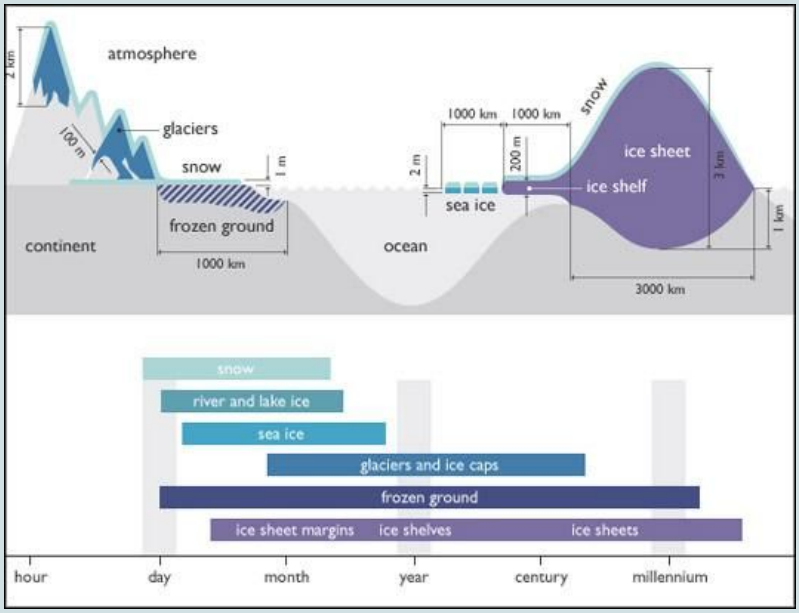
Chapter 17

Glacial & Periglacial Landscapes

Cryosphere

Cryosphere - the portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (which includes permafrost).

- Generally found at high latitudes and at high elevations


atmosphere
2 km
glaciers
100 m
snow
1 m
frozen ground
1000 km
continent
ocean
1000 km
1000 km
snow
2 m
200 m
sea ice
ice sheet
ice shelf
3 km
1 km
3000 km
snow
river and lake ice
sea ice
glaciers and ice caps
frozen ground
ice sheet margins
ice shelves
ice sheets
hour
day
month
year
century
millennium

Snowline

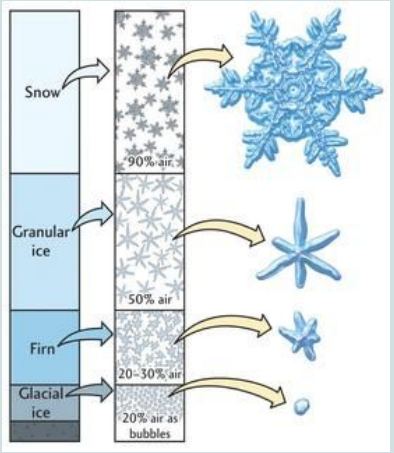
- The climatic **snowline** is the point above which snow and ice cover the ground throughout the year.
- Glaciers form by the continual accumulation of snow that recrystallizes under its own weight into an ice mass.
- Through the summer, rain and snowmelt seeps down into the snowfield and refreezes.
- Air spaces are compressed as the snow packs to a greater density

When snow falls to Earth, it will either melt or accumulate.

Firn

Firn - a type of snow that has been left over from past seasons and has been recrystallized

- It is ice that is at an intermediate stage between snow and glacial ice.



- Firn has the appearance of wet sugar, but has a hardness that makes it extremely resistant to shovelling.
- It can often be found underneath the snow that accumulates at the head of a glacier.

Glacial Ice

Glacial ice - dense ice produced over a period of many years

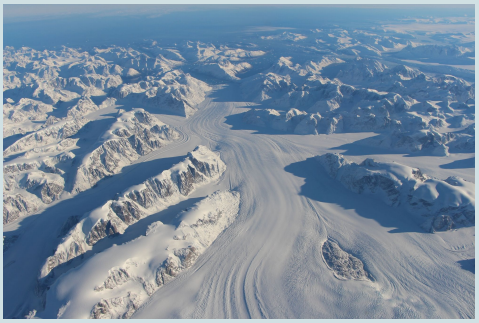
- up to 1,000 years in Antarctica due to the dryness of the climate

- Glacial ice is the largest reservoir of fresh water on Earth. Many glaciers from temperate, alpine and seasonal polar climates store water as ice during the colder seasons and release it later in the form of meltwater as warmer summer temperatures cause the glacier to melt, creating a water source that is especially important for plants, animals and human uses when other sources may be scant. Within high-altitude and Antarctic environments, the seasonal temperature difference is often not sufficient to release meltwater.
- A large piece of compressed ice, or a glacier, appears blue, as large quantities of water appear blue. This is because water molecules absorb other colors more efficiently than blue. The other reason for the blue color of glaciers is the lack of air bubbles. Air bubbles, which give a white color to ice, are squeezed out by pressure increasing the density of the created ice.

