The Cryosphere

Chapter 17: Glacial Landscapes and the Cryosphere

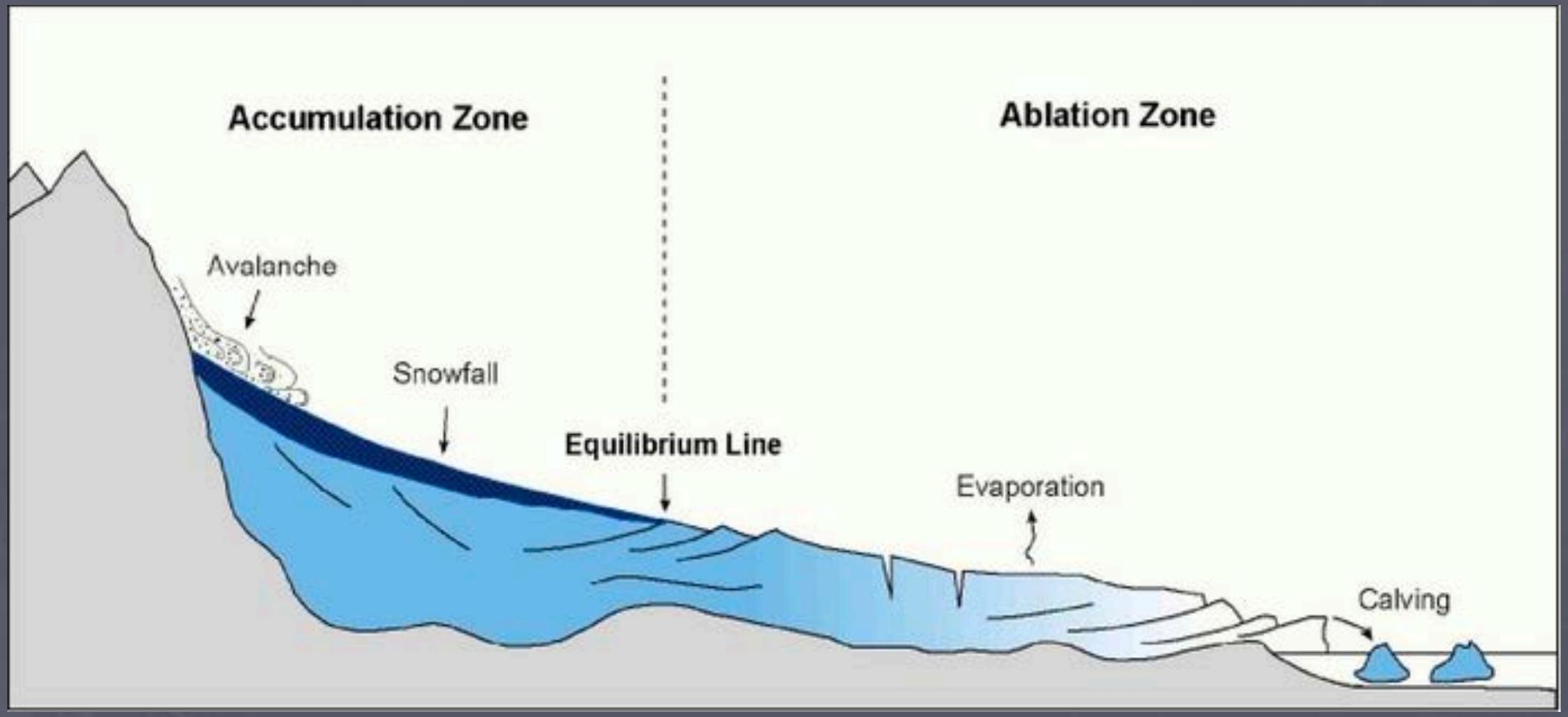
Defining Glaciers

- Glaciers are large masses of ice that can be on land or floating in the ocean as an ice shelf adjacent to a land mass.
  - Glaciers formed by the gradual accumulation and compaction of falling snow

Glacial Dynamics

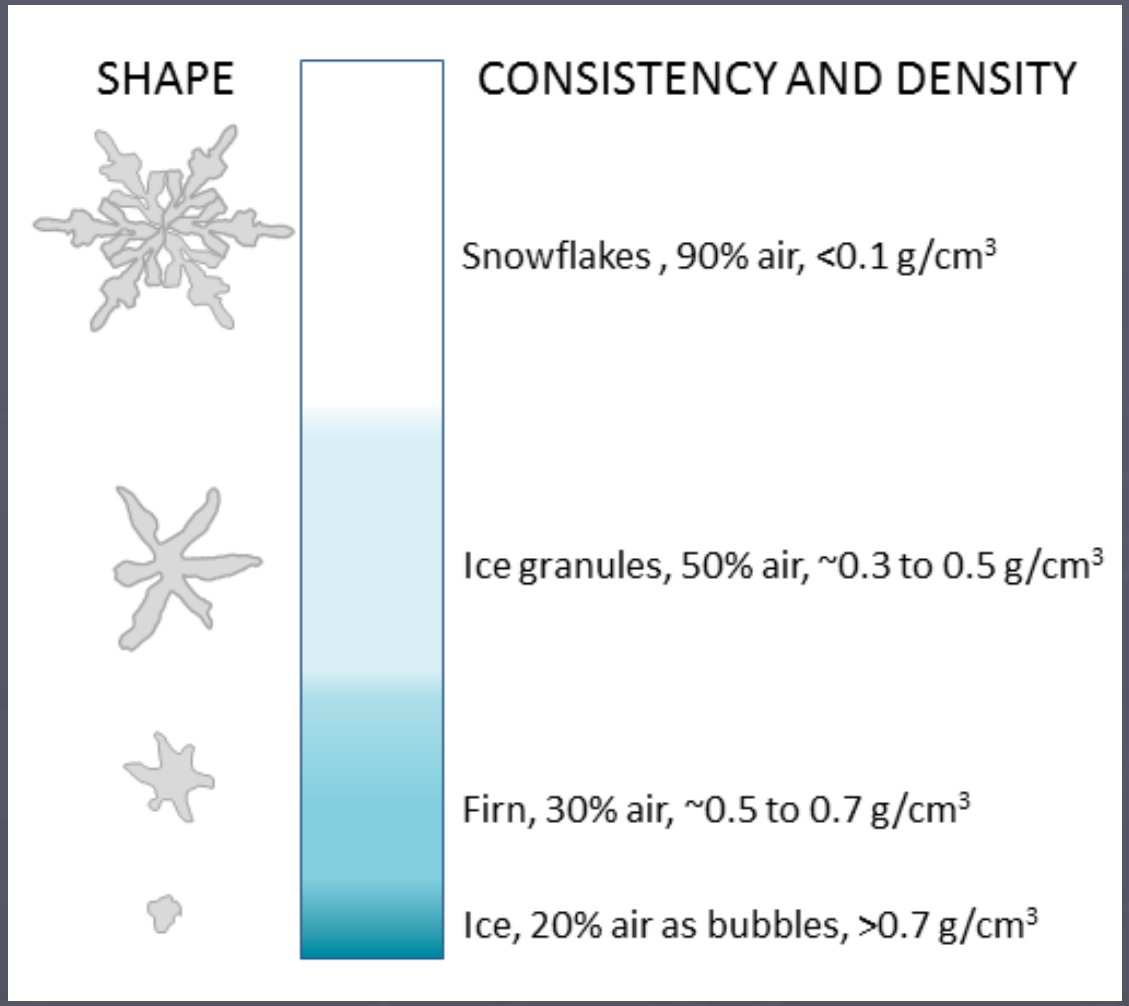
- Glaciers are not static, instead are constantly moving
  - Zones of accumulation – areas of net input where more new snow/ice accumulated than melted/broken off
  - Zones of Ablation – areas of net decrease where more ice is melted/broken off than is accumulated

Accumulation vs. Ablation



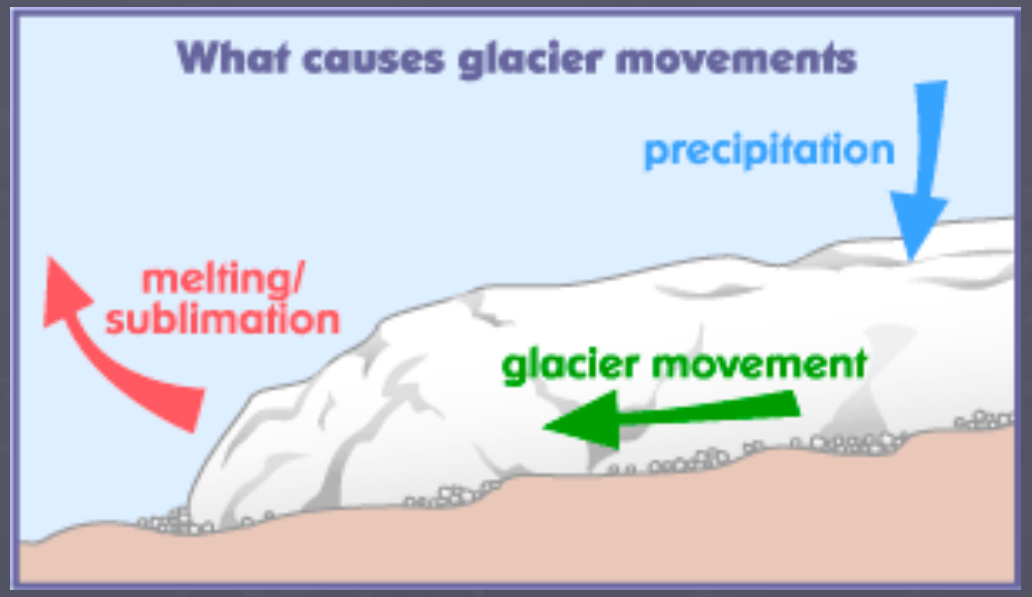
Glacial Formation

- Glaciers form over thousands of years
  - Gradual accumulation and compression of snow/frost to form dense glacial ice
  - Main Stages are snow-> Firn -> Glacial Ice



