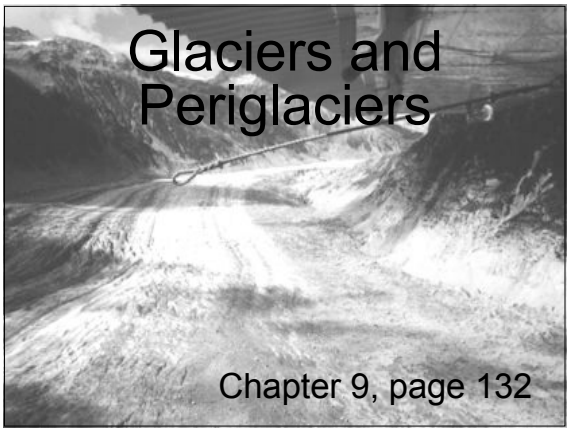


Glaciation

- 1836 – Louis Agassiz theorized that parts of Europe and North America were covered by huge ice sheets.
- Known as the Pleistocene Ice Ages

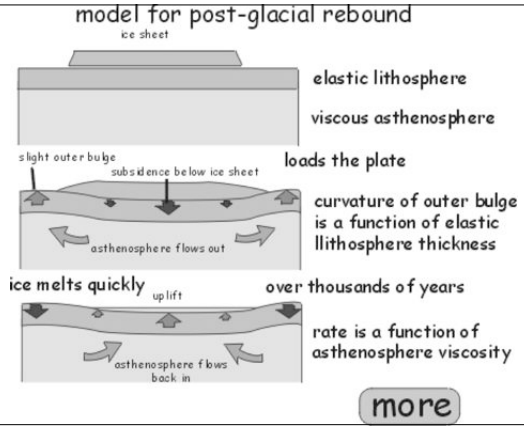
Why do we have glaciers?

- Changing continental positions
- Uplift of continental blocks
- Reduction of CO_2 in the atmosphere.
- Changes in the earth's orbit.

- Pleistocene ice sheets advanced and retreated several times.
- Advances = glacials
- Retreats = interglacials

Isostatic Rebound

- Occurs as the land rises once the burden of glacial ice has been removed from the land.
- In parts of Alaska the land is still rising, as much as an inch/year.

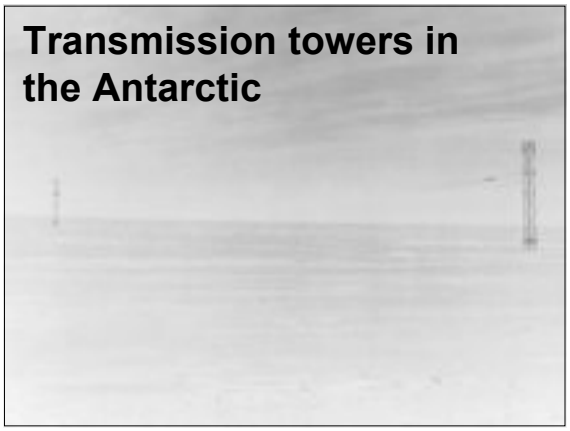


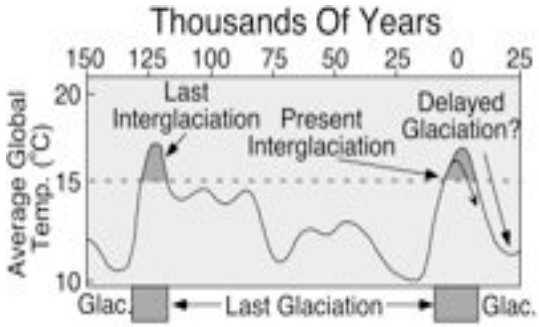
Ice age

- We could be in an interglacial period.
- Ice sheets survive on Greenland, Antarctica, and in high mountain areas.
- Evidence that the ice age may not be over!

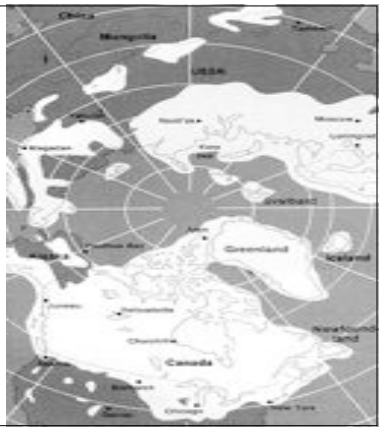
Construction Crane, or what's left of it!

