Book of Abstracts

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January air palaeotemperature for 28-21 cal. ka BP based on stable isotope composition of AMS radiocarbon dated syngenetic ice wedges at Seyakha site, Yamal Peninsula

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The main aims of the study are ^{14}C dating of syngenetic ice wedges and enclosing sediments, obtaining the data of stable oxygen and hydrogen composition of ice for high-resolution isotope diagrams from detailed sampled yedoma exposed in third lagoon-marine terrace near the mouth of the Seyakha (Zelyonaya) River, on the coast of the Ob Bay, Yamal Peninsula (70°9'26.51"N, 72°34'8.76"E).

Seyakha syngenetic ice wedges were ^{14}C dated with conventional liquid scintillation counting (for enclosing sediments) and by AMS dating (organic micro-inclusions extracted directly from ice wedges).

Radiocarbon age measurements. AMS radiocarbon dating was carried out in the Laboratory of Radiocarbon Dating and Electron Microscopy of the Institute of Geography of the Russian Academy of Sciences (obtaining counting material) and the Center for Isotope Research of the University of Georgia in the USA (direct measurement on an accelerator mass spectrometer). ^{14}C ages of 3 bulk samples were obtained in the Institute for the History of Material Culture, St. Petersburg.

Stable isotope measurements. The isotope composition of oxygen and hydrogen in the ice were made in the mode of constant helium flux (CF-IRMS) on a Delta-V mass spectrometer using a gas-bench complex, at the isotope laboratory of the Geography Department, Lomonosov Moscow State University (MSU).

Chronostratigraphy. For organic micro-inclusions, extracted from ice wedges, 4 AMS ^{14}C dates in the range from 28 to 21 cal ka BP were obtained (Table1). For the enclosing sediments 3 dates in the range from 29 to 27 cal ka BP were obtained (Table 2).

Stable isotope ratio. Ice wedges from 2 sections on Seyakha outcrop were sampled for stable oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$) isotopes. In the upper ice wedge, two vertical trends for $\delta^{18}O$ values can be distinguished: from +12 to +14.2 m $\delta^{18}O$ values vary in the range of about 1.5‰ – from –24.18 to –25.75‰, from +14.2 to +15.8 m there is a clear upward positive trend of $\delta^{18}O$ values of 2.6‰ from –25.75 to –23.15 ‰.

The range of $\delta^{18}O$ values along the horizontal line at the height of +15.2 m is 1.49‰ – from –23.41 to –24.9‰. The lower fragment of the ice wedge, exposed at +6 m, is characterized by a wider range of values of $\delta^{18}O$ than in the upper fragment: $\delta^{18}O$ values along the horizontal line vary from –23.41 to –26.63‰.

Previously obtained isotope-oxygen diagram for ice wedges from Seyakha yedoma [Vasil'chuk et al., 2000] has a step of 800 years, and new isotope data allowed to obtain the diagram with a step of 80-100 years. This suggests that the new high-resolution isotope-palaeotemperature record almost has no gaps and covers a period of 5-8 thousand years from 28 to 21 cal ka BP.

Table 1. Radiocarbon dates of TOC (organic micro-inclusions, extracted from ice wedges) samples from the Laboratory of Radiocarbon Dating and Electron Microscopy of the Institute of Geography of the Russian Academy of Sciences and the Center for Isotope Research of the University of Georgia (USA)

Sample ID	Height, m asl	^{14}C, BP (1σ)	Lab ID	from cal BP	to cal BP	Median cal BP
YuV-16S/52	+15.2	17680±50	IGAN$_{AMS}$-7335	21800	21015	21399
YuV-16S/12	+12.1	21755±55	IGAN$_{AMS}$-7338	26347	25829	25969
YuV-16S/62	+6.0	24495±80	IGAN$_{AMS}$-6907	29120	28405	28755
YuV-16S/69	+6.0	25281±80	IGAN$_{AMS}$-6908	29958	29185	29551

Table 2. Dating of allochthonous peat horizons from the Seyakha yedoma exposure

Sample ID	Height, m asl	^{14}C, BP	Lab ID	from cal BP	to cal BP	Median cal BP
YuV-16S/ 76	+5.0	23300 ± 640	Le-11406	29865	25902	27596
YuV-16S/ 77	+3.0	24100 ± 300	Le-11407	29205	27425	28292
YuV-16S/ 78	+2.0	25200 ± 420	Le-11408	30923	28083	29497

New stable isotope data suggest that from 28 to 21 cal ka BP the mean January air temperature, reconstructed according to the equation from [Vasil'chuk, 1991], ranged from -35 to -39°C (recent mean January air temperature is -23°C). A marked upward increase of oxygen isotope values in the ice wedge is most likely due to the increase of mean air January temperature at the final stages of the ice wedge growth.

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Bibliography

Vasil'chuk, Yu.K. 1991. Reconstruction of the paleoclimate of the Late Pleistocene and Holocene on the basis of isotope studies of subsurface ice and waters of the permafrost zone. Water Resources. Published by Consultants Bureau. New York. Vol. 17. N6. P. 640-647.

Vasil'chuk Yu.K., van der Plicht J., Jungner H., Sonninen E., Vasil'chuk A.C. 2000. First direct dating of Late Pleistocene ice-wedges by AMS. Earth and Planetary Science Letters. Vol.179. N2. P. 237-242. doi.org/10.1016/S0012-821X(00)00122-9