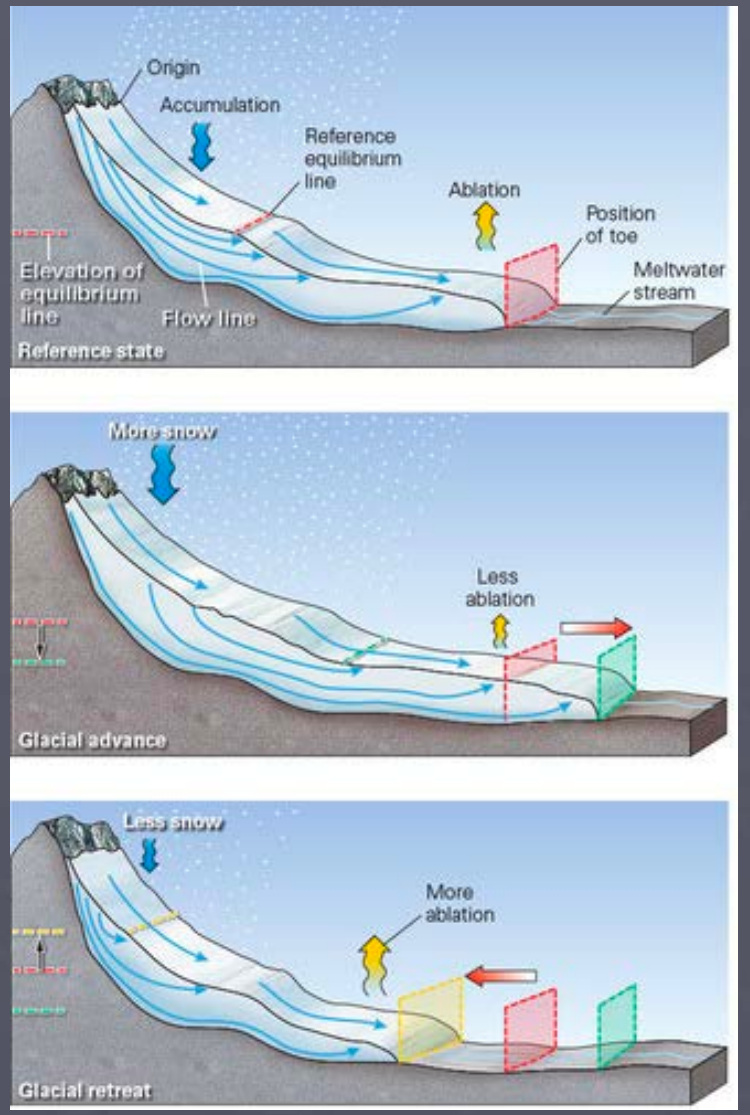
Glacial Movement

- Alpine flow - Glaciers move from high elevation to low
- Deformation (Plastic Flow) – Accumulation in middle of glacier pushes outward
- Speed varies from inches/year to feet/day



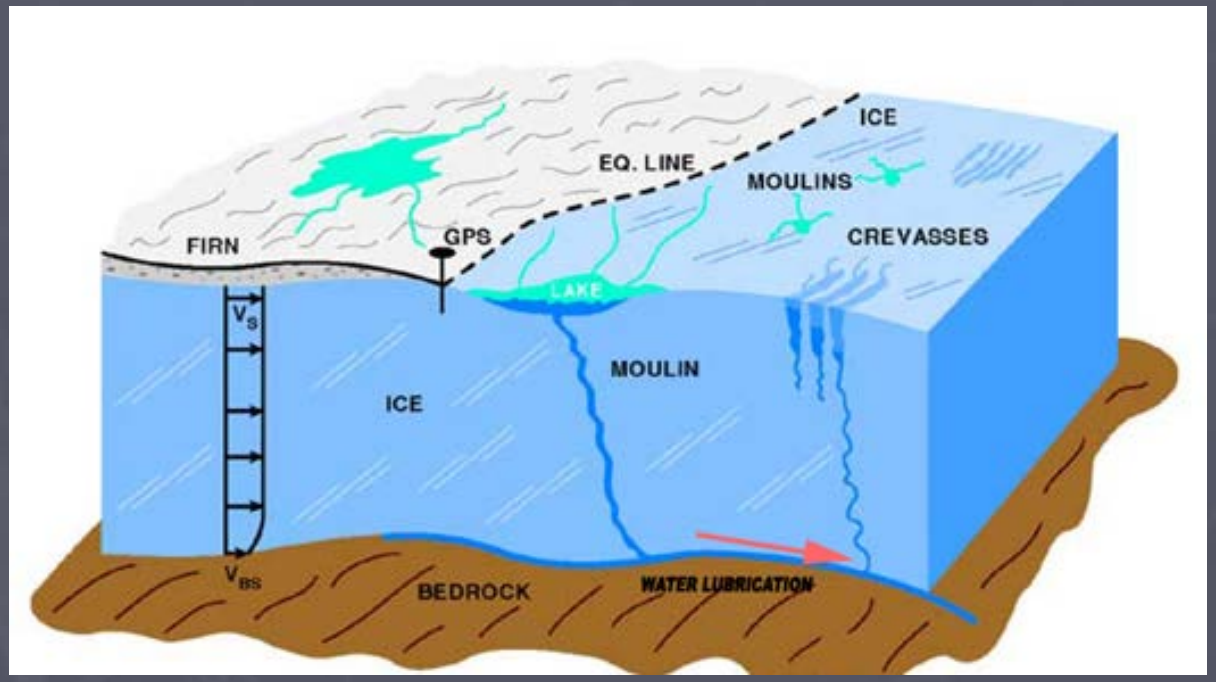
Glacial Flow: Advance and Retreat

- Advance – When Accumulation>Ablation
- Retreat – When Ablation>Accumulation



Crevasses, Meltwater & Surges

Ice melts on the surface, falls through crevasses and holes (moulins) in the ice, lubricating the underside of the glacier, potentially causing a surge in movement.



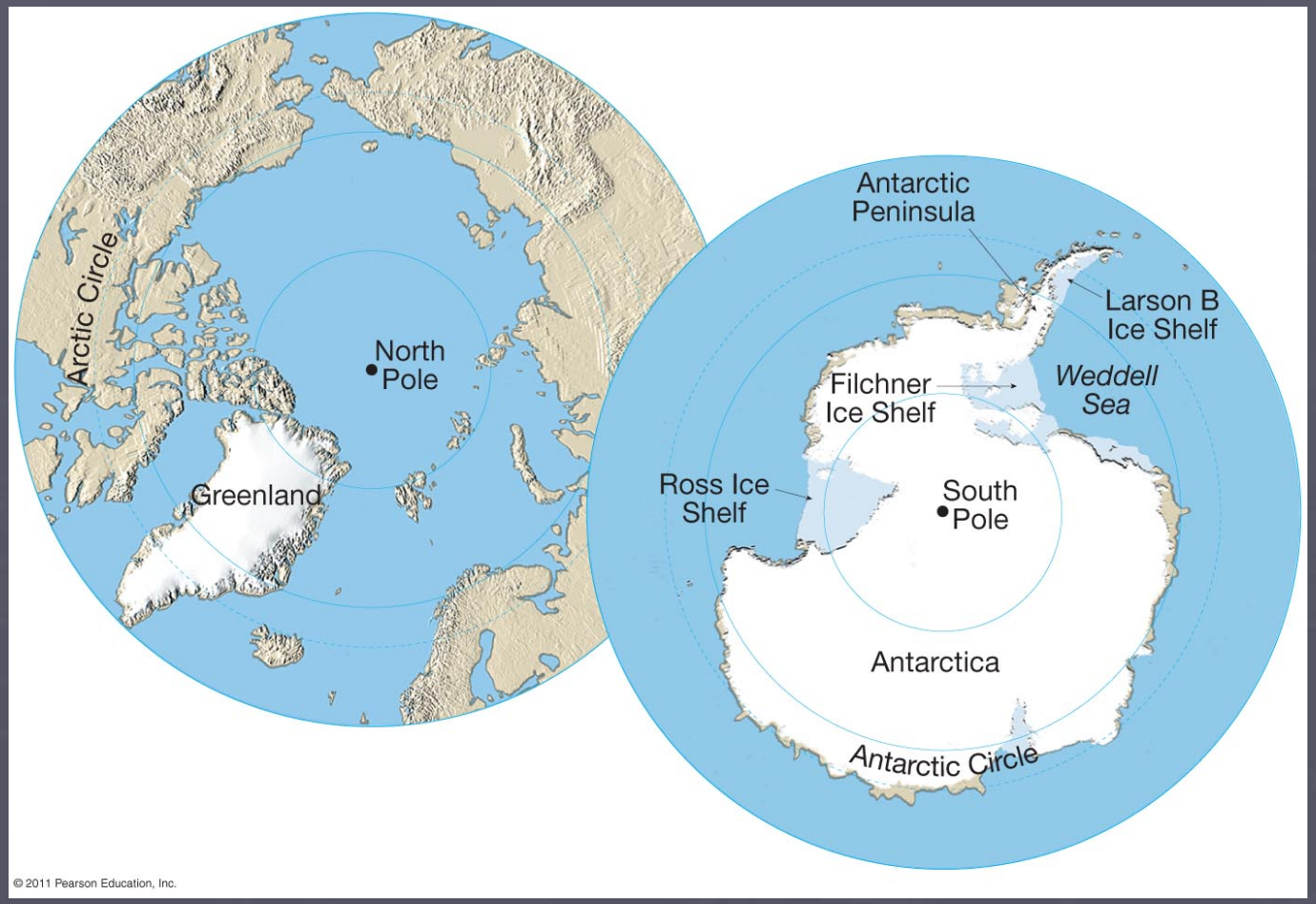
Glacial Retreat

Main Types of Glaciers

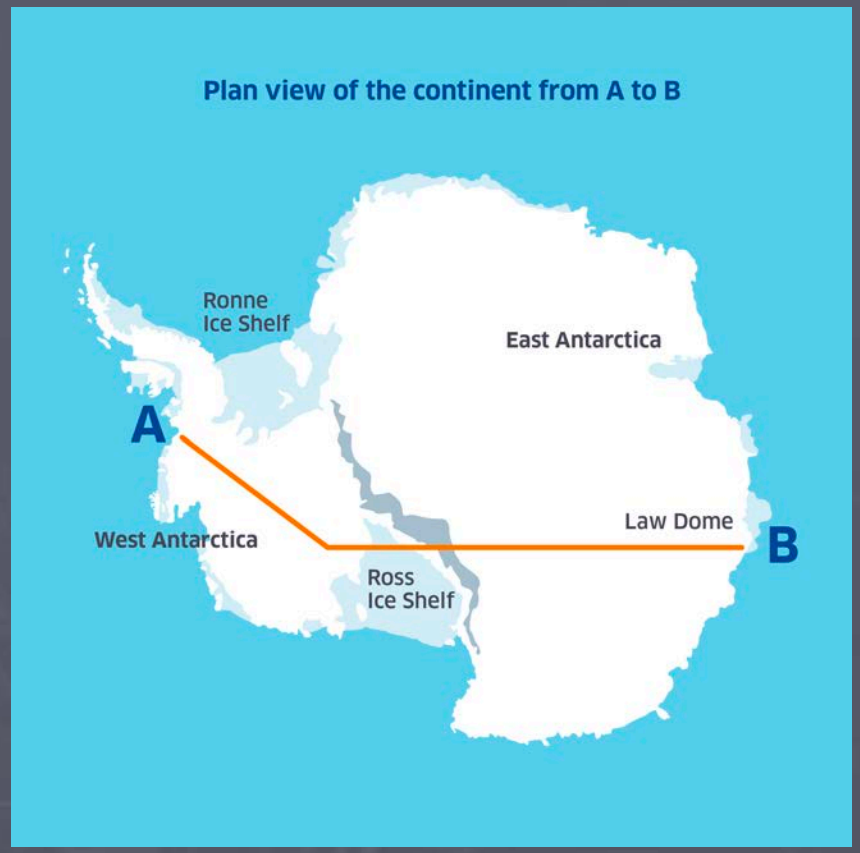
- Ice Sheets/Continental Glaciers
  - Form in non-mountainous areas. Can be miles thick and over 10,000 square miles
  - Presently located only at the poles
- Mountain/Alpine Glaciers
  - Form at high altitude
  - Much smaller than Continental glaciers
  - Found on every continent
    - Minimally near Kilimanjaro and New Zealand