Transmission towers in the Antarctic

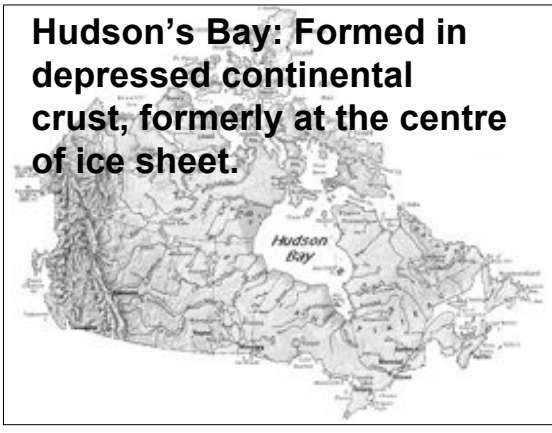




Areas affected in the last ice age.



Hudson's Bay: Formed in depressed continental crust, formerly at the centre of ice sheet.



Formation of glaciers

Requirements:

1. Cold temperatures
2. Snowfall

- Glaciers form in areas where more snow falls in winter than melts during the summer.

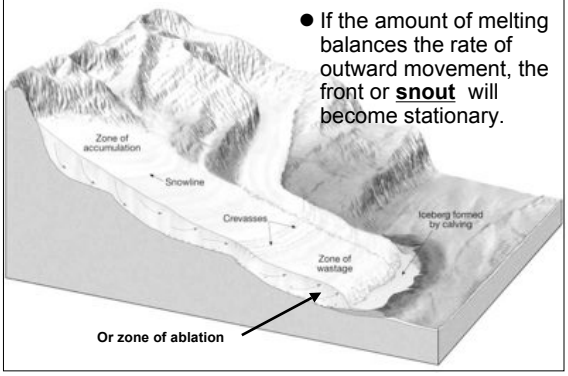
From Snow to Firn to Ice

- Fluffy snow accumulates
- Extremities of crystals evaporate and recrystalize into sand-like snow (old snowbanks) – Firn (neve)
- Pressure (50 metres thick) from weight will fuse firn into a solid mass, creating…glacial ice

Movement of a Glacier

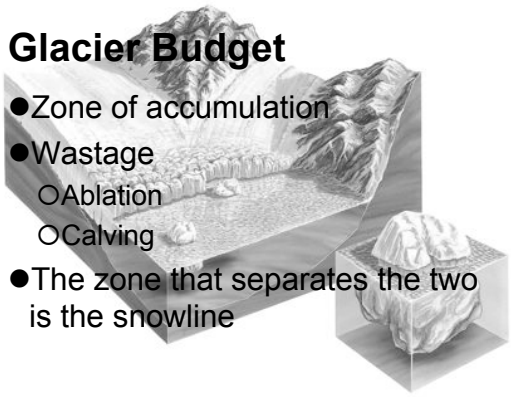
- Pressure that turns snow to ice responsible for flow.
- **Plastic flow:** 50 metres of weight causes brittle ice to become like plastic
- **Basal slip:** slipping along the ground – water acts as a hydraulic jack and lubricant

Movement continued



- If the amount of melting balances the rate of outward movement, the front or **snout** will become stationary.

Glacier Budget



- Zone of accumulation
- Wastage
  - Ablation
  - Calving
- The zone that separates the two is the snowline

Speed of Glacier

- Velocity similar to the flow of a river
- Some glaciers move only centimetres per day, while others can move metres per day

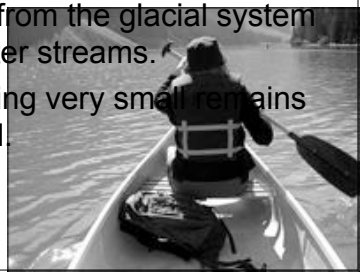
Glacial Erosion

Two major types:

1. Abrasion (sandpaper)
   - Creates rock flour
2. Plucking

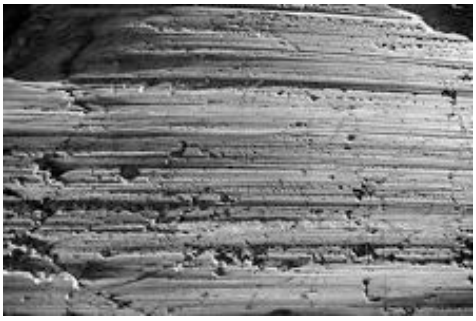
Rock Flour

- Finely ground remains of rock.
- Removed from the glacial system by meltwater streams.
- Flour – being very small remains suspended.