Glacier

Glacier - a persistent body of dense ice that is constantly moving under its own weight over many centuries.

- Rests on land or floats in the sea attached to a landmass as an ice shelf.



- Glacial ice behaves in a plastic, or pliable, manner - it slowly deforms and flows due to stresses induced by their own weight and gravity.
- As a valley glacier flows slowly downhill it erodes the mountains, canyons, and river valleys beneath its mass, transporting material within or along its base.
- A portion of the transported debris may also be carried on its icy surface, visible as dark streaks and bands.
- Glaciers move in streamlike patterns, merging as tributaries into large rivers of ice that slowly flow outward toward the ocean
- **Fig. 17.1 a**

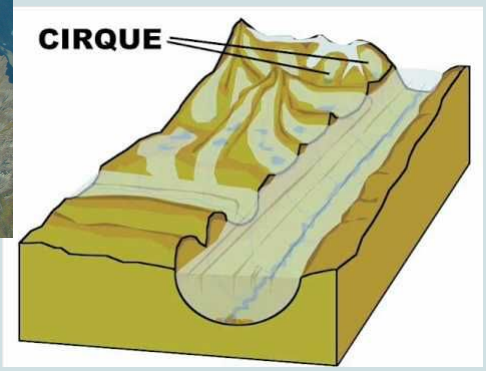
Glacier Categories

Two general groups based on their form, size, and flow characteristics:

- **Alpine glaciers** - form in mountain ranges
- **Continental ice sheets** - extensive ice sheets that cover large landmasses

Cirque

Cirque - a bowl-shaped depression carved out of a mountain by an alpine glacier.



Usually the accumulation area for head of a glacial mass.
Many cirque glaciers may jointly feed a valley glacier.
A piedmont glacier forms wherever several valley glaciers pour out of their confining valleys and coalesce at the base of a mountain range.

Calving

Ice calving - the breaking of ice chunks from the edge of a glacier.

- The ice that breaks away can be classified as an iceberg, growler, or bergy bit.

Occurs wherever a glacier meets and ocean, bay, or fjord.

- Calving of glaciers is often accompanied by a loud cracking or booming sound before blocks of ice up to 60 metres (200 ft) high break loose and crash into the water. The entry of the ice into the water causes large, and often hazardous waves.

Continental Ice Sheet

Ice sheet - a mass of glacier ice that covers surrounding terrain and is greater than 50,000 km^2 (19,000 sq mi), this is also known as **continental glacier.**

- The only current ice sheets are in Antarctica and Greenland

Ice sheets cover 90% of Antarctica and 81% of Greenland
These ice sheets have such enormous mass that large portions of each landmass beneath the ice are isostatically depressed - pressed down by weight - below sea level
Each ice sheet reaches thicknesses of more than 3000 m (9800 ft) with average thicnkess around 2000 m (6500 ft), buying all but the highest peaks of the land.
At the edge of ice sheets are ice shelves, permanent masses off ice that extend out over the sea - these shelves reach thicknesses of 1000 m (3280 ft)

Ice Cap/Ice Field

- **Ice cap** - an ice mass that is roughly circular and covers less than 50,000 km² of land area (usually lies over the top of a mountain) **Fig. 17.4**
- **Ice field** - least extensive form of a glacier, with mountain ridges and peaks visible above the ice **Fig. 17.5**

Glacial Balance

Glaciers acquire snow in their accumulation zone, a snowfield at the highest level of an ice sheet or ice cap or at the head of a valley glacier - a cirque.

Ablation - the opposite of accumulation — refers to all processes that remove snow, ice, or water from a glacier or snowfield.

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- Ablation refers to the melting of snow or ice that runs off the glacier, evaporation, sublimation, calving, or erosive removal of snow by wind.