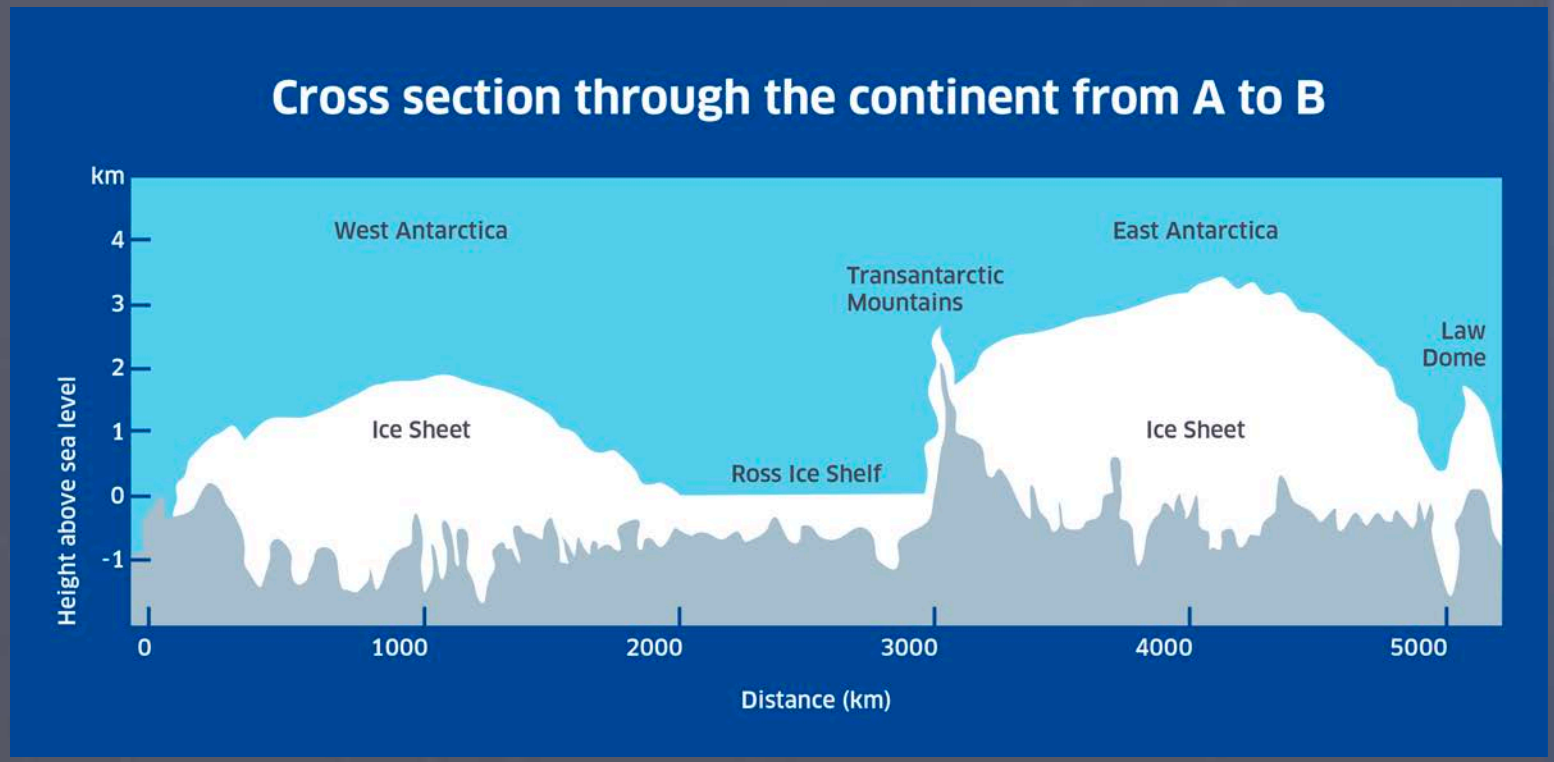
Continental Ice Sheets

Today only two remain: Greenland and Antarctica



Antarctica Ice Sheet



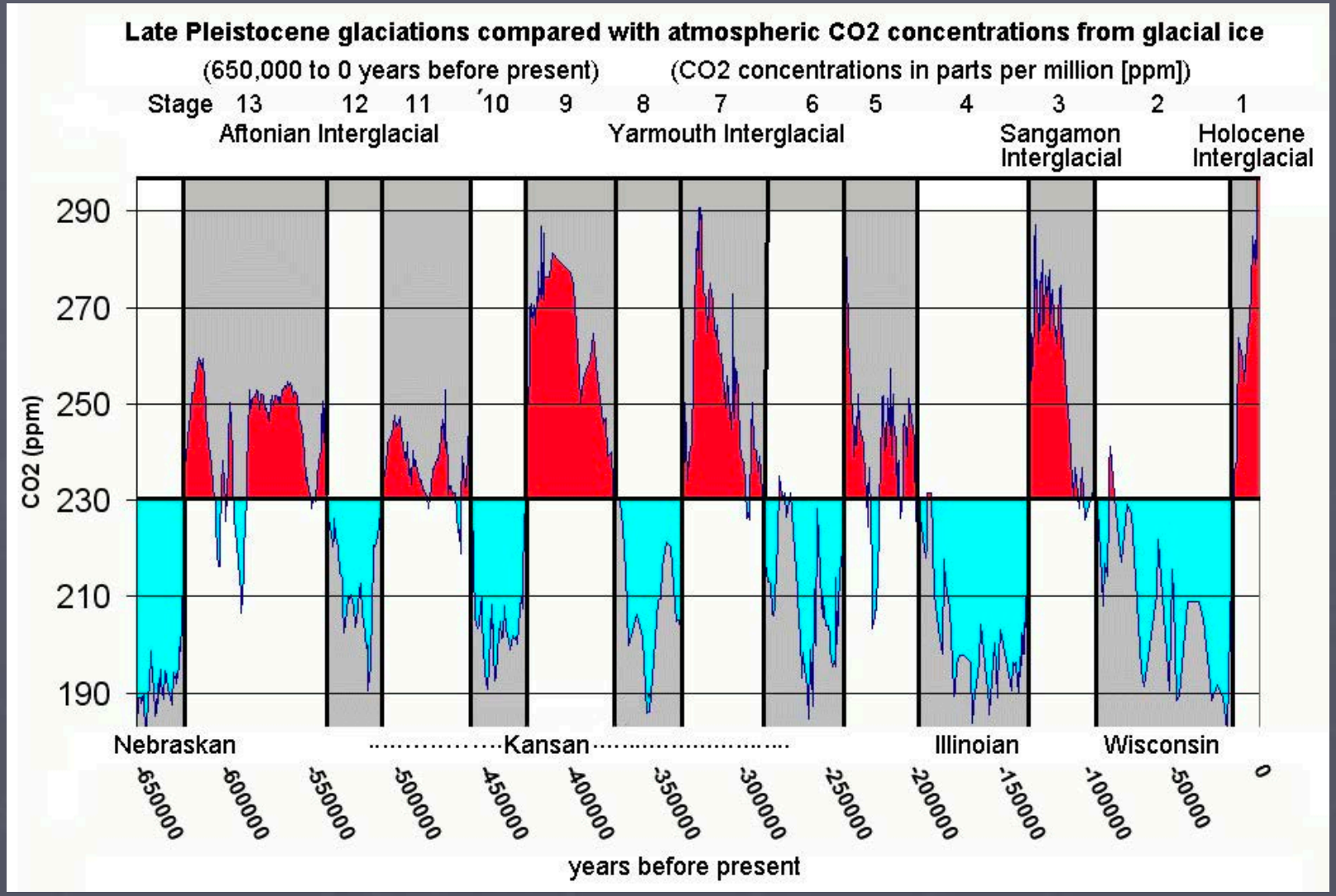


Antarctic Ice Sheet Divided into two sections – western is grounded below sea level, eastern is larger at above sea level

