Ice Complex chronologies and environments in western Beringia

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INTRODUCTION

Tundra-steppe environments and syngenetic ice-wedge polygons evolved during late Quaternary stadial and interstadial periods in non-glaciated **Beringia** [(1)]**.** Remnants of such past landscapes are named as **Ice Complex** strata (IC; ледовый комплекс in Russian) in local and regional stratigraphic charts. When using IC as **archives** of palaeo-**environmental dynamics**, changes of summer and winter conditions **at millennial time scales** can be resolved. Commonly applied summer proxies are **fossils** of pollen, plants, insects and, most prominent, fossils of the Mammoth fauna. Geochemical properties of **ground ice** allow for insights into freezing (segregation ice) and winter conditions (ice wedges), while **sediment** properties reflect depositional processes.

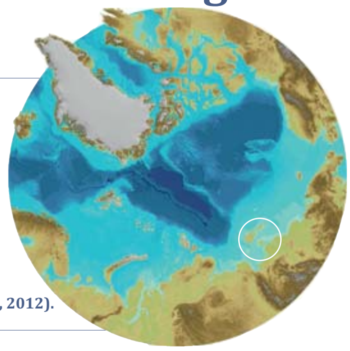

Figure 1. Study region in eastern Siberia (IBCAO, 2012).

ICE COMPLEX DEPOSITS IN EASTERN SIBERIA

The southern coast of **Bol'shoy Lykhovsky Island** (New Siberian Archipelago, Figure 2) exposes permafrost dating back to about 200 kyr ago [(2)]. This is among the longest record of **late Quaternary terrestrial permafrost** deposition in East Siberia. The most prominent **Yedoma IC** [(3, 4)] is radiocarbon-dated between about >55 and 22 kyr BP (**MIS3-2**). Older Ice Complex deposits are the **Buchchagy IC** [(5)] dated from about 126 to 98 kyr (**MIS5**) by ^{230}Th/U radioisotope disequilibria in peat, and the **Yukagir IC** [(2)] dated to about 200 kyr by ^{230}Th/U (**MIS7a**).

Figure 2. Ice Complex deposits of four generations exposed at the southern coast of Bol'shoy Lyakhovsky Island (New Siberian Archipelago).

SUMMER PROXY - POLLEN DATA

Stadial and interstadial vegetation dynamics are seen in pollen data from IC deposits. **Tundra-steppe vegetation** is inferred for all studied periods [(3, 4, 5, 6)]. The MIS5 IC pollen record documents colder summers than during the MIS3 and MIS7a, but warmer than MIS2 (Figure 3). High percentages of Cyperaceae, Poaceae and Brassicaceae characterise MIS5 IC spectra, while Cyperaceae, Poaceae and Caryophyllaceae dominate MIS3 spectra. Brassicaceae is more typical today for high arctic vegetation than Caryophyllacea. The MIS2 record reveals higher abundances of *Artemisia* then all other IC pollen spectra from Bol'shoy Lyakhovsky Island. *Artemisia* is indicative for dry conditions and hence, we assume a drier conditions during MIS2 than during MIS7a, MIS5 and MIS3.

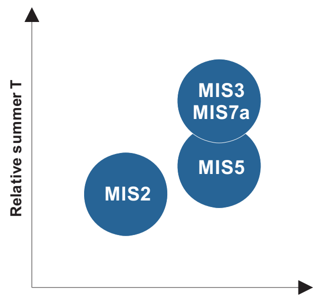

Figure 3. Generalised summer conditions as inferred from pollen data. Detailed pollen records are given in [(3, 4, 5, 6)]**. The plot highlights similarities in pollen associations during interstadial periods in comparison to the Last Glacial Maximum.**

WINTER PROXY - STABLE ISOTOPES IN ICE WEDGES

The narrow range of the MIS5 ice-wedge data indicates persistant **moisture sources** and cold **winter conditions**. The mean δ^{18}O value is about 2 ‰ lower than that of the Yedoma interstadial (MIS3) ice wedges and about 1‰ lower than that of the Yukagir (MIS7a) ice wedges (Figure 4). Coldest winter conditions are deduced from Yedoma (MIS2) ice wedges whose mean δ^{18}O value is about -37 ‰. The slope of 6.9 in a δ^{18}O-δD co-isotope regression of MIS5 data and the mean *d* excess value of 7.2 resemble those of the Yedoma stadial (MIS2) ice wedges and point to similar general **atmospheric circulation dynamics** but slightly differ for MIS3 and MIS7a data.

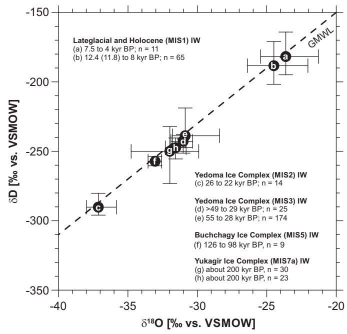

Figure 4. Bi-plot compilation of stable-water isotope data in several generations of syngenetic ice wedges. Ice-wedge data sources: Lateglacial and Holocene (MIS1) [(7, 8)]**; Yedoma Ice Complex (MIS2)** [(3)]**; Yedoma Ice Complex (MIS3)** [(4, 8)]**; Buchchagy Ice Complex (MIS5)** [(5)]**; and Yukagir Ice Complex (MIS7a)** [(8)]**.**

CONCLUSIONS

I Four Ice Complex generations between MIS7a and MIS2 reflect comparable climate conditions allowing for syngenetic ice-wedge growth.

II Permafrost aggradation took place during MIS5 under climate conditions colder than during MIS3, but warmer than during MIS2.

III Geochronological dates of Last Interglacial thermokarst deposits aligned to the MIS5 climatic optimum are still lacking and its chrono-stratigraphic relation to the MIS5 Ice Complex remains unknown.

REFERENCES - CONTACT - CREDIT

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