NEW DATA ON HOLOCENE STRATIGRAPHY IN NORTHWESTERN CHUKOTKA

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ABSTRACT

Palynological analyses of radiocarbon-dated alluvial and colluvial sedimentary sections from the Elgygytgyn Lake basin and the upper portions of the Enmyvaam River basin are described. New data that confirm the distribution of forest communities in the central region of northwestern Chukotka during the Boreal and the beginning of the Atlantic periods of the Holocene are summarired.

INTRODUCTION

During recent years, paleogeographic investigations have focused on obtaining detailed information on the history of past environmental responses to changing climates as an aid for predicting both short- and long-term changes in the future. With this approach, paleogeographic reconstructions of Late Pleistocene and Holocene environments considered to be the most detailed and therefore the most effective means of investigations. Information concerning Holocene climatic variations and associated vegetation responses for far northeastern Asia are based on widely dispersed sites that provide insufficient coverage for this vast region. Consequently, every new well-dated palynological record is of great interest.

Results of interdisaplinary study of a series of alluvial and colluvial sedimentary sections in the interior mountainous region of northwestern Chukotka provide additional material for paleoclimatic reconstructions. These new data are important both for the definition of late Quaternary climatic events, and the description of the landscape at such a unique feature as the Elgygytgyn basin.

THE PECULIARITIES OF OROGRAPHIC PLAN AND THE CHARACTERISTICS OF MODERN PLANT COVER

Before describing the sections, we discuss the origins of the regional orographic environments.

During the last so years the Elgygytgyn Lake has been of great interest to biologists, geomorphologists and geologists. Discussions about the origin duration, and history of development of this round, deep basin, continue to the present day. Hypotheses about its origin agree that the basin was formed as the result of an explosion. However, explanations of the character of the explosion differ. One hypothesis, with V.F.Belyi (1982, 1993) as the strongest proponent, suggests this basin was the result of repeated emissions of volcanic gases. A second hypothesis proposes that the basin is a meteorite impact crater (Gurov, Valter et al., 1978; Gurov, Gurova, 1981; Impactites, 1981). Numerous potassium-argon dates indicate the age of the impactite rock to be 3.5 m.y. In either case, the formation of this unique structure influenced geomorphological processes (e.g. specific features of slope morphogenesis, the development and reconstruction of the drainage system).

The Elgygytgyn basin is located near the Pacific-Arctic drainage divide, between the eastern extension of the Anyui Range and the northwestern section of the Anadyr Upland. Albian-Senomanian volcanogenic rocks, represented mostly by felsic lavas, ignimbrites, tuffs and some basalts, characterize the geological composition of the district (Belyi, 1982).

Elgygytgyn Lake lies (Fig.1) at an elevation of 489.5 m. The like itself occupies the central part of the vast circular depression. Its shoreline is also nearly round, being slightly deformed by erosion. The lake's maximum diameter is 11.5 km, with on area exceeding 117.5 km^2, and the maximum depth of 169 m (Nekrasov, 1963). Numerous small incised channels flow into the lake, and only the Enmyvaam River flows out of it. The basin proper is surrounded by mountains of 400-600 m height.

The vegetation of the Elgygytgyn Lake district and of the basin of the upper Enmyvaam River is characterized as alpine low shrub and lichen tundra with relicts of maritime phytoceonosis within the broader zone of arctic 3tundras (Kozhevnikov, 1993). The composition and distribution of the modern plant cover reflect the combined effects of oceanic and continental influences on the regional climate. Shrubs are not common and are represented mainly by small thickets of low willow that are restricted to areas protected from the strong winds typical of this region. Sufficiently low summer temperatures combined with the cold damp winds remove result in the southern shift of the forest-tundra boundary (Kozhevnikov, 1989). The modern vegetation of northwestern Chukotka deviates from general latitudinal patterns due to the presence of cool waters of the bordering seas that results in the expansion of tundra vegetation into interior regions. Although the broad expanse of Elgygytgyn Lake has probably influenced the local climate throughout its existence, regional climate was probably largely determinated

by the effects of global changes on the Polar Basin. The new palynological data presented in this paper strongly support such a conclusion.