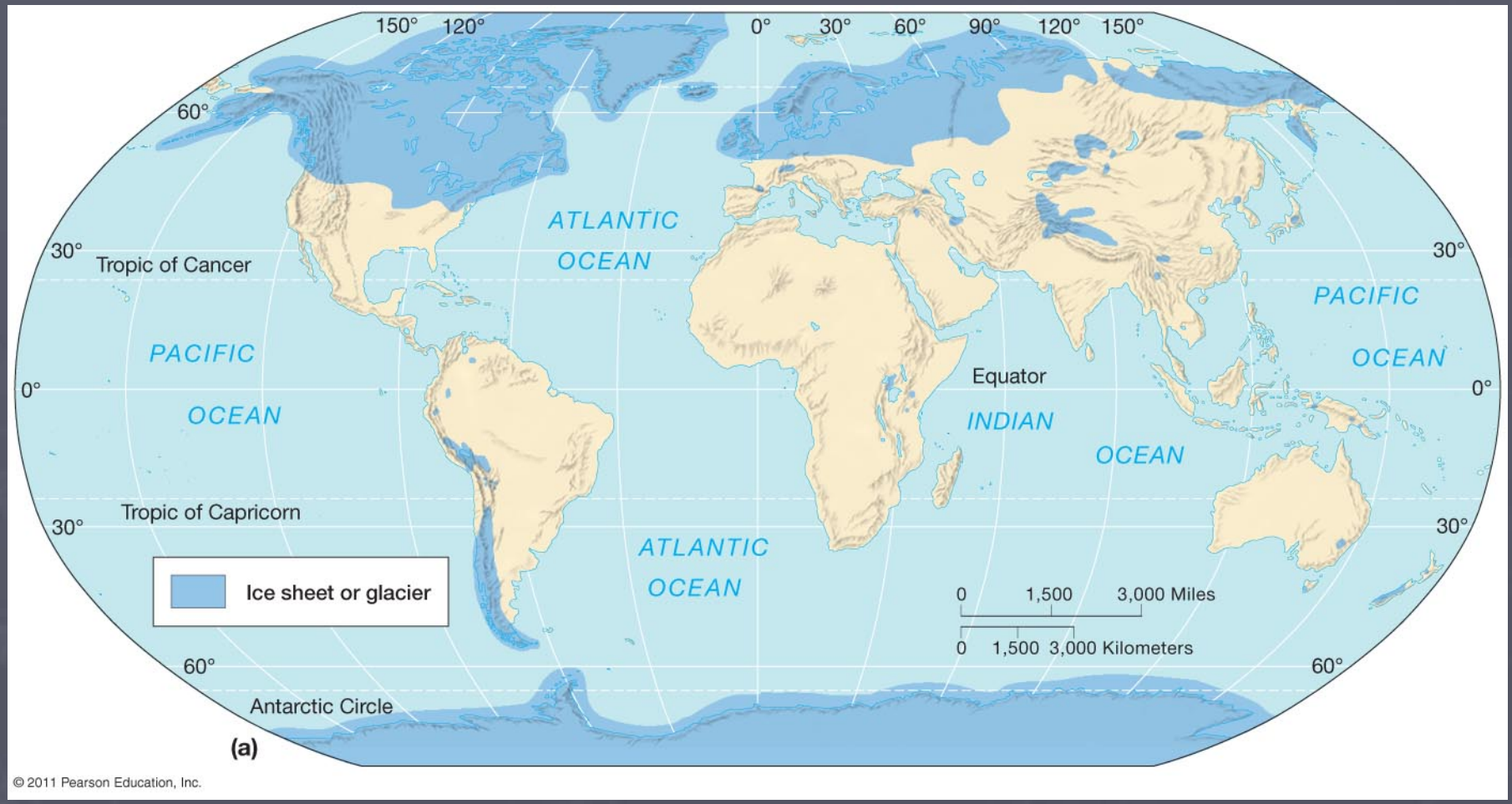
The Pleistocene Epoch

- Geological period from about 2.6 m.y.a to 12,000 y.a.
  - Characterized by steady periods of glaciation and thawing

