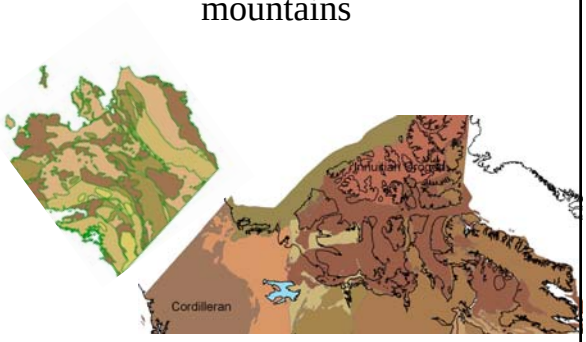
Arctic coastal plain, lowlands and mountains



Overview

- Most northern part of North America
  - Only coastal plains are in AK and Canada
    - Considered part of the Cordilleran province
  - Lowlands and mountains in Canada
    - Considered part of the Canadian Shield, Innuitian, and Arctic Lowlands provinces

Cordilleran province

- In US: Includes the Pacific Mountain System, Intermontane Plateaus, and the Rocky Mountain System, Alaska
- In Canada: Coast Mountains, Rocky Mountains

Overview: coastal plains, low lands, mountains

- Encompassing over 20% of Canada's landmass (smaller portion in Alaska), characterized by permafrost, patterned ground, and pingos
  - Latitude give the region long winters and short cool summers
    - Low evaporation
  - *Recent* glaciation

Arctic Coastal Plain

- Arctic Coastal Plain: Narrow seaward edge of the low islands and coastal land in the western arctic
  - Slopes gently into the Beaufort Sea
  - Unconsolidated alluvial surface
  - Experiences isostatic rebound

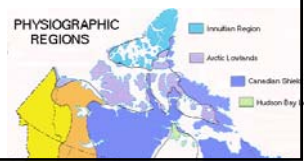
Arctic Coastal Plain near the James Dalton Highway, Alaska

Innuitian Mountains

- Folded, faulted and elevated sedimentary rocks at the edge of the Canadian Shield
  - Elevations of up to 7800 ft above m.s.l
  - Much older than the Rocky Mountains

Arctic lowlands

- Consists of sedimentary rocks
  - Abuts or overlaps the Canadian Shield
  - Weathered bedrock and glacial deposits
  - Generally low elevations; some cliffs along coastlines
- Geologic region: Canadian Shield
- Geographic region: Arctic lowlands
- The 2 regions overlap



Arctic Lowlands

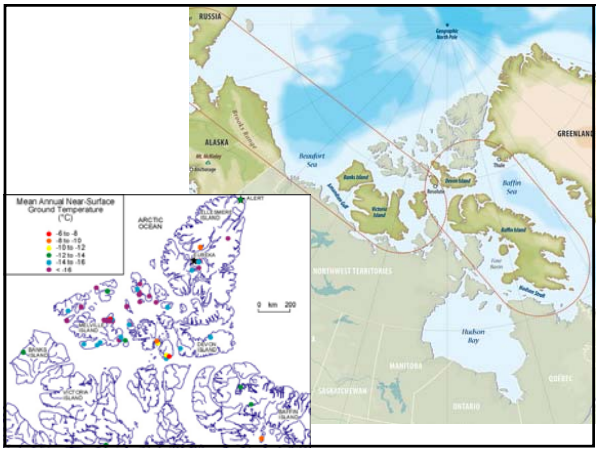
- Arctic lowlands: a continuous belt stretching between Nova Scotia and the Alaska, generally above 60º north latitude and containing areas of continuous permafrost
- Canadian Shield reaches farther south than the Arctic lowlands