Plucking

Abrasion creates Striations (scratches)



Glaciers: Two major types

1. Continental – major sheets of ice
2. Alpine (mountain) – smaller glaciers which form in mountainous regions

Continental Glaciers

- Erosional features:
  - Rock basin lakes
  - Rock knob topography: landscapes consist of rounded hills and lakes.

Rock knob topography: deranged pattern.

Canadian Shield topography

Glacial Deposition

1. Glacial Till: unsorted and unlayered clays, sands, silts, gravel and boulders.
2. Erratic
3. Moraine

Ice-deposited Materials

- **Glacial erratics:** Really cool rocks usually in the middle of nowhere
- Rocks that have been carried from their areas of origin.

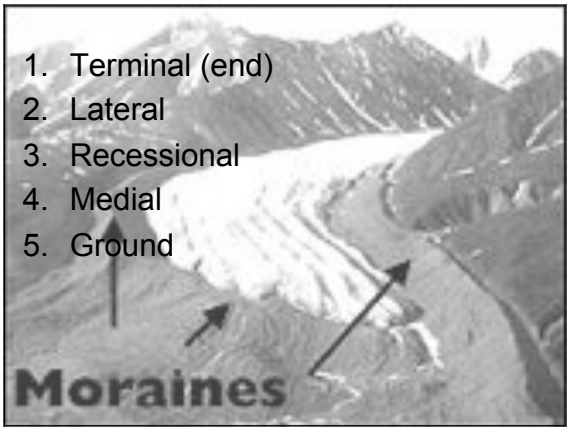
Can be somewhat annoying!

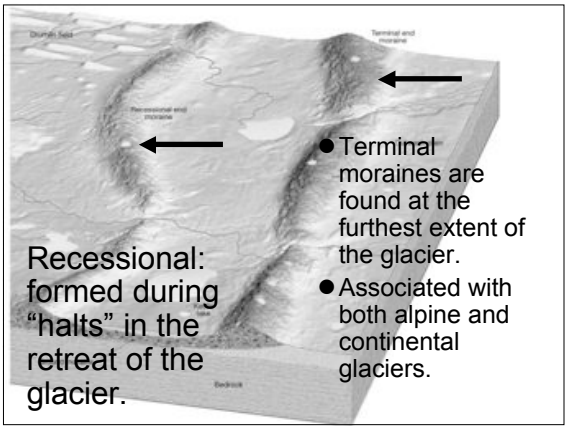
So annoying they even have signs!

Erratic

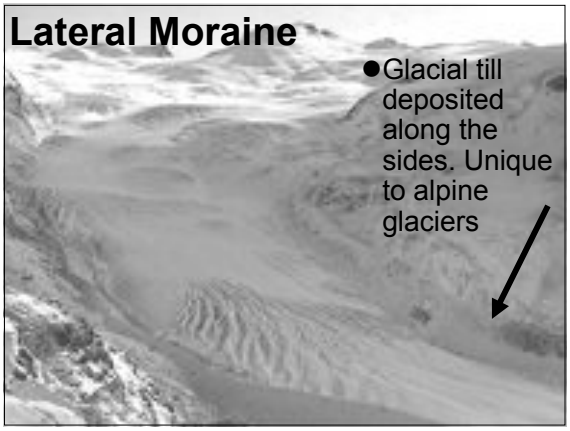
Moraines (not morons) Depositional material

- Most common depositional feature
- Debris is pushed up in front of and along bottom of an advancing glacier.
- Unsorted glacial till
- Can be continental or alpine.





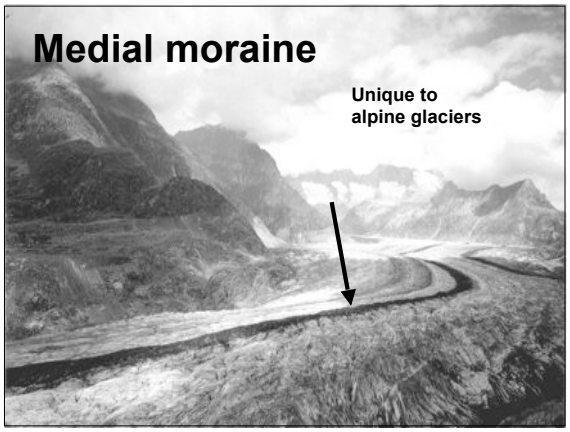
Lateral Moraine



- Glacial till deposited along the sides. Unique to alpine glaciers

Bloomfield, Michigan. Moraines make good cemeteries. Why?