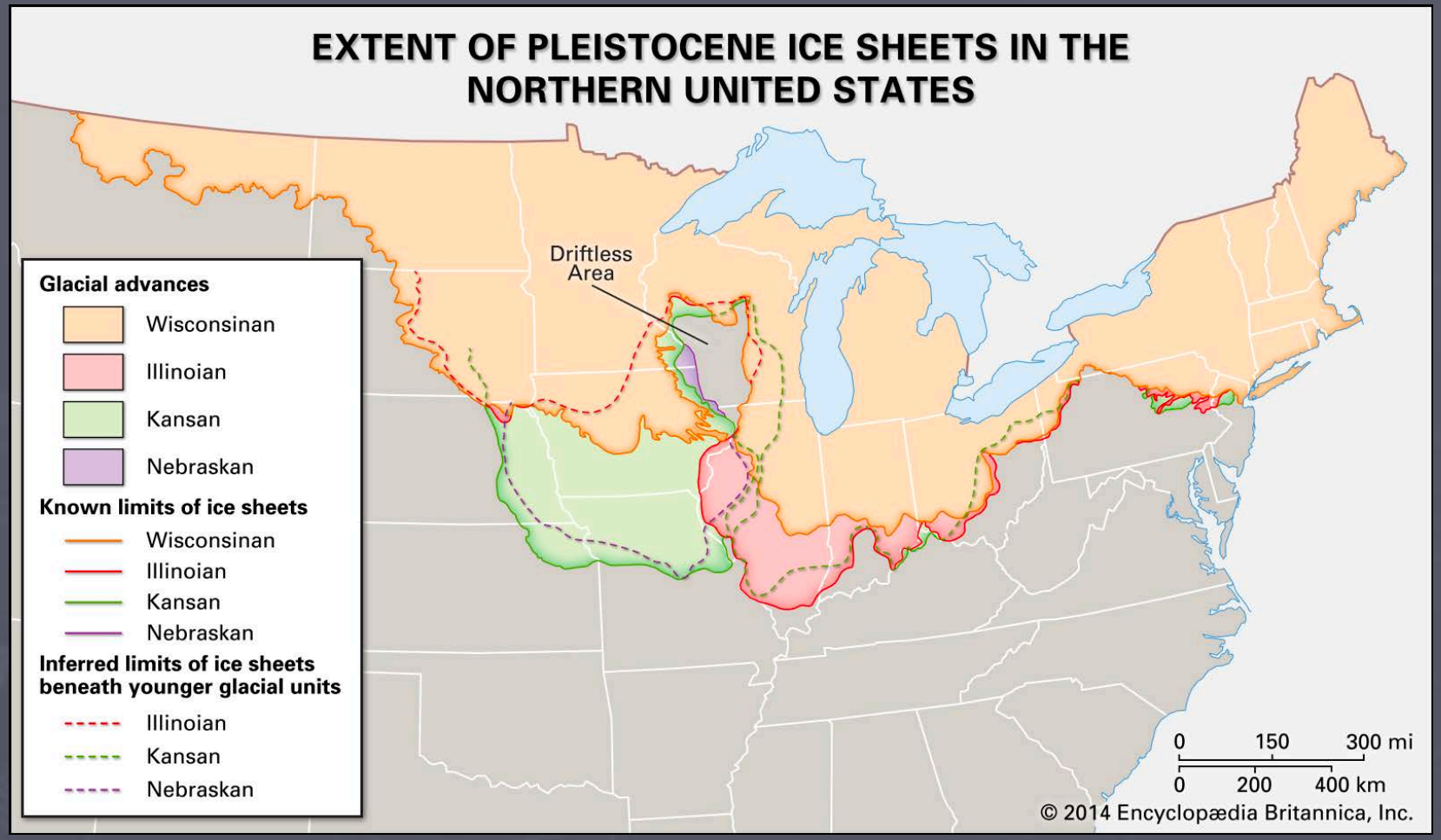
The Pleistocene Epoch



Pleistocene Glaciation

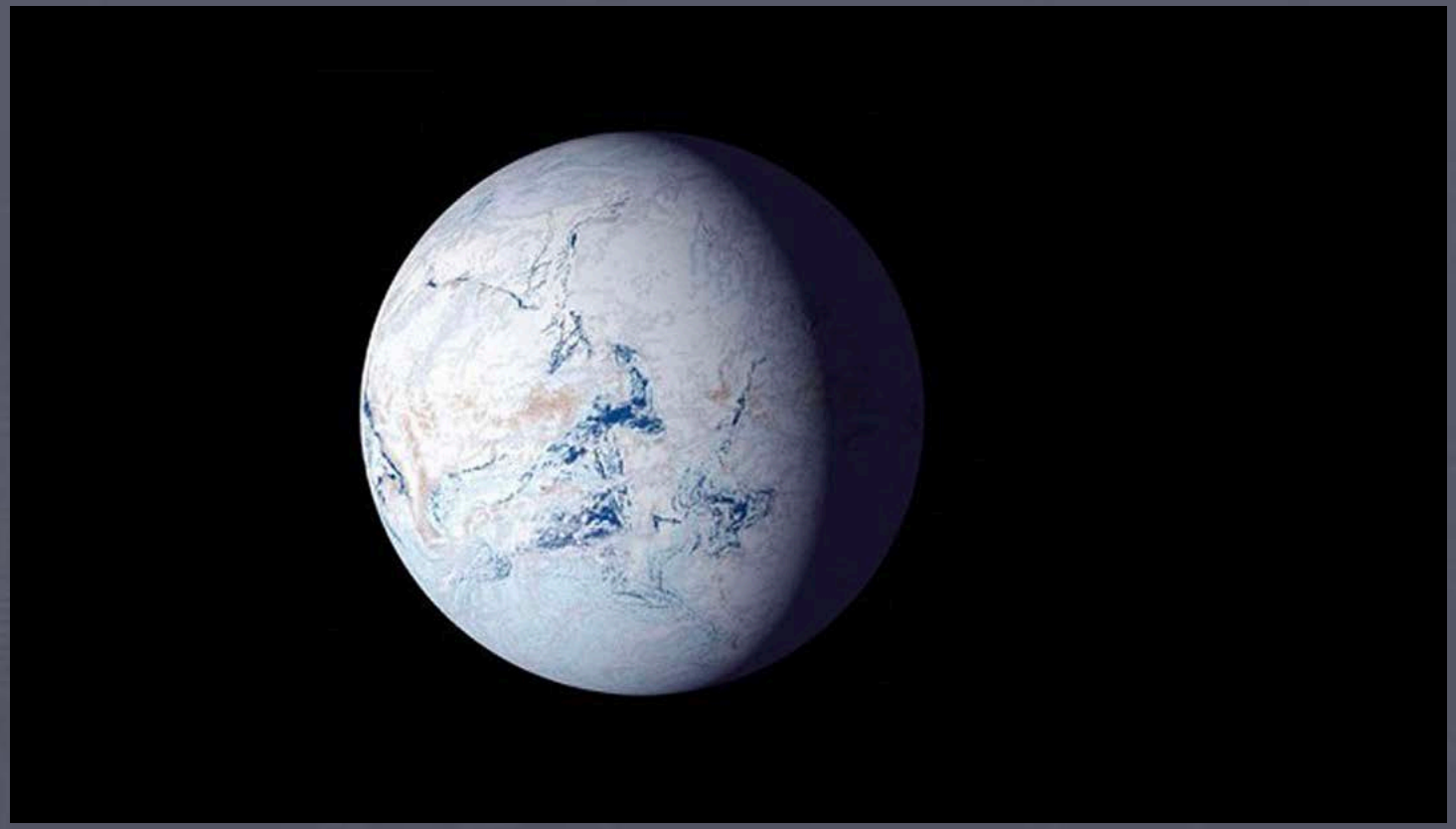


Pleistocene Ice Ages



Snowball Earth Hypothesis

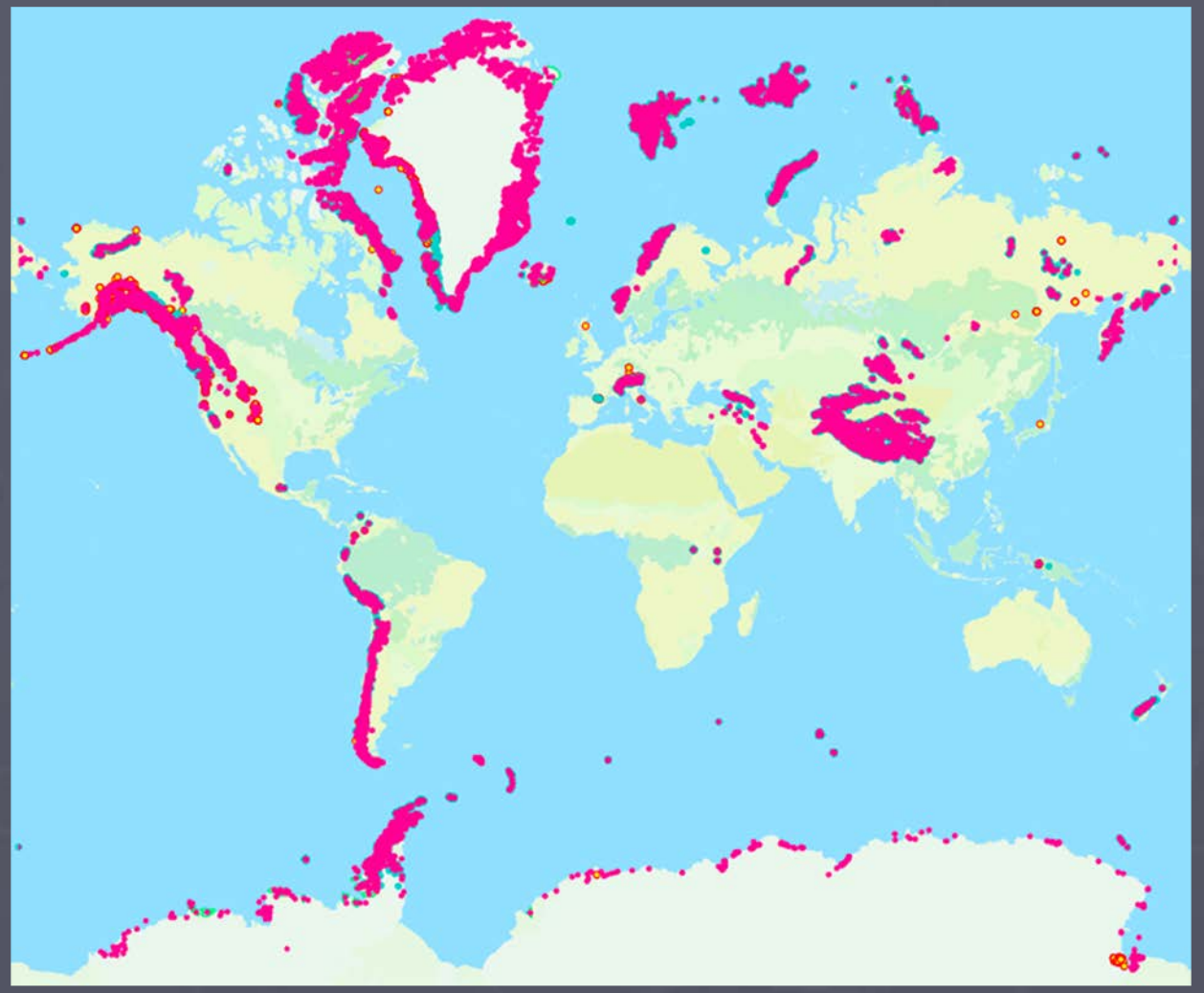
- Theorized that around 650 M.Y.A Earth was completely glaciated



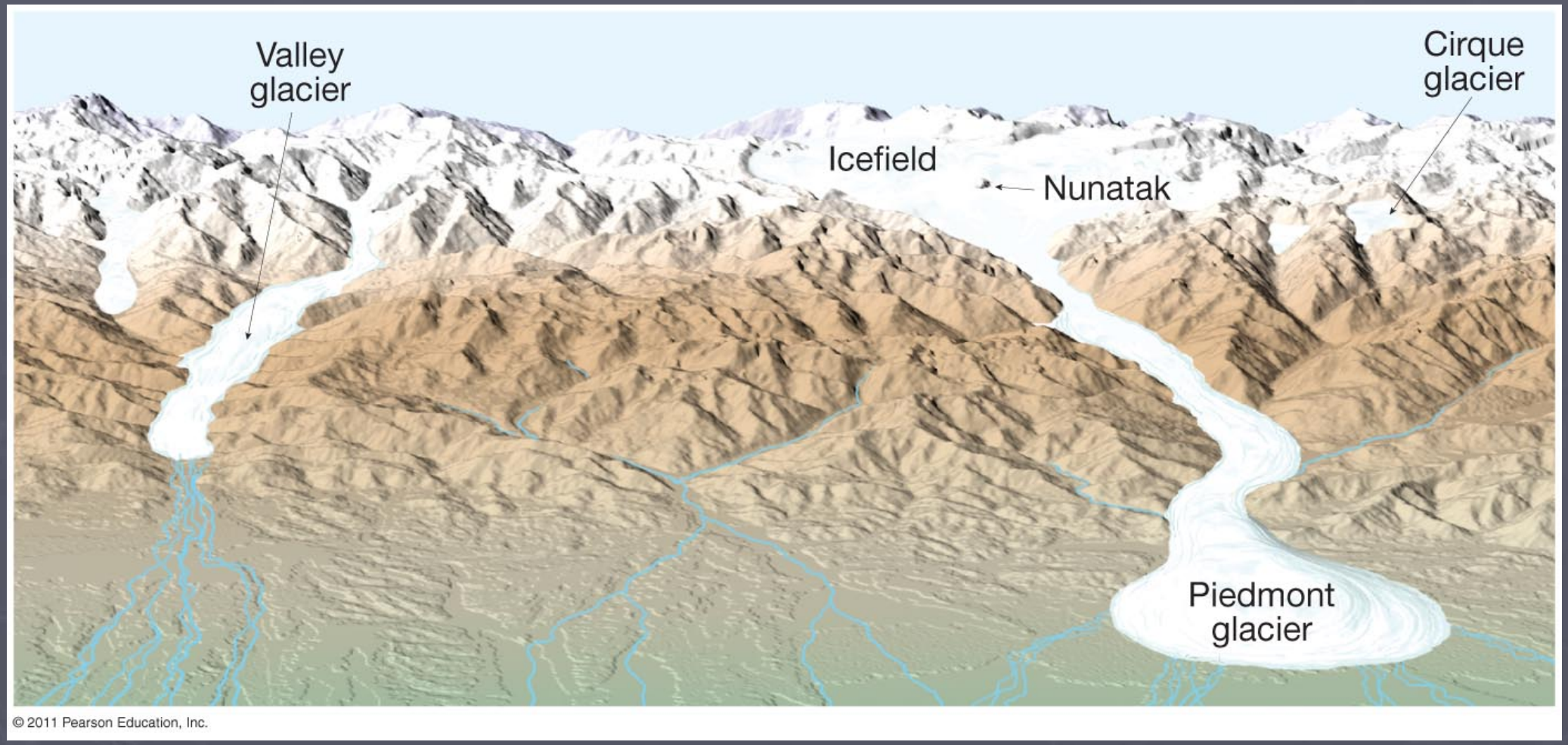
Mountain/Alpine Glaciers

- Alpine glaciers found at high altitudes, especially at higher latitudes
- Alpine glaciers make up less than 1% of total mass of ice in cryosphere

Glacial Distributions



Alpine Glacier Structure



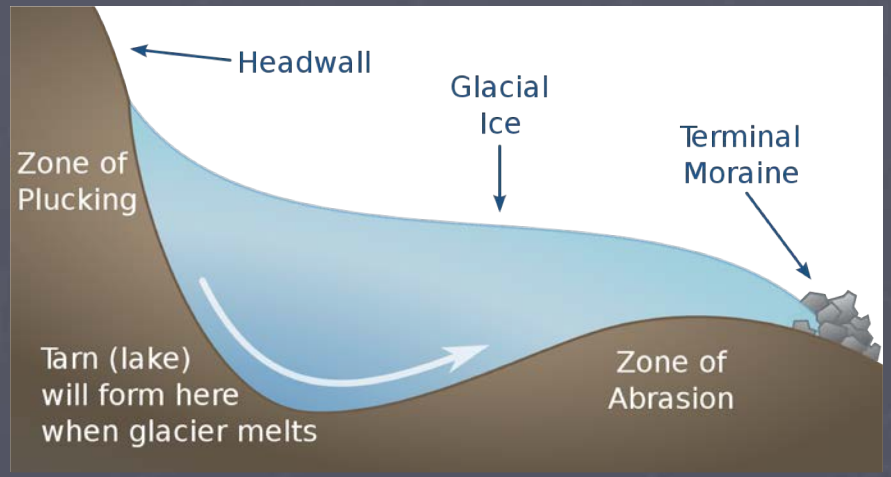
© 2011 Pearson Education, Inc.

Piedmont Glaciers

- Forms when alpine glaciers flow onto flat plains with room to spread out
  - Minimal change in elevation

Cirques

- Large amphitheater like bowls that serve/ed as creation spots for glaciers in high alpine
  - When they melt they often leave small lakes behind called tarns



Horns and Arêtes

- Arête: steep ridge between cirques.
- Horn: steep summit where three or more cirques intersect.