CHRONO- AND BIOSTRATIGRAPHY OF ALLUVIAL AND COLLUVIAL SEDIMENTS

For the first time for interior Chukotka a series of sections was described, palynological analyses were made, and a suite of ^{14}C dates were obtained from the first fluvial terraces above the floodplain and from colluvial sediments of the Elgygytgyn Lake basin(?). Large tree remains in the sections suggest that there were considerable regional climatic variations during the final stages of geomorphic development.

Palynological spectra and ^{14}C dates from fluvial and floodplain facies of alluvium and colluvium characterize the stages of vegetation development at the end of the Pleistocene and during the Boreal and Atlantic periods of the Holocene.

1. The mouth of the first left affluent of the Enmyvaam River (1.7 km to the south of Elgygytgyn Lake), the first fluvial terrace (2.5-3.0 m height). This terrace was of great interest because of the presence of roots and branches from large shrubs, that are absent on the modern landscape. At the bottom of the section near the water's edge, is an ice vein of about 0.5 m thickness. The ice is vesicular and bedded. The vein is intruded into a grey, poorly rounded coarse gravel that includes many non-rounded rock fragments and thin lenses and bands of plant detritus (0.35 m). The coarse gravel is overlain by a particoloured layer of alternating bands and lenses of yellow-grey, poorly sorted sand, sandy loam, and loam with bands and lenses of brown peat containing remains of roots and branches of large *Alnus* shrubs (0.35 m). Three ^{14}C dates were obtained from wood of this horizon: 9250±90 (MAG-1477); 9125±30 (MAG-994); 8120±25 (MAG-1478). The overlaying layer is a loamy. Bands and lenses of peat are of yellowish brown, and 8tree remains are rare (0.4 m). From this horizon we have obtained ^{14}C dates of 7770±50 (MAG-1480) and 6620±30 (MAG-1476). The horizon is overlain by a ferruginated loam with thin humus bands containing herbaceous stems and roots (0.7 m). The top of the section is a pale yellow-grey loess-like loam containing roots of herbs and dwarf shrubs (0.2).

We distinguish three of spore-pollen assemblages in section I: 1.8-1.35 m (zone ***A***), 1.35-0,85 m (zone ***B***), 0.85-0.0 m (zone ***C***). The pollen of alder and birch shrubs (50-60%) dominates all spectra (Fig.2), tree birch and *Pinus pumila* was also found. Following the scheme of Blitt-Sernander (Khotinsky, 1977), the accumulation of the major part of the alluvial thickness apparently took place during the Boreal and Atlantic periods of the Holocene. The vegetation of the Boreal period perhaps was a birch-alder high shrub tundra with elements of birch forests. A gradual increase in *Pinus pumila* pollen was observed in spectra from the upper horizons of this section. This characteristic is typical for the coastal regions of the Polar Basin (Khotinsky, 1977; Kaplina, Lozhkin, 1982; Ivanov et.al., 1984). The pollen of *Pinus pumila* is abundant only in sediments dated not younger than 6600 years ago. An increase in its percentages usually indicates the expansion of this shrub up mountain slopes adjacent to the lowlands. It is supposed that the spread of this shrub was due to lower summer temperatures and increased snow cover in winter which would result in more favorable conditions for its growth.

2. Left bank of the Enmyvaam River (45 km to the south from the Elgygytgyn Lake), alluvial terrace 7-9 m height. Bedrock (4.0 m) is a Cretaceous tuff-conglomerates and is exposed at the terrace bottom. Bedrock is overlain by coursely laminated fluvial deposit dominated by a bed of large pebbles (2.0 m). Deposits of gravel, poorly sorted sand, and sandy loam interbedded with plant detritus (containing large fragments of trunks and branches of trees and shrubs) occur above the pebble-bed, but with traces of washout (3.5 m). A ^{14}C date of 7450± 55 (MAG-1433) was obtained from a wood fragment from this horizon at 3.6 m depth. The horizon (0.5 m) of nonbedded loess-like loam completes the section.