Medial moraine



Unique to alpine glaciers

Ground Moraine

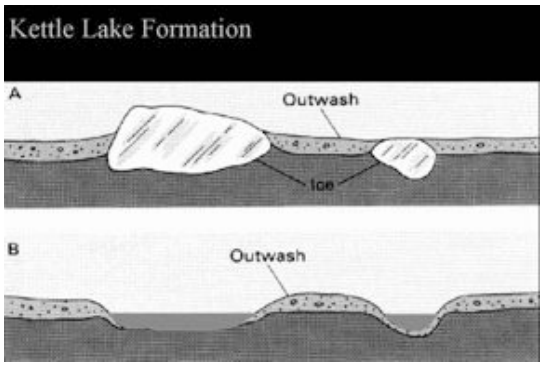
Associated with continental glaciers

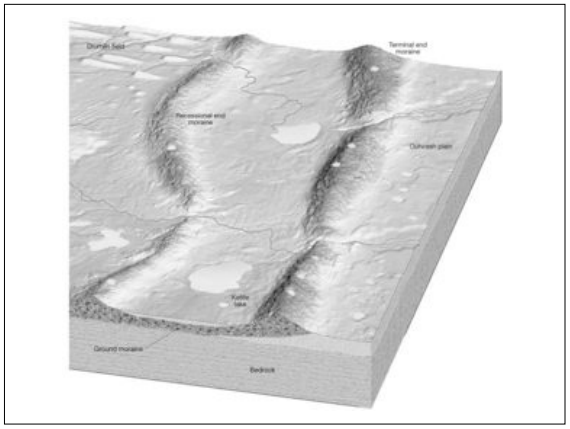
Ground Moraine (pretty exciting stuff hey!)

See movie

Water-deposited Materials

- Depositional activity often occurs at the snout where melting occurs.
- Outwash plains: melt waters flow out, cover large areas, deposit sands and silts
- Kettles: depressions created when blocks of ice become lodged in glacial deposits and later melt



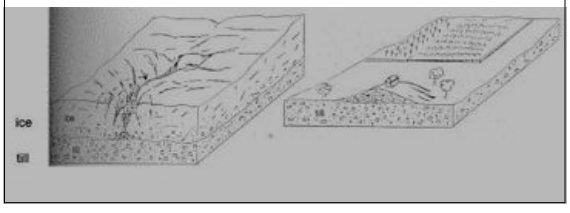


Jackson's Hole: outwash plain, dotted with evergreen-filled kettle holes

Kames

- A steep-sided hill composed of sand and gravel originating when sediment collected in openings in stagnant glacial ice

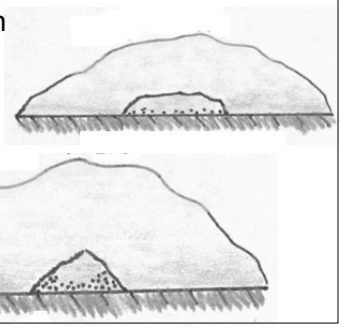
Formation of a Kame

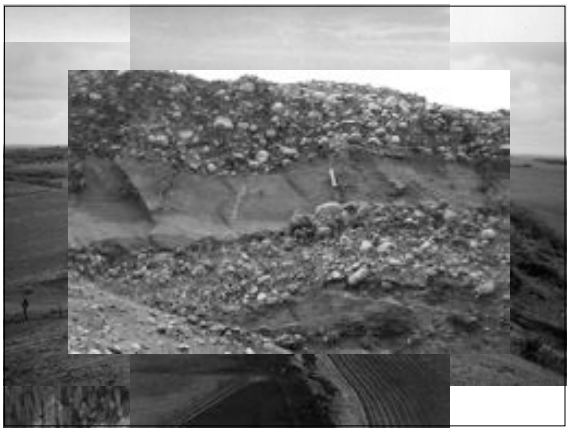


Michigan: often ski hills are on kames (that's if you call it a ski hill)

