Carbon inventory of Siberian Yedoma and thermokarst deposits

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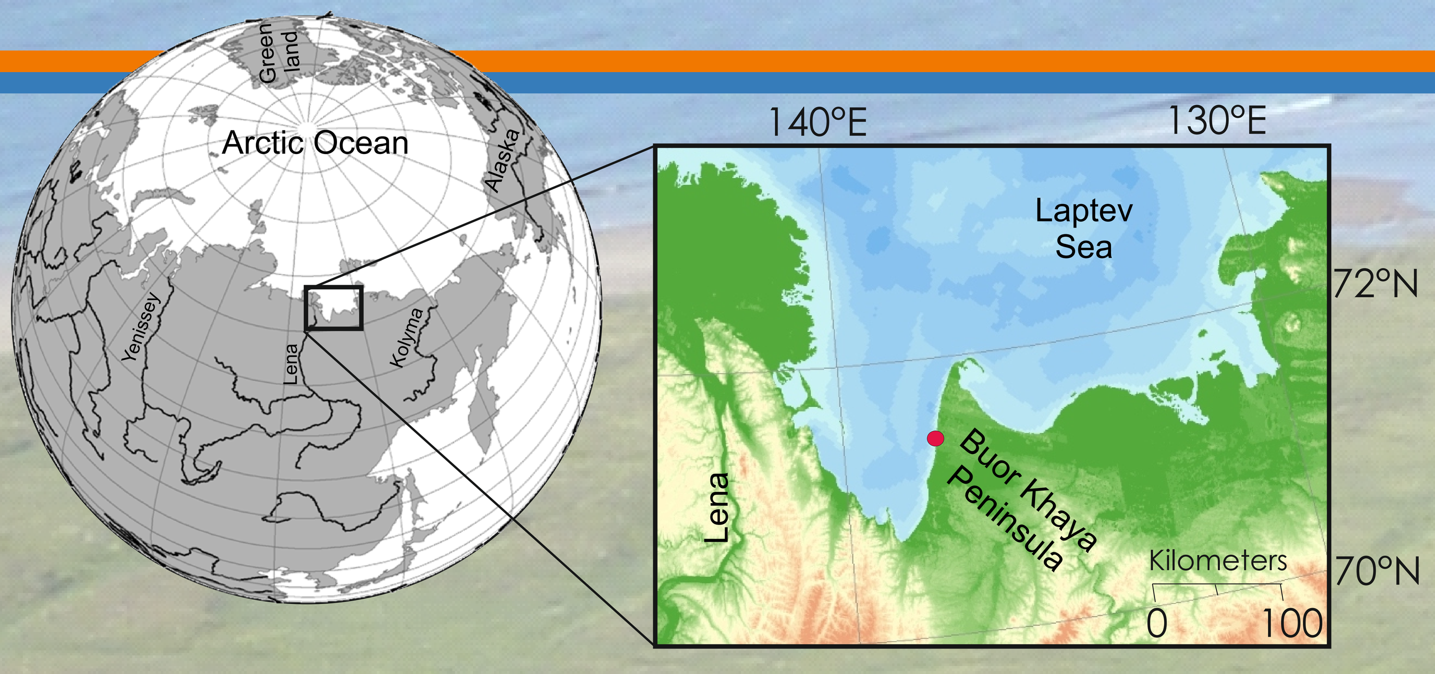

Fig. 1: Study site Buor Khaya

I. Background

During the late Quaternary, a large pool of organic carbon accumulated in the arctic permafrost zone. Because of the potential re-introduction into the biogeochemical cycle from degrading permafrost, the organic-matter (OM) inventory of ice-rich permafrost deposits and its degradation features is relevant to current concerns about the effects of global warming.

Our study site is located on the Buor Khaya peninsula (N 71.6°, E 132.2°, **Fig. 1**), Yakutia (Russia).

The research questions are:

- How much and which type of OM is stored in ice-rich arctic lowlands?
- What are the paleoenvironmental conditions of the source biota?

