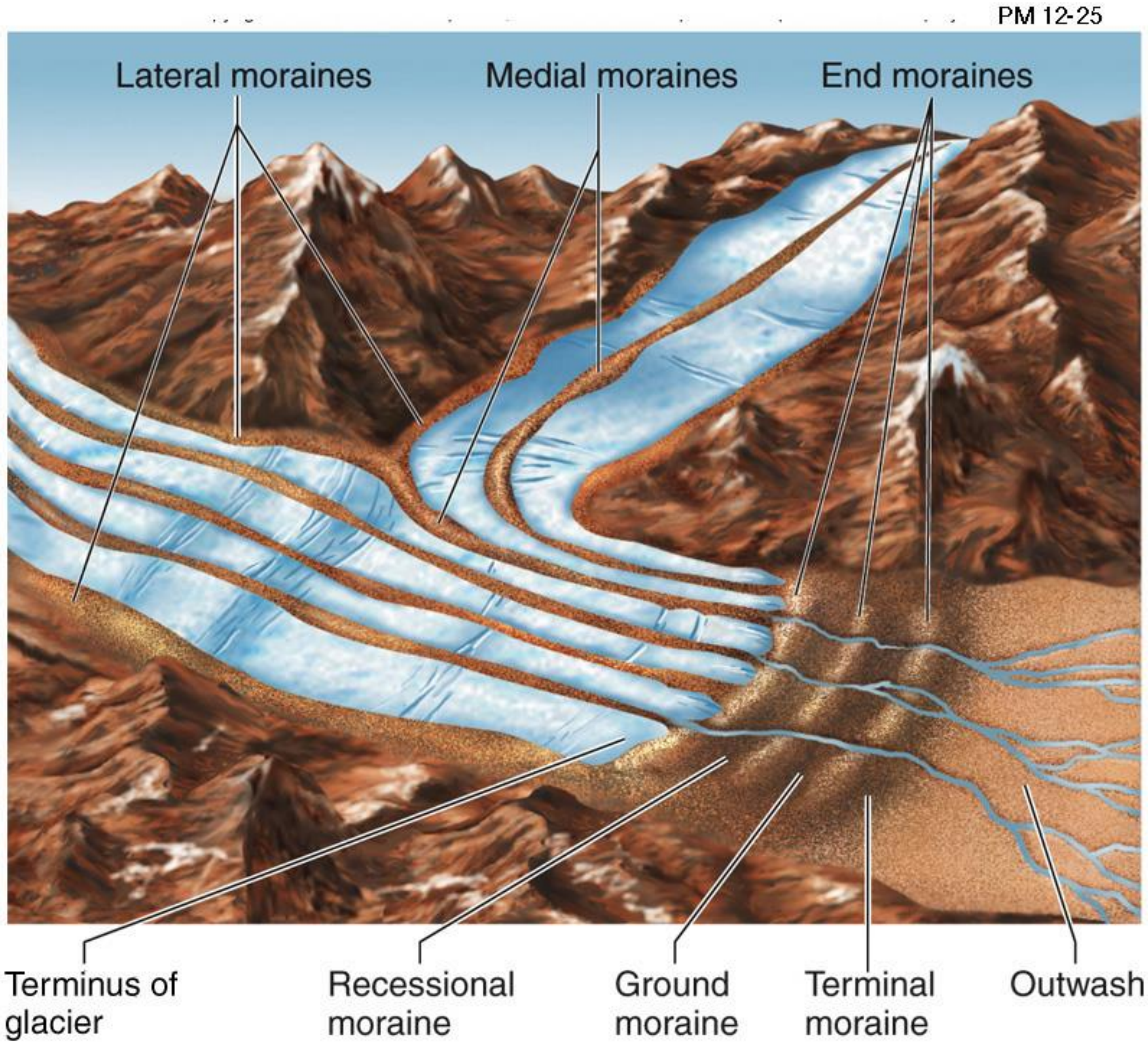




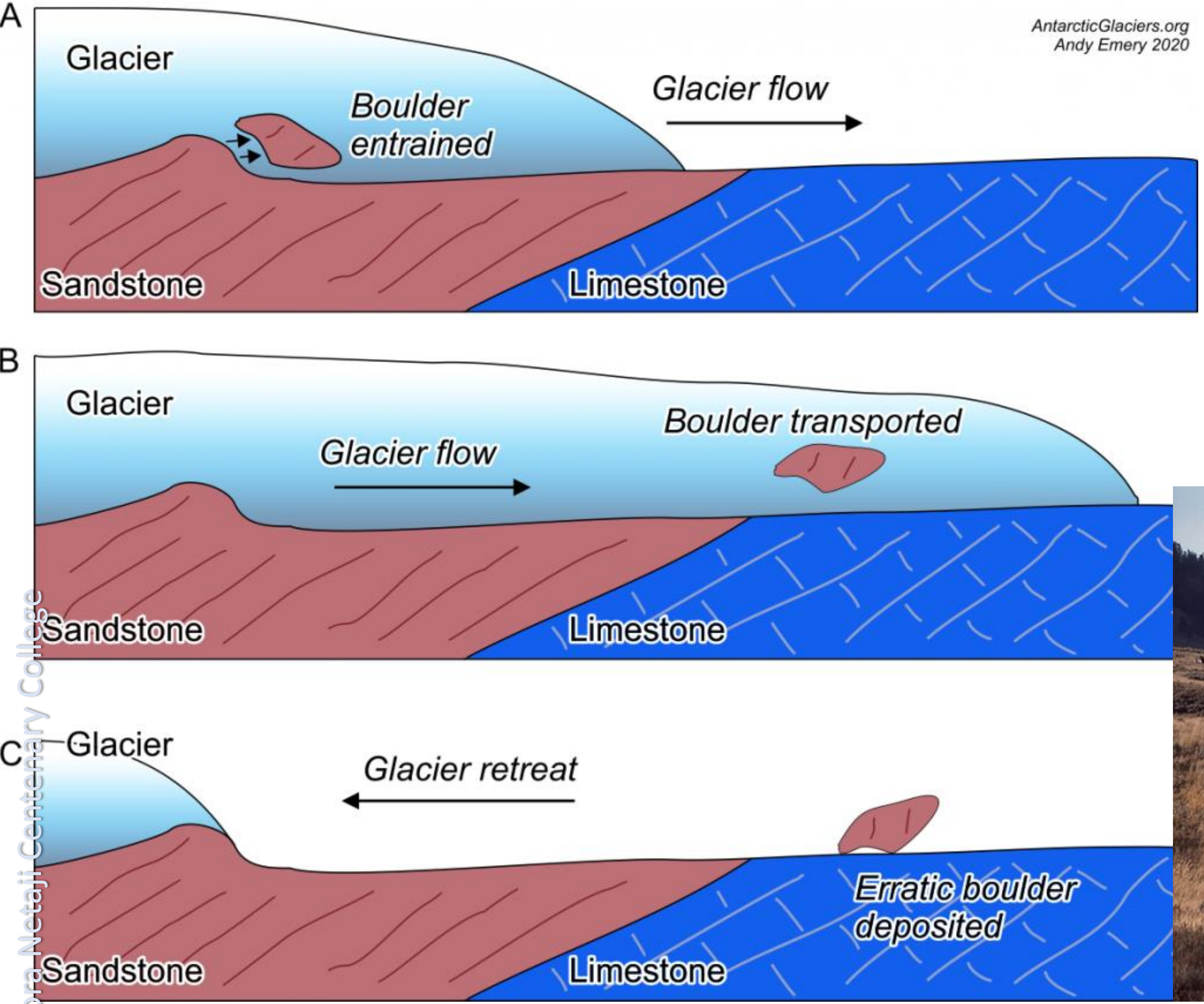
Glacial depositional landforms

1. Moraine, accumulation of rock debris (**Till**, in geology, unsorted material deposited directly by glacial ice and showing no stratification.) carried or deposited by a glacier. The material, which ranges in size from blocks or boulders (usually faceted or striated) to sand and clay, is unstratified when dropped by the glacier and shows no sorting or bedding. Several kinds of moraines are recognized:

1. ground moraine
2. terminal moraine
3. lateral moraine
4. medial moraine
5. recessional moraine




lateral
moraine
Mueller
Glacier
glacial
lake
lateral
moraine
recessional
moraines
terminal
moraine



