УСТОЙЧИВОСТЬ ПРИРОДНЫХ И ТЕХНИЧЕСКИХ СИСТЕМ В КРИОЛИТОЗОНЕ

Материалы Всероссийской конференции с международным участием, посвященной 60-летию образования Института мерзлотоведения им. П.И. Мельникова СО РАН Якутск, Россия, 28-30 сентября 2020 г.

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Институт мерзлотоведения им. П. И. Мельникова
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**МАТЕРИАЛЫ
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THE YEDOMA CLIFF OF SOBO SISE ISLAND - INSIGHTS INTO PAST AND MODERN PERMAFROST DYNAMICS AND RELATED ORGANIC MATTER STOCK AND RELEASE

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БЕРЕГОВОЙ ОБРЫВ ЕДОМЫ НА ОСТРОВЕ СОБО-СИСЭ – ИСТОЧНИК ИНФОРМАЦИИ О ПРОШЛОЙ И СОВРЕМЕННОЙ ДИНАМИКЕ КРИОЛИТОЗОНЫ И ЗАПАСАХ И ВЫНОСЕ ОРГАНИЧЕСКОГО ВЕЩЕСТВА

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Abstract. The present study of the permafrost exposed the Sobo-Sise Yedoma cliff in the eastern Lena Delta provides a comprehensive cryostratigraphic and organic matter (OM) inventory, insights into permafrost aggradation and degradation over the last about 52 thousand years and their climatic and morphodynamic controls on regional scale of the Central Laptev Sea coastal region in NE Siberia.

Аннотация. Исследовано обнажение многолетнемерзлых пород на береговом обрыве едомы о-ва Собо-Сисэ, которое содержит полную запись криостратиграфии и органического вещества, позволяющую получить информацию об аградации и деградации криолитозоны в течение последних 52 тыс. лет, а также о климатических и морфодинамических условиях ее динамики в региональном масштабе в центральной части побережья моря Лаптевых на Северо-Востоке Сибири.

The Lena Delta in eastern Siberia is the largest Arctic delta, whose terrestrial surface is shaped by four geomorphologic units, i.e. terraces and the modern floodplain [1]. The oldest unit is built of remnants of late Pleistocene Yedoma Ice Complex (IC) and its degradation features.

The studied Yedoma cliff on Sobo Sise Island in the South-Eastern part of the delta ranges from river level to about 28 m height and is about 1.7 km long. During a field campaign in 2018, the entire permafrost sequence of the Sobo Sise Yedoma cliff has been sampled in 0.5-m vertical intervals by a joint Russian-German team [2] (Figure 1).

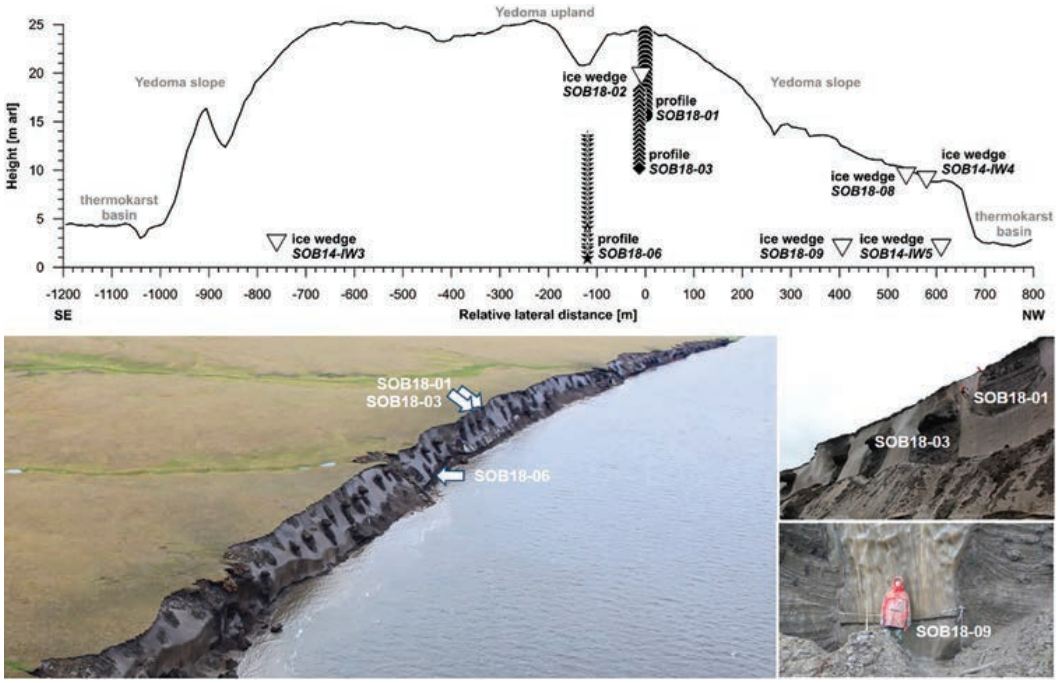

Figure 1. Profile positions of sediment profiles SOB18-01, SOB18-03 and SOB18-06 as well as ice-wedge profiles at the Sobo-Sise Yedoma cliff in 2014 and 2018