Palynological data (Fig.3) indicate the initial accumulation of alluvium during the end of the Late Pleistocene (zone ***A***), with the subsequent deposition of flood plain sands during the Atlantic period (zones ***B*** and ***C***). The vegetation of this time was dominated by a high alder-birch shrub tundra that probably also included small groves of tree birch.

3. Piedmont plain bordering Elgygytgyn Lake. A section with rock debris, colluvial sediments, and compact peats was found in the he8adwaters of a small downgrading stream approximately 2 km in length. There sediments were exposed in a steep bench of 2-2.5 m height. The colluvium (0.7 m) is charactered by individual blocks, angular fragments, rock debris, and gruss in an aggregate of frozen loam and/or sandy loam. Throughout the section, the colluvial sediments are interbedded with undisturbed bog sediments represented by a reddish brown compacted peat, consisting of poorly decomposed stems of herbaceous plants (0.65 m) that are in h8orizontal positions. Bog sediments are overlain by pale yellow-grey loess-like loam that includes rare angular fragments and rock debris (0.4 m). ^{14}C dates of 5080±35 (MAG - 1335) and 4850± 400 (MAG - 1334) were obtained from the lower and upper parts of the peat horizon, respectively. These dates are accompanied by spore-pollen spectra (Fig.4) that characterize the vegetation of the Elgygytgyn Like region during the final stage of the

Atlantic period. Pollen of alder, shrub birches, Ericales and *Pinus pumila* dominate the diagram. The vegetation is characterized as a high shrub tundra. The composition and peculiarities of the spore-pollen spectra show that during the final stages of the Atlantic period climatic conditions in the region began to change with decreasing 8temperature and winter snow cover.

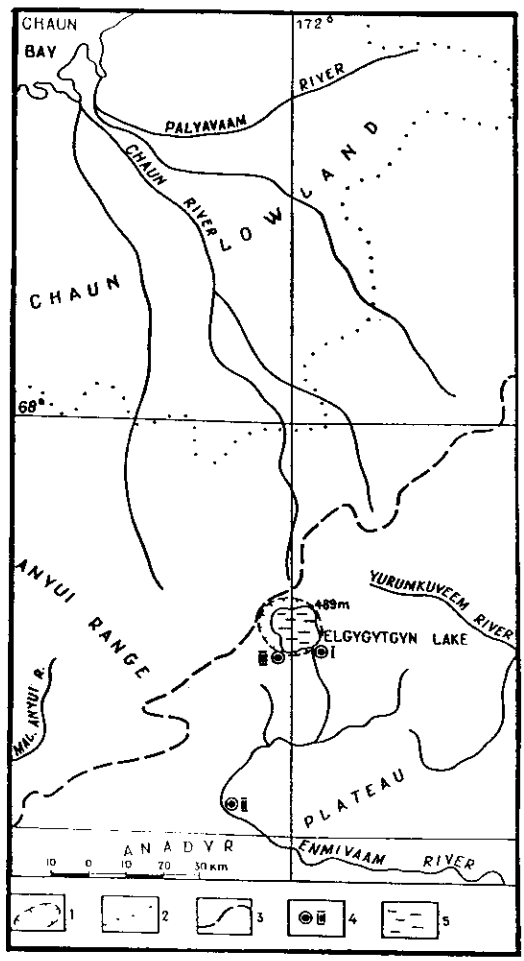

Fig.1. Location of sections in the Elgygytgyn Lake region.
1 - boundary of the Elgygytgyn meteoritic crater; 2 - boundary of the Chaun lowland; 3 - line of the Pacific-Arctic drainage divide; 4 - location of the sections and their numbers; 5 - catchment of Elgygytgyn Lake.

DISCUSSION

Up to the present time, Holocene paleogeographic reconstructions for northeastern Siberia relied on data from sections of alluvial, lake-bog and alas sediments located in widely separated areas. These regions include the Central-Kolyma, Primorsk lowlands of Yakutia, islands of the East Siberian Sea and northern Priokhotye (Khotinsky, 1977; Lozhkin, Kazakova, Titov, 1982; Shilo, Lozhkin et al., 1983, Lozhkin, 1987).