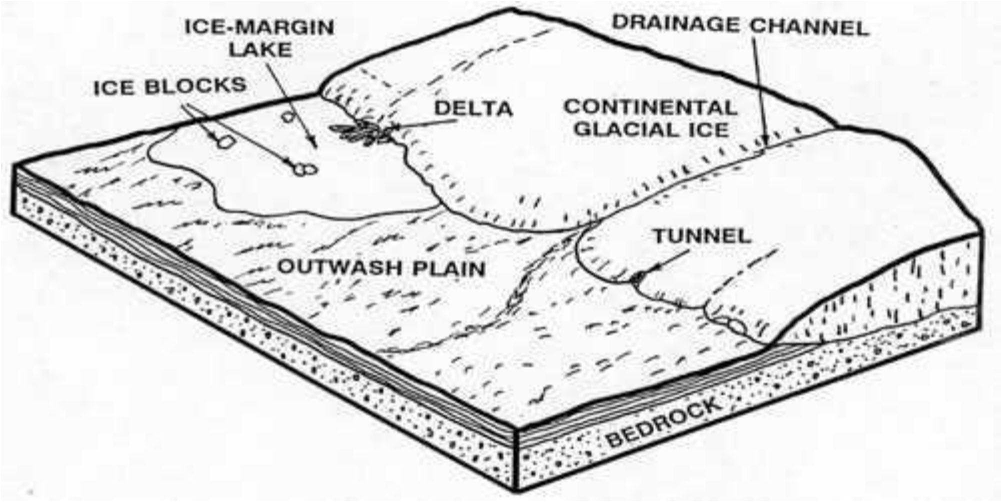
2. Erratics: Glaciers can pick up chunks of rocks and transport them over long distances. When they drop these rocks, they are often far from their origin—the outcrop or bedrock from which they were plucked. These rocks are known as glacial erratics. Erratics record the story of a glacier's travels.

3. Drumlins

- Drumlins are generally found in broad lowland regions, with their long axes roughly parallel to the path of glacial flow.
- Although they come in a variety of shapes, the glacier side is always high and steep, while the lee side is smooth and tapers gently in the direction of ice movement.
- Drumlins can vary widely in size, with lengths from 1 to 2 km (0.6 to 1.2 miles), heights from 15 to 30 m (50 to 100 feet), and widths from 400 to 600 m.
- Drumlins are commonly found in clusters numbering in the thousands. Often arranged in belts, they disrupt drainage so that small lakes and swamps may form between them.

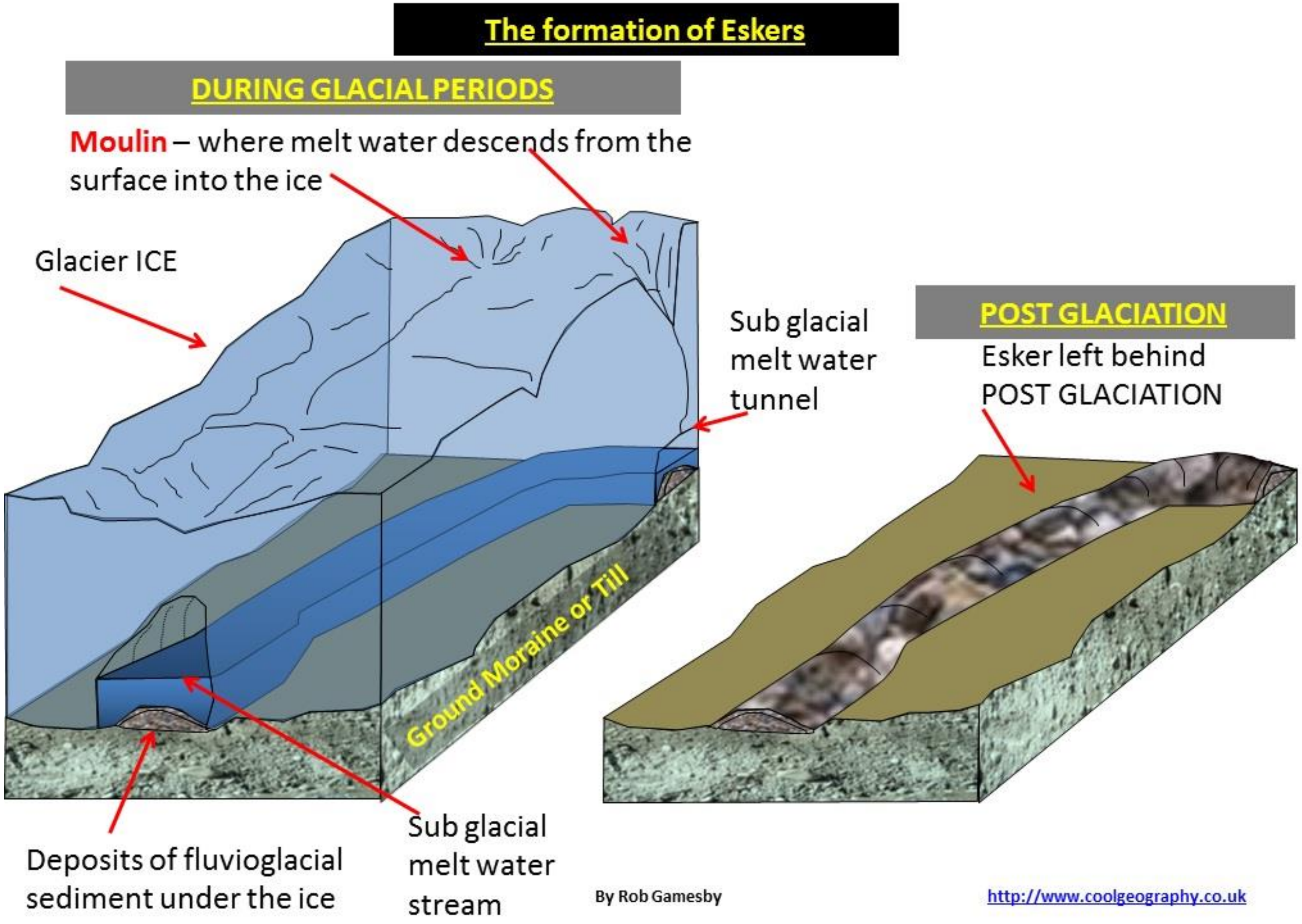
Glacio-Fluvial Landforms:

1. **Out Wash plain**: **Outwash**, deposit of sand and gravel carried by running water from the melting ice of a glacier and laid down in stratified deposits.



2. Valley train/ Sandur: An accumulation of fluvioglacial deposits laid down in a valley by meltwaters escaping from a decaying glacier. The surface slopes quite steeply down-valley, and is incised by shifting braided streams.

3. **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.

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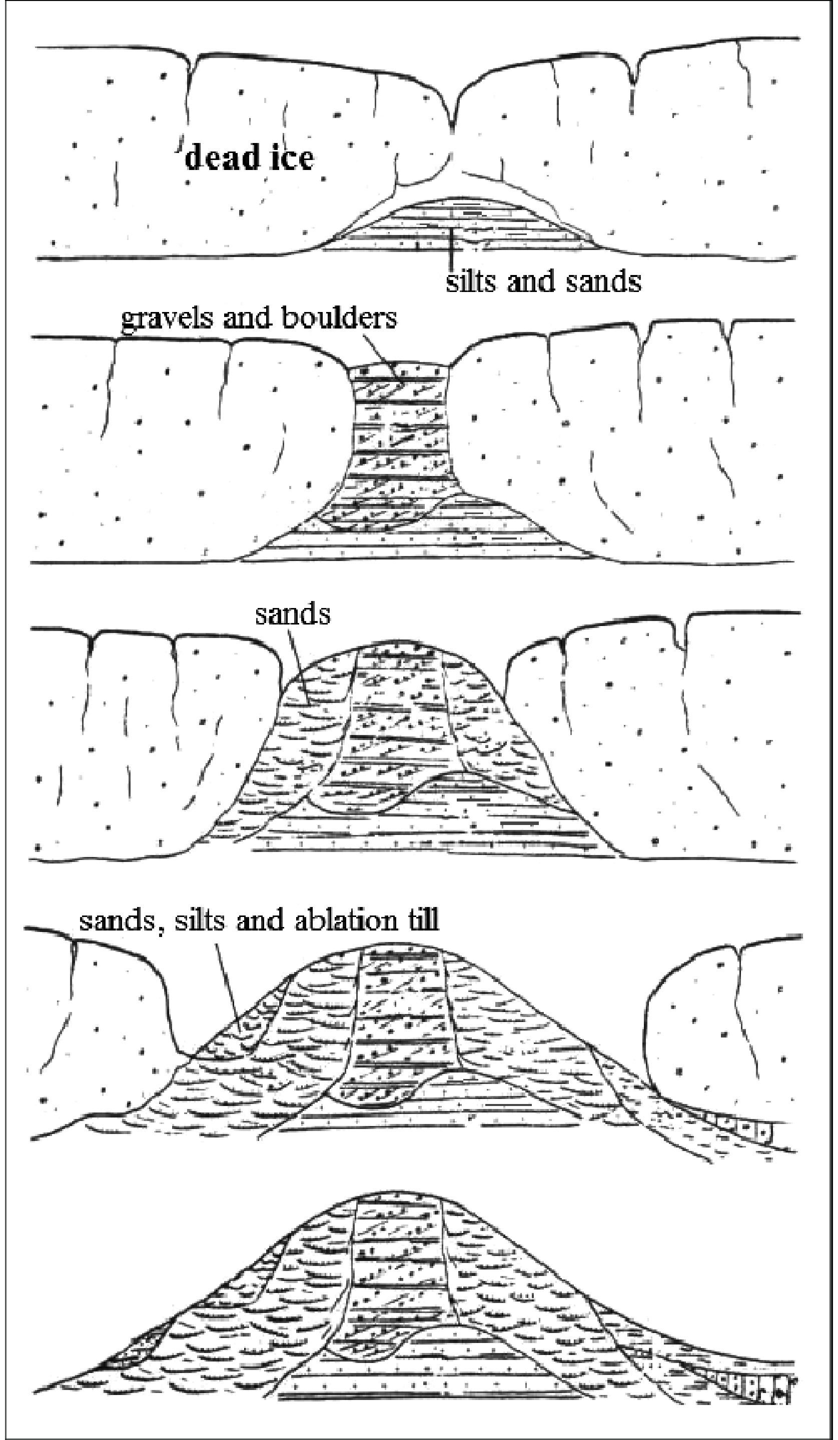


