PINGOS

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To be discussed:

- What is a pingo?
- Distribution
- Pingo Features
- Pingo Growth and Development
  - Hydrostatic (closed) System
  - Hydraulic (open) system
- Case Study: Ibyuk Pingo,Tuktoyaktuk
- Current Research

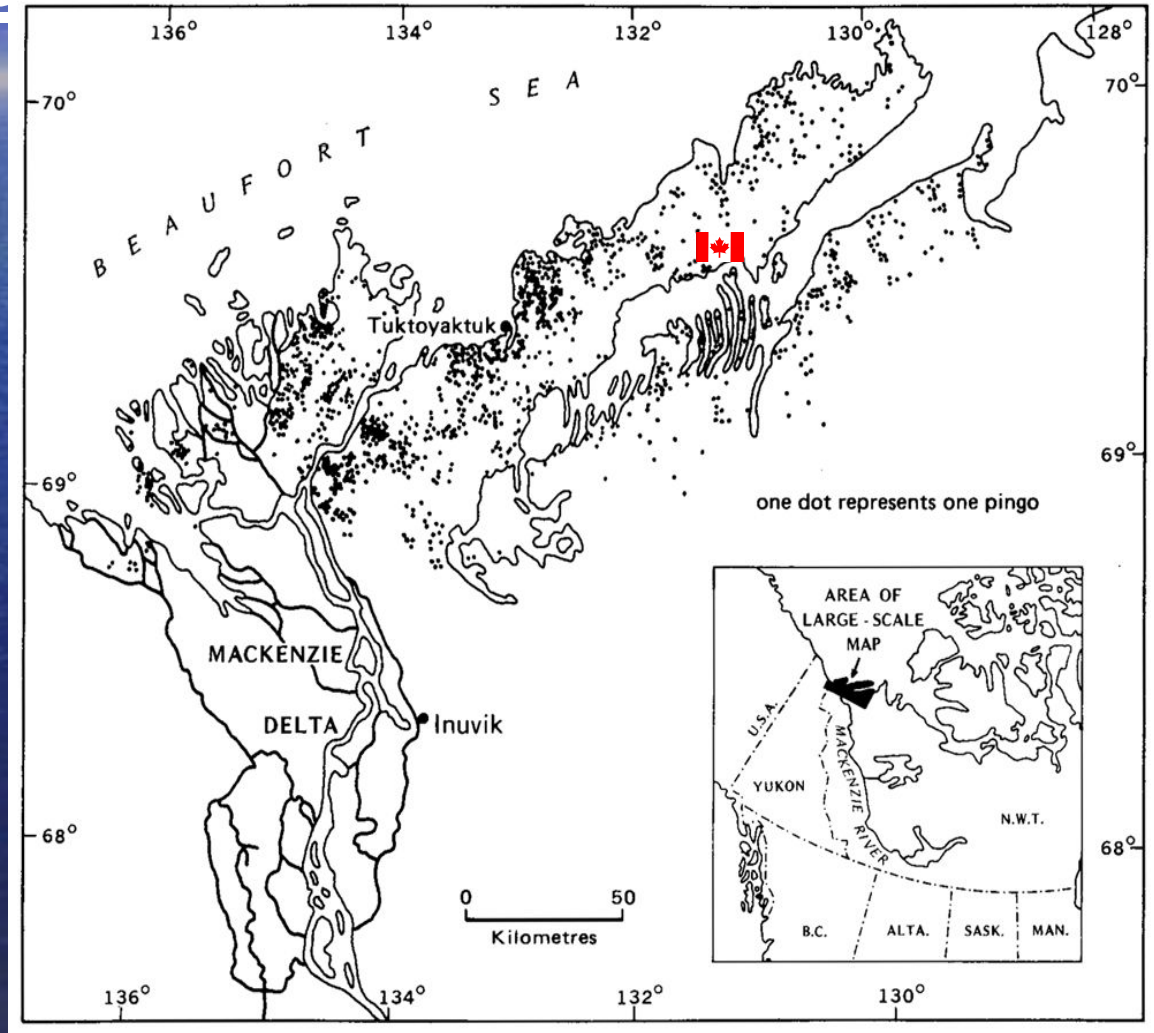
Pingos

- Inuit term *pinguryuaq* meaning "hill"
- Ice cored, conical mounds and hills
- Periglacial environments: permafrost ground stays below 0°C for at least 2 years
- Size varies: 10-70m high, 20-400m diameter
- Result from preferential migration of water
- 25 - >1000 years old