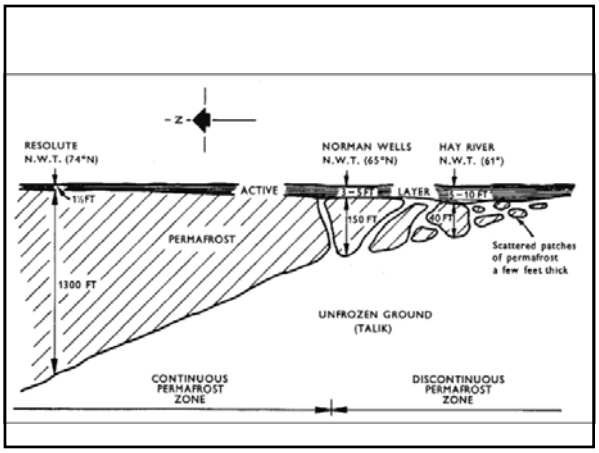
Characteristics

- Most dominating characteristic of all three regions is the presence of permafrost and other periglacial features
- Area recently (1000s yo) undergone multiple changes
  - Sea level rise
  - Retreat of glaciers
  - Drainage patterns rudimentary – cold climate

Permafrost Defined

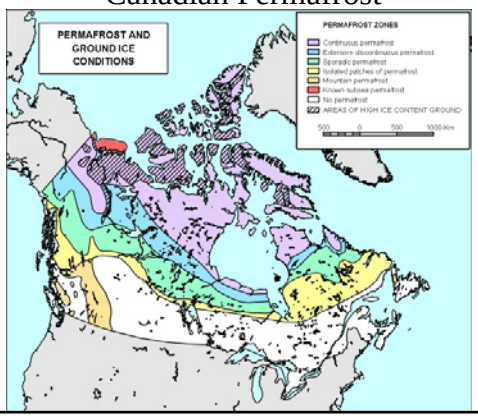
- Perennially frozen ground; ground below the freezing point, whether it be wet or dry.
- Remains below freezing for 2 or more years
- Zones: continuous; discontinuous, contains unfrozen areas (*talik)* in small, scattered area; sporadic (small islands of permafrost in generally unfrozen area; and isolated (tiny patches)



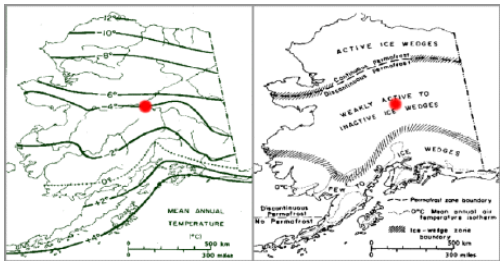


- Depth of Permafrost depends on:
  - Air temperature at the ground surface
  - Thermal properties of the ground material
  - Moisture content of the ground
  - Lack of protection of the ground from cover of vegetation, water, or snow.

Canadian Permafrost



Alaska Permafrost



Properties of Permafrost

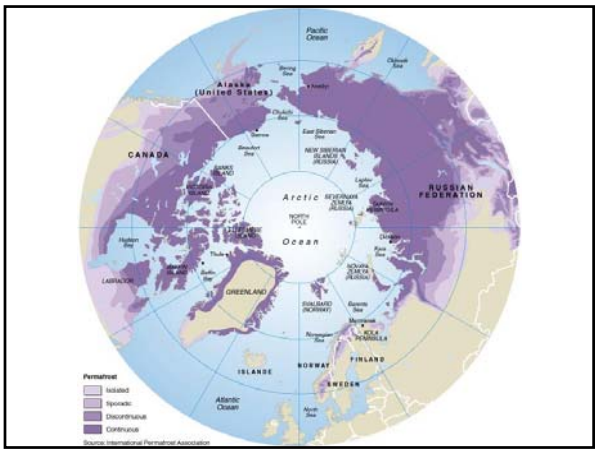
- Part of ground stays frozen
- Area nearest the surface thaws in summer: Active layer
- Active layer: biological and hydrological activity usually occur here
- Thickness of Active Layer dependent on surface temperature and ground cover