Fig. 2: Yedoma profile Buo-02 (photo taken by F. Günhter)

II. Methods

Proxy	Method / Device
Radiocarbon ages	AMS ^{14}C
Grain size	Coulter Laser (LS 200)
Bulk density	Archimedes principle and a gas pycnometer (Accu-Pyc-1330, Micrometrics)
OM characteristics	TOC (Vario Max C, Elementar) C/N ratios (Vario El III, Elementar)
Stable water isotopes	mass spectrometer (Finnigan MAT Delta-S)
Lipid biomarkers (isoprenoid and branched glycerol dialkyl glycerol tetraether, GDGT)	HPLC (Shimadzu LC10AD)-MS (Finnigan TSQ 7000)

III. Results and Discussion

Stratigraphically, there are two main types of deposition units at the study site. The first unit is composed of ice-rich permafrost (Yedoma, **Fig. 4 and 5**). The second unit are thermokarst deposits (Alas, **Fig.3**) resulting from thermal degradation of Yedoma. Grain-size (distribution curves and fractions) illustrate that Alas is made up of degraded Yedoma. The bulk density average is ca. 1 10^3kg/m³. The TOC content is 2.4 wt% for Yedoma, 10.2 wt% for Alas and low degraded. This illustrates that the deposits accumulated at relatively fast rates and the OM underwent a short time of decomposition before it was incorporated into permafrost. The volumetric OM content of the Yedoma and Alas is 13 ± 11 kg/m³ and 27 ± 18 kg/m³, respectively.

The stable water Isotopes reveal cold temperatures especially for Yedoma. Alas deposits indicate warmer conditions compared to Yedoma, but at the lower part (**Fig. 5**, Buo-04-C) Yedoma reflects a remarkably warm isotope signal.

After Wejers et al. (2007) it is possible to calculate absolute temperature values using bacterial (branched) GDGT's. Negative values (exception at Buo-02-B, **Fig. 4**) reveal feasible results for permafrost. An astonishing fact is that Alas reveals the lowest temperatures. We interpret these GDGT temperatures as a growth/summer periods signal. Possibly the Holocene summers have been colder because of a lesser continental climate.

The concentration of archaeol suggests a response of archaeal communities to temperature and humidity changes in the past (Griess et al. 2011). More archeol means larger acheal communities, which is related to a drier and warmer climate (**Fig.3**).