Pingo in the Canadian Arctic
source:
http://www.mbari.org/news/news_releases/2003/paull_images/pingo1_350.jpg

Global distribution

- ~5000 worldwide
- 25% of these are found in Mackenzie Delta – Tuktoyaktuk Peninsula
- Other locations: Yukon, Alaska, Siberia, Spitsbergen (Norway), Greenland
- Occur in drained lake basins, or former fluvial channels
- ~200 undersea pingos mapped in submarine permafrost of Beaufort Sea



Source: Mackay, 1962

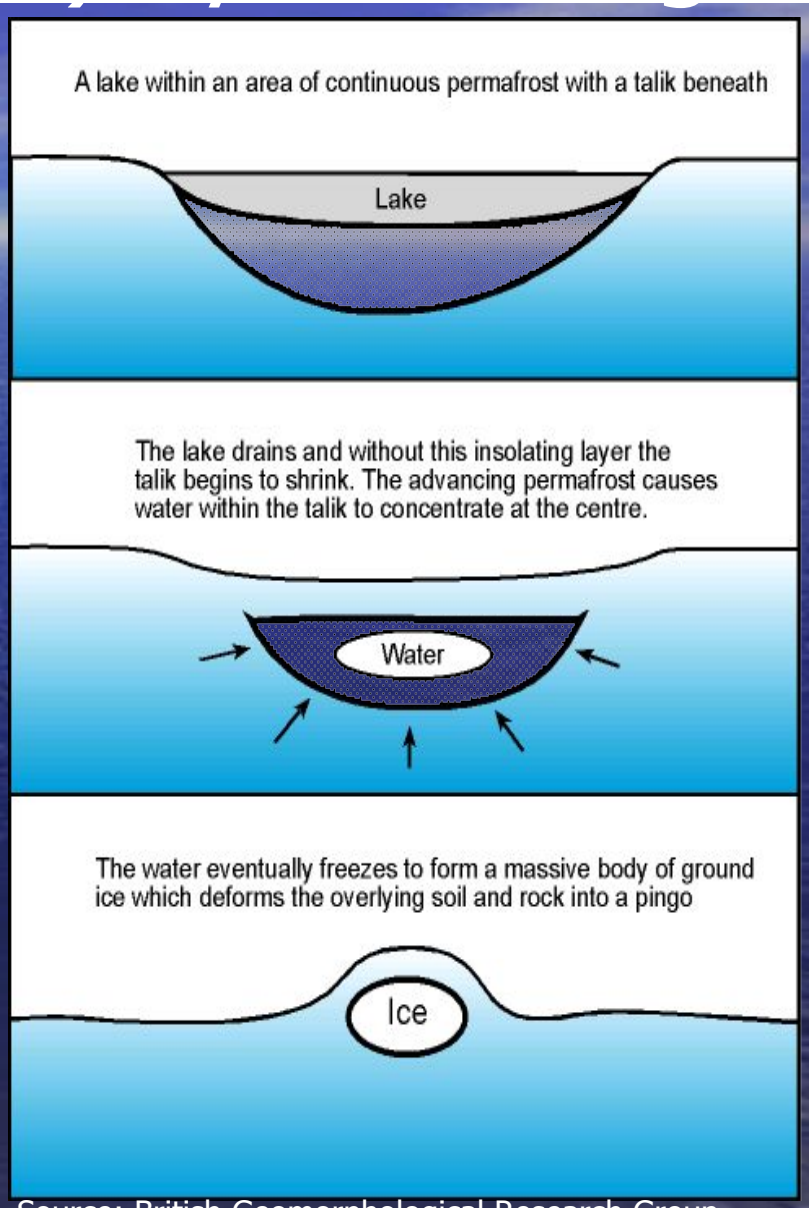
Pingo Features

- Pingos grow upward from the base as the ice core expands
- Cover/Overburden of vegetation and soil similar to surrounding area
- Dilation and Radial cracks induced by growth of the summit and base
- Cracks may form trenches, gullies, craters, and fractures