It was established that in regions with different climate types (e.g. moderate-continental, sharply continental, subpolar), the nature of the change from the last glacial maximum to the Holocene optimum and the time of this change varied from region to region. For example, in the Kirgilyakh Creek basin (Shilo, Lozhkin et al., 1983), located in the continental Central-Kolyma climate types paleoclimates were sharply continental during the entire Holocene. The modern pollen floras are similar to subfossil ones, beginning from 7500 years ago. The Holocene optimum in this region was poorly manifested.

In contrast, climatic variations were great in the Primorsk lowlands of Yakutia and islands of the East Siberian Sea (Kaplina, Lozhkin, 1982; Klimanov, 1989). The deviations of annual temperatures 8500 years ago were 2-3°C. Palynological data and ^{14}C dates show the rise of temperatures and the advance of forest species to 69-71°N shrub latitude. In these northern localities, stems of large shrubs and high shrub birch were dated to between 10,000 and 7,000 years ago. At present, the northern boundary of high shrub birch is 68°N (Voroshilov, 1966). Wood macroremains were not found in sediments from the Atlantic period. Spectrum analysis of numerous sections shows that by the second half of the Atlantic period, the distribution of plant communities was similar to modern.

We have analyzed several sections in the Chaun lowland and near the mouth of the Amguema River. This analysis is accompanied by ^{14}C dates (Ivanov et al., 1984). In the palynological spectra, distinct vegetation changes reflect increasing of temperature. This change is synchronous with a similar temperature shift in the Primorsk lowlands of Yakutia. Remains of trees and large shrubs dated to between 10400-8400 years ago were found in the sections.

The Loren River valley of the Bering Sea coast located in the zone of subpolar climate, is similar Chaun lowland (Davidovich, Ivanov, 1976; Ivanov, 1982) in that pollen-spore spectra dated to 8800-8500 years ago show the expansion of shrub birch and Ericales. Today this region is characterized as Arctic tundra. Paleobotanical data show a climatic amelioration during the Boreal period. However, this improvement was not expressed as strongly as in the coastal regions of the Polar Basin.

Reconstructed landscapes of the Elgygytgyn Lake region during several periods of the Holocene, show the considerable similarity to the landscapes of the East Siberia and Chukotsk Seas, despite the relatively continental position of Elgygytgyn. Thus, the flooding of the Bering land bridge about 12 thousand years ago (Hopkins, 1976) perhaps resulted in the flow of relatively warm waters of the Bering Sea into the seas of the Polar basin.

Increased temperature resulted in forest expansion, both in the coastal lowlands and in the mountain regions of northwestern Chukotka.