Eskers

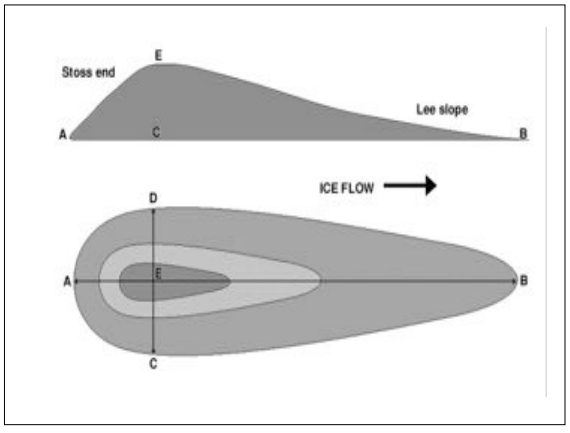
- Streams often run inside the glacier

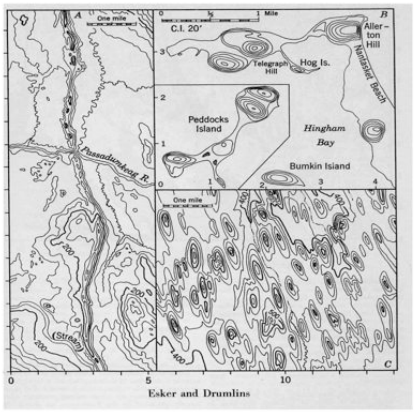




Drumlins

- Streamlined, tear–shaped hills
- Wide, rounded <u>front</u> end
- Longer, tapering tail





Drumlin Field

What happens to water deposited glacial features?

- Uses of water deposited glacial material?
- Important sources of sand
- Gravel for roads, sidewalks, buildings etc.
- Fast disappearing

Alpine Glaciation

- Highest areas
- Most formed on the windward side.
- Why?
- Snow is more abundant
- Most alpine glaciers today survive due to high elevation and/or high latitude.

Erosional features

- Ice is channelled
- Action roughens and steepens the terrain
- Moves vast amounts of debris downslope

Cirques or Corries

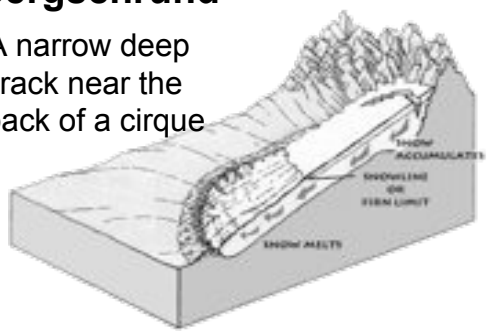
- Glacial ice moves outwards and erodes the sides, bottoms and backs, creating bowl-shaped depressions.
- If these bowls are occupied by water it is called a “TARN”