Source: http://www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1SEC826257

Hydrostatic (Closed) System Pingos

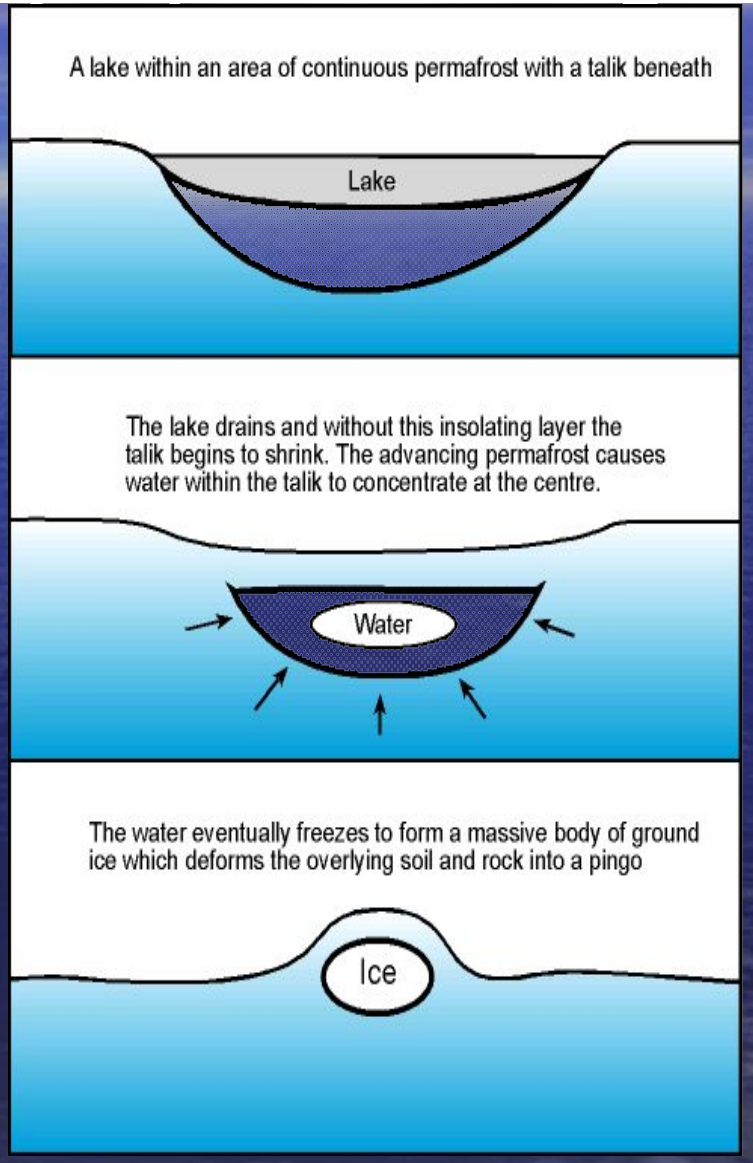
- Lake underlain by talik: unfrozen ground/sediments in permafrost
- Lake is drained, bottom is exposed to cold air temps.
- Permafrost aggrades/advances
- Unfrozen ground water within the talik experiences hydrostatic pressure
- Pressures force water to move upward and laterally to where it is forced toward the ground surface.
- As the water approaches the surface, it freezes and forms a conical, ice-cored hill; a pingo



Source: British Geomorphological Research Group, www.bgrg.org/

Hydrostatic (Closed) System Pingos

- Larger, isolated pingos
- Mackenzie Delta
- Derive water pressure from pore water expulsion within talik (maintains form of the pingo)
- Confined to zones of continuous permafrost



