THERMOKARST LAKES FORMED IN BURIED GLACIER ICE

Observations from Bylot Island, eastern Canadian Arctic

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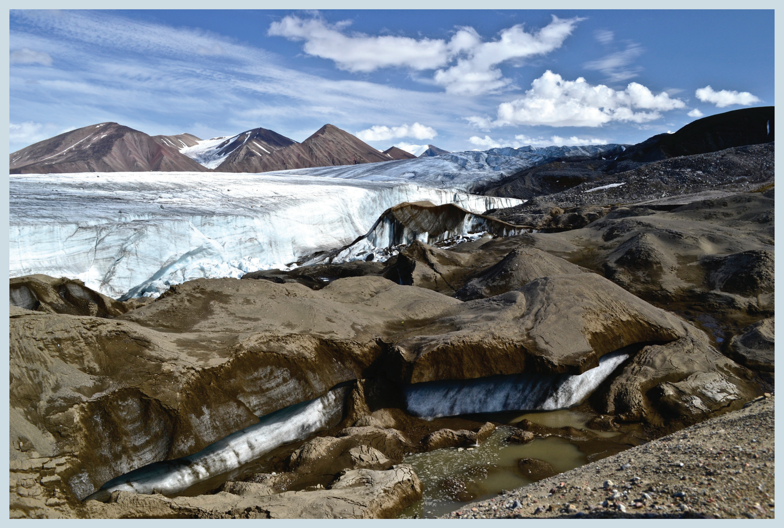
In formerly glaciated permafrost regions, extensive areas are still cored by a large amount of glacier ice buried underneath a thick cover of sediments. Its spatial distribution can play a significant role inreshaping periglacial landscapes, in particular the aquatic systems.

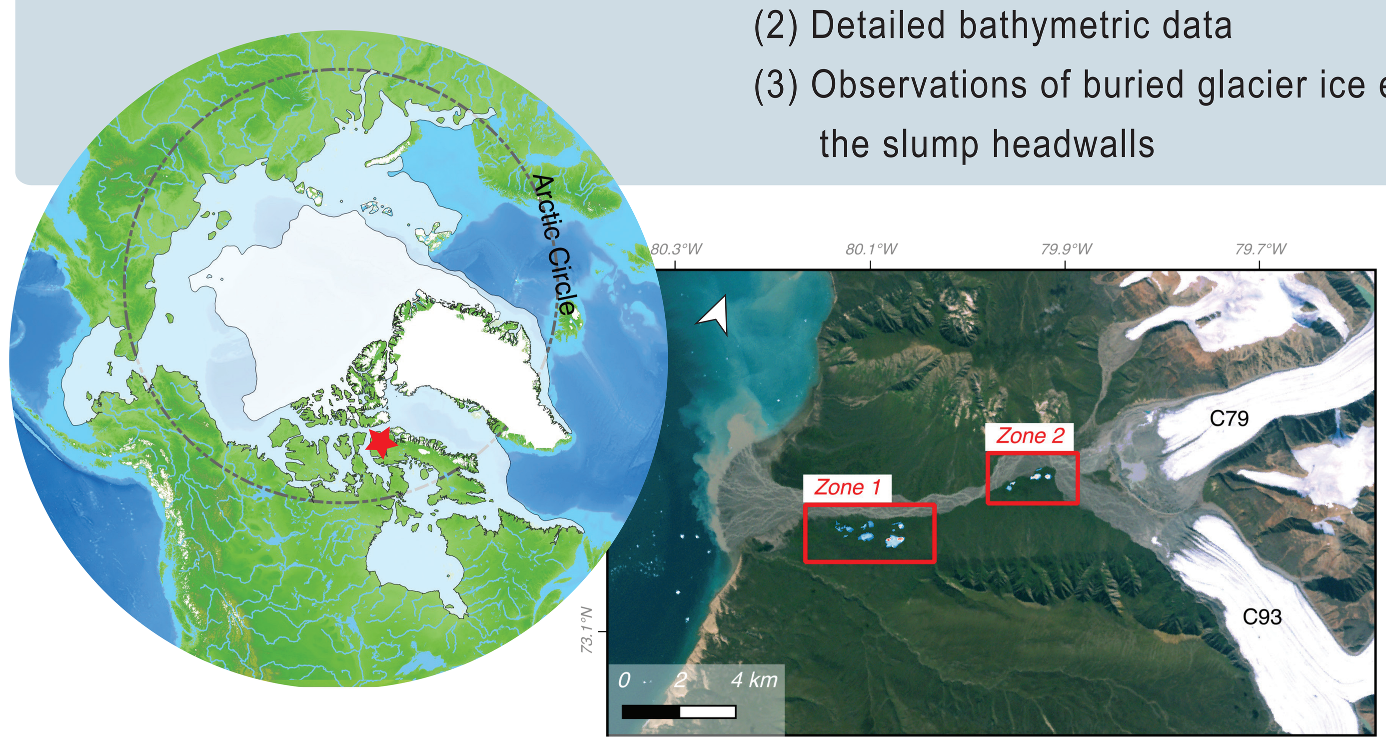
This study focuses on in lake initiation and development in response to the melting of buried glacier ice on Bylot Island, Nunavut. We studied a lake-rich valley using:

