DIATOMS OF PELUKIAN DEPOSITS AT NOME (ALASKA)

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ABSTRACT

An 8-10 m terrace 2km west of Nome (Alaska) was investigated. The base of the section is made up of beach sand and gravel, overlain by a 3-m layer of peat with traces of cryogenic structures. The section is capped by a layer of silt and loam about 1 m in thickness. Three complexes of diatoms were delineated. In the sand and gravel diatoms of nearshore shelf origin were studies. Higher in the section they are replace by bog diatoms, discovered in the package of sand and peat. A marine nearshore complex was discovered in the loam. These three complexes correlate to the 5e, 5d, and 5c phases (oxygen isotope substages) of Pelukian transgression. The relatively high position of the marine diatom-bearing layers in relation to the modern shoreline indicates the occurrence of favorable tectonic movements, at lease since Sangamon time.

INTRODUCTION

The fifth transgressive package of marine deposits of the Gubik Formation, which is express by an 8-10 m terrace along the west and northwest coast of Alaska, formed at the beginning of the late Pleistocene (Hopkins, 1976; Kaufman & Brigham-Grette, 1993). Generally the Pelukian transgression is understood only as that period of time which coincides with oxygen isotope state 5e (Shackleton & Opdyke, 1976). The stratigraphy of the Pelukian deposits is extremely important, because on its degree of detail depends solutions to problems of establishing the boundary between the Sangamon and Wisconsin, and also a more precise definition of the stratigraphic volume of the latter. The presence of two marine packages in the deposits of the 8-10 m terraces along the shore of the Bering, Chukchi, and Beaufort Seas compel a reexamination of the stratigraphic extent of the Pelukian horizon.

The basis of the present research is analysis of diatoms studies in the Pelukian deposits. Diatoms are an especially fine indicator of the ecological parameters of the habitat, which are conducive to a precise determination of the genesis of the enclosing deposits and of the paleoclimatic character of their formation.

MATERIAL AND APPROACH

In August of 1993, with the assistance of the U.S. National Science Foundation and the Alaska Quaternary Center of the University of Alaska, Fairbanks, we conducted field work on the western and northern coasts of Alaska. The work involved study of the deposits of the Gubik and Flaxman formations, in whose sediments all six late Pliocene and Pleistocene transgressions are expressed.

One of the most complete and representative sections of Pelukian deposits was studies in a sand pit 2 km west of Nome, which was produced as a result of gold dredging (Fig. 1). This section is located 200 m from the beach of the sea, and its base is positioned 2.8 m above modern sea level.