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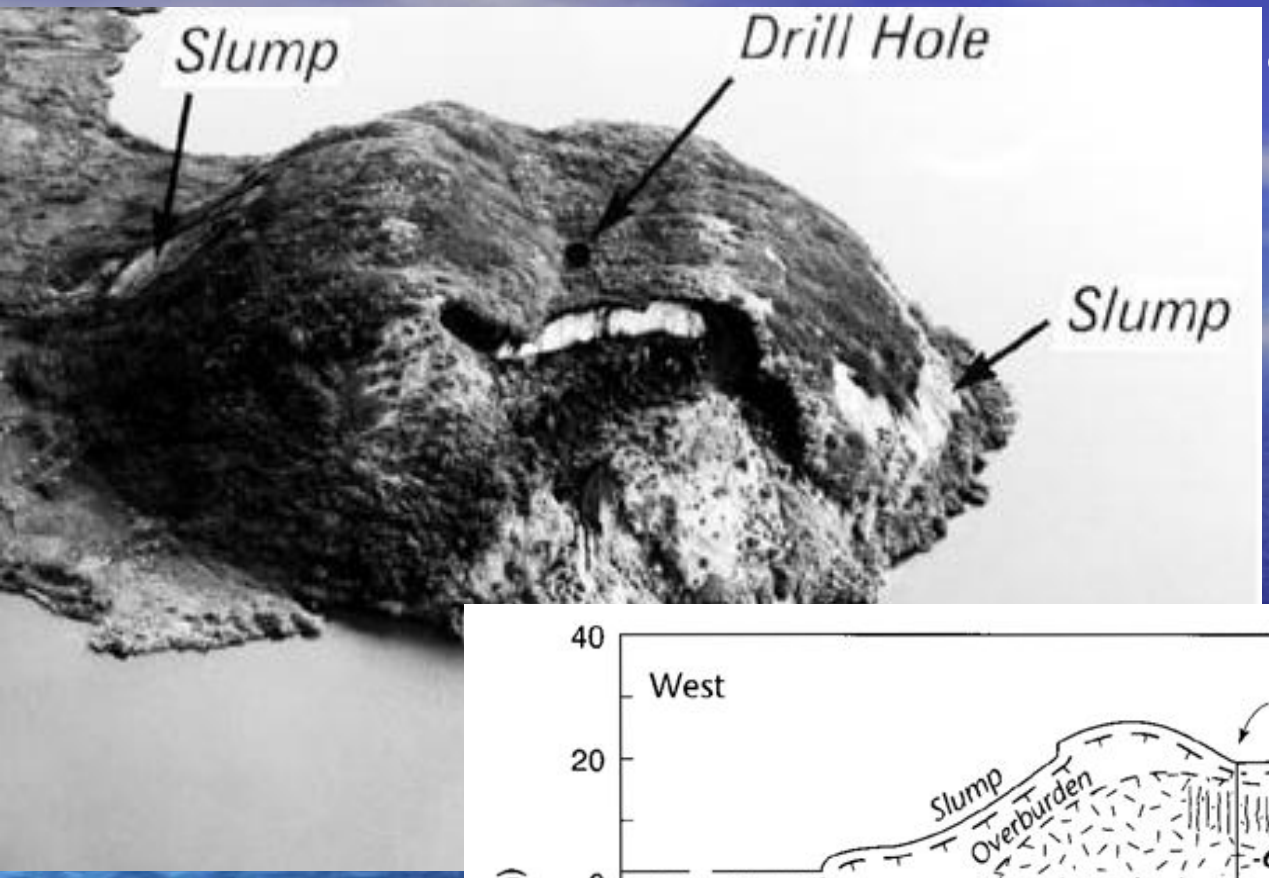
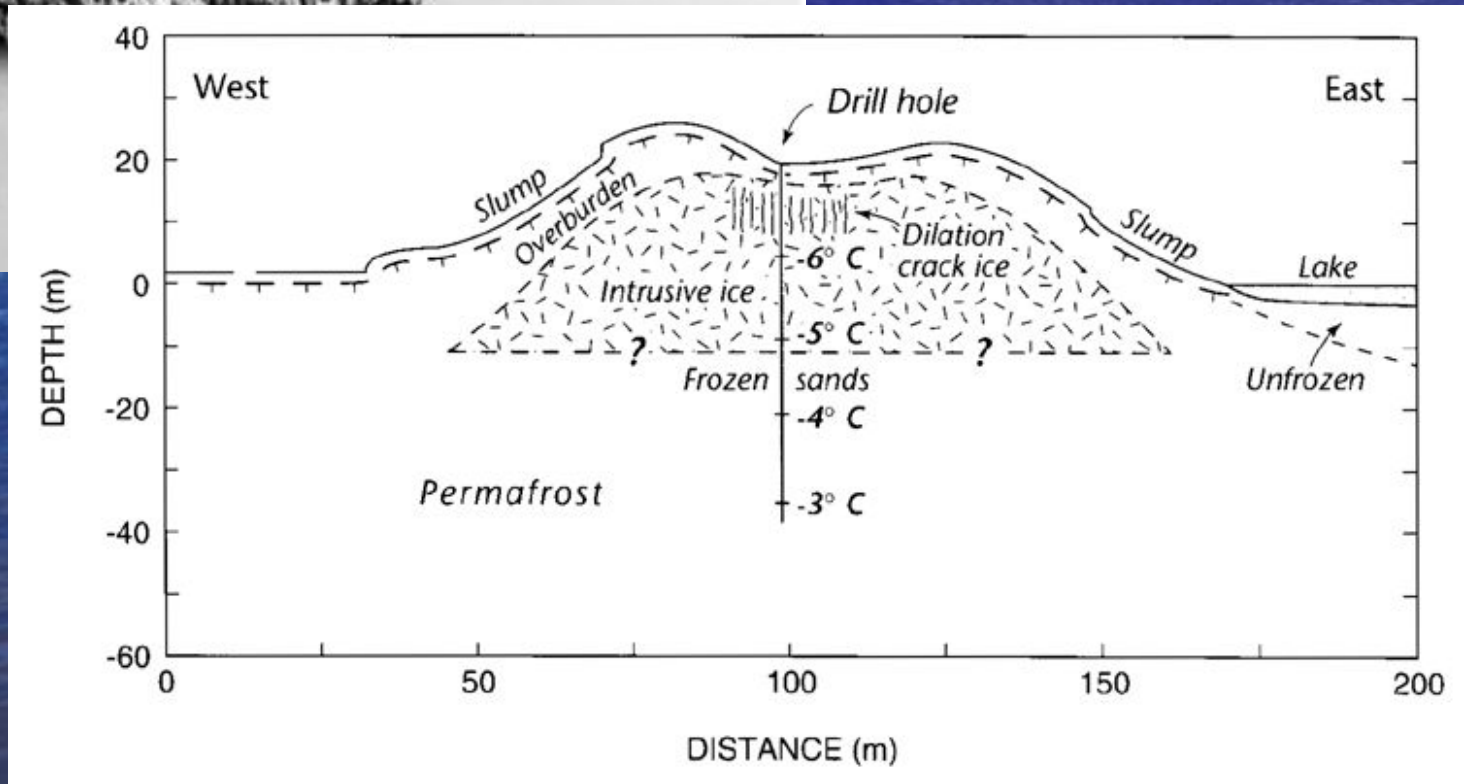


