Palaeogeography, Palaeoclimatology, Palaeoecology 479 (2017) 1–15

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Diatom records and tephra mineralogy in pingo deposits of Seward Peninsula, Alaska

Olga Palagushkina [a], Sebastian Wetterich [b], Boris K. Biskaborn [b,*], Larisa Nazarova [a,b,c], Lutz Schirrmeister [b], Josefine Lenz [b,c], Georg Schwamborn [b], Guido Grosse [b,c]

[a] Kazan Federal University, Institute of Management, Economics and Finance, Kazan, Russia
[b] Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Department of Periglacial Research, Potsdam, Germany
[c] University of Potsdam, Institute of Earth and Environmental Science, Potsdam, Germany

A R T I C L E   I N F O

Article history:
Received 9 December 2016
Received in revised form 30 March 2017
Accepted 4 April 2017
Available online 6 April 2017

Keywords:
Microalgae assemblages
Palaeoenvironments
Thermokarst
Late Quaternary
Permafrost

A B S T R A C T

Vast areas of the terrestrial Subarctic and Arctic are underlain by permafrost. Landscape evolution is therefore largely controlled by climate-driven periglacial processes. The response of the frozen ground to late Quaternary warm and cold stages is preserved in permafrost sequences, and deducible by multi-proxy palaeoenvironmental approaches. Here, we analyse radiocarbon-dated mid-Wisconsin Interstadial and Holocene lacustrine deposits preserved in the Kit-1 pingo permafrost sequence combined with water and surface sediment samples from nine modern water bodies on Seward Peninsula (NW Alaska) to reconstruct thermokarst dynamics and determine major abiotic factors that controlled the aquatic ecosystem variability. Our methods comprise taxonomical diatom analyses as well as Detrended Correspondence Analysis (DCA) and Redundancy Analysis (RDA). Our results show, that the fossil diatom record reflects thermokarst lake succession since about 42 ^{14}C kyr BP. Different thermokarst lake stages during the mid-Wisconsin Interstadial, the late Wisconsin and the early Holocene are mirrored by changes in diatom abundance, diversity, and ecology. We interpret the taxonomical changes in the fossil diatom assemblages in combination with both modern diatom data from surrounding ponds and existing micropalaeontological, sedimentological and mineralogical data from the pingo sequence. A diatom-based quantitative reconstruction of lake water pH indicates changing lake environments during mid-Wisconsin to early Holocene stages. Mineralogical analyses indicate presence of tephra fallout and its impact on fossil diatom communities. Our comparison of modern and fossil diatom communities shows the highest floristic similarity of modern polygon ponds to the corresponding initial (shallow water) development stages of thermokarst lakes. We conclude, that mid-Wisconsin thermokarst processes in the study area could establish during relatively warm interstadial climate conditions accompanied by increased precipitation due to approaching coasts, while still high continentality and hence high seasonal temperature gradients led to warm summers in the central part of Beringia.

1. Introduction

Intense landscape dynamics in Arctic and Subarctic regions underlain by permafrost, which are presently observed and to a large extent triggered by climate, will most likely accelerate in the future. The current Arctic warming promotes intensified permafrost thaw, which has similar warm periods in the Quaternary past. Ongoing permafrost research on palaeoclimate and permafrost responses focuses on Arctic lowlands in Beringia; the landmass that connected the Eurasian and North American continents during the Wisconsin glacial period, enabling floral, faunal and human migration (Hopkins, 1959). Permafrost deposits, which aggraded during cold stages in non-glaciated region of Beringia, as well as permafrost degradation facies from warm stages, such as lacustrine thermokarst deposits, provide insights into past environmental conditions and periglacial landscape dynamics. The interplay between late Quaternary climate variations and Beringian periglacial landscapes is archived in fossil, sedimentary and ground-ice properties of permafrost deposits.

The Seward Peninsula (NW Alaska) is located close to the central part of the former Bering Land Bridge (Fig. 1), and here permafrost research focused on modern (Jones et al., 2011) and Holocene (Hopkins and Kidd, 1988; Jones et al., 2012b; Farquharson et al., 2016; Lenz et al., 2016b, Bouchard et al., 2017) thermokarst lake dynamics while

* Corresponding author.
E-mail addresses: opalagushkina@mail.ru (O. Palagushkina), sebastian.wetterich@awi.de (S. Wetterich), boris.biskaborn@awi.de (B.K. Biskaborn), nazarova_larisa@mail.ru (L. Nazarova), lutz.schirrmeister@awi.de (L. Schirrmeister), josefine.lenz@awi.de (J. Lenz), georg.schwamborn@awi.de (G. Schwamborn), guido.grosse@awi.de (G. Grosse).

http://dx.doi.org/10.1016/j.palaeo.2017.04.006
0031-0182/