

Contents lists available at [ScienceDirect](http://ScienceDirect)

## Quaternary Science Reviews

journal homepage: [www.elsevier.com/locate/quascirev](http://www.elsevier.com/locate/quascirev)

### Ice Complex permafrost of MIS5 age in the Dmitry Laptev Strait coastal region (East Siberian Arctic)



Sebastian Wetterich <sup>a,\*</sup>, Vladimir Tumskoy <sup>b,c</sup>, Natalia Rudaya <sup>d,e,f,g</sup>,  
 Vladislav Kuznetsov <sup>h</sup>, Fedor Maksimov <sup>h</sup>, Thomas Opel <sup>a</sup>, Hanno Meyer <sup>a</sup>,  
 Andrei A. Andreev <sup>g,i</sup>, Lutz Schirrmeister <sup>a</sup>

<sup>a</sup> Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Department of Periglacial Research, Potsdam, Germany

<sup>b</sup> Lomonosov Moscow State University, Faculty of Geology, Russia

<sup>c</sup> National Research Tomsk Polytechnic University, Russia

<sup>d</sup> Institute of Archaeology and Ethnography, SB RAS, Novosibirsk, Russia

<sup>e</sup> Novosibirsk State University, Russia

<sup>f</sup> Altai State University, Barnaul, Russia

<sup>g</sup> Kazan Federal University, Institute of Geology and Petroleum Technologies, Russia

<sup>h</sup> St. Petersburg State University, Institute of Earth Sciences, Köppen Laboratory, Russia

<sup>i</sup> University of Cologne, Institute of Geology and Mineralogy, Germany

#### ARTICLE INFO

##### Article history:

Received 26 March 2015

Received in revised form

30 October 2015

Accepted 20 November 2015

Available online 18 December 2015

##### Keywords:

Cryostratigraphy

Palaeoenvironments

<sup>230</sup>Th/U dating

Permafrost

Bol'shoy Lyakhovskiy Island

Oyogos Yar

Beringia

Marine Isotope Stage 5

#### ABSTRACT

Ice Complex deposits (locally known as the Buchchagy Ice Complex) are exposed at both coasts of the East Siberian Dmitry Laptev Strait and preserved below the Yedoma Ice Complex that formed during MIS3 and MIS2 (Marine Isotope Stage) and lateglacial-Holocene thermokarst deposits (MIS1). Radioisotope disequilibria (<sup>230</sup>Th/U) of peaty horizons date the Buchchagy Ice Complex deposition to 126 + 16/−13 kyr and 117 + 19/−14 kyr until 98 ± 5 kyr and 89 ± 5 kyr. The deposit is characterised by poorly-sorted medium-to-coarse silts with cryogenic structures of horizontal ice bands, lens-like, and lens-like reticulated segregation ice. Two peaty horizons within the Buchchagy Ice Complex and syngenetic ice wedges (2–4 m wide, up to 10 m high) are striking. The isotopic composition (δ<sup>18</sup>O, δD) of Buchchagy ice-wedge ice indicates winter conditions colder than during the MIS3 interstadial and warmer than during MIS2 stadial, and similar atmospheric winter moisture sources as during the MIS2 stadial. Buchchagy Ice Complex pollen spectra reveal tundra-steppe vegetation and harsher summer conditions than during the MIS3 interstadial and rather similar vegetation as during the MIS2 stadial. Short-term climatic variability during MIS5 is reflected in the record. Even though the regional chronostratigraphic relationship of the Buchchagy Ice Complex to the Last Interglacial remains unclear because numerical dating is widely lacking, the present study indicates permafrost (Ice Complex) formation during MIS5 *sensu lato*, and its preservation afterwards. Palaeoenvironmental insights into past climate and the periglacial landscape dynamics of arctic lowlands in eastern Siberia are deduced from the record.

© 2015 Elsevier Ltd. All rights reserved.

#### 1. Introduction

Late Pleistocene ice-rich permafrost deposits with syngenetic ice-wedges (Ice Complex, IC) are widespread in the East Siberian Arctic (Schirrmeister et al., 2011a) and have analogues in formations found in north-western Siberia (e.g. Streletskaya et al., 2013), Alaska (e.g. Kanevskiy et al., 2011), and Canada (e.g. Froese et al.,

2009). An Ice Complex (ледовый комплекс [ledovyi kompleks] in Russian) as defined by Solov'ev (1959) includes syngenetic ice wedges (IW, grown synchronously with sediment deposition), fine-grained ice-rich sediments, and a considerable amount of organic material (Strauss et al., 2012, 2013). Such deposits preserve late Quaternary records of the Beringian tundra-steppe ecosystems that maintained the Mammoth fauna. The most prominent IC type is termed Yedoma. It formed during MIS3 and MIS2 between about >55 and 13 kyr BP in eastern Siberia (Schirrmeister et al., 2011a). Yedoma ICs have been extensively studied for their origin (for

\* Corresponding author.

E-mail address: [sebastian.wetterich@awi.de](mailto:sebastian.wetterich@awi.de) (S. Wetterich).