UCRL-JRNL-220653

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April 18, 2006

Doklady Akademii Nauk

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Radiocarbon Dates and Palynological Characteristics of Sediments in Lake Melkoe, Anadyr River Basin, Chukotka.

N. A. Shilo[1], A. V. Lozhkin[2], P. M. Anderson[3], T. A. Brown[4], T. V. Matrosova[2], and A.N. Kotov[5]

1 Presidium of the Russian Academy of Sciences, Leninskii pr. 14, Moscow, 117901 Russia

2 Northeast Complex Research Institute, Far East Division, Russian Academy of Sciences, ul. Portovaya 14, Magadan, 685000 Russia; e-mail: lozhkin@neisri.magadan.ru

3 Quaternary Research Center, University of Washington, Seattle, Washington 98195, USA; e-mail: pata@u.washington.edu

4 Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, PO Box 808, Livermore, CA, 94551-9900, USA; e-mail: tabrown@llnl.gov

5 Chukchi Branch, Northeast Complex Research Institute, Far East Division, Russian Academy of Sciences, ul. Energetikov 15, Anadyr, 686710 Russia; e-mail: nauka@anadyr.ru

The formation of Lake Melkoe (64°5130 N, 175°14 E, altitude 36 m), one of the largest lakes of the Anadyr Lowland, is related to the moraine [1] left by the Tyellakh Glacier, which originated on the Pekul'nei Ridge (Fig. 1). The lake (6 km long and 4.4 km wide) extends in the northwestern direction. The Kholmy Priozernye moraine (16 km long along the arc, 1.5 km wide, and 92–103 masl) surrounds the lake in the west and south. The lake coasts are covered by sand with pebbles and shingle. The flat lake bottom dips toward its central part to a depth of 160 cm. In distinction from many other lakes of the Anadyr Lowland, the thickness of the upper layer of water-saturated sediments overlying compact aleurites in Lake Melkoe is only 5–6 cm. Such a peculiarity of the bottom is explained by the large size of the lake, low sedimentation rates, and frequent storms caused by strong winds. Regional and local vegetation corresponds to a mosaic tundra represented by high shrubs Pinus pumila, Duschekia fruticosa, and hummocky Betula–Ericales–Eriophorum communities. Pinus pumila and Alnus form thickets on the banks of the Anadyr River, coasts of lakes, and moraine slopes.

Cores 188 cm long were obtained by a piston corer from the central part of Lake Melkoe. Because of a high compactness of sediments, their total thickness is unknown. However, radiocarbon dates and palynological analysis of examined sediments suggest the formation of Lake Melkoe at the transition between isotopic stages 4 and 3 (Zyryanka and Kargino periods of the late Pleistocene). The section is composed of the following sediments (from the top to bottom):

(0–6 cm) gray plastic water-saturated silt;

(6–33 cm) gray plastic horizontally bedded silt;

(33–69 cm) gray plastic compact, lumpy silt with horizontal bedding emphasized by fine

organics;

(69–151 cm) gray to dark gray, horizontally bedded, slightly plastic, lumpy silt;

(151–188 cm) gray with brownish tint, horizontally bedded, compact silt with angular splintering, indicating freezing with formation of ice schlieren during lake level fall.

The AMS analysis of lacustrine sediments yielded 21 radiocarbon dates for plant remains (PR) and humic acids (HA). These dates fall into three time intervals.

(1) The second half of the Kargino interstade (isotopic stage 3) is characterized by the following dates (years BP):

depth:

(185–186 cm) 33410 ± 440, PR (CAMS55071); 31110 ± 340, HA (CAMS55075);

(165–166 cm) 34200 ± 420, PR (CAMS58293); 35420 ± 500, HA (CAMS58298);

(154–155 cm) 31970 ± 370, PR (CAMS55070); 35420 ± 500, HA (CAMS58298).

(2) The terminal Sartan glacial stage (isotopic stage 2) is characterized by the following dates (years BP):

depth:

(138–139 cm) 13220 ± 60, PR (CAMS55069); 12280 ± 50, HA (CAMS55074);

(110–111 cm) 12270 ± 50 yr BP, PR (CAMS58794); 12320 ± 50, HA (CAMS59795);

(88–89 cm) 12740 ± 50, PR (CAMS64803); 11840 ± 50, PR (CAMS63821); 12770 ± 50, HA (CAMS64000);

(61–62 cm) 12780 ± 50, PR (CAMS64802); 12030 ± 40, PR (CAM63803); 12450 ± 40, HA (CAMS63999);

(31–32 cm) 13290 ± 50, PR (CAMS59792); 12400 ± 50, HA (CAMS59791);

(20–21 cm) 10620 ± 50, PR (CAMS58292); 10620 ± 50, HA (CAMS58297).