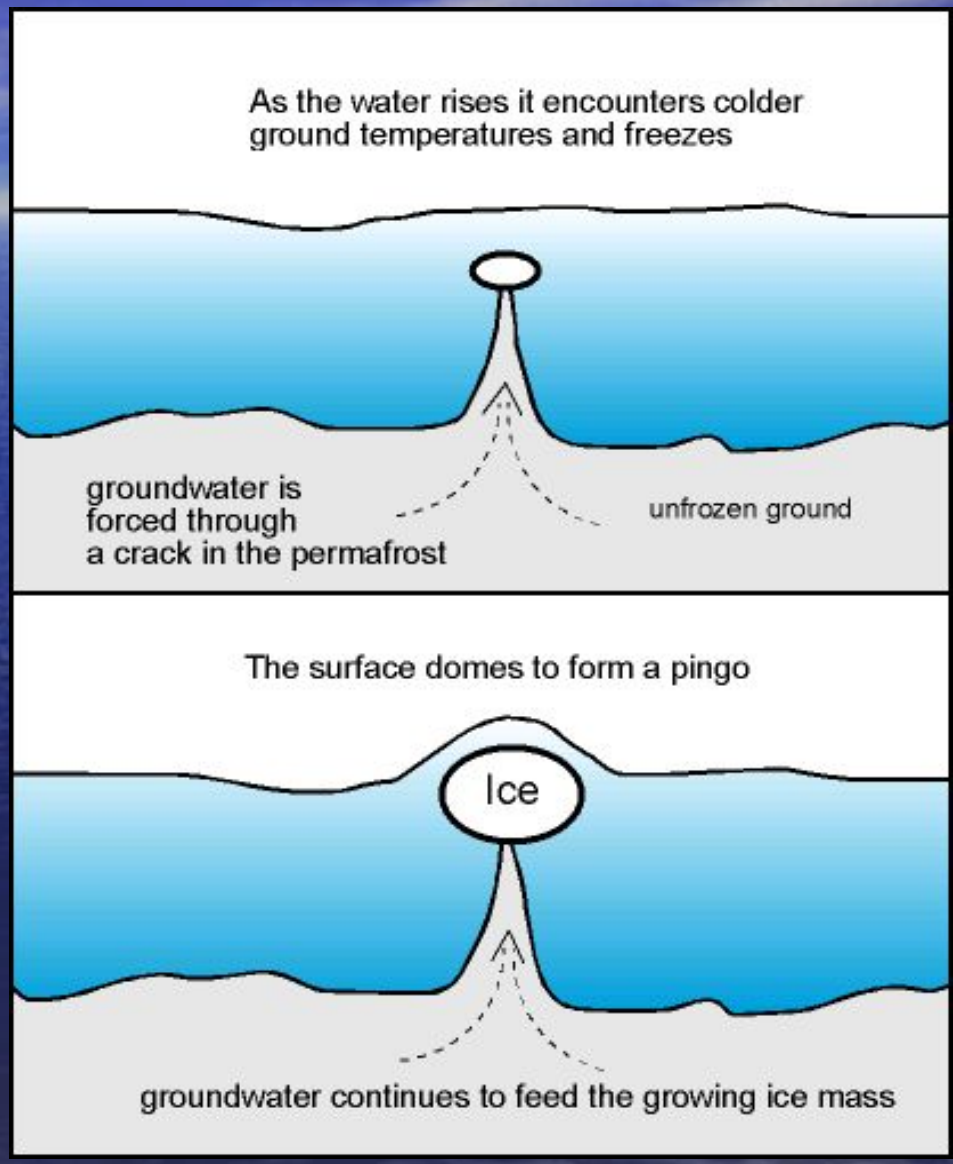
- Cross Sectional View of a Hydrostatic Pingo