Glacial Movement

- Glaciers are only rigid on the surface.
- Below this layer is a plastic zone that moves forward.
- The base layer grinds and slides along with varying speed due to temperature and presence of lubricating water beneath the ice.
  - Compression of the ice from an uneven surface will cause it to melt, and later it will refreeze.

Fig. 17.6

Crevasse

Crevasse - a deep, vertical crack, or fracture, found on the surface of an ice sheet or glacier.

- form as a result from friction with valley walls, and due to stretching and compression

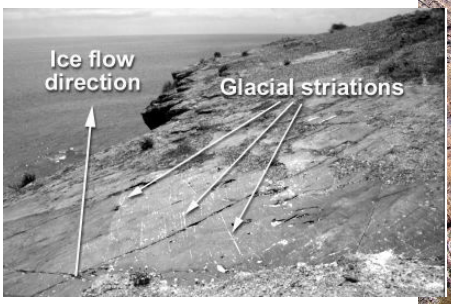
Glacial Erosion

- Glaciers mechanically pick up rock material and carry it away in a process known as *glacial plucking*.
- Debris is also carried on its surface and transported internally.
- As a glacier retreats, it can leave cobbles and boulders that are “foreign” in composition and origin to the ground on which they are deposited - called *glacial erratics*.


GLACIAL
BOULDER

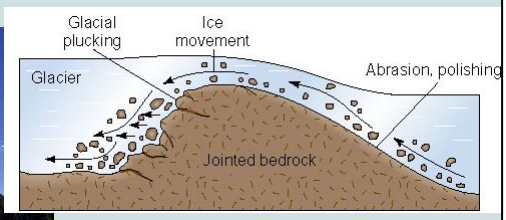
Abrasion

- Rocks pieces frozen to the basal layers of the glacier enable the ice mass to scour the landscape like sandpaper.
- Glacial **abrasion** produces a smooth surface on exposed rock, which shines with glacial polish when the glacier retreats.
- Larger rocks in the glacier act like chisels, gouging the underlying surface and producing glacial striations parallel to the flow direction.


Ice flow
direction
Glacial striations

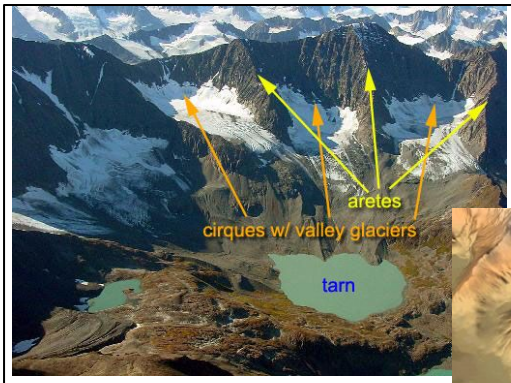
Glacial Erosional Landforms

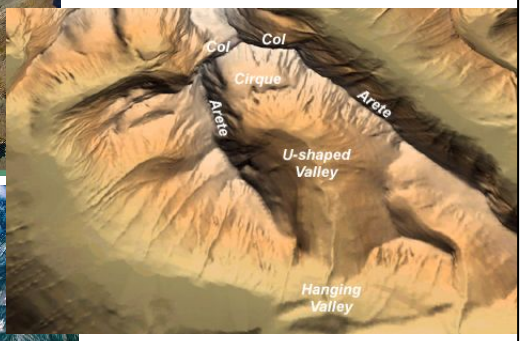
- **Rôche moutonnée** - an asymmetrical hill of exposed bedrock.
  - has a characteristic gently sloping upstream side (stoss side) that is polished smooth by glacial action and an abrupt and steep downstream side (lee side) where the glacier plucked rock pieces.

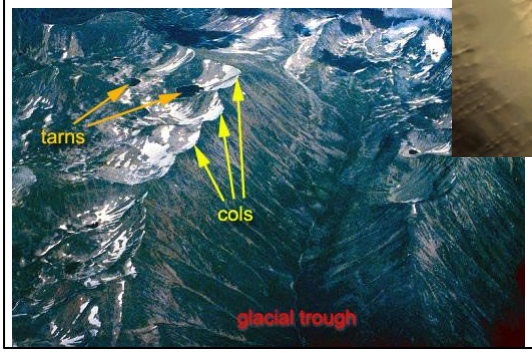


Arête/Col

- An **arête** is a narrow ridge of rock which separates two valleys. It is typically formed when two glaciers erode parallel U-shaped valleys.
- Two eroding cirques may reduce an arêtes to a saddle-shaped pass, or **col**.
- Where three or more cirques meet, a pyramidal peak is created.