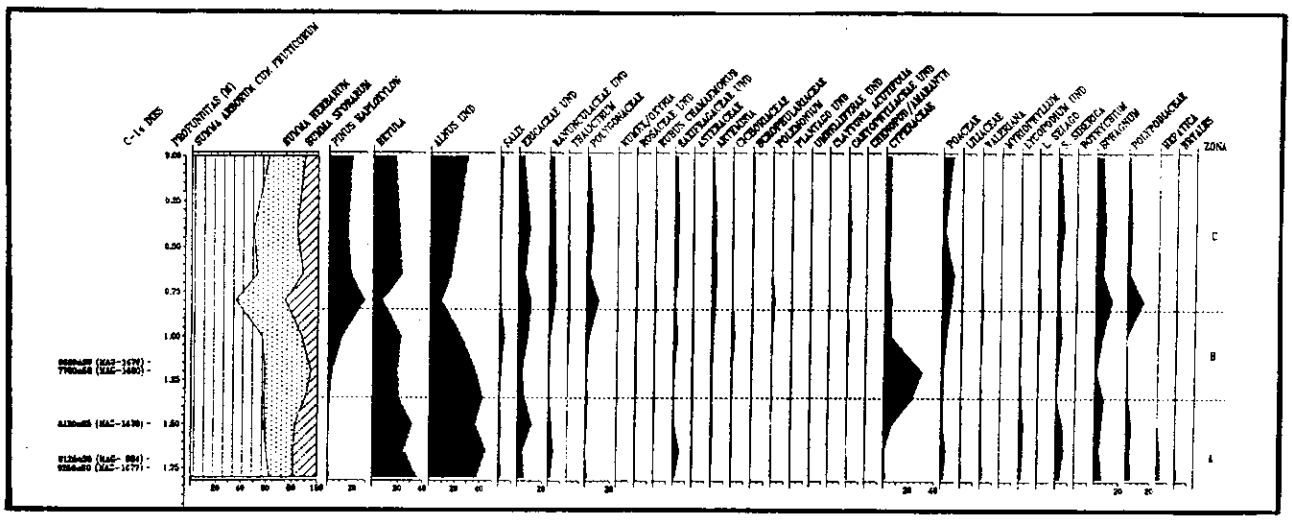

Fig.2. Spore-pollen percentage diagram of sediments along the section of the Enmyvaan River terrace (headwaters) 2.5 to 3.0 m height.

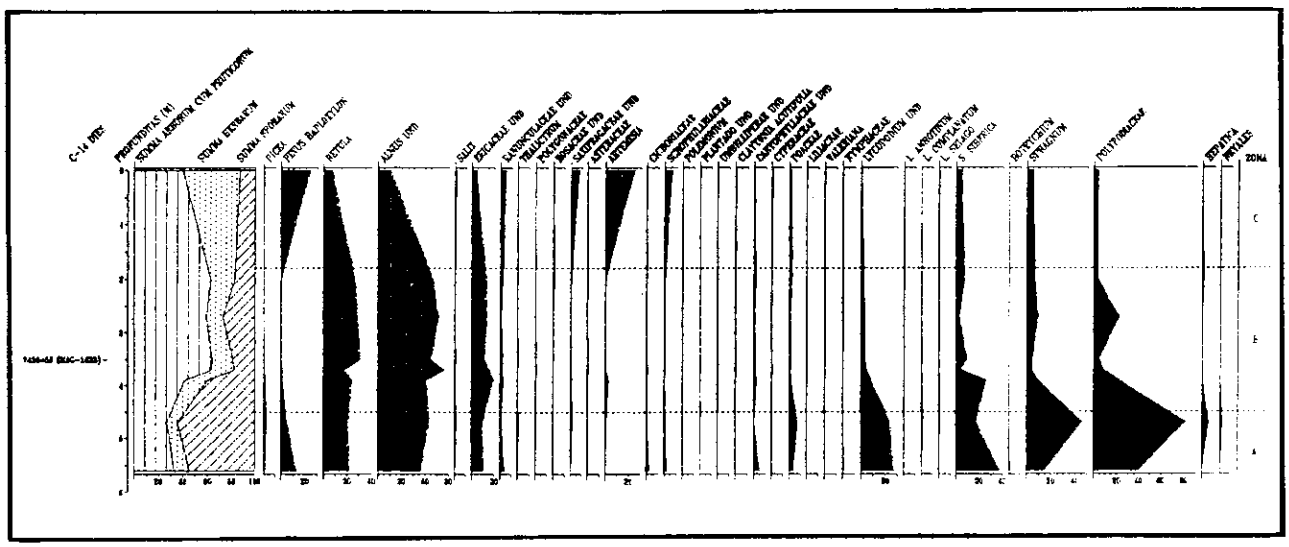

Fig.3. Spore-pollen percentage diagram of alluvial sediments along the section of the upper Enmyvaan River terrace 7-9 m height.

New data have also made it possible to solve some problems of the developmental history of the Elgygytgyn basin. In areas of the basin that border the modern lake, I.A.Nekrasov (1958, 1963) distinguished remnants of lake shorelines at several levels. Our observations (Glushkova, 1993) show that the first lake shoreline (2.5 - 3.0 m level) is correlated with the same level of the first fluvial terrace floodplain of the in the upper Enmyvaam River. Therefore, the time of its formation is the end of the Late Pleistocene and/or beginning of the Holocene.

The new data on the chrono- and biostratigraphy of alluvial terraces and lake shorelines are also very important for restring the problem of Late Pleistocene glaciations. Correlation of the Enmyvaam River terraces with those of rivers in the nearby Anyui and Ekityk glacial regions (Glushkova, 1982; Glushkova, 1994) make it possible to more completely describe the glacial dynamics. However, absolute dates for this events in these nearby regions currently are absent.