4. **Kames** are mounds of poorly sorted sand and gravel deposited from running water in close association with stagnant glacial ice. Kames form within holes or fissures in the glacier or between the glacier and the land surface. They may appear, after melting of the ice, as a single mound (a kame or moulin kame), groups of closely associated mounds (kame field, kame complex, or kame group) or as a ridge called a crevasse filling , if straight, or an esker , if long and winding. Bedding within any type of kame is highly irregular, locally cross-bedded, and frequently distorted as a result of collapse of supporting ice.

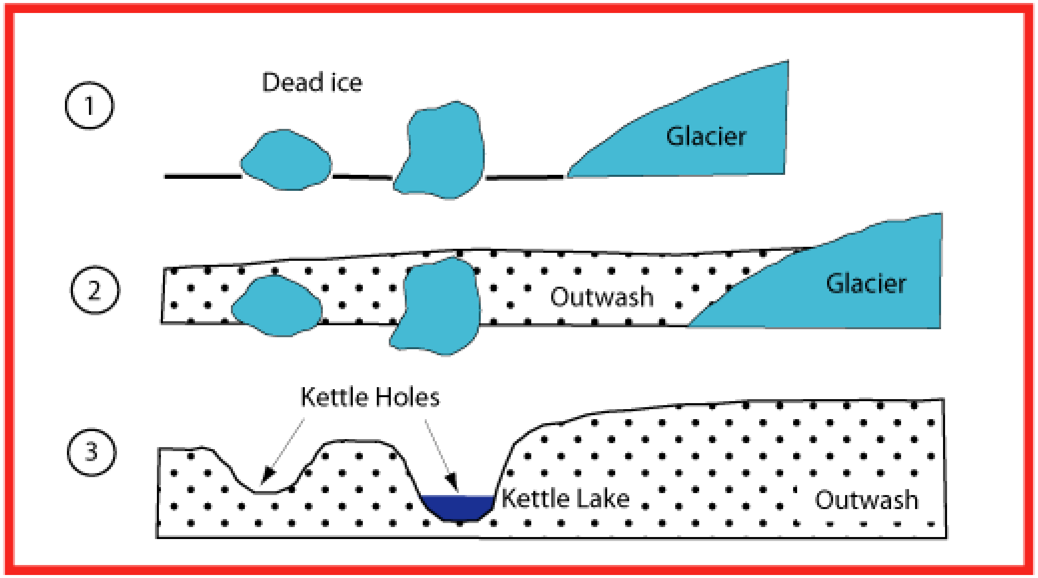
Ice Contact Features
Kame Terrace

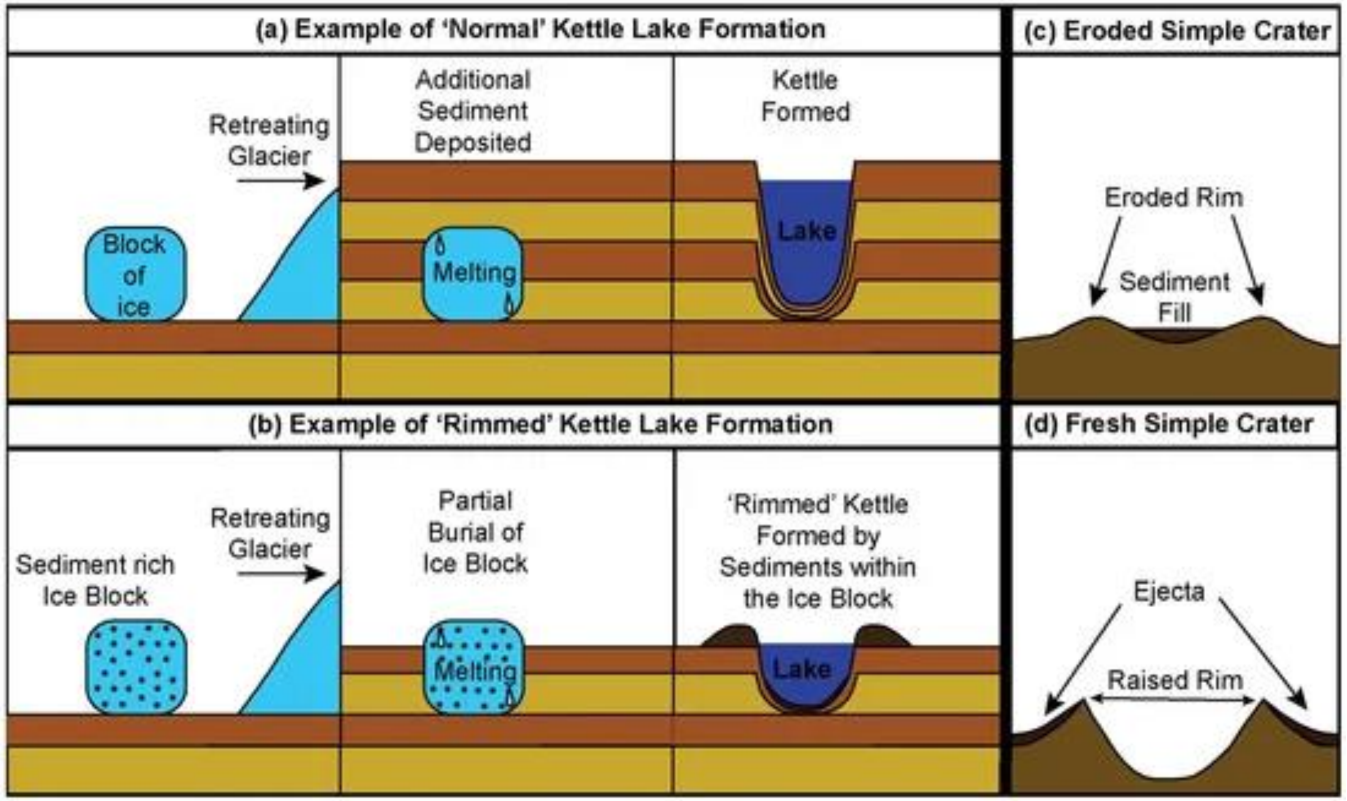
Appearance:

Ridges of material running along the edge of the valley floor.

Formation:

- Sediment accumulates in ponds and lakes trapped between lobes of glacier ice.
- Sometimes between a valley glacier and the valley side.





5. **Kettles** form when a block of stagnant ice (a serac) detaches from the glacier. Eventually, it becomes wholly or partially buried in sediment and slowly melts, leaving behind a pit. In many cases, water begins fills the depression and forms a pond or lake—a kettle. Kettles can be feet or miles long, but they are usually shallow.

Why study glaciers

- Glaciers cover about 10% of the land surface near Earth's poles and they are also found in high mountains. During the Ice Ages, glaciers covered as much as 30% of Earth.
- Around 600 to 800 million years ago, geologists think that almost all of the Earth was covered in snow and ice. Scientists use the evidence of erosion and deposition left by glaciers to do a kind of detective work to figure out where the ice once was.
- Glacial erosion is hyper effective at shaping unique landscapes. Evidence suggests that glacial erosion is commonly more rapid than fluvial erosion. The onset of glaciation associated with late Cenozoic climate change is also hypothesized to have increased global erosion rates and influenced tectonic deformation.
- The study of glacier fluctuations is relevant to an understanding of climate and climate change over temporal scales from decades to thousands of years, and at regional to global spatial scales.
- Failure of glacier dams can cause floods that engineers and town officials seek to prevent. Anthropogenically induced global warming is causing retreat of ice sheets and mountain glaciers; planners and policy makers want to know how to stop this retreat, and how fast it will raise sea level, impacting coastal infrastructure. A quantitative understanding of the physics of glaciers is essential for rigorous analysis of many of these problems.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