Source: Mackay, 1998

Hydraulic (Open) System Pingos

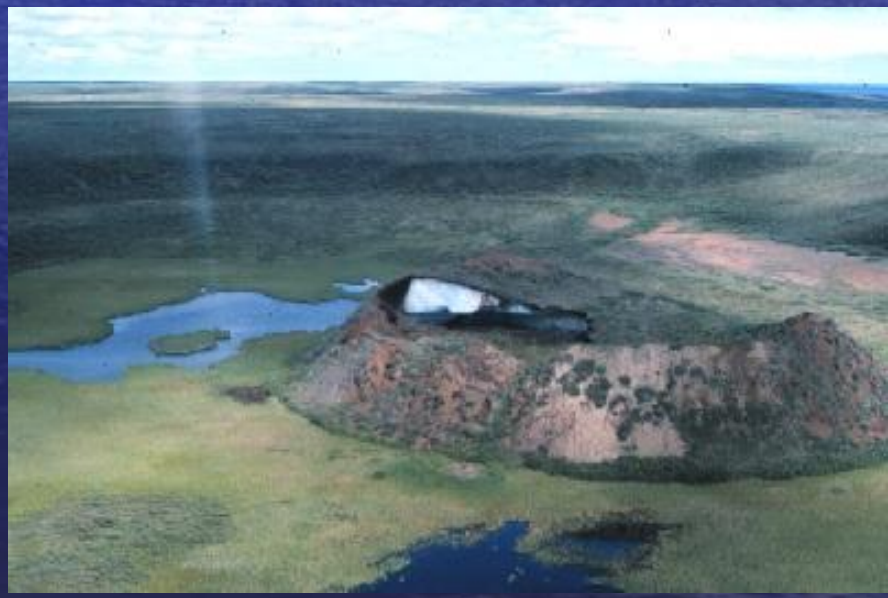
- Common in Alaska, the Yukon, Greenland, and Spitsbergen, areas of discontinuous permafrost
- Requires flowing water beneath permafrost
- May form on sloping terrain, which sets up hydrostatic gradient
- Water beneath or within permafrost is under high pressure
- Water under pressure forces its way towards the surface
- As it freezes, doming occurs, pingo forms