(3) The Atlantic period of the Holocene (isotopic stage 1) is characterized by the following dates (years BP):

depth:

(10–11 cm) 6110 ± 40, PR (CAMS59790); 7080 ± 60, HA (CAMS59791).

Based on proportions of main pollen–spore taxons in palynological spectra, six palynozones are defined in sediments of Lake Melkoe (Fig. 2). The share of each taxon is given as a percentage of the pollen sum. The content of spores is given as a relative value of the total quantity of pollen grains for each spore taxon. Zone ML1, with dominant Poaceae and Betula pollen accompanied by notable content of Artemisia pollen and Selaginella rupestris spores, records the development of a dry herbaceous tundra with decumbent Betula and Salix forms. Judging from radiocarbon dates obtained for the depth interval of 151–186 cm, this zone corresponds to the Konoshchel cooling of the Kargino interstade [2]. Spectra of Zone ML2 suggest wider development of shrubs (including alder groves), which is likely explained by both a gradual increase in the temperature of the vegetation period and climate humidity at the end of this period.

Zone ML3 is characterized by a peak of Alnus pollen (Fig. 2), pointing to the development of

large-shrub Betula–Alder tundra. The increase of soil humidity and decrease of xerophilous communities are reflected in the high share of Sphagnum spores in palynological spectra and reduced content of Artemisia pollen and Selaginella rupestris spores. As is evident from radiocarbon dates, Zone ML3 corresponds to a substantial warming in the terminal Sartan period. This zone can most likely be correlated with the Kokorevo warming in Siberia [2] or with the Boelling event. The shrub Betula–Alder tundra, with an insignificant share or complete absence of Pinus pumila, remained dominant in Zone ML4. The increased proportion of Sphagnum spores in spectra indicates that moderately hygrophilous Ericales–Sphagnum communities began to play a notable role, at least locally. Considering the composition of palynological spectra and radiocarbon dates, Zones ML3 and ML4 are similar to the Betula pollen zone, testifying to a significant reorganization of vegetation in northeastern Siberia during the Pleistocene– Holocene boundary period caused by climate warming [3].

Radiocarbon dates of samples CAMS58292 and CAMS58297 (10620 ± 50 yr BP) allow Zone ML5 to be correlated with the Younger Dryas. Spectra from this zone reflect an insignificant decrease in the share of shrub pollen and simultaneous increase in the content of Pinus pumila pollen, which becomes progressively notable in the vegetation community. As is evident from data on Zone ML6, the further increase in the role of the latter pollen in the Atlantic period of the Holocene was related to the formation of vegetation communities similar to the present-day ones [3].

Thus, palynological, radiocarbon, and cryolithological characteristics of Lake Melkoe sediments reveal a general evolution trend, which is undoubtedly typical of other lakes of the Anadyr Lowland. It demonstrates, for example, a significant hiatus during the ML1–ML2 boundary period, i.e., approximately 32 ka BP. The cryogenic structure of compact “dry” sediments in the depth interval of 151–188 cm reflects the freezing of sediments (with the formation of ice schlieren) during their exhumation, as a result of a fall in lake level. Glaciers formed on the left bank of the lower reaches of the Anadyr River in the second half of the Kargino interstade and Sartan glacial stage covered a large region, including Lake Melkoe. Sedimentation in the lake resumed during the warming epoch and degradation of glaciers, approximately 13 ka BP.

The fissures in sediments from the depth interval of 33–151 cm related to the development of thin ice schlieren implies their freezing. It is quite probable that freezing could happen due to the lake level fall during the Younger Dryas cooling, when the lake froze down to the bottom. It is conceivable that the older sediments were again exposed. The next lake level rise at the beginning of the Holocene was caused by glacial thawing and increased atmospheric precipitation.

ACKNOWLEDGMENTS

This work was supported by the Russian Foundation for Basic Research (project no. 03-05-64294), the Far East Division of the Russian Academy of Sciences (project no. 05-III-B-09-009), the US National Science Foundation (publication 231 of the International Program "Paleoenvironmental Arctic Sciences"), and by, the Lawrence Livermore National Laboratory of the University of California (contract W-7405-Eng-48).