Glacial Trough

- Valley carved out along the path of a glacier in which the glacier has since retreated
  - Often has steep sides
  - Will usually have a flat bottom

Glacial Landscape – Yosemite Valley

Fjord

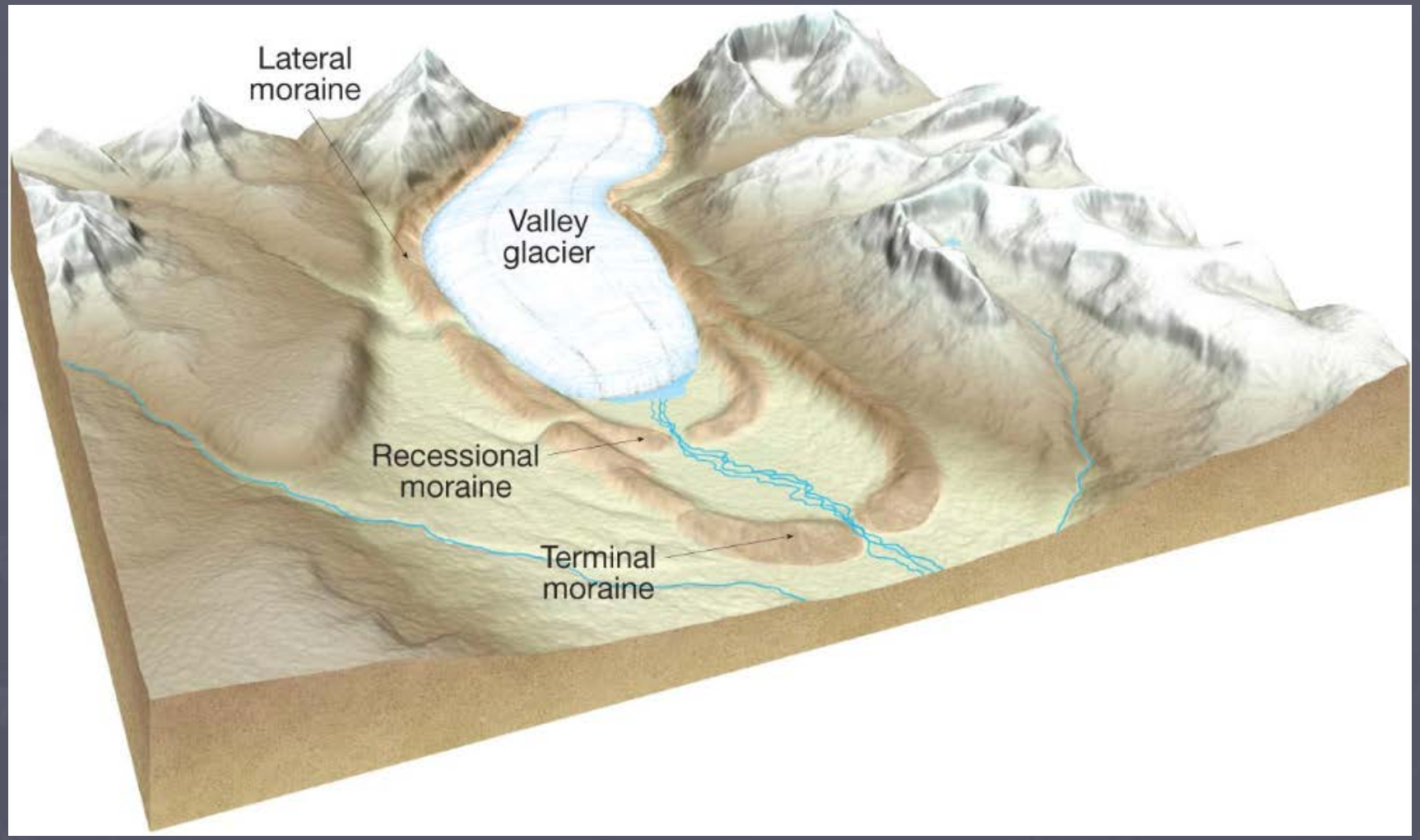
- A trough that has since filled in with water as the glacier has connected all the way to the sea

Fjords Aerial Imagery

Glacial Landscape – Killary Harbour

Glacial Landscape – Alaskan Fjords

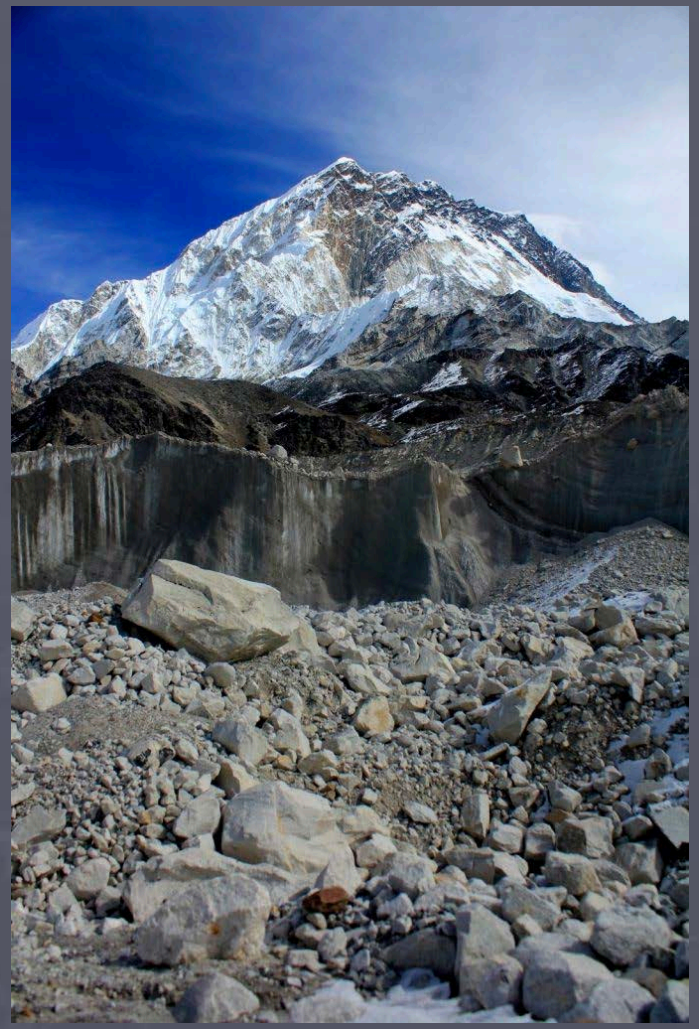
Deposition by Mountain Glaciers



Lateral and Medial Moraines

- Lateral Moraines mark the edges of a glacier (running lateral to flow of the glacier)
- Medial Moraines form when two glaciers flow together – moraines mark boundary of tributary glaciers

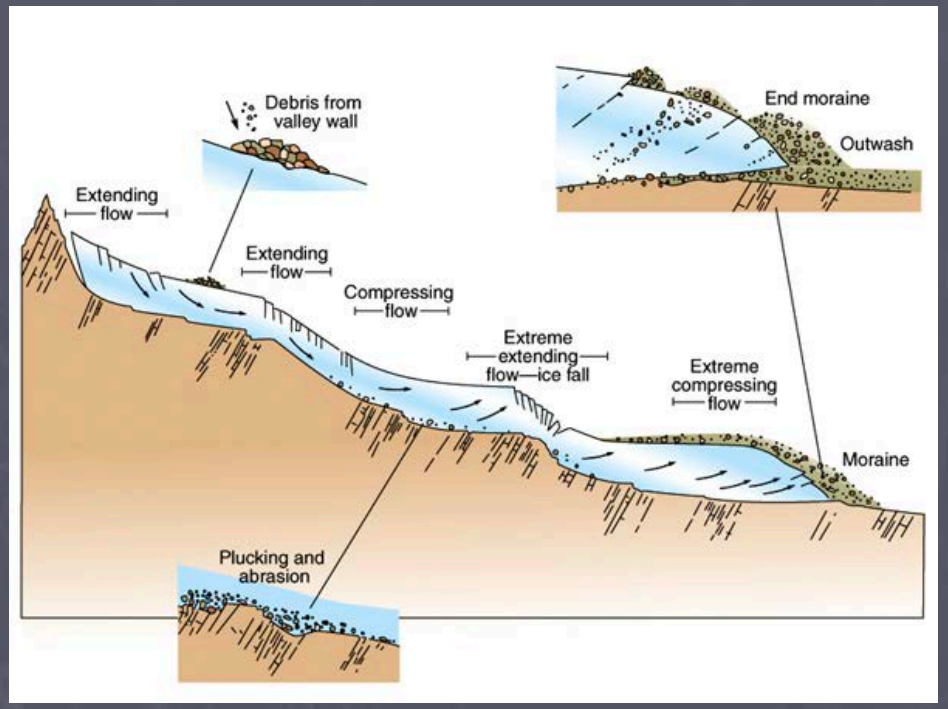
Glacial Erosion

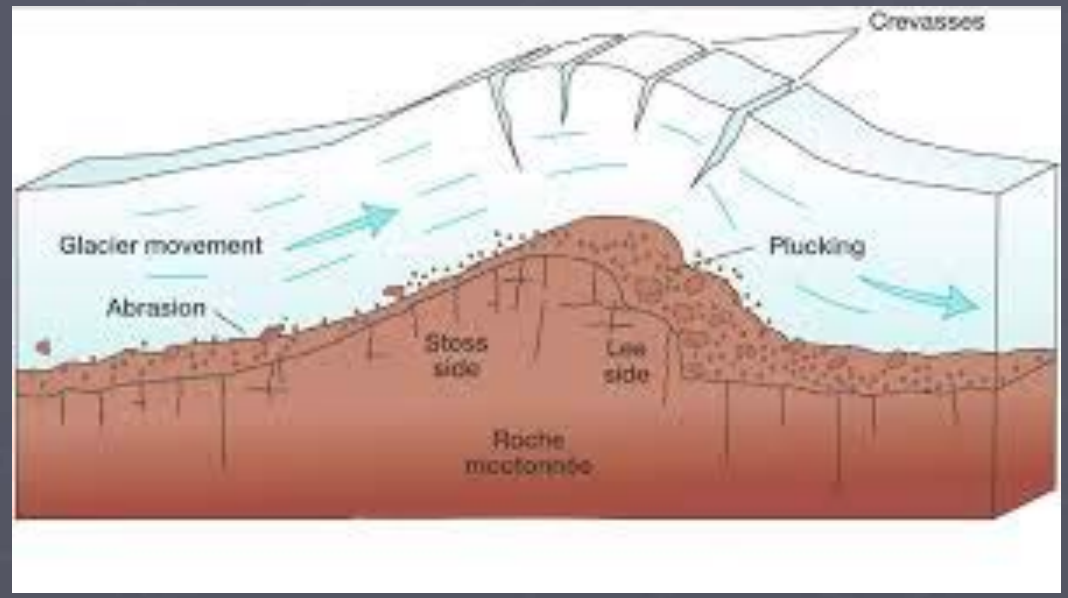


- Over periods of thousands or millions of years glaciers carve away and redistribute rock and soil
- Accomplished through glacial plucking, abrasion, and meltwater