Source: British Geomorphological Research Group, www.bgrg.org/

Pingo Age Data

- Radiometric data shows N.A. pingos are approx. 4000-7000 years old
- Timing of climatic conditions can be obtained from pingo ice
- Seasonal growth bands within the ice core record climate changes
- Radiocarbon dating of organic material in overburden
- Changes in vegetation cover may record recent climate change



Source: http://www.hi.is/~oi/quaternary_geology.htm
http://gsc.nrcan.gc.ca/beaufort/pingos_e.php

Pingo Collapse

- Ground stretches to accommodate pingo growth
- Dilation cracks form in Tundra near the summit, can create a crater
- Water collected in the crater may melt the ice core
- Or, the steep slopes erode, exposing the core to sunlight, which leads to melting of the ice core and pingo collapse

Collapsed Pingo

Source: Parks Canada, 1988

www.pc.gc.ca/docs/v-g/ pingo/sec3/natcul1_e.asp

Pingo Collapse – 3 Factors

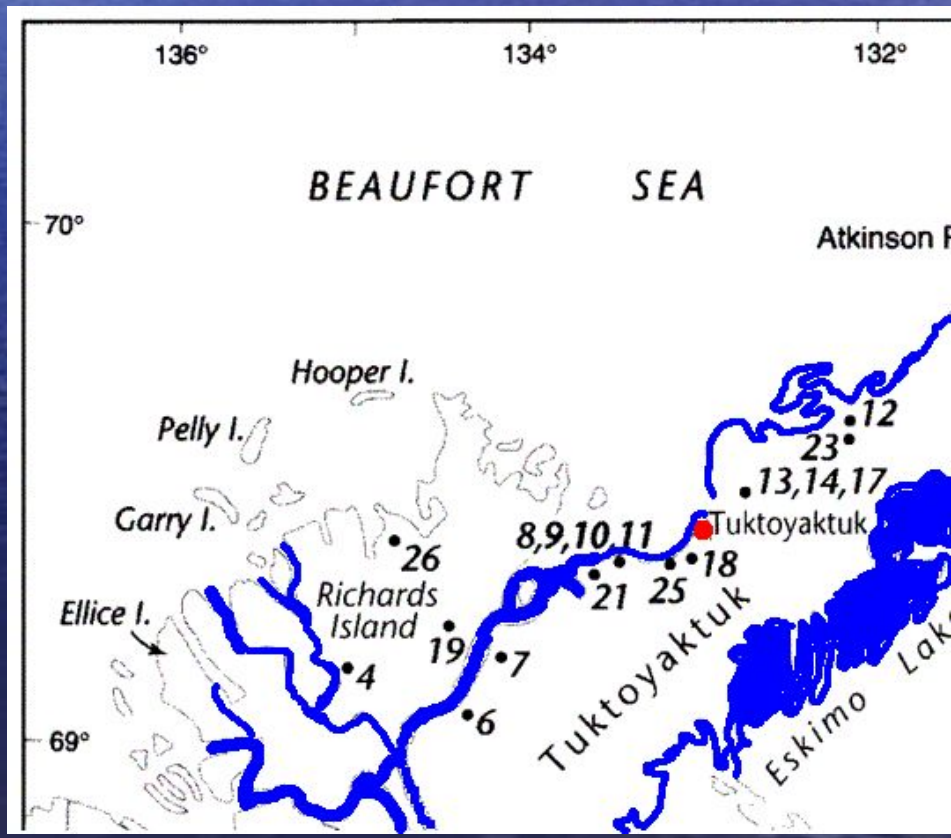
- Mass Wasting
  - slumping of overburden
- Wave Erosion
  - storm surges/tides erode slopes
- Thermokarst effects
  - Exposure of ice core to warmer temps = greater risk for collapse