(1) Dated lake-sediment cores
(2) Detailed bathymetric data
(3) Observations of buried glacier ice exposed in the slump headwalls

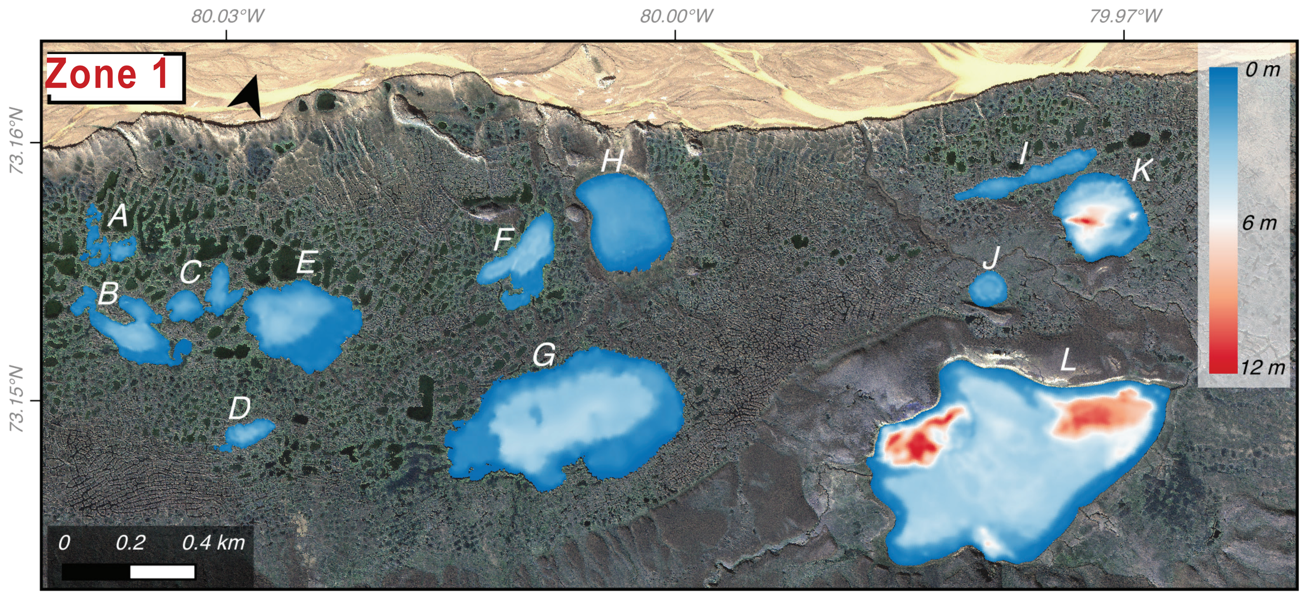
Active burial of modern glacier ice on Bylot Island (Glacier C-93)