Landforms

- Permafrost is the dominant feature
- Permafrost affects the
  - formation of lakes
  - degradation of land
  - vegetation cover
- Nonpermafrost landforms generally are associated with ice

Ice

- Thermal properties of ice: upon freezing it expands in volume an added 9% more than in its liquid state
- Very important in permafrost studies and very important in periglacial studies

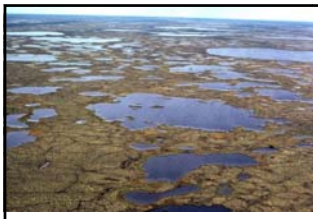


Permafrost

- Permafrost is not forming – already formed
- So land is "held-up" by permafrost
- Thermokarst terrain: land surface created as permafrost thaws
  - Natural or human-caused
  - Melting water and rain pool into depression left by thawing ground – permafrost prevents downward movement of water
    - Result is a region with lakes, ponds, sunken features, swamps, caverns

Thermokarst

- Considered a hazard because of ground failure – changes the appearance of the landscape
- Structures (buildings, roads, pipelines) built on permafrost must be insulated beneath, or isolated above ground surface, for heat dissipation.

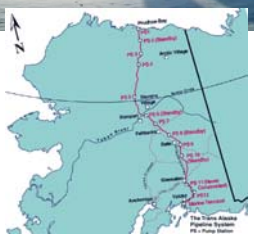


Thermokarst

- Will get thermokarst lakes or thaw lakes: depressions that fill with melting water from Active layer thawing

Buildings on Stilts in Tuktoyaktuk, NWT; Designed to Dissipate Heat and Avoid Permafrost Degradation

- To avoid thawing the permafrost, structures built on stilts



Periglacial

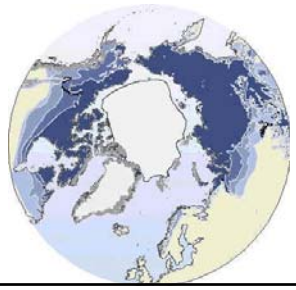
- Term first used in 1909, in reference to frost weathering conditions in Europe, and then to the climatic and geomorphic conditions in areas marginal to Pleistocene ice sheets.
- Now, it refers to “nonglacial processes and landforms associated with cold climates, particularly with respect to frozen ground”.

Periglacial Processes

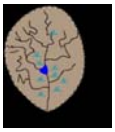
- Freezing and Thawing
- Frost Heave
  - As water freezes in soil: water segregates into ice lenses, heaving soil/stones upward
- Upfreezing of Stones and Soil – the progressive upward movement of stones during frost heaving
- Frost Sorting – similar sizes of particles group together, patterned ground

Periglacial environment

- Occurs over a greater surface than the permafrost environment



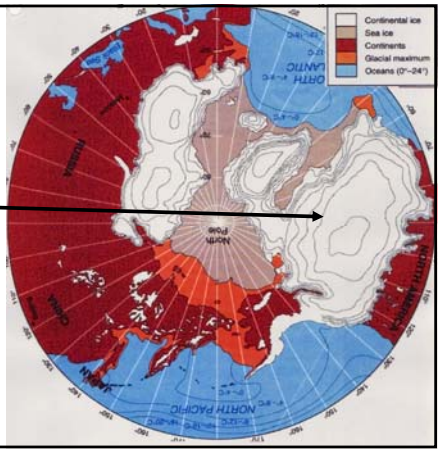
Environment



- Area most recently de-glaciated in the Pleistocene:
  - As the glaciers receded, this was the last environment where the glaciers existed
  - Result: a very "young" region existing on very old rock (Precambrian)
  - Drainage patterns are undeveloped (deranged stream pattern), lack of incision by streams
  - Not much time for soil development either