The geochronological record of the Sobo Sise Yedoma spans the last 52 ka cal BP based on radiocarbon dating and age-height modelling. The sequence differentiates into three cryostratigraphic units that are MIS 3 Yedoma IC (52–28 ka cal BP), MIS 2 Yedoma IC (28–15 ka cal BP) and MIS 1 Holocene cover (7–0 ka cal BP). The cryostratigraphic sequence is not continuous, but has chronological gaps at 36–32.5 ka cal BP, at 20.5–18 ka cal BP and at 12.5–9 cal ka BP (Figure 2).

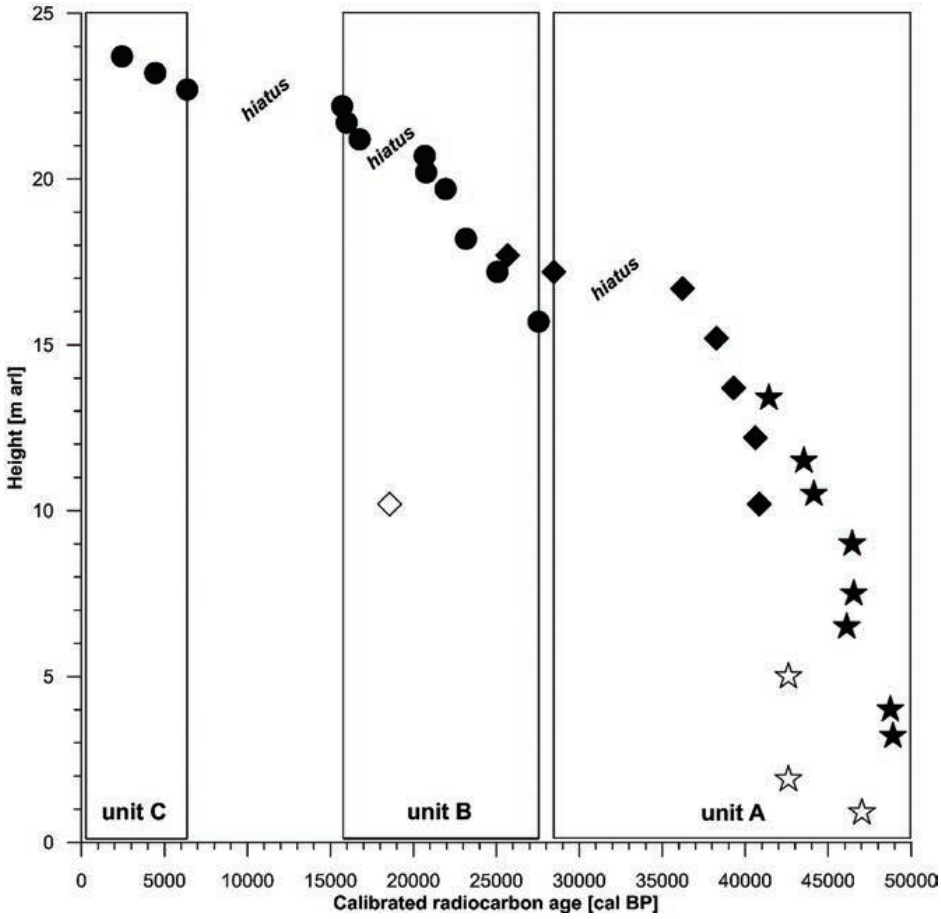

Figure 2. Age-height relation of the Sobo-Sise Yedoma cliff exposure shown in calibrated radiocarbon ages. Note the sampling overlap of the profiles SOB18-01 (circles), SOB18-03 (diamonds) and SOB18-06 (stars) and their alignment to cryostratigraphic units A, B and C. The hollow symbols ages of redeposited material or indicate infinite radiocarbon ages

These gaps represent traces of past changes in climatic conditions as well as in permafrost deposition and/or erosion regimes. Similar observation have been made on adjacent Yedoma IC sites on Bykovsky Peninsula and Kurungnakh-Sise Island (Figure 3) and are likely related to repeated outburst floods of glacial Lake Vitim along the Lena Valley into the Arctic Ocean during MIS 3 and MIS 2 as proposed by Margold et al. [3].