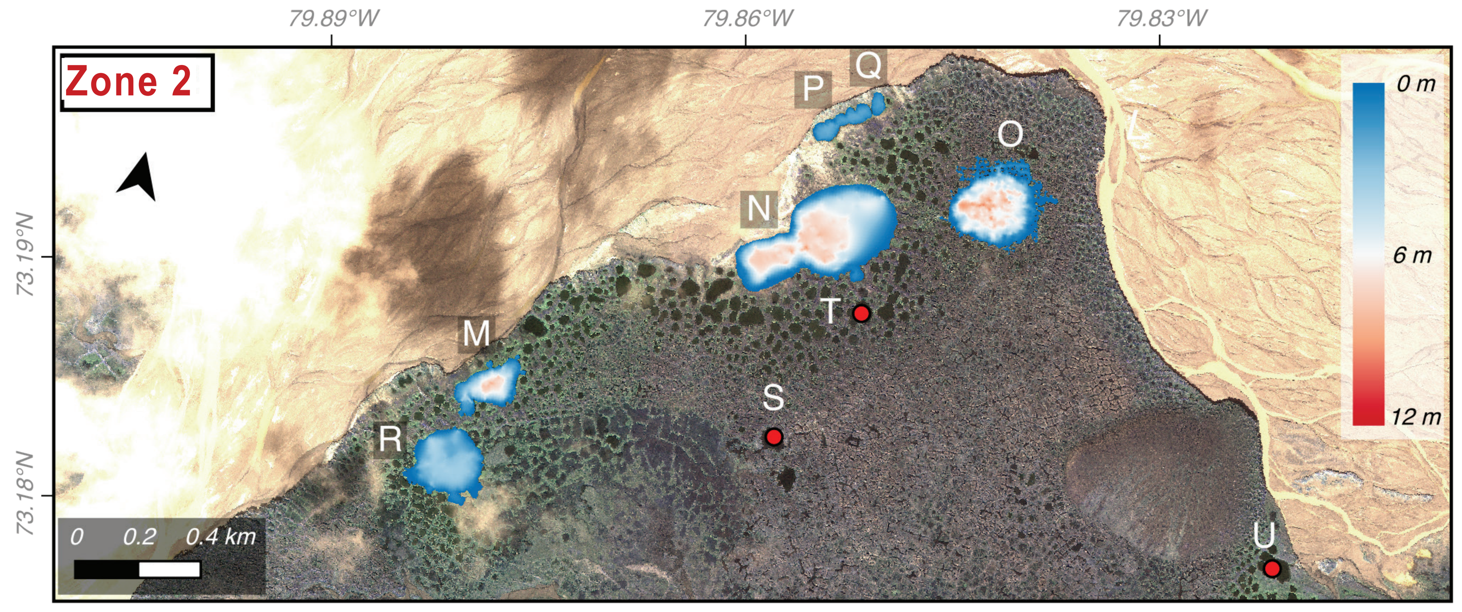
The burial of glacier ice occurs as a considerable volume of sediments is deposited in ice-marginal environments. These large masses of glacier ice will persist or only melt at very low rates once the sediment cover is sufficiently stable and exceeds the active layer thickness (i.e. depth of annual thawing).



Location of Bylot Island (73°, 80) in the eastern Canadian Arctic Archipelago. Numerous outlet glaciers still flow out from the local ice cap covering the mountainous core of the island. This study focuses on a specific valley (Qarlikturvik) where remnants of buried glacier ice were discovered.



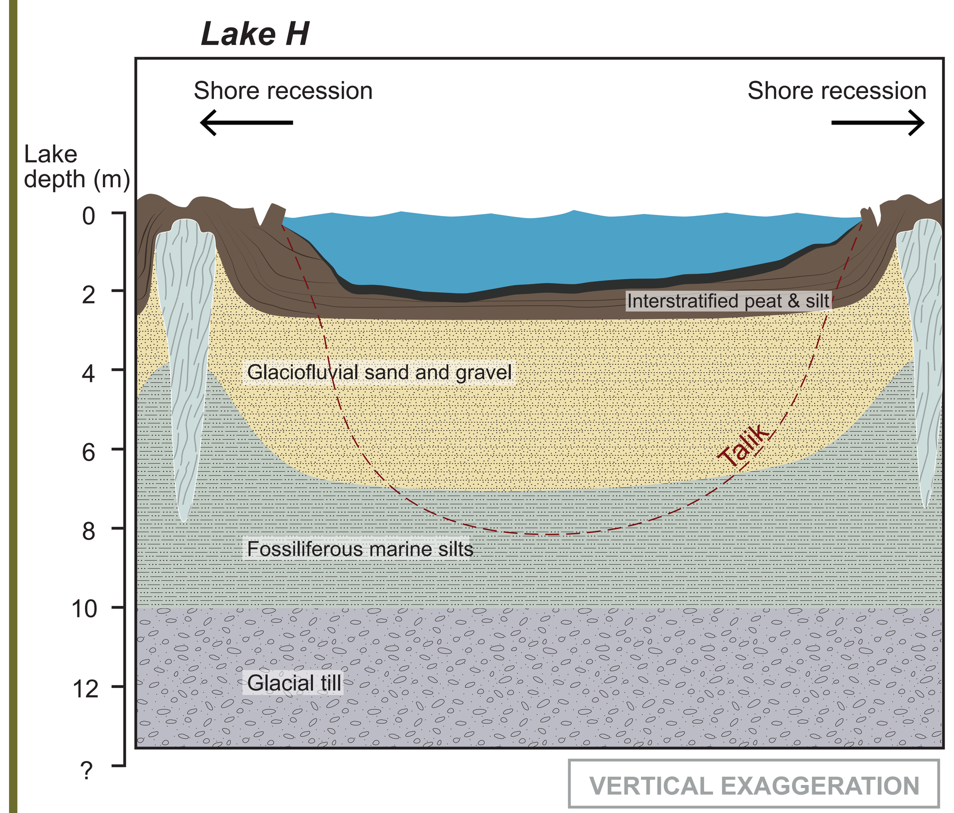
Maximum depth (m): A: 2.9 B: 3.2 C: 2.4 D: 2.8 E: 3.3 F: 3.9 G: 4.0 H: 2.5 I:3.0 J:2.4 K:12.2 L: 11.7