Glacial conditions in Wisconsin Glaciation

Laurentide ice sheet



Distinctive landforms

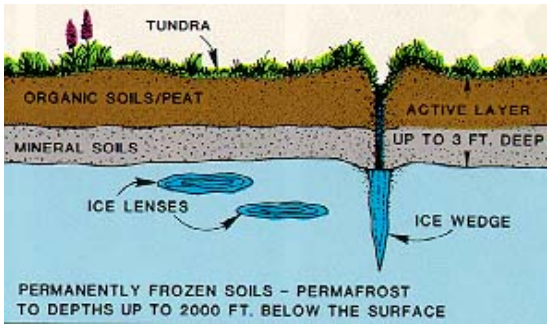
- Pingos: a landform with a core of solid ice; they grow larger as more water freezes onto the ice in the center of the hill
- Conical hill upwards of 100 m high
- Over ¼ world's pingos located in Tuktoyaktuk Peninsula, Canada

G-57…… PINGO!

Pingo Near Inuvik, Mackenzie River delta area, NWT

Ice Wedges and Ice Wedge Polygons

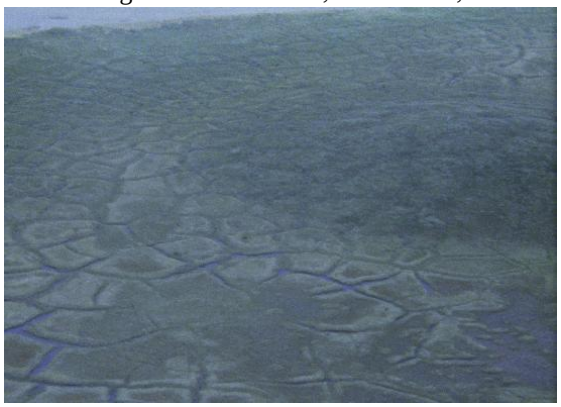
- Near-vertical, downward tapering, ice wedges may extend 10m or more below the ground surface.
- Intense cold cracks ground open; fills with water during summer; freezes and expands crack in winter; repeat again and again.
- As ice wedges melt, sediment collapses into them, leaving a wedge-shaped mass of debris known as an ice-wedge cast.
- Modern wedges grow only in areas of continuous permafrost where mean annual temp is -6 to -8C.



A typical ice wedge

Close-ups of Relict, In-filled Pleistocene Ice Wedges

Ice Wedges Surface Pattern, near Inuvik, NWT

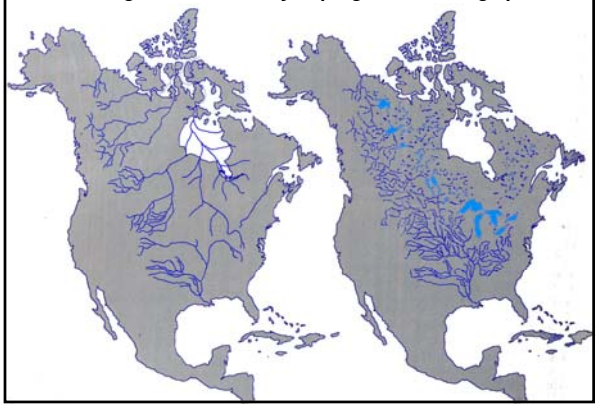


Environment

- Area does have features created by glaciers: more typical of alpine and valley glaciation (Innuitian Mountains)
- Fjords: U-shaped valleys created when valley glaciers moved through the area
- After glaciers receded, sea levels rose, flooding valleys

Fiord = flooded U-shaped valley

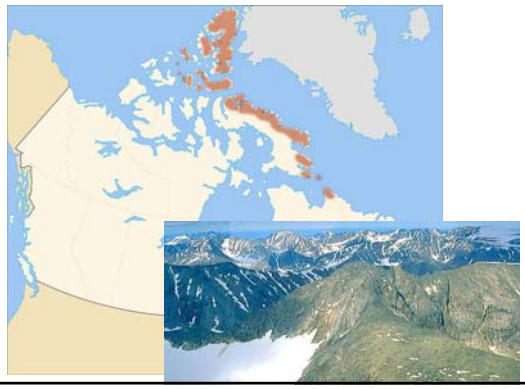
Continental glaciation destroyed preglacial drainage pattern



