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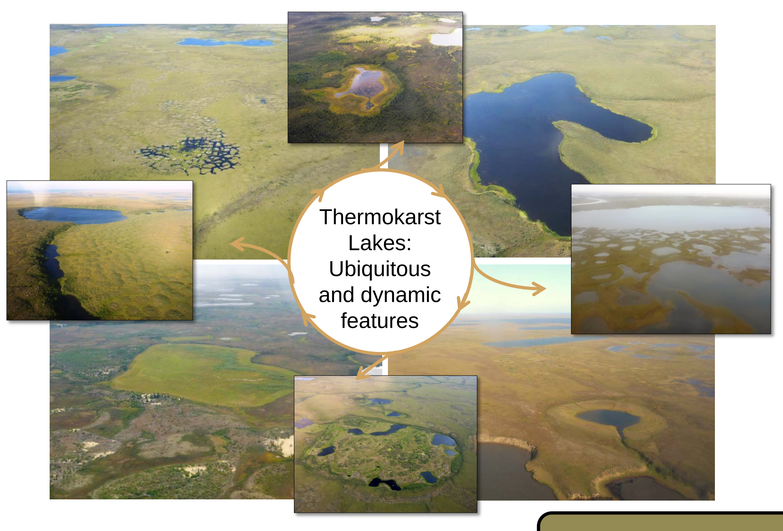
Small Lake - Large Impact?

Sedimentary records from Northern Alaska reveal lake expansion history and carbon dynamics

Relevance of thermokarst lake records

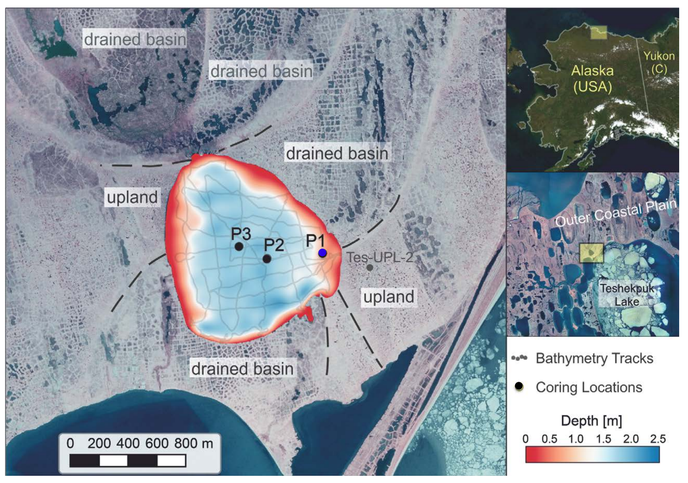
Holocene lake archive



Carbon source or sink?

Study area of Peatball Lake

- Cold-monomictic, subcircular lake of 1.2 km²
- lake ice thickness 1.5-2 m
- Complex catchment situation within drained lake basins and upland remnants



Degradation of organic matter

	Upland	Near-shore	Center
$TOC_{avg.}$	30 wt%	1.6 wt%	7 wt%
$TN_{avg.}$	1.4 wt%	<0.2 wt%	0.5 wt%
^{14}C (cal yr BP)	6,840±100 in 159 cm	130-3,480 (mixed)	500-4,330 (mixed)

Key findings

Thermokarst activity since ~1,400 years based on 3 independent methods

Large impact of landscape morphology and genesis on sedimentation dynamics

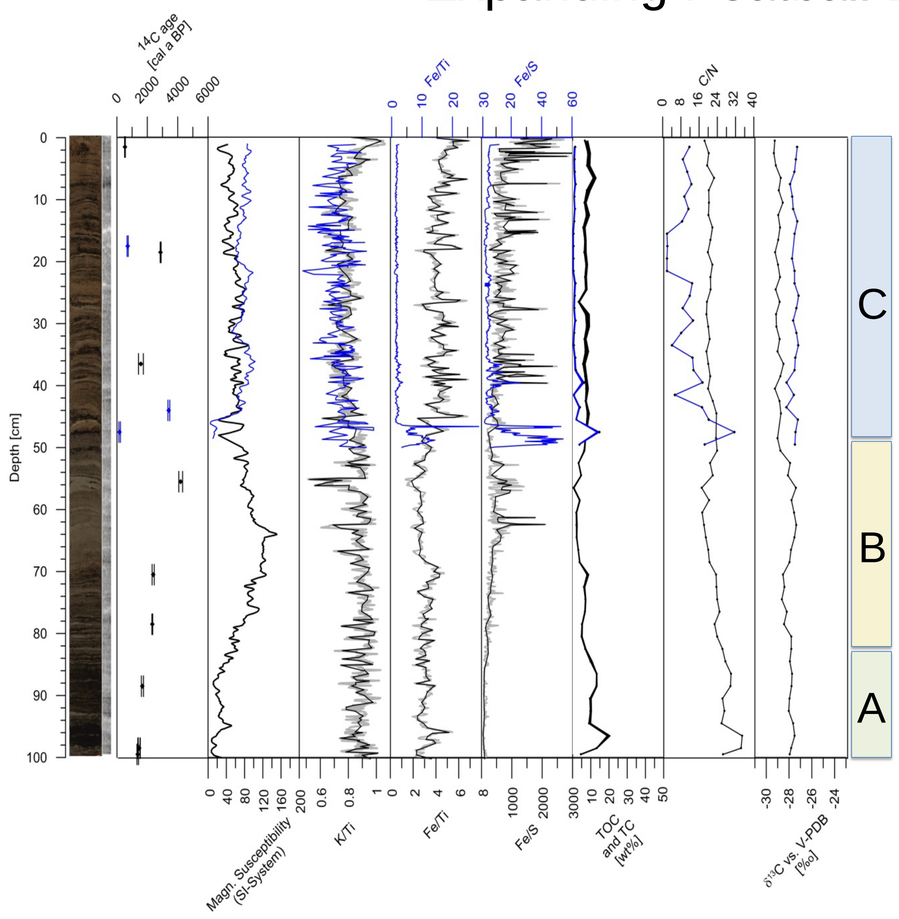
Recycling and re-deposition of permafrost carbon

