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Heterogeneity of Yedoma Ice Complex deposits due to regional genesis processes

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Background

Yedoma

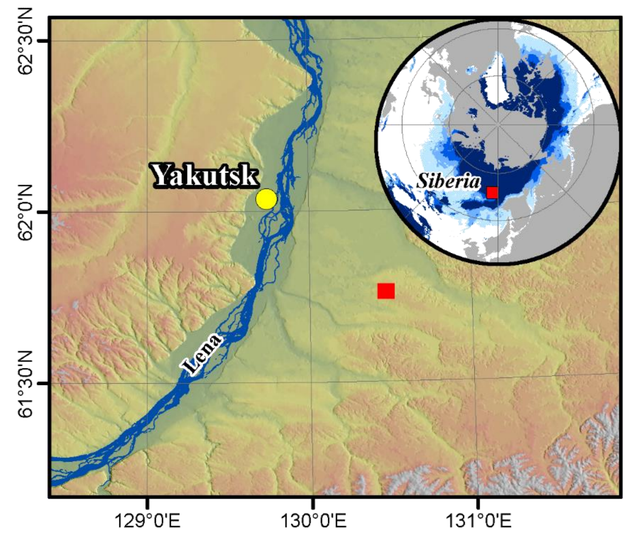
- ice-rich (50-90 vol%), organic-bearing Pleistocene permafrost
- **highly vulnerable** to warming climate due to its high sediment ice content and ice wedges (Strauss et al. 2017).
- Yedoma domain (Yedoma deposits, thermokarst deposits resulting from Yedoma, taberal deposits, Holocene cover) give an amount of **327 to 466 Gt carbon** (Strauss et al. 2017) → organic content, this makes it very relevant for discussing **carbon emissions** from the Arctic.

Research question:

- **How do local genesis processes influence Yedoma composition and therefore its carbon content?**

Methods

Field work in March 2015
Study site:
Yukechi Alas, Yakutia



Subsampling of the 22 m core approx. every 50 cm:

- **TC** and **TN** analysis
- **TOC** analysis
- **$\delta^{13}C$** isotope ratio
- **$\delta^{2}H$** and **$\delta^{18}O$** isotope ratios from pore ice & ice wedge
- Mass specific **magnetic susceptibility** (0.465 kHz)
- **Grain size distribution** measurement
- **Radiocarbon** dating

Conclusions

- shift in (presumingly fluvial/alluvial) **sedimentation regime** → thick sand layers without carbon

→ **heterogenous deposits** which has to be considered when calculating circum-arctic Yedoma domain carbon stock