Topography

- Mountains to the extreme north:
  - Arctic Cordillera
  - Deeply dissected (fluvial and glacial)
  - Mountains in Nunavut, most northern tip of Labrador, and northeastern Quebec
  - Series of ranges over 6,500 ft high (2,600 meters+)
    - Challenger Mountain Range
  - Highest mountain: Barbeau Peak on Ellesmere Island at 2,616 m (8,583 ft), which is the highest point in eastern North America (Canada and US)

Topography

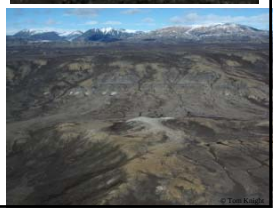


Innuitian Region: Mountainous north

- Contain ice shelves, ice caps and alpine glaciers
  - All have reduced in the size since first discovered
- Mountains are younger than the Appalachians but older than the Rockies
- Mostly sedimentary but some gneiss (metamorphic) and granite (igneous)
- Volcanic features (likely associated with Icelandic hot spot) are 1.2 billion to 65 million years old.

Innuitian Region:

- Typical mountainous terrain: mountain ranges with plateaus, uplands and lowlands.
- Mountain ranges include the Grantland, the Axel Heiberg, and the Victoria and Albert mountains.
- Ice sheets still bury some mountains with only peaks visible (nunataks)



Arctic Lowlands

- Large areas of exposed rock and boggy plains where soils are thin
- Mostly islands
- Sea ice forms in the winter, in the straits between outlying islands, which means that people can actually walk over the water
- In summer, the sea ice begins to melt and breaks up into huge floating sheets called ice floes, which can be several kilometers across (each km=0.6 miles)

Environment

- Glaciated environment
- Rias or drowned coastlines
- Moraines along the outer edges of the glaciated areas
- Bogs: spongy peat deposits, acidic waters, and a floor covered by a thick carpet of moss. Great place for mosquitoes and black flies
- Coastline – longest coastline in the world
- Fjords
  - Ellesmere Island
  - Baffin Island

Baffin Island

Continental glacial landforms

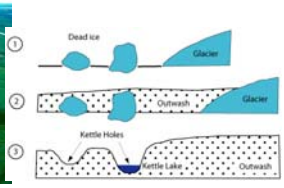
- Striations : multiple straight, parallel grooves representing the movement of the base of the glacier.
- Sediments carried and pushed by the glacier carve, scour, and polish the bedrock.
- Most glacial striations were exposed by the retreat of glaciers since the Last Glacial Maximum (15,000 yo)

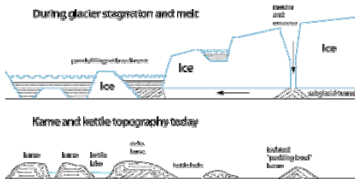
Large glacial striations

Kettle and kame topography: coastal plain and lowlands

- Kettles: result of blocks of ice calving from the front of a receding glacier and becoming buried partially to wholly by glacial outwash
- Kames: an irregularly shaped hill composed of stratified glacial debris that accumulates in a depression on a retreating glacier, and is then deposited on the land surface
- Also occurs in Canadian Shield

Kettles and kames





Coastal plains

- Plain with a maximum elevation of 600 ft
- Underlain with permafrost up to 1,000 ft thick
  - Active layer less than 5 ft
- Area is poorly drained – very marshy in summer
  - Lots of thaw lakes
- Sedimentary rock covered by Quaternary and Tertiary sediment
- No glaciers

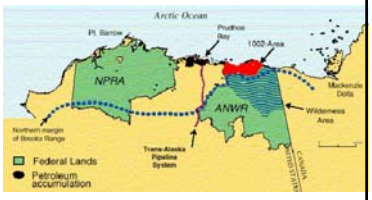
Coastal plains

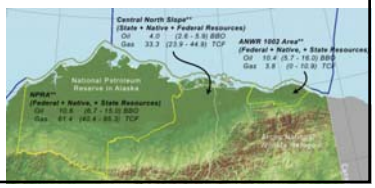
- Pingos, ice-wedge polygons, and other periglacial features present
- Vegetation present

Based on data of R. F. Flint, *Glacial and Pleistocene Geology*. John Wiley & Sons, New York.