Core material

Core ID	Location	Core length (cm)	Water depth (cm)
P1	Near-shore	50	148
P2	Center	100	215
P3	Center	49	230

Results and Discussion:

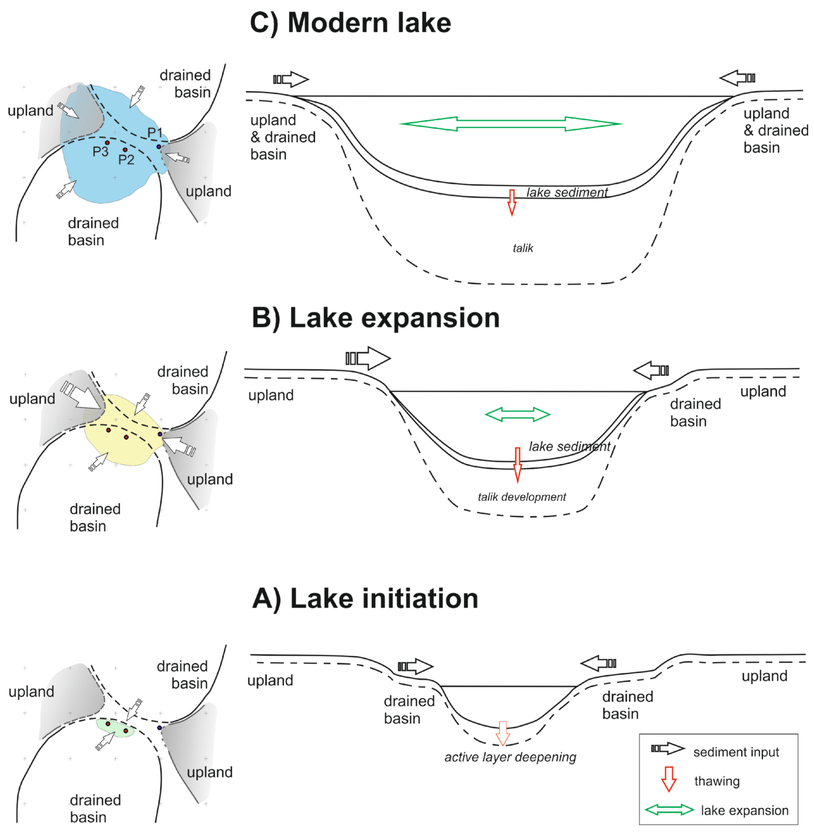
Expanding Peatball Lake intersecting with different catchment units

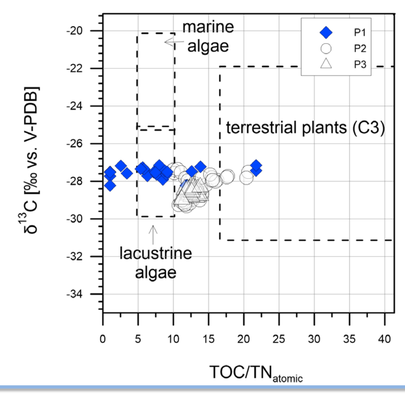


C) Modern Peatball Lake expanding into upland remnants and drained basins
source: balanced between re-deposited thermokarst basins and upland deposits

B) Shore expansion into upland remnants and drained basins
source: upland bluffs and re-deposited thermokarst lake sediments

A) Initial Lake Phase ~ 1,400 yrs ago as a remnant of a drained lake
source: re-deposited thermokarst sediments



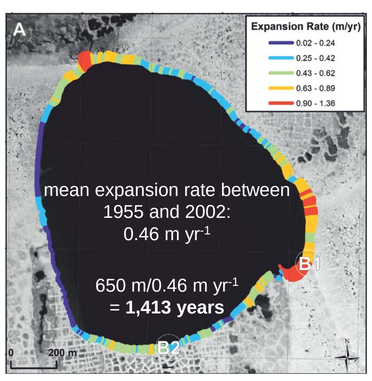


Origin of organic matter

- Wide range of organic matter sources in sublittoral deposits
  according to Meyers & Lallier-Verges (1999)
- In thermokarst lakes also indicator of carbon degradation

Lake age estimation

- P2 base dated 3x ^{14}C (plant remains and bulk): 1,370-1,470 cal yr BP
- $^{210}Pb/^{137}Cs$: Max. age 2,100 yrs
- Age estimation by inverted mean shoreline expansion rate: 1,413 yrs



References:

- **Lenz J**, Jones BM, **Wetterich S**, Tjallingii R, **Fritz M**, Arp CD, Rudaya N, **Grosse G** (2016). Impacts of shore expansion and catchment characteristics on lacustrine thermokarst records in permafrost lowlands, Alaska Arctic Coastal Plain. Arktos, 2 (25), 1-15.
- Sediment data of this study on PANGAEA: https://doi.org/10.1007/s41063-016-0025-0
- Meyers PA and Lallier-Verges E (1999).Lacustrine sedimentary organic matter records of Late Quaternary paleoclimates. Journal of Paleolimnology 18, 211-218.