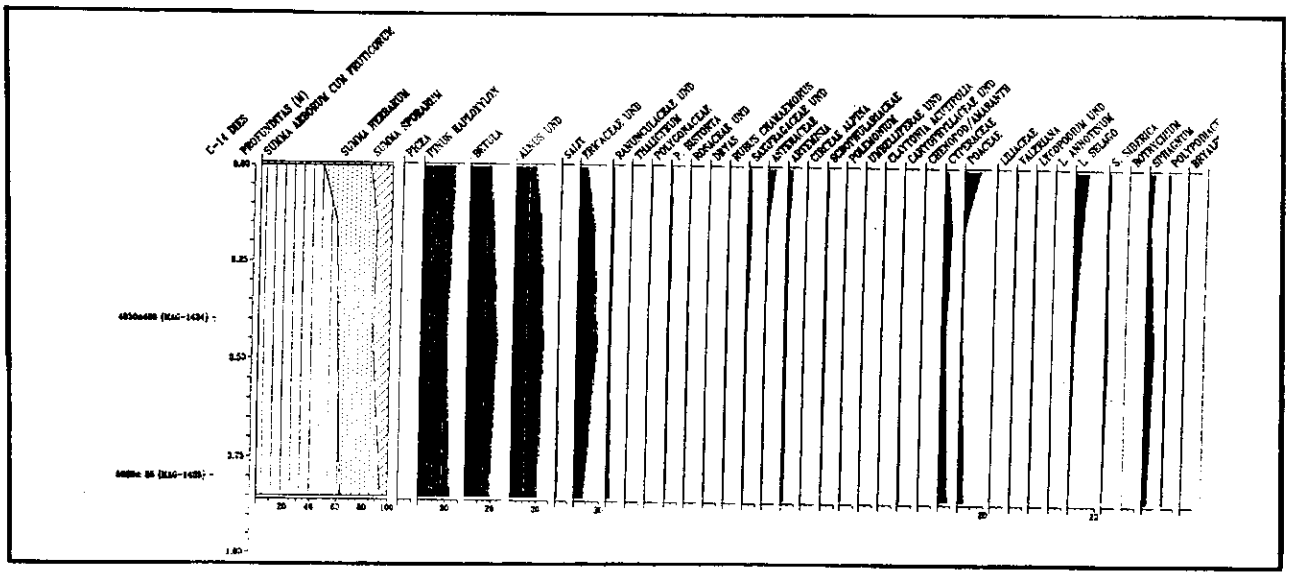

Fig.4. Spore-pollen percentage diagram of colluvial sediments in the flange of the Elgygytgyn meteoritic crater.

CONCLUSION

In conclusion, we want to stress that the Pleistocene and Holocene stratigraphy and paleogeography of northwestern Chukotka are some of the most poorly understood for all of northeastern Siberia. Available data on Holocene paleoclimates and paleovegetation make it possible to outline the general character of climatic variations during this period.

The comparison of paleobotanical data with data from other regions of northeastern Siberia shows the similarity in temporal variations and climate characteristics of the Boreal and Atlantic periods to that described for the Primorsk lowlands of Yakutia. We may also distinguish basic differences with the Central-Kolyma region. Strong contrasts of climatic changes during the first half of the Holocene are associated with changes in global circulation patterns and associated regional feedbacks as they affected coastal and interior regions of the Chukchi Peninsula.

According to the chrono- and biostratigraphic data from alluvial and colluvial sediments, we distinguish the Elgygytgyn Lake region as key for determining the succession of climatic events in the Holocene and for further examination of paleogeographic reconstructions. These data make it possible to refine the regional stratigraphy, 8to trace the final stages of geomorphic development, to carry out the correlation with the Elgygytgyn Lake terrace and thus, to gain additional information about the history of this unique lake.

ACKNOWLEDGMENTS

The authors thank I.V.Glazatov for assistance in data collection, B.V.Belaya for the identification of difficult pollen-spore taxa, M.A.Trumpe for help with computer programs, including preparation of pollen diagrams, and Ye.P.Burak for translation.

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