Results

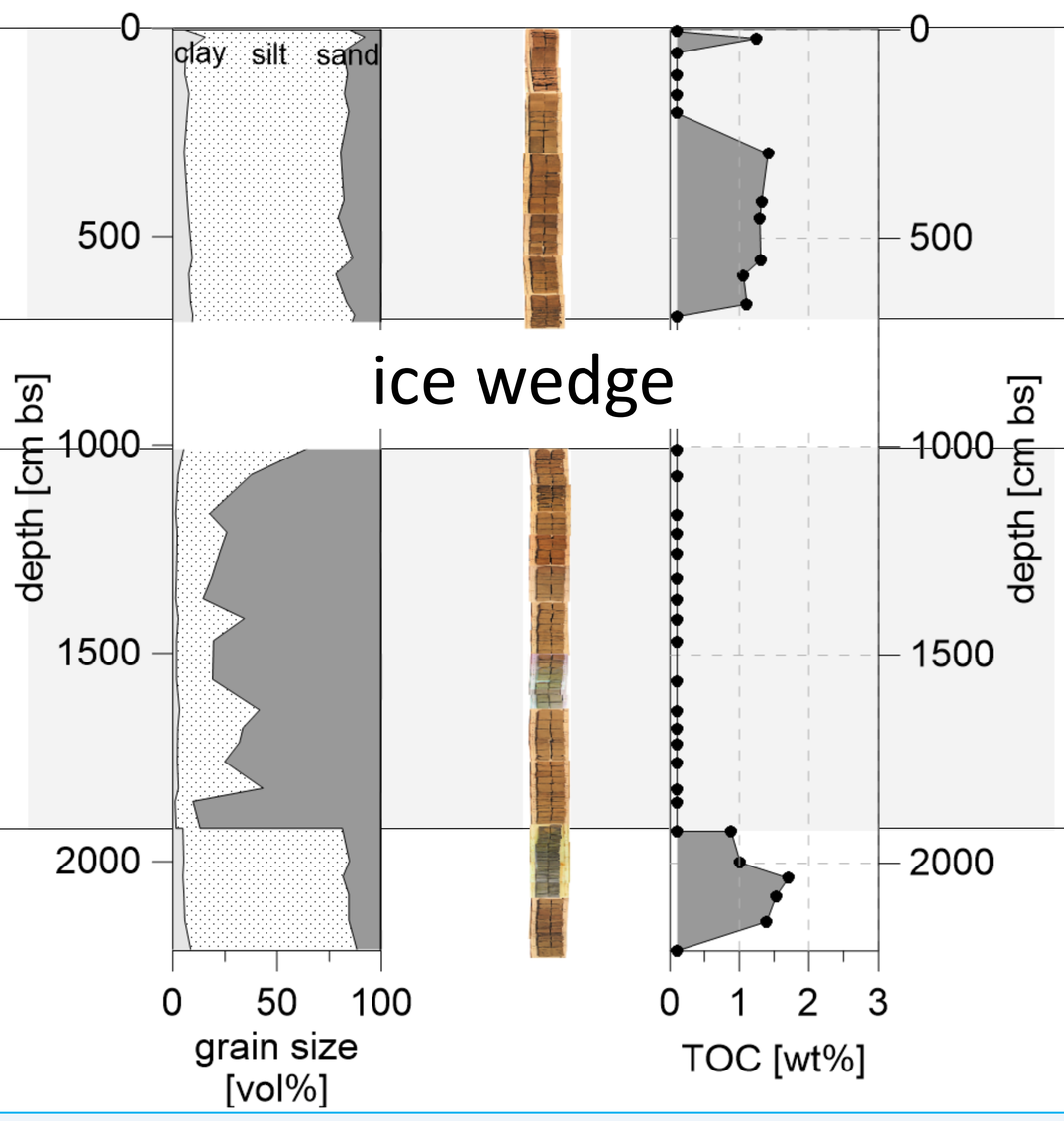
Sedimentary characteristics:

Unit 1: 0-714 cm bs
sandy silt (silt > 70.5 vol%)
mean grain size 19.9 µm

Unit 2: 714-1010 cm bs
ice wedge;
no sediment found

Unit 3: 1010-1927 cm bs
(fine) sand (> 56.87 vol%)
mean grain size 120.5 µm

Unit 4: 1927-2235 cm bs
sandy silt (see unit 1)
mean grain size 24.3 µm



Carbon characteristics:

TOC up to 1.410 wt%
< 0.1 wt% from 54 to 202 cm bs
radiocarbon age: 40608 cal yr BP (589.5 cm bs)
21890 cal yr BP (157.5 cm bs)

ice wedge; not analyzed for carbon

TOC below detection limit (< 0.1 wt%)
radiocarbon age: infinite age (> 49000 cal yr BP) (1636 cm bs)

TOC up to 1.703 wt%
mean TOC content of 1.303 wt%
radiocarbon age: 49323 cal yr BP (1998.5 cm bs)

Discussion

- Units 1 & 4 show similar sediment composition and carbon content and may result from similar deposition processes with similar sedimetn source areas
- Unit 3 is in sharp contrast to the other sediment units, most likely due to increased flooding and streaming velocity, which resulted in deposition of more coarse material while fine (organic) material was swept away

References:
Strauss, J., Schirrmeister, L., Grosse, G., Fortier, D., Hugelius, G., Knoblauch, C., Romanovsky, V., Schädel, C., Schneider von Deimling, T., Schuur, E. A. G., Shmelev, D., and Veremeeva, A.: Deep Yedoma permafrost: A synthesis of depositional characteristics and carbon vulnerability, Earth-Science Reviews, 75-86, https://doi.org/10.1016/j.earscirev.2017.07.007, 2017.

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