Case Study – Ibyuk Pingo, Tuktoyaktuk

Source: http://www.pwnhc.ca/inuvialuit/placenames/ibyukwhat.html

Case Study - Ibyuk

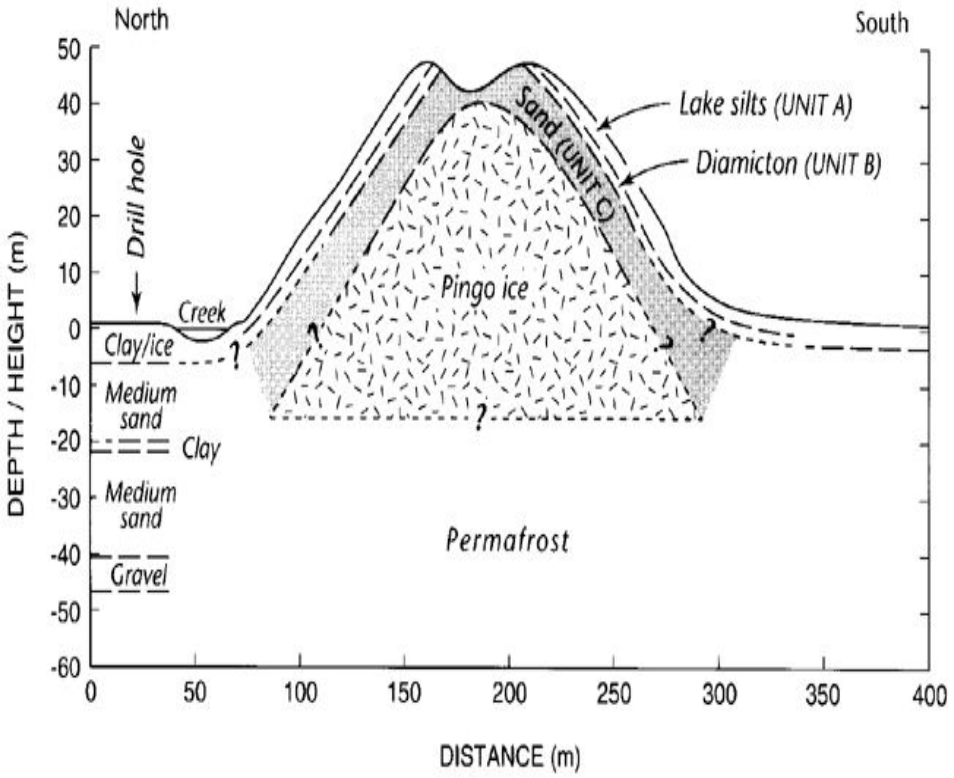
- The presence of numerous lakes in the Tuktoyaktuk Peninsula may explain the abundance of pingos
- Pingo Canadian Landmark protects 8 pingos in the area around Tuktoyaktuk



Source: Mackay (1998)

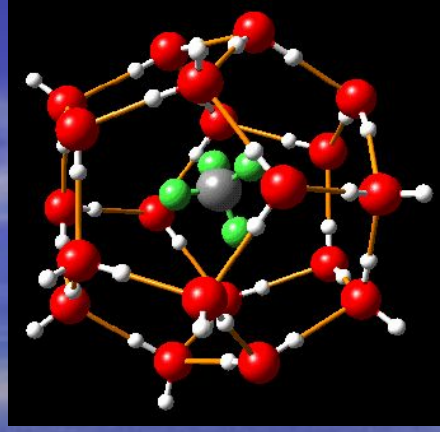
Ibyuk Pingo – Hydrostatic (Closed)

Profile View of Ibyuk Pingo



Cross Sectional View of Ibyuk Pingo
Source: Mackay, 1998

Current Research



- Marine Geophysical Research
- Gas-hydrates are a potential source of clean burning natural gas
- Paull and Ussler, 2003

  - Studied submarine pingos for methane gas-hydrate content

  - found gas in cores of sediments from pingos
- Clough, 2004

  - Studied pingos along fault zones in Alaska for methane "gas seeps"
- Mechanisms for entrapment/extraction of gas-hydrates in pingo-like features still poorly understood

The End