

How is permafrost carbon affected by seawater inundation?

Estimating greenhouse gas production in thermokarst lagoons of Bykovsky Peninsula, Siberia

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Hypothesis: Newly formed thermokarst lagoons are producing a significant amount of greenhouse gases that is relevant for pan-Arctic carbon fluxes.

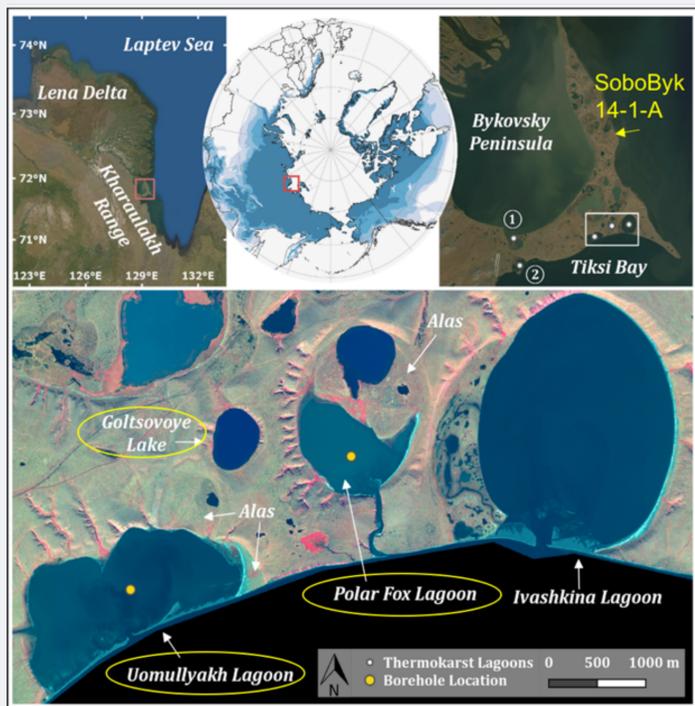
Key questions

- How high are future greenhouse gas (GHG) releases from newly formed Arctic lagoons?
- What impact does an increasing salinity have on GHG production in submerged sediments in lagoons?

What are thermokarst lagoons?

- thermokarst (thaw) lakes and basins, which are inundated by the sea
- they are an important transition stage between terrestrial and marine permafrost

Study site: Bykovsky Peninsula, Siberia



Jenrich et al., 2021

- **SoboByk14:** Yedoma permafrost outcrop (2.9 m height), undisturbed permafrost
- **Goltsovoye Lake:** Thermokarst lake core (30 m length), thawed sediment
- **Polar Fox Lagoon:** Closed thermokarst lagoon core (25 m length), thawed, seawater influenced sediment

Take home message

- salt water inundation and therefore lagoon formation has an impact on GHG production
- increasing salt content leads to higher anaerobic CO₂ production in permafrost sediments
- higher anaerobic GHG production in deep, more recently thawed permafrost sediments than surface sediments
- GHG production is not significantly correlated with TOC content

Incubation experiment setup

I. Sampling

II. Processing

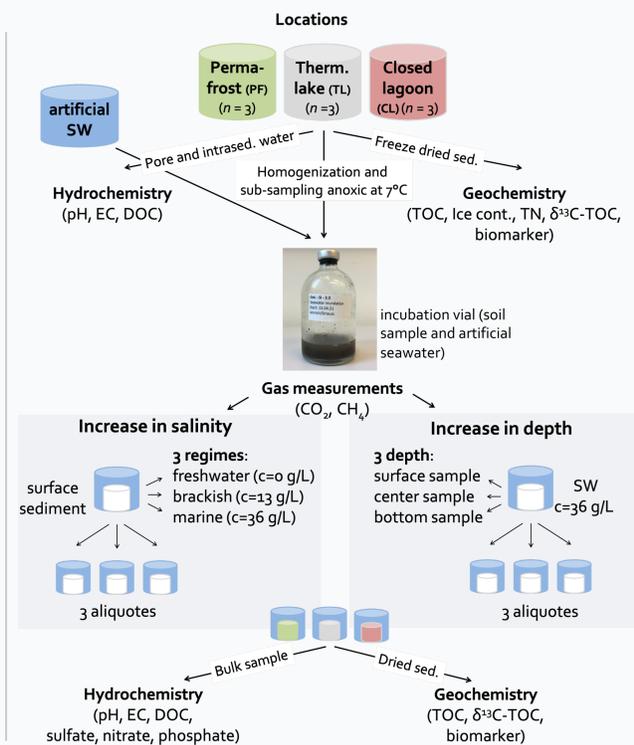
III. Pre-analysis (day 0)

