Permafrost properties of the Yedoma key site at Duvanny Yar (Kolyma lowland, East Siberia)

Jens Strauß, Sebastian Wetterich* and Lutz Schirrmeister

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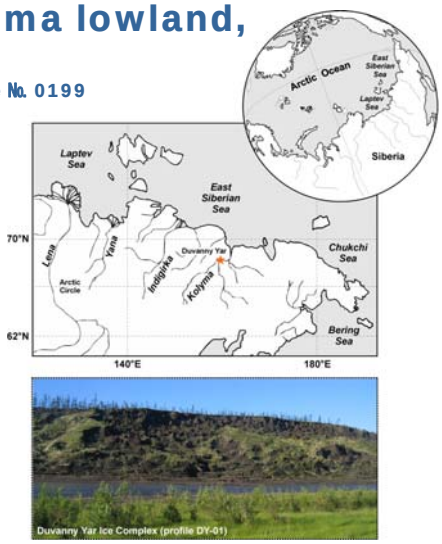


Figure 1 Location of the Yedoma key site

I. BACKGROUND

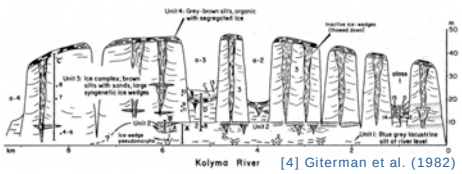
Duvanny Yar is the well known stratigraphic key site for late Quaternary deposits in Beringia, the landmass non-glaciated during the late Pleistocene between the Taymyr Peninsula and Alaska [1]. The outcrop is dominated by Middle Weichselian ice-rich permafrost sequences, termed as "Ice Complex" or "Yedoma Suite" [2].
In course of the **IPY project #15: Past Permafrost**, the aim of this study was to obtain a comprehensive cryolithological characterization of Ice Complex deposits which represent a significant carbon reservoir under climate warming conditions due to permafrost degradation [3].

II. STRATIGRAPHY

Six permafrost profiles along the right bank of the Kolyma river were sampled in summer 2008 (Figures 1). They exposed Eemian lacustrine deposits (profiles DY-02 , DY-03), long sequences of Middle Weichselian Ice Complex deposits (profiles DY-01, DY-05) and Holocene lacustrine and bog deposits in thermokarst depressions (profile DY-04) (Figure 2).

III. MULTIPROXY APPROACH

A multidisciplinary approach of cryolithological methods was applied to obtain data sets of stable isotope composition of ground ice ($\delta^{18}O$, δD), ice contents, grain size and biogeochemical parameters (TOC, TN, $\delta^{13}C$), mineral density, mass-specific magnetic susceptibility and radiocarbon ages of the sediments (Figures 3-6). Based on density, ice and TOC contents (in wt%), the organic carbon content (in kg TOC per m^3) was estimated for the Ice Complex to quantify the carbon pool stored therein.



[4] Giterman et al. (1982)

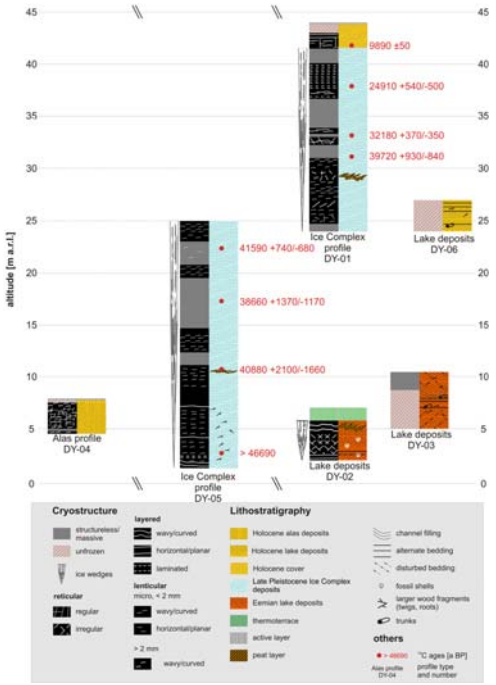


Figure 2 Cryolithological schemes of the studied profiles

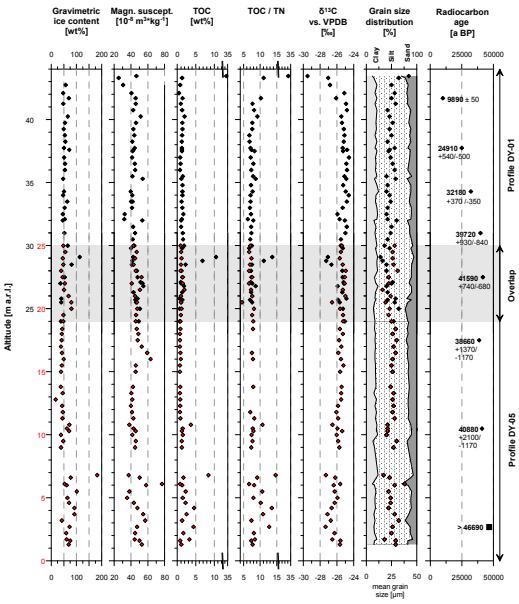


Figure 3 Sediment records of the composite Ice Complex profiles DY-05 (red diamonds) and DY-01 (black diamonds) including its Holocene top