Glacial Plucking

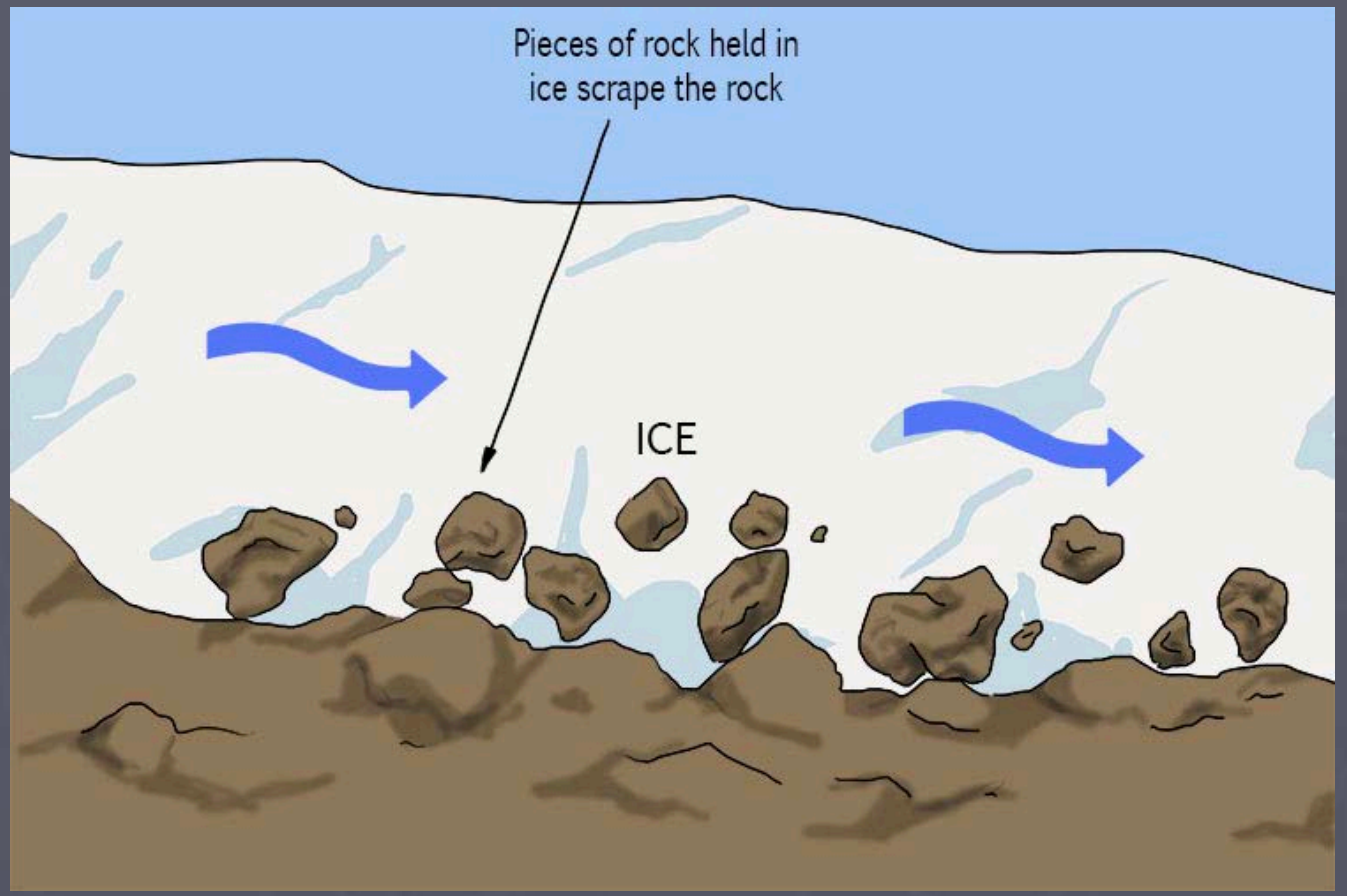
- As the glacier moves meltwater seeps into cracks, freezes and thaws until bedrock pieces break off
  - They then become part of the glacier and are deposited elsewhere





Glacial Abrasion

- The wearing down and smoothing out of a surface of the glacier, or rocks along the bottom of the glacier



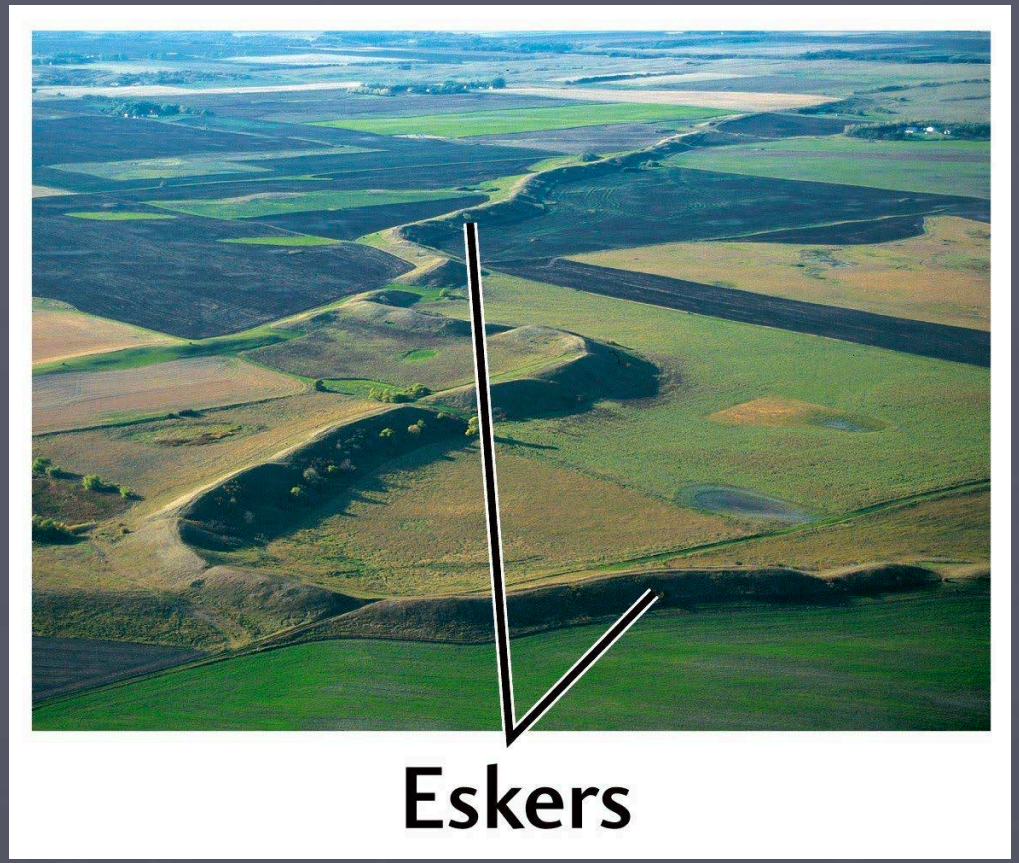
Glacial Landscape – Central Park

Glacial Meltwater

- Meltwater can be pushed down below glacier – when combined with consistent flow and increase pressure can have an eroding effect
- Meltwater from glacier front carries sediment away from glacier and into rivers/lakes/sea

Eskers

- Ridges made up of depositions by rivers of meltwater within a glacier
  - Remain as a glacier retreats



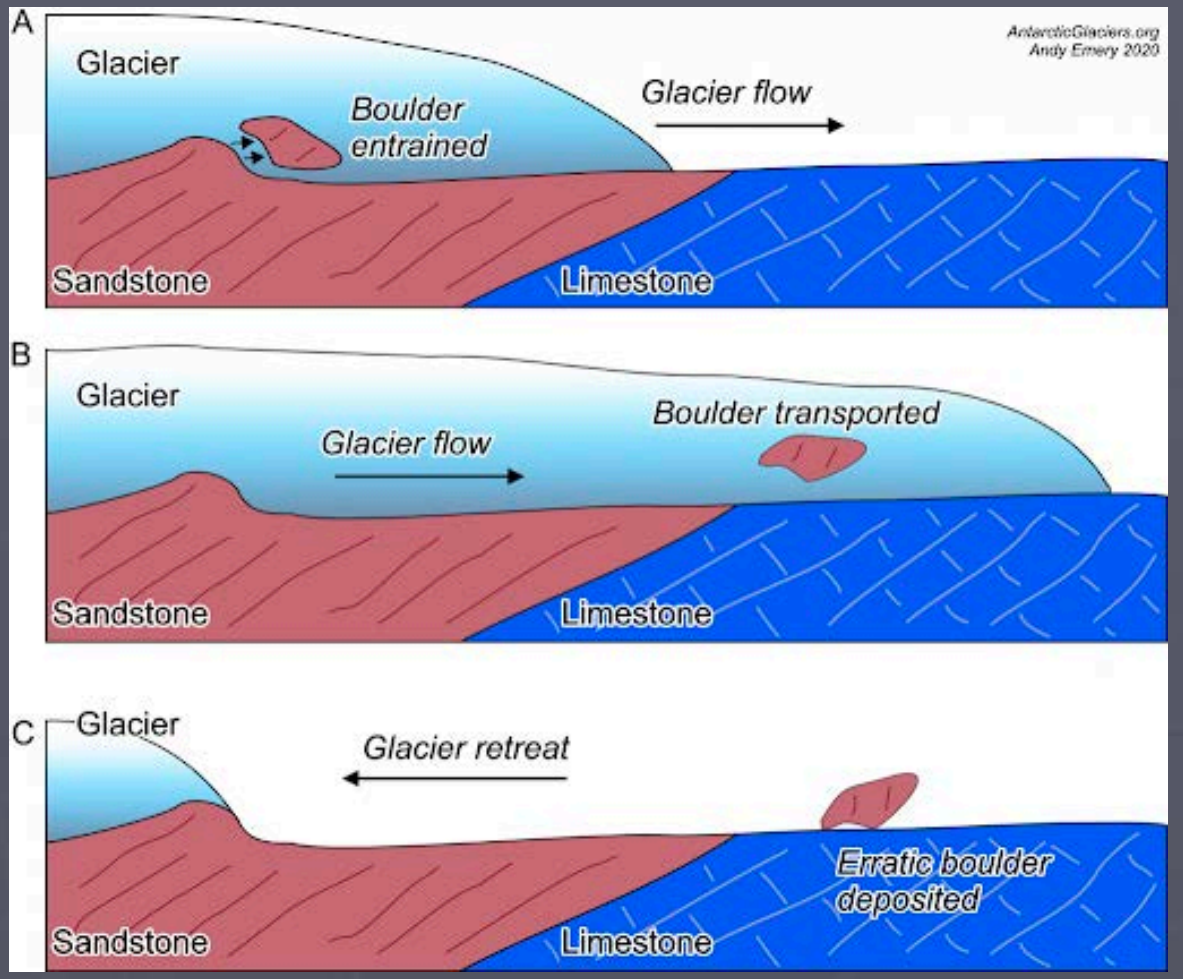
Glacial Deposition

- Drift: general term for material deposited by glaciers.
- Till: rock debris deposited directly by moving ice. Unsorted.
- Glacial erratics: huge boulders carried by glaciers and deposited as they retreat.
- Glaciofluvial deposition: deposition of material by glacial meltwater.