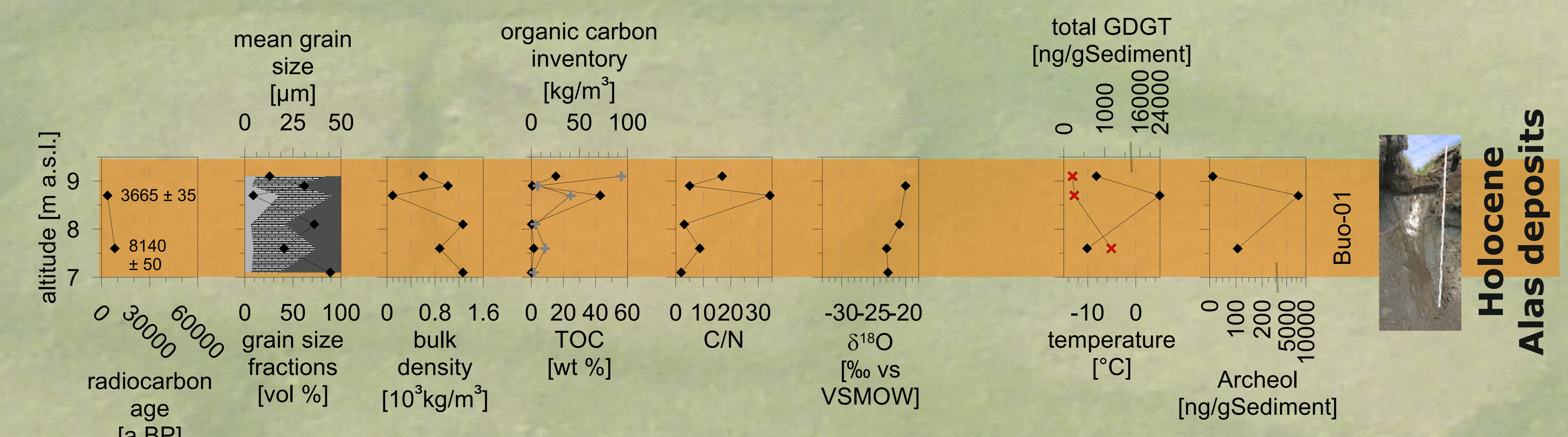

Fig. 3: Summary of OM and lipid biomarker proxies; Alas profile Buo-01

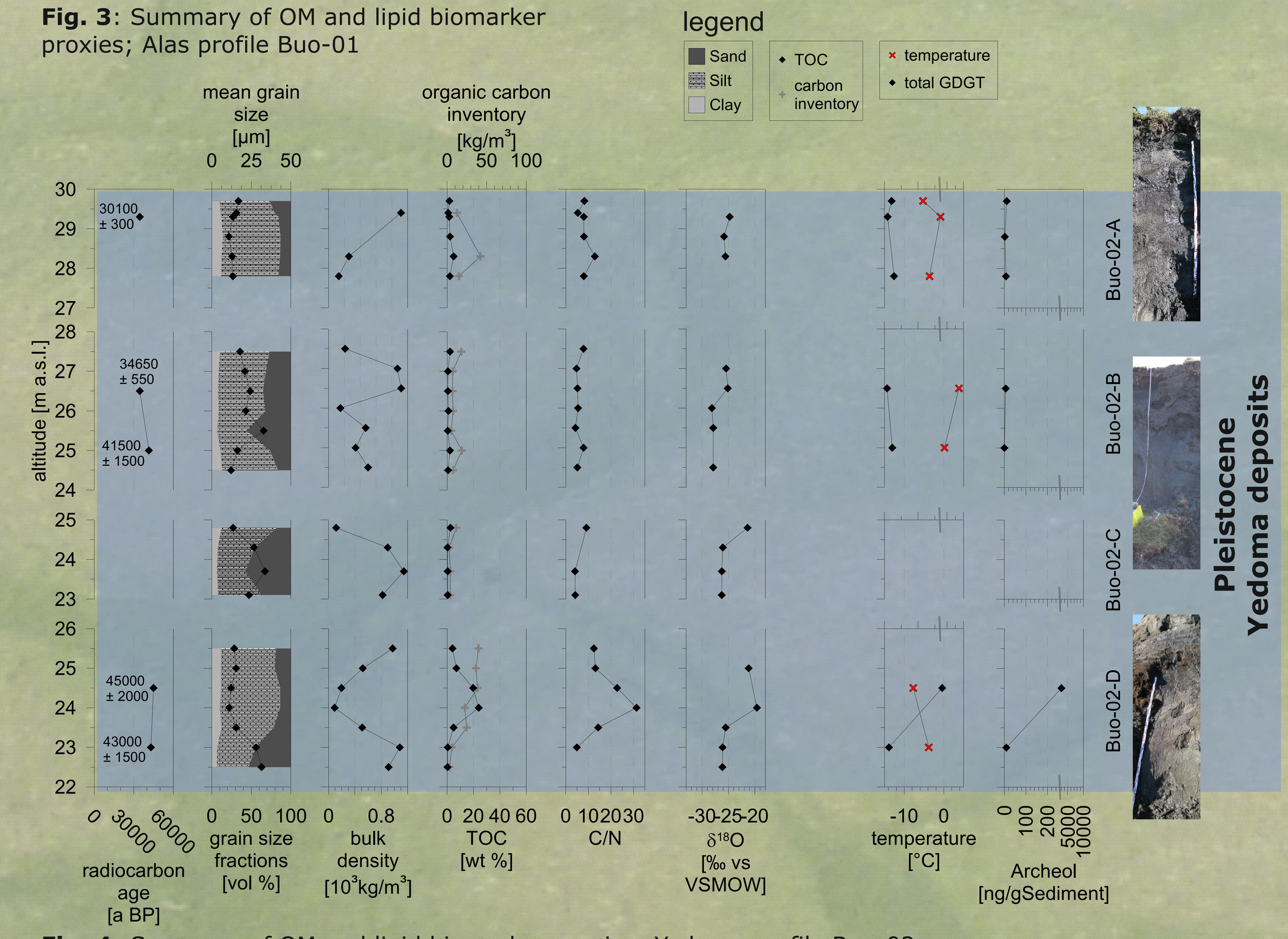

Fig. 4: Summary of OM and lipid biomarker proxies; Yedoma profile Buo-02

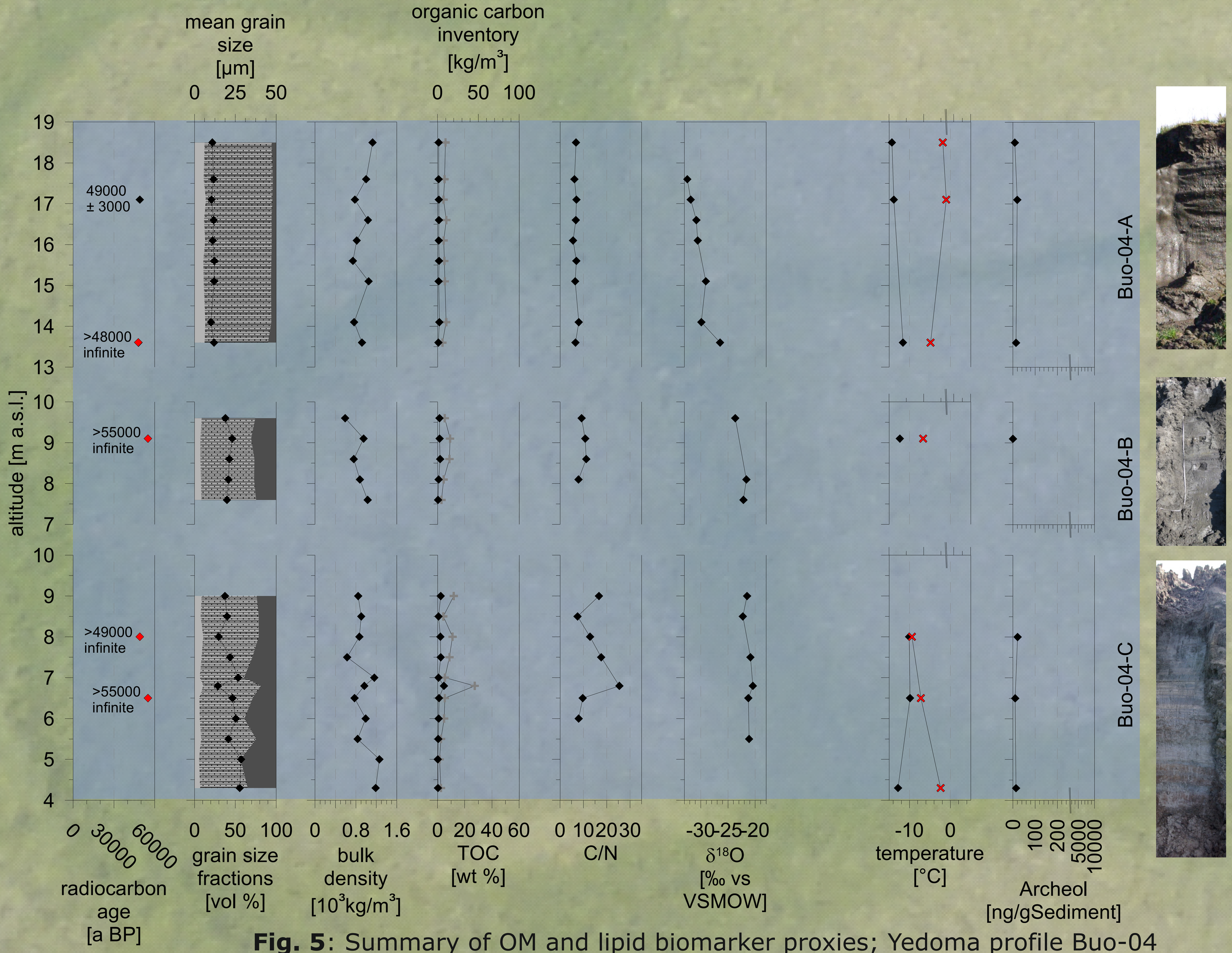

Fig. 5: Summary of OM and lipid biomarker proxies; Yedoma profile Buo-04

IV. Conclusion

- OM proxies reveal a significant carbon inventory of the studied deposits. Yedoma and Alas contain 13 ± 11 kg/m³ and 27 ± 18 kg/m³, respectively.
- Nearly all Biomarker temperature reconstruction reveal negative values This biomarker proxy is a promising tool and could be an ideal supplement to the temperature signals inferred from water isotopes.
- Archeol can be employed as a proxy for archeal communities and therefore used as paleoclimatic reconstructions

On-going work focusses on identifying other Biomarkers like alkanes, steranes, hopanes, fatty acids, alcohols and sterols for identifying the TOC sources, quality and vulnerability.

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Funded by: Studienstiftung des deutschen Volkes · POLMAR · AWI Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft · GFZ Helmholtz Centre Potsdam