Coastal plains

- Huge projected oil reserves
- Indicates that the environment used to be much different
- Flora and fauna very sensitive to changes





Vegetation

- In mountains, expect to see alpine vegetation: but too soon since deglaciation
- Primarily, the arctic tundra biome
  - A sparse grass and shrub dominated landscape found beyond the arctic treeline
  - Height of vegetation is less than 3 ft tall
  - Short growing season (3 months or less average)

Vegetation

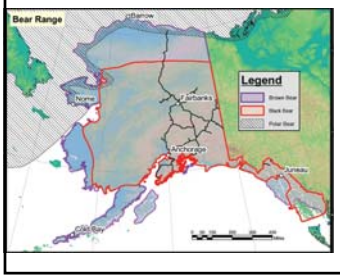
- Increase in latitude usually results in increased spacing between plants
  - Plant height decreases
- Low creeping species
- Low diversity
- Herbs, when they occur, often have large, bright flowers (poppys)

Flora

- No reptiles or amphibians live in the tundra
- Animals and include lemmings, voles, caribou, snowy owls, polar bears, brown (grizzly) bears, ringed seals, musk ox, arctic fox

Bears

2 species northern Alaska and Canada



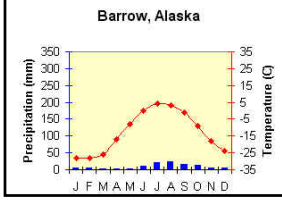
http://www2.hawaii.edu/~tmcgover/photos/wildlife/brownbear.jpg

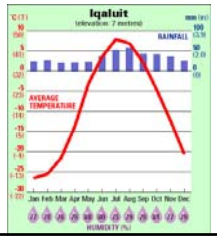
Climate

- Mid-winter, the Arctic is totally dark twenty-four hours a day
  - No radiation (heat) reaching the region
- Little precipitation in the Arctic; rain is uncommon, some snow falls in winter, but less than most other places in Canada
  - Desert environment – little rain
  - Compensated by little evaporation

Climate

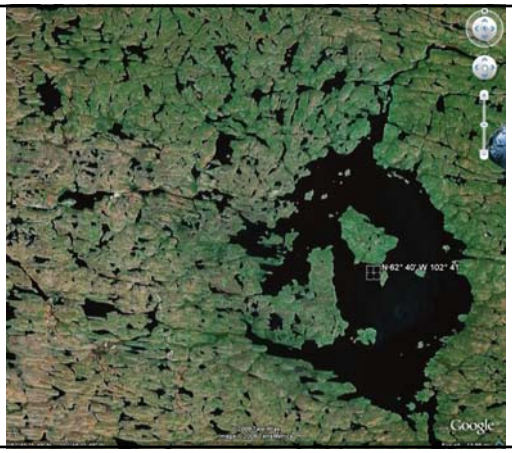
- Short, sunny summer, with temperatures that can reach 15º C (59ºF)
- Winters are cold and long, with low temperatures of -45º C (- 49ºF)
  - Winters can average -35ºF





Soil

- Soil is classified based on its characteristics
- Canada and US have different classification systems
- Soil in region forms slowly, frequently frozen, little vegetation to add organic matter
- Soil may be quite “young”
- Cryosol: high latitudes soil common in the tundra. This soil has a layer of **permafrost** within one meter of the soil surface.



Impact Database

- http://www.unb.ca/passc/ImpactDatabase/NorthAmerica.html