IV. Incubation

at 4°C, anaerobic, dark
CO₂ and CH₄ measurements
(250 µL subsample)
- first two weeks: 5 times
- next 8 weeks: once a week
- since then: biweekly
Measuring device:
Gas Chromatograph
Agilent GC 7890A with an
Agilent HP-PLLOT Q
column

V. Processing

VI. Post-analysis (after 365 days)

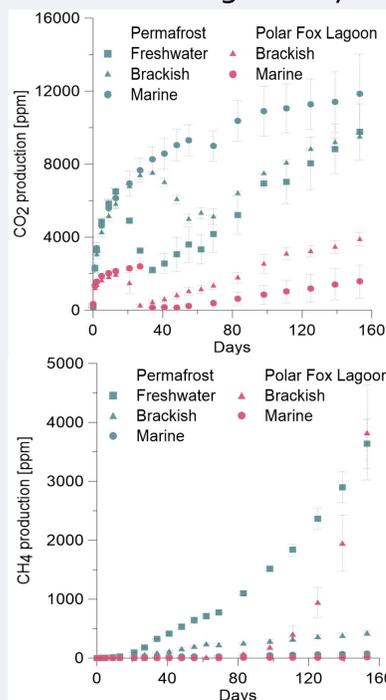


Abbreviations: SW: seawater; sed.: sediment; EC: electric conductivity; DOC: dissolved organic carbon; TOC: total organic carbon; TN: total nitrogen

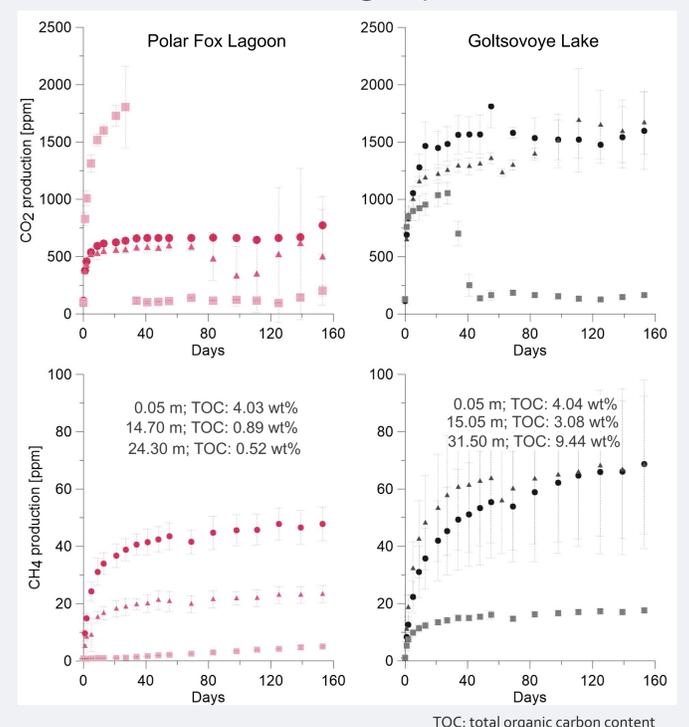
Preliminary results on anaerobic GHG production

- GHG production is higher for inundated terrestrial sediments than for inundated lagoon sediments
- increasing salinity is favoring anaerobic carbon dioxide production
- high CO₂ and CH₄ production in deep sediments (> 15m depth)

Increasing salinity



Increasing depth



TOC: total organic carbon content



Related paper

Jenrich et al.: Thermokarst Lagoons: A Core-Based Assessment of Depositional Characteristics and an Estimate of Carbon Pool on the Bykovsky Peninsula, *Front. Earth. Sci.* 9, 518, <https://doi.org/10.3389/feart.2021.637899>, 2021.

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