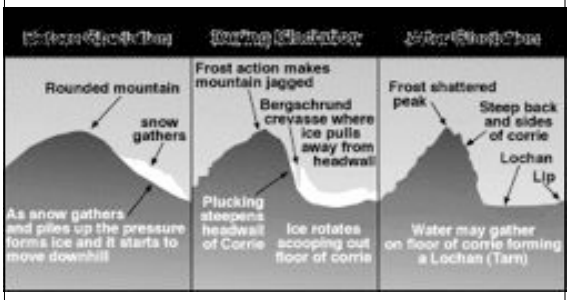
Tarn or Lochan

Cirque and Tarn: Old Man Lake

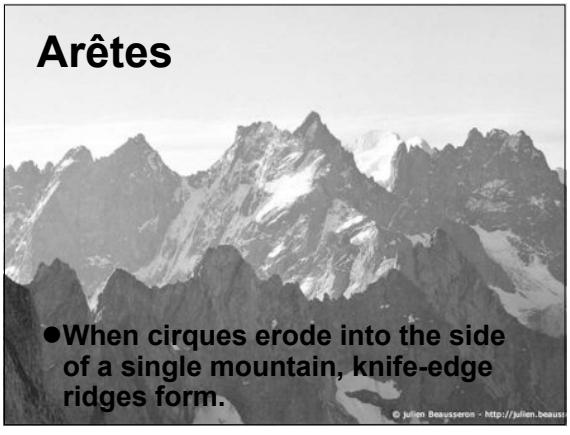
Bergschrund

- A narrow deep crack near the back of a cirque





Arêtes

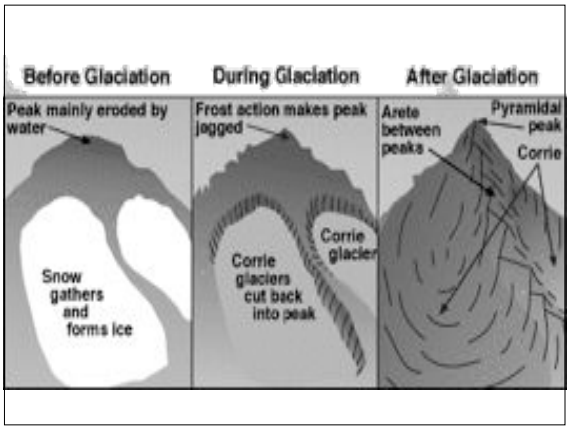


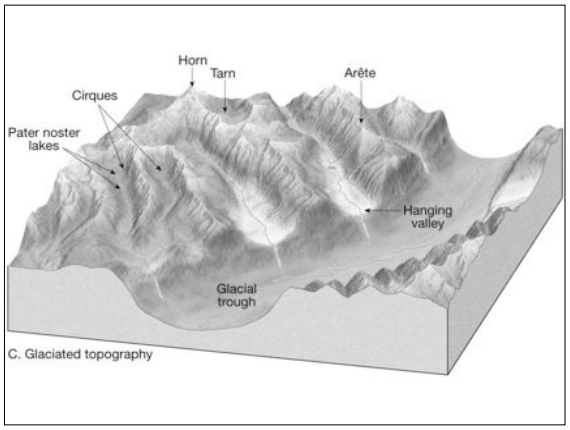
- **When cirques erode into the side of a single mountain, knife-edge ridges form.**

Ptarmingan Wall: arête

Horn or Pyramidal Peak

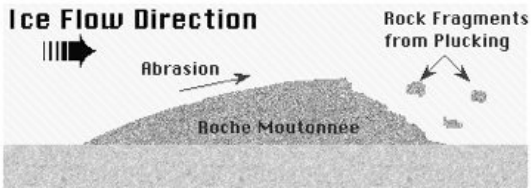
- When several cirques erode back into a mountain



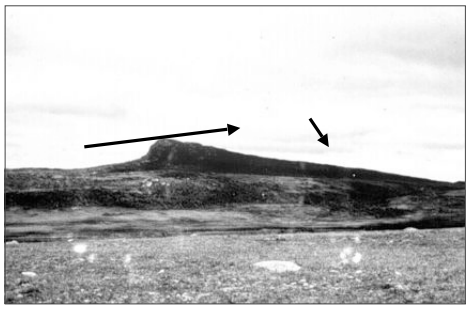


Roche Moutonnee

- Hard, resistant rock
- Smooth, rounded up-valley
- facing the direction of the ice flow.



Roche Moutonnee



Roche Moutonnee

Crag and Tail

- Glacial resistant mass of rock has withstood passage of ice sheet, thereby protecting an elongated ridge (tail) of more easily eroded rocks on its leeward side.
- Tail often deposits of till.

Crag and Tail

Salisbury Crag: Scotland

Castle Rock: Edinburgh, Scotland (origins of my name)

U-shaped valleys

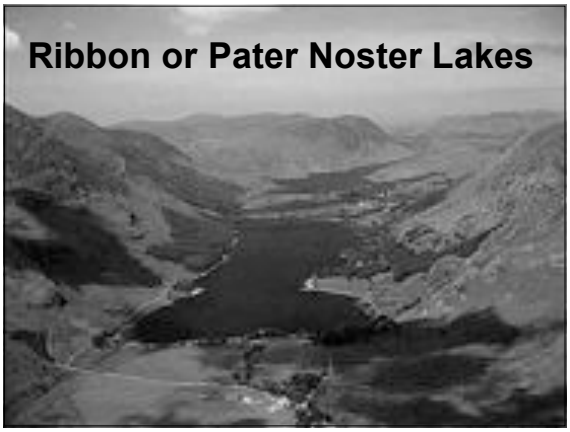
- As ice moves down from a cirque, it widens and deepens
- Creates a U-shaped valley
- Often have “misfit streams” running through.
- “misfit” because far too small to have cut the valley.

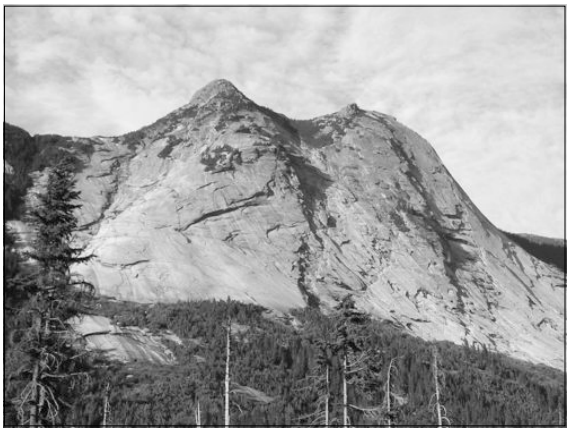
Alpine glacier

U–shaped valley: Yellowstone

Glacial Trough

Ribbon or Pater Noster Lakes





Fjords

- When U–shaped valleys cut down below sea level.
- Flooding
- Fjords common in Norway, and B.C.