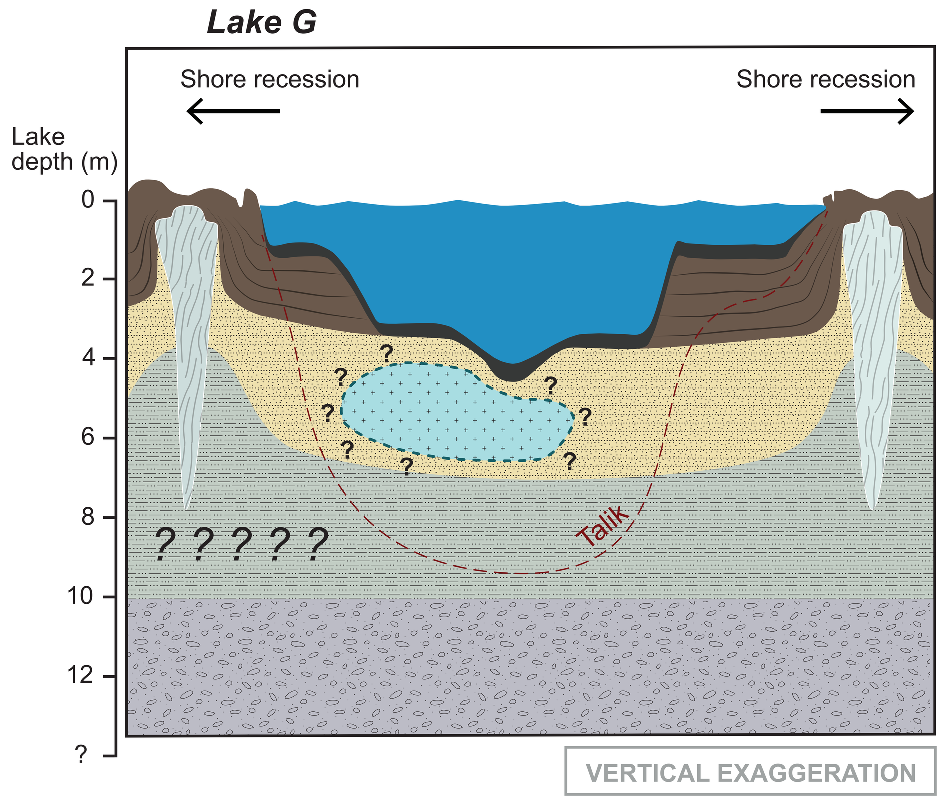
Maximum depth (m): M: 8.4 N: 9.4 O: 9.8 P: 2.3 Q: 1.8 R: 3.9 S: 1.2 T: 1.2 U: 2.2

We have identified **3 types of lakes** according to their lake sediment facies and lake-floor geomorphology:

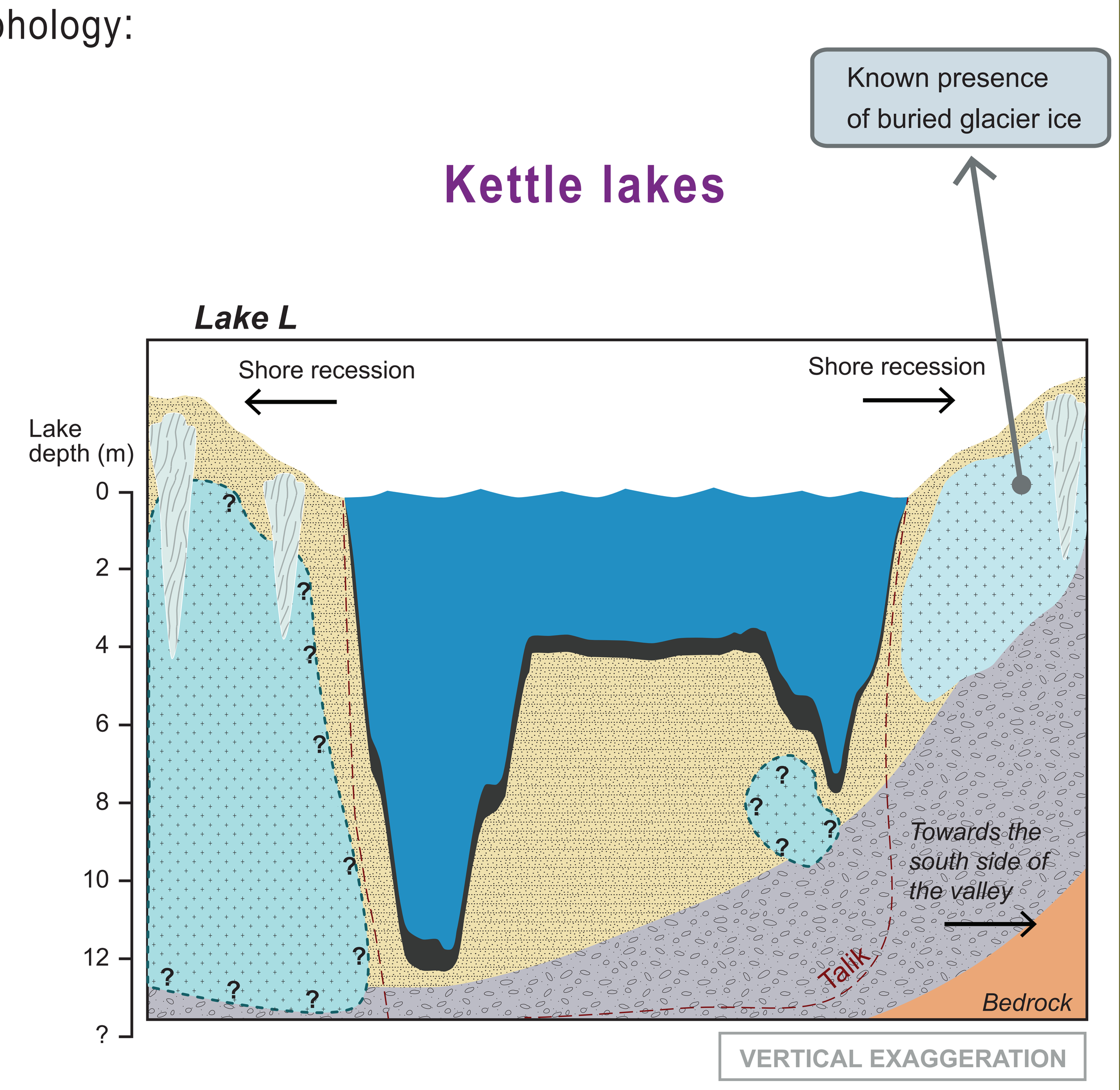
Thermokarst lakes that formed from the melting of permafrost intrasedimental ice and ice wedges



Thermokarst lakes that formed from the melting of buried glacier ice



Kettle lakes



Description

Thermokarst lakes (permafrost intrasedimental ice and ice wedges):
- Shallow lakes (~ 2-3 m) *classic thermokarst lakes*
- Fairly uniform depth, with a central pool

Thermokarst lakes (buried glacier ice):
- Shallow lakes (~4 m)
- The central pool is deeper than the thickness of the intrastratified silty peat sequence (~ 2-3 m deep)

Kettle lakes:
- Deep lakes (~9-12 m)
- Presence of multiple steep-sided sub-basins (in some cases)
- A body of buried glacier ice was exposed by lakeside slumps

Lake development

These shallow thermokarst lakes evolved from the:

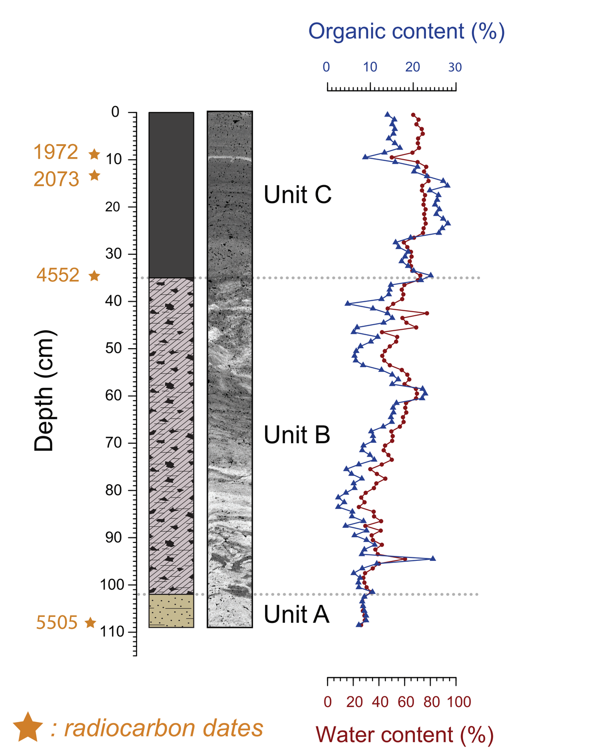
- Enlargement of ponds enclosed in the depression of low-center ice wedge polygons
- Melting of ice wedges and intrasedimental ground ice that formed in the surrounding material

Lake initiation of deeper thermokarst lakes is believed to have been triggered **by the melting of buried glacier ice**. Over time, they have enlarged through thermal and mechanical shoreline erosion, and subsequently coalesced with neighbouring water bodies to form larger lakes.

These deep lakes were primarily kettle holes that resulted from **the melting of buried stagnant blocks of glacier ice.** These lakes now evolves as classic thermokarst lakes that expand in area and volume as a result of the melting of the intrasedimental ground ice in the surrounding material.

The sedimentary sequence from the kettle lake (K) also suggests a different origin and formation as compared to the sediment cores obtained from the thermokarst lake (G).

Lake G (thermokarst lake)

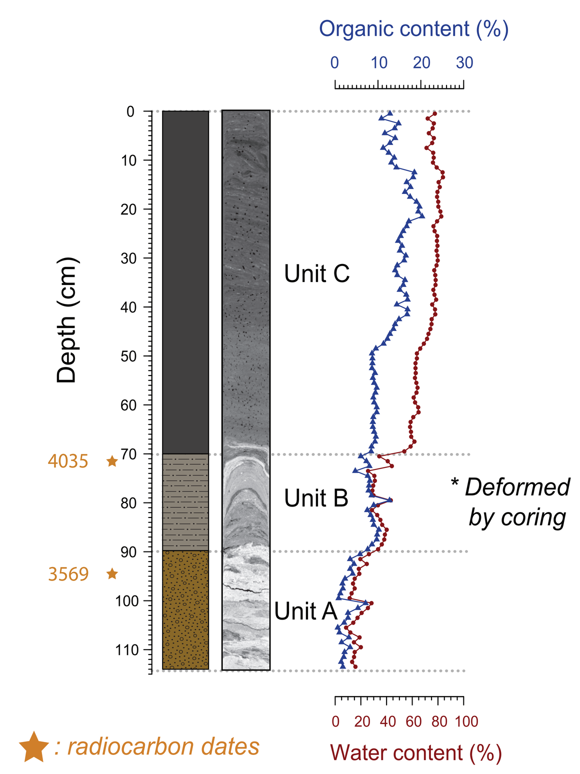


Unit C: Recent lacustrine sediments
- Silty gyttja and dark peat

Unit B: "Trash layer"
- Organic-rich sandy mud
- Collapsed bank material (in reponse to thermo-mechanical erosion)

Unit A: Terrestrial silty peat unit
- Organic-poor sandy mud
- Base of the interstratified silt and peat unit

Lake K (kettle lake)



Unit C: Recent lacustrine sediments
- Silty gyttja (organic mud)

Unit B: Lacustrine sediments
- Organic-rich sandy mud

Unit A: Glaciofluvial sediments
- Organic-poor sand and gravel

Buried glacier ice has the potential to initiate major geomorphic changes and significantly alter the trajectory of landscapes in response to the warming of the Arctic.

It is expected that the deepening of talik and enlargement of arctic lakes in response to global warming will reach undisturbed buried glacier ice which in turn will significantly alter lake bathymetry, geochemistry and Green House Gas emissions of artic lowlands.

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