Glacial Till

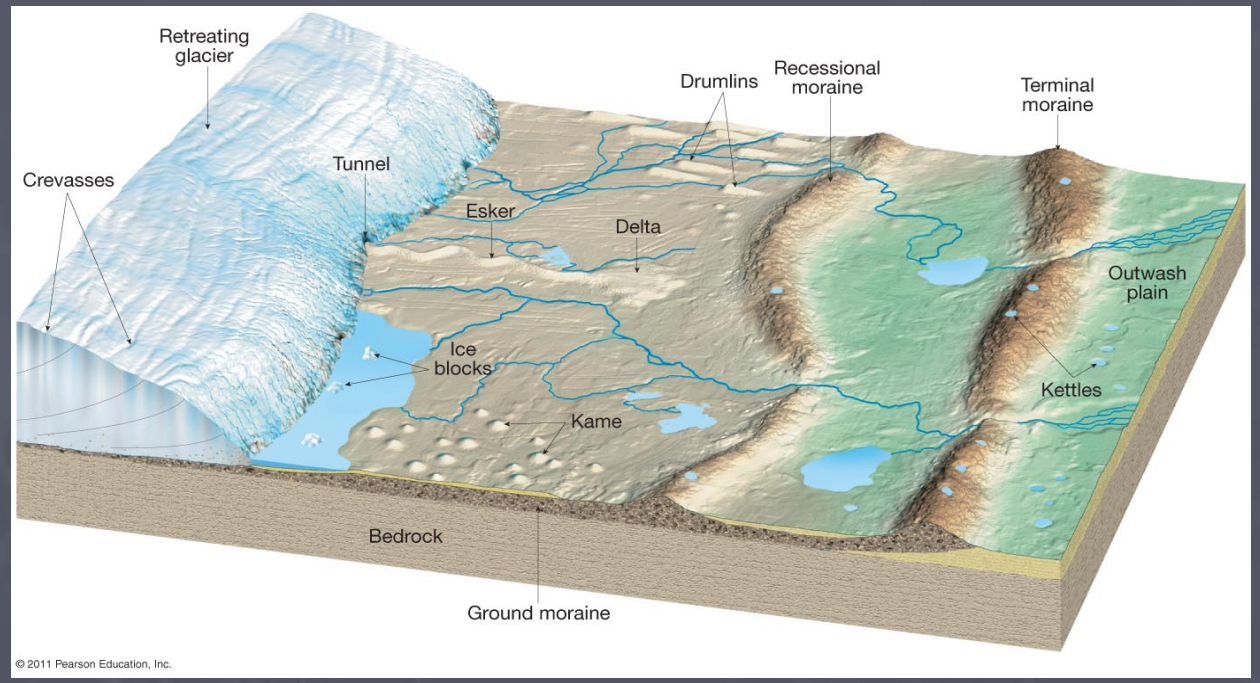
- Unsorted deposition, as in not stratified

Glacial Erratics



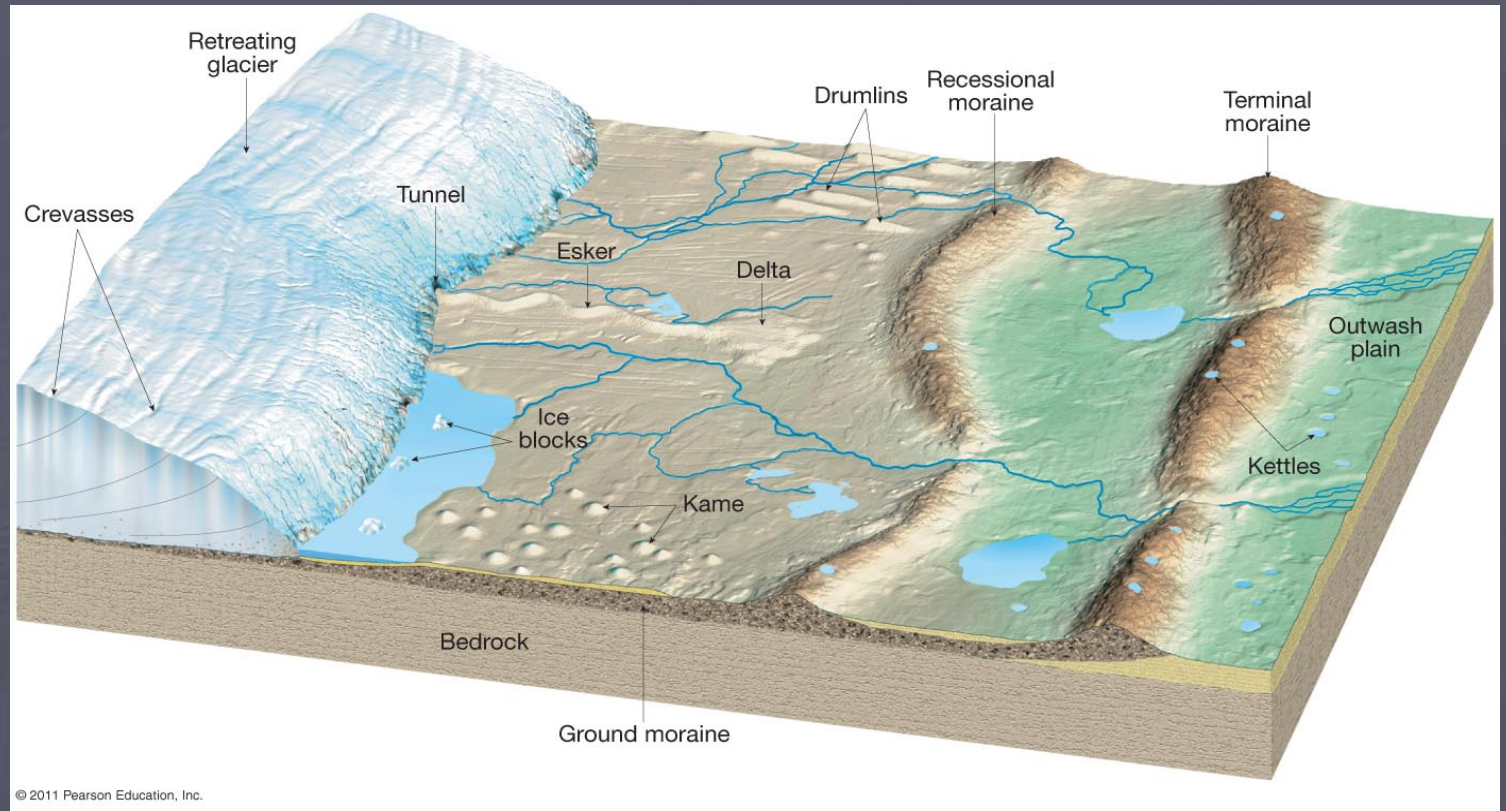
Moraines

- Deposited by both continental glaciers/ice sheets and alpine glaciers
- Hills composed of glacial till, left behind as glacier retreats
- Types: terminal, recessional, ground, medial, lateral



Ground Moraines

Typically smaller moraines, till laid down underneath glacier rather than along the edge.

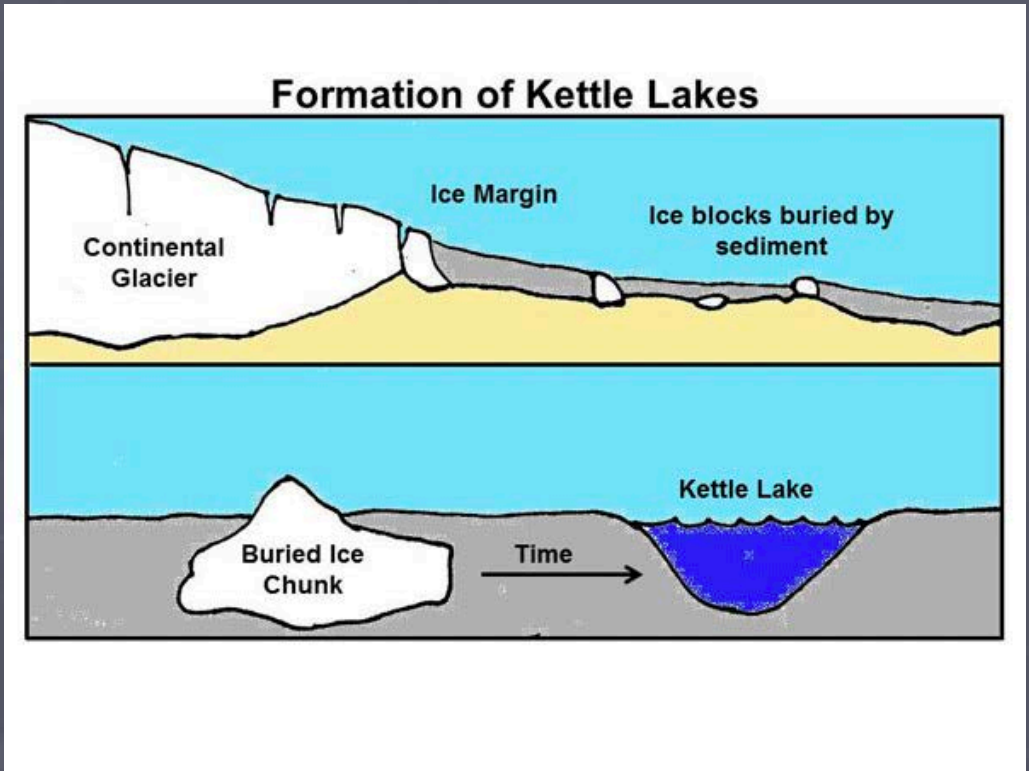


Drumlins

Hills of till, typically smaller than moraines, that form parallel to movement of the ice.

Kettles

- Blocks of ice left behind by retreating glacier form depressions that often fill with water: kettle lakes.



Glacial Thinning