This work was performed under the auspices of the U. S. Department of Energy by University of California, Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

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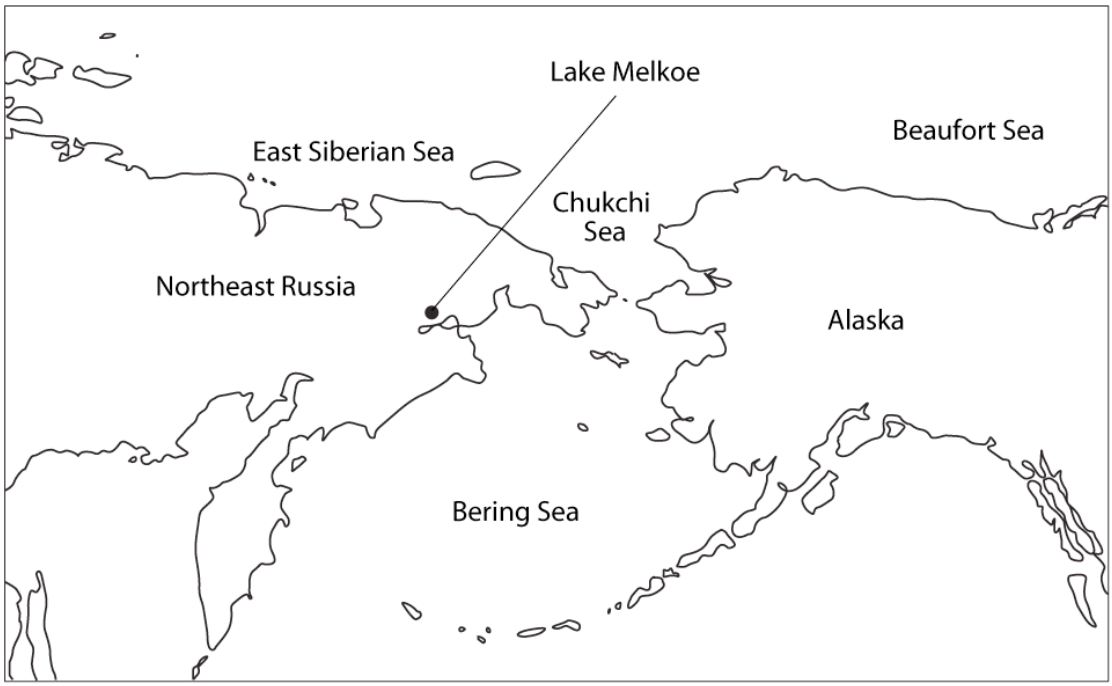

Fig. 1. Geographic location of Lake Melkoe.

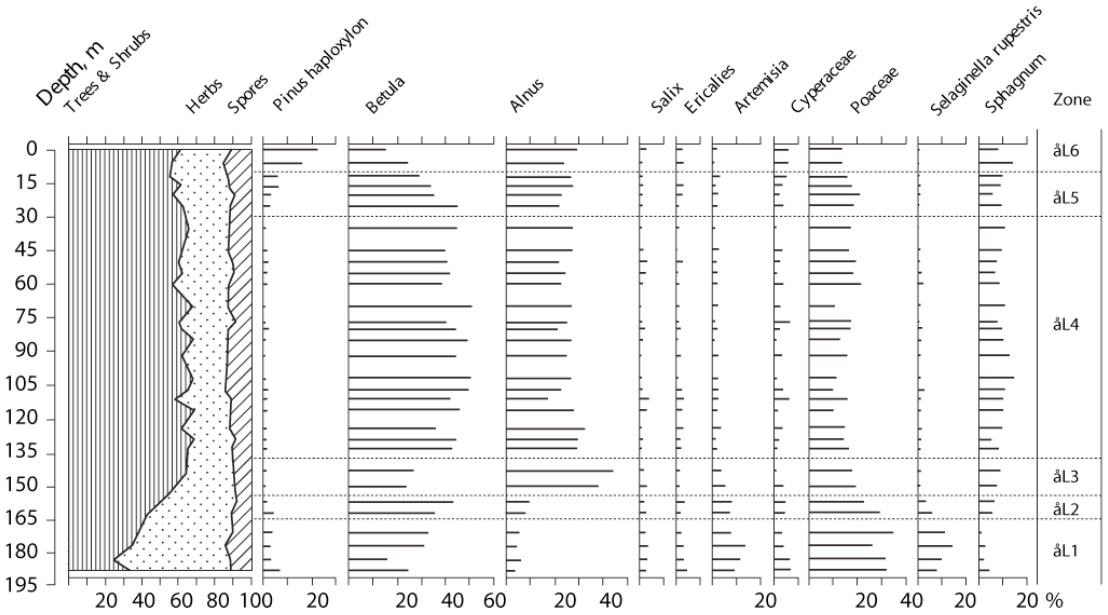

Fig. 2. Spores–pollen diagram obtained for sediments of Lake Melkoe (see the text for explanations).