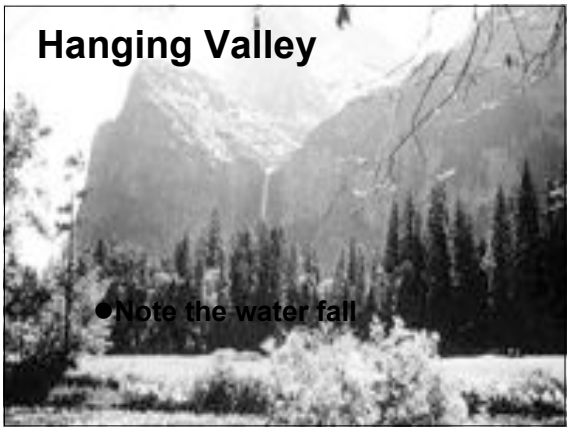
Map of fjords

Beautiful B.C. fiord

Hanging Valley

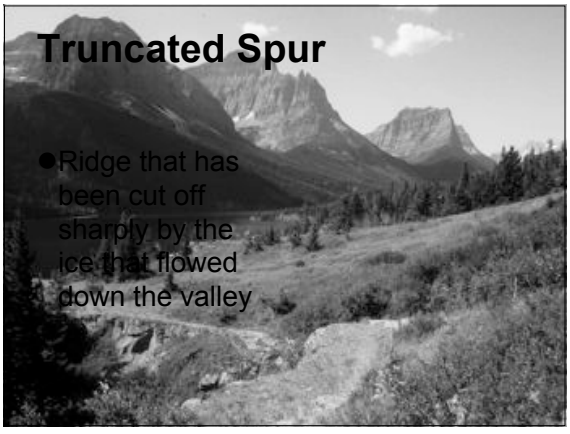
- Two glaciers of different sizes come together.
- The larger glaciers have deeper valleys after the ice recedes the smaller glacier is often left “hanging”
- Water falls are created where streams flow over such hanging valleys

Hanging Valley



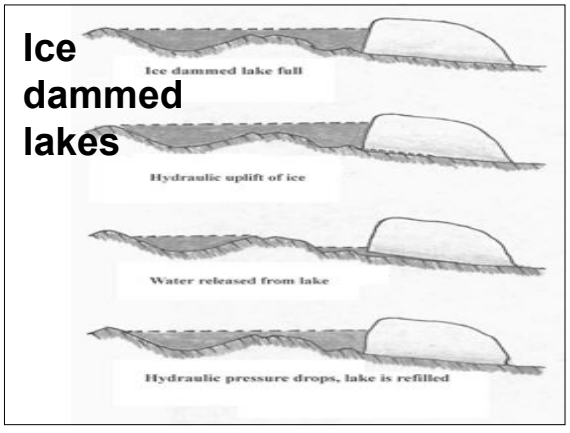
- Note the water fall

Truncated Spur



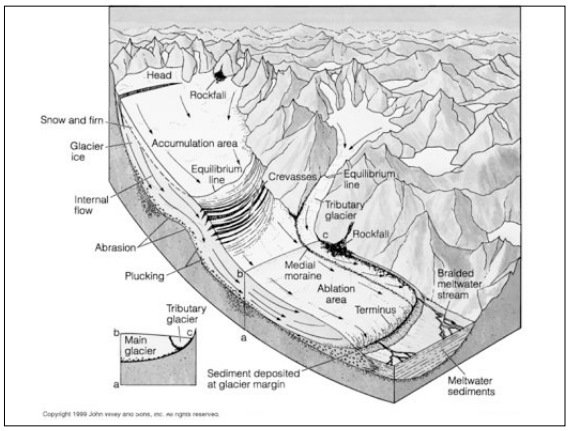
- Ridge that has been cut off sharply by the ice that flowed down the valley

Ice dammed lakes



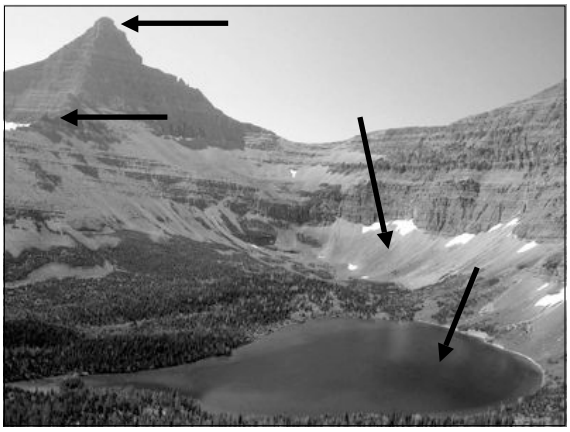
Ice-dammed lakes: Norway

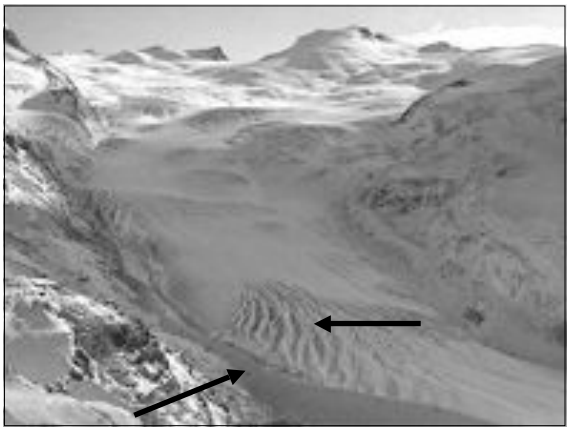
Braided: Meltwaters from ice-dammed lakes become braided in their flow pattern. Often occupy the whole valley in spring and summer.



QUIZ

Let's see if you have been paying attention





What type of glacier?

Name the type of erosion and describe how it works

Periglacial

Peri = around or surrounding

Develops in glacier free regions

Climate is cold but snow does not accumulate

Three characteristics

1. Permafrost – rock or soil that remains below freezing level for 2 years
2. Development of landforms due to freezing and thawing.
3. Predominance of mechanical over chemical weathering.

Permafrost

- Continuous or discontinuous
- Approx 12% is continuous, mainly in northern hemisphere.

Landscapes

- Either devoid of vegetation or have only shallow root plants. (grasses, mosses and lichens)
- Soils = undecayed organic material and peats
- Poorly drained: high water table
- Waterlogged soils in summer

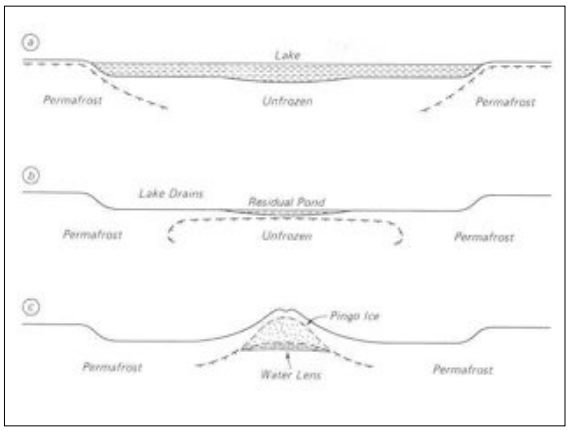
Frost Action

- Active layer – upper zone where melting and refreezing occurs
- Solifluction: slow downslope movement of water-saturated soil and rock under the force of gravity

Solifluction

Landforms

- Pingo (Inuit = hill)
- Isolated, conical, ice-cored mound.
- N.W.T.
- Forms when water seeps down to the permafrost, freezes and expands.



Pingo at Tuktoyaktuk: looks like a cinder cone doesn't it?

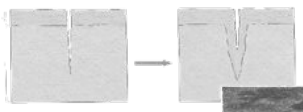
"Pingo was my name'o" typical periglacial landscape

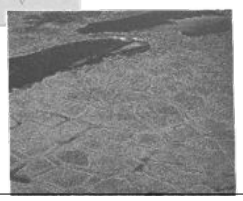
Patterned Ground

- Intense winter freezing causes the ground to crack into polygon shapes.
- In summer, water seeps into the cracks.

Periglacial Landforms

- An ice wedge forms when water seeps into an open crack in the ground and freezes
- after several hundred years the ice wedge grows
- patterned ground are often formed in periglacial regions





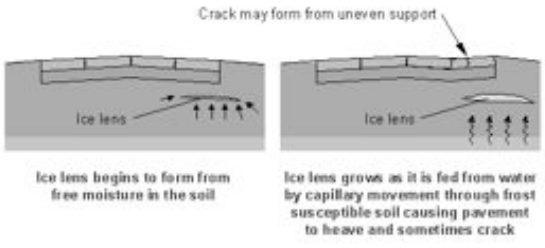
patterned ground on Alaska's north slope

Patterned Ground

Patterned Ground

Frost heaving

Hard on roads



Ice lens begins to form from free moisture in the soil

Ice lens grows as it is fed from water by capillary movement through frost susceptible soil causing pavement to heave and sometimes crack

Stone circle or garland

The End

Test in a week.