The cryostratigraphic units of the Yedoma cliff are characterized by differing properties of their clastic, organic and ice components. All units are built of poorly sorted sandy silt but differ in prevalent grain-size fractions ranging from fine silt to middle sand. The organic matter (OM) content is highest in the thin MIS 1 Holocene cover (TOC of 11.3±9.9 wt%, TN of 0.6±0.3 wt%), but still substantial in MIS 3 Yedoma IC (TOC of 4.5±2.5 wt%, TN of 0.3±0.1 wt%) and in MIS 2 Yedoma IC (TOC of 2.1±1.3 wt%, TN of 0.2±0.1 wt%). The presence of syngenetic ice wedges in all units and the high content of intrasedimentary ice amount to a total volumetric ice content of 88.4 vol%. The high ice content in combination with the exposition of the cliff towards the main river channel results in a very high susceptibility to thaw and fluvial thermo-erosion. The high mean cliff erosion rate of 15.7 m yr^{-1}

(2015-2018) results in large OM quantities entering the Lena River (5.2±3.3 x 10^6 kg organic C per year, 0.4±0.2 x 10^6 kg N per year (2015-2018) along the 1.7 km long Yedoma cliff [4].

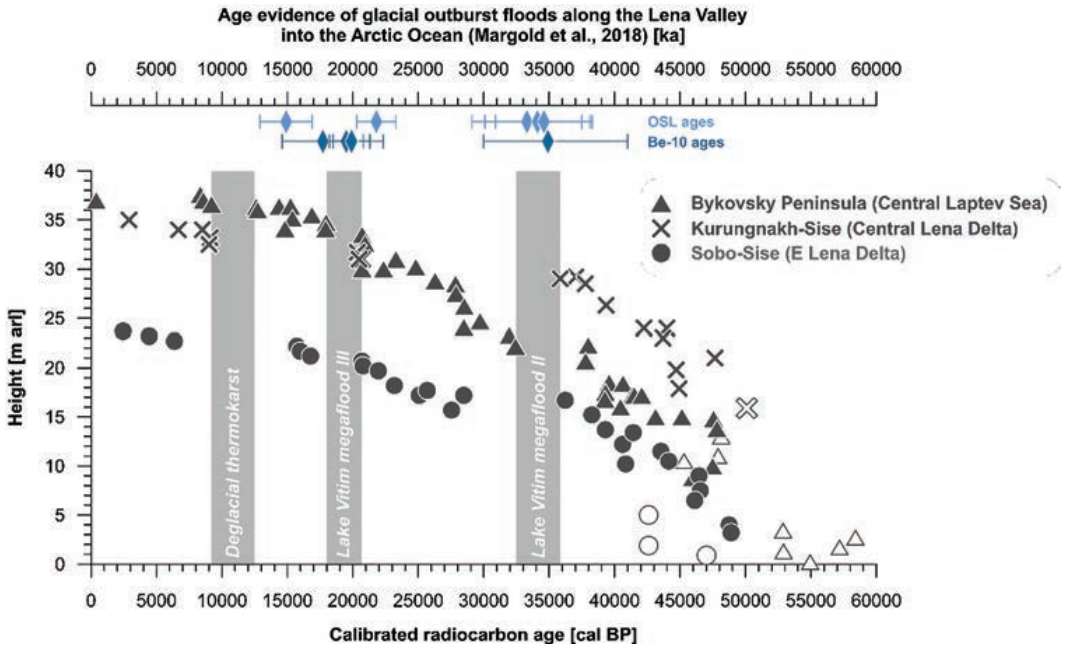

Figure 3. Comparison of interpreted chronology gaps (shaded rectangles) in the Yedoma IC records from Bykovsky Peninsula [4], Sobo-Sise Island (this study) and Kurungnakh-Sise Island [5, 6]. Infinite radiocarbon dates are given as hollow symbols. Age evidence for repeated megafloods from the glacial Lake Vitim along the Lena Valley into the Arctic Ocean [3] is shown for comparison

Ongoing fluvial dynamics and changing runoff regimes with extended ice-free seasons and warmer water will most likely maintain high permafrost cliff erosion rates in the future and further facilitate high fluxes of terrestrial fossil OM into the riverine and eventually marine ecosystems.

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