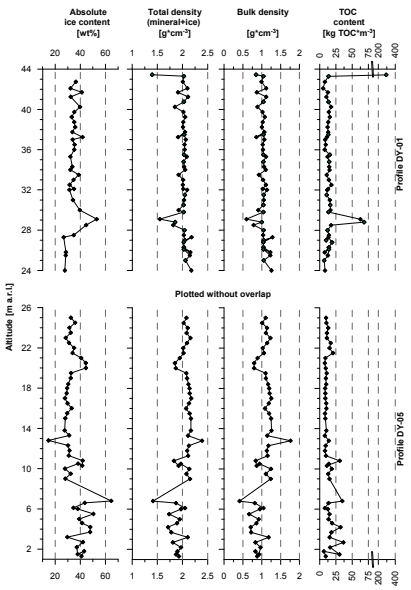


Figure 4 Parameters for TOC content estimations of Ice Complex deposits. Green marked data in profile DY-01 indicate not measured ice content hence the mean value of 34 wt% was used.

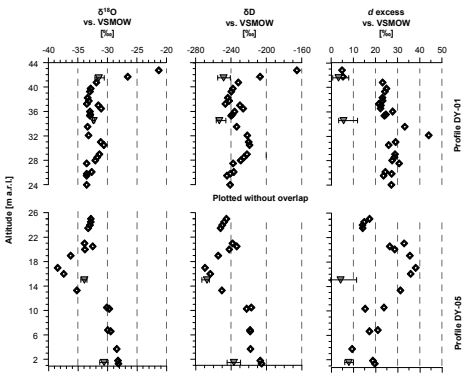


Figure 5 Stable water isotopes of texture ice (open diamonds) and ice wedges (triangle) of the composite Ice Complex profiles DY-05 (red diamonds) and DY-01 (black diamonds) including its Holocene top

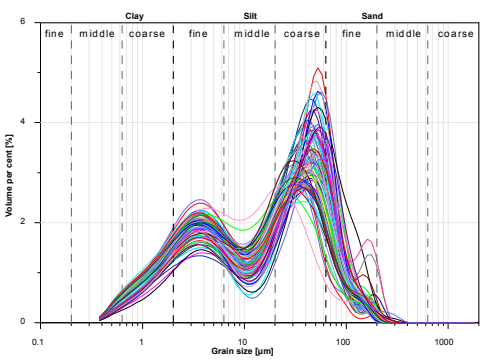


Figure 6 Polymodal grain size distribution of the composite Ice Complex profiles DY-05 and DY-01 (n=79)

IV. ICE COMPLEX CHARCTERISTICS

Ice

- Massive to lenticular and layered cryostructures; thus syngenetic freezing processes
- Mean gravimetric ice content: 55 to 60 wt%
- Huge syngenetic ice wedges: up to 2.5 m wide and up to 7 m long

Grain size

- Uniform polymodal grain size distribution
- Poorly sorted clayey and sandy silt: Trask sorting co-efficient 3-4
- Two major peaks in fine silt and coarse silt fractions, one minor peak in fine sand fraction
- Magnetic susceptibility mainly from 30 to 60 SI indicating a rather homogenous mineral composition; thus stable sediment source
- Regular transport and accumulation conditions during the whole period of Ice Complex formation

Organic carbon

- TOC (0.5 to 2 wt%), TOC/TN (5 to 15), $\delta^{13}C$ (-27.4 to -24.6 ‰); thus organic source from fresh water and subaerial terrestrial environments
- Peaty paleocryosols with higher TOC (>2 wt%) and TOC/TN (>10)
- Estimated mean organic carbon amounts to 16±11 kg*m^{-3}

References
[1] Hopkins DM (1982) In: Paleoecology of Beringia, Academy Press, NY, London, pp. 3-27.
[2] Sher AV (1991) Quaternary International 10-12: 215-222.
[3] Zimov et al. (2006) Science 312: 1612-1613.
[4] Giterman et al. (1982) In: Paleoecology of Beringia, Academy Press, NY, London, pp. 43-73.

*Contact
sebastian.wetterich@awi.de
Alfred Wegener Institute
Department of Periglacial Research
Potsdam, Germany;