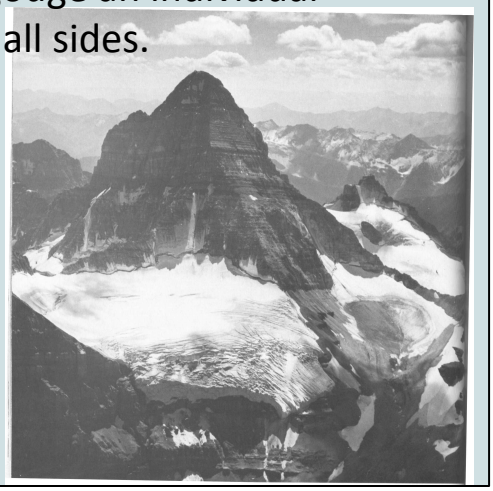

aretes
cirques w/ valley glaciers
tarn


Col
Col
Cirque
Arete
Arete
U-shaped
Valley
Hanging
Valley


tarns
cols
glacial trough

Horn

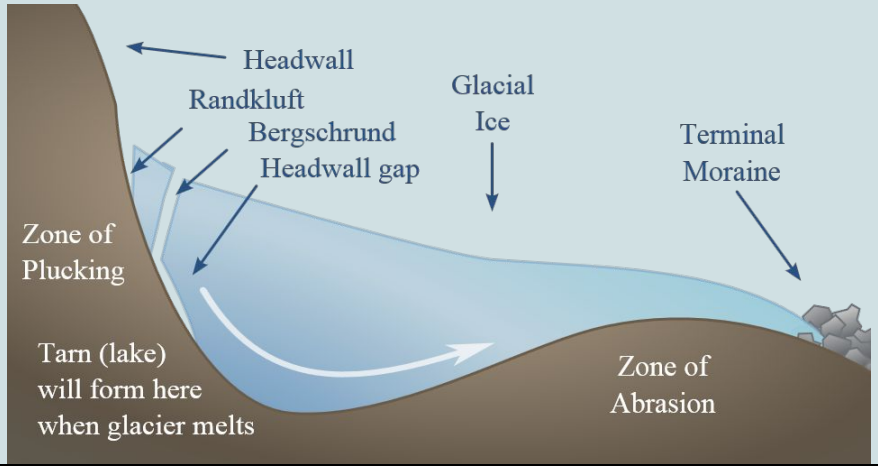
- A **horn**, or pyramidal peak, is an angular, sharply pointed mountain peak which results when several cirque glaciers gouge an individual mountain summit from all sides.



The Matterhorn, a classic example of a pyramidal peak.

Bergschrund

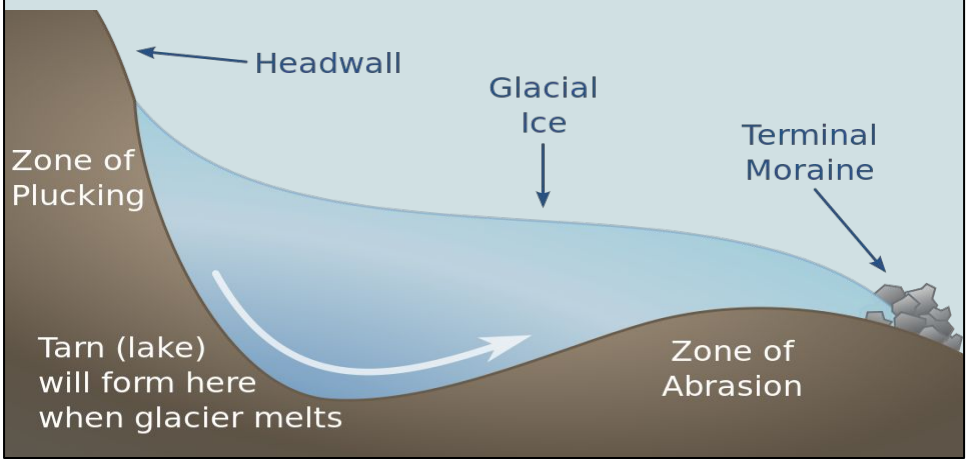
- A **bergschrund** is a crevasse that forms where moving glacier ice separates from the stagnant ice or firn above.



- It is often a serious obstacle for mountaineers.

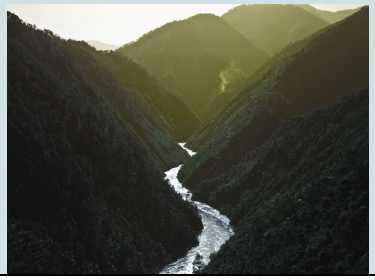
Tarn

- A **tarn** is a mountain lake or pool, formed in a cirque excavated by a glacier. It is formed when either rain or river water fills the cirque.



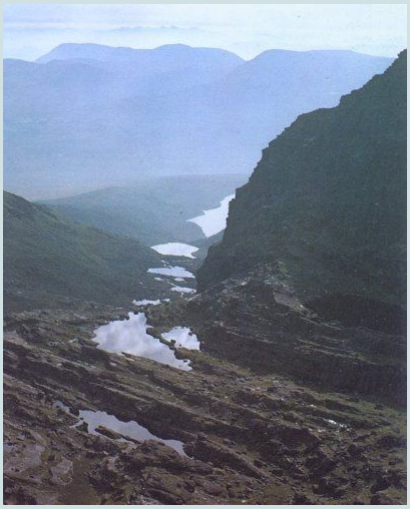
U-shaped Valleys

- **U**-shaped valleys result from glacial erosion.
- V-shaped valleys are stream-cut.



Paternoster Lake

- **Paternoster lakes** small, stair-stepped lakes.
- Formed from differing resistance of rock to glacial processes or from damming by glacial deposits.

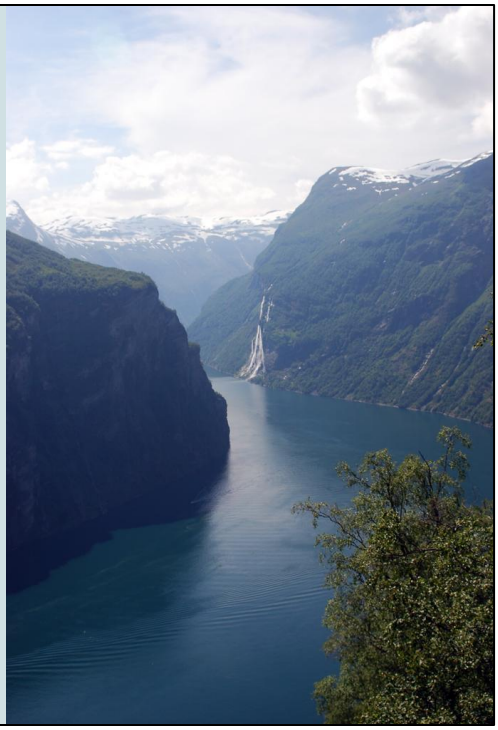


Fjord

Where a glacial trough meets the ocean, the glacier can continue to erode the landscape, even below sea level.

- **Fjord** is a deep, long, narrow inlet with steep sides or cliffs, created by glacial erosion.

Fig. 17.13



Glacial Deposits

Glaciers transport materials on and inside the ice, producing unsorted sediment deposits.

The actions of meltwater streams under the glacier and at the glacier's downstream end, produce sorted deposits.

- **Glacial drift** - general term for all glacial deposits

- **Till** - the unsorted and unstratified debris deposited on the ground by a glacier as it melts
  - usually marks the glacier's former margins

Moraine

A **moraine** is any glacially formed accumulation of unconsolidated glacial debris (regolith and rock).

- **Lateral Moraines** are formed at the side of the ice flow
- **Medial Moraines** are formed where two glaciers meet.
- **Terminal Moraines** are formed at the foot of the ice flow, marking the maximum advance of the glacier.

Till Plain

- A **till plain** is an extensive flat plain of glacial till that forms when a sheet of ice becomes detached from the main body of a glacier and melts in place, depositing the sediments it carried.

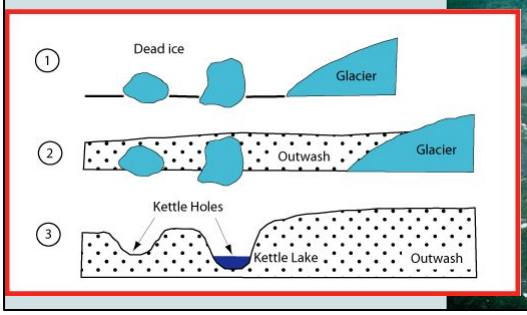
Esker

- An **esker** is a long, winding ridge of stratified sand and gravel which formed in a glacial tunnel.
- Examples of which occur in glaciated and formerly glaciated regions of Europe and North America.

Eskers

Kettle

- A **kettle** (**kettle hole, pothole**) is a shallow, sediment-filled body of water formed by retreating glaciers or draining floodwaters.
- The kettles are formed as a result of blocks of ice calving from glaciers and becoming submerged in the sediment on the outwash plain.



Periglacial

- **Periglacial** describes geomorphic processes that result from seasonal thawing of snow in areas of permafrost, the runoff from which refreezes in ice wedges and other structures.
  - "Periglacial" suggests an environment located on the margin of past glaciers. Therefore, periglacial environments are anywhere that freezing and thawing modify the landscape in a significant manner.
- Tundra is a common ecological community in periglacial areas.

Active Layer

- In environments containing permafrost, the **active layer** is the top layer of soil that thaws during the summer and freezes again during the autumn.

The frozen subsurface is called ground ice.
The amount of ground ice present varies with moisture content, ranging from only a small percentage in drier regions to almost 100% with saturated soils.
When cracks develop in the active layer, water can seep in, or well up. If it freezes, it will widen the cracks.

Patterned Ground

- **Patterned Ground** is the distinct, and often symmetrical natural pattern of geometric shapes formed by ground material in periglacial regions.

The expansion and contraction of soils due to freezing and thawing, or frost action, results in the movement of soil particles, stones, and small boulders into distinct shapes.

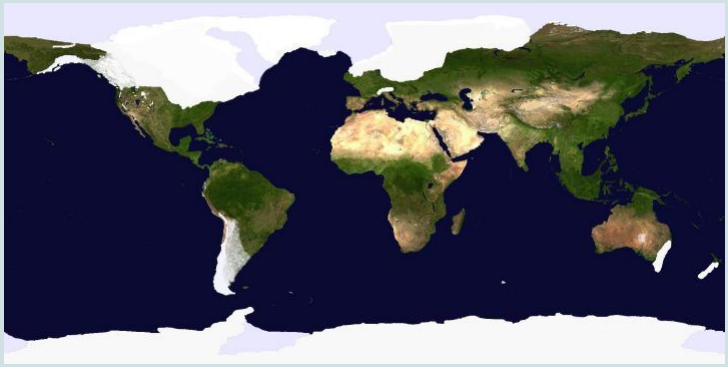
Humans & Paraglacial Lanscapes

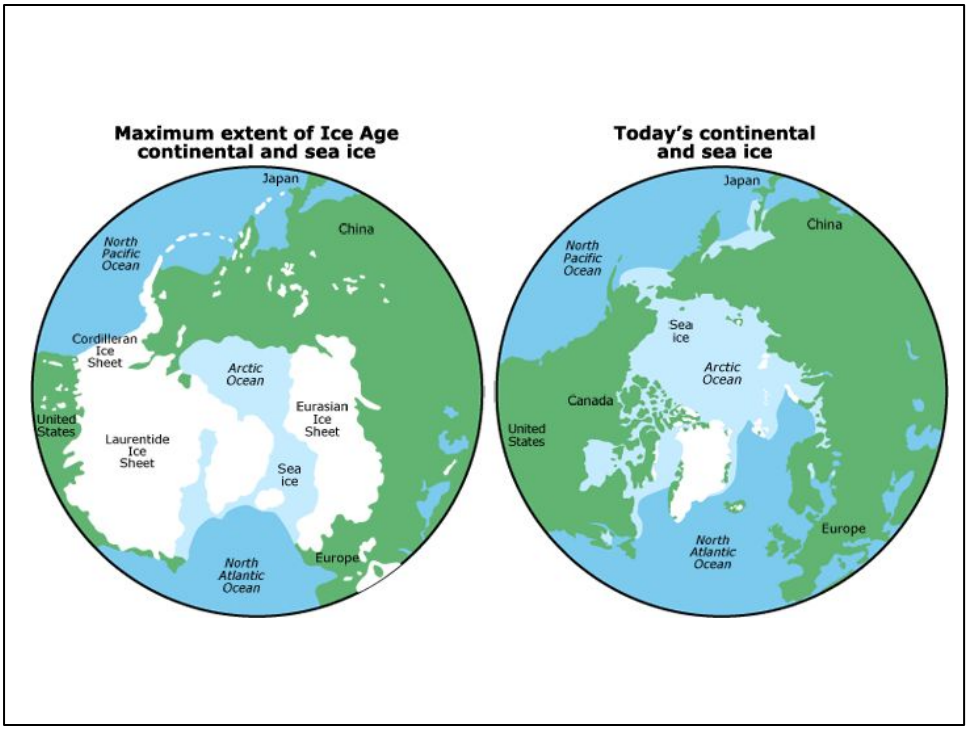
- Structural collapse
  Fig. 17.23

- Trans-Alaskan oil pipeline
  Fig. 17.24

Ice Age

- An **ice age** is a period of long-term reduction in the temperature of Earth's surface and atmosphere, resulting in the presence or expansion of continental and polar ice sheets and alpine glaciers.



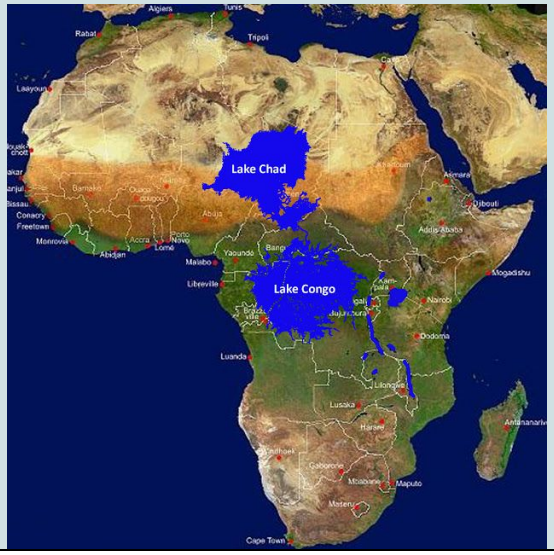

Maximum extent of Ice Age continental and sea ice
Japan
China
North Pacific Ocean
Cordilleran Ice Sheet
Arctic Ocean
Eurasian Ice Sheet
United States
Laurentide Ice Sheet
Sea ice
North Atlantic Ocean
Europe
Today's continental and sea ice
Japan
China
North Pacific Ocean
Sea ice
Arctic Ocean
Canada
United States
North Atlantic Ocean
Europe

Paleolake

- An ancient lake (especially one that no longer exists)

Fig. 17.26

Fig. 17.27



Lake Chad is the remnant of a former inland sea, palaeolake Mega-Chad. At its largest, sometime before 5,000 BC, Lake Mega-Chad was the largest of four Saharan palaeolakes and is estimated to have covered an area of 400,000 km2 (150,000 sq mi), larger than the Caspian Sea is today.

This total map of the total African continent shows the massive size of both lakes, in comparison to both existing Great Lakes of Africa (Lake Victoria, Lake Malawi, etc.) and to the size of the continet as a whole. The map also shows ths distinct difference between the two lakes. Lake Congo is a tropical lake while the southern half of Lake Chad lies in the Sahel, and it's northern half in the Sahara.

Read more:
http://egyptsearchreloaded.proboards.com/thread/1718/africas-giant-ancient-lakes#ixzz4mgZDyPcR

Arctic Region

- Land within the Arctic region has seasonally varying snow and ice cover, with predominantly treeless permafrost-containing tundra.
- Arctic seas contain seasonal sea ice in many places.

Antarctic Region

- The region around the Earth's South Pole, opposite the Arctic region around the North Pole.
- The Antarctic comprises in the strict sense the continent of Antarctica and the island territories located on the Antarctic Plate. In a broader sense the Antarctic region include the ice shelves, waters, and island territories in the Southern Ocean situated south of the Antarctic Convergence, a zone approximately 32 to 48 km (20 to 30 mi) wide varying in latitude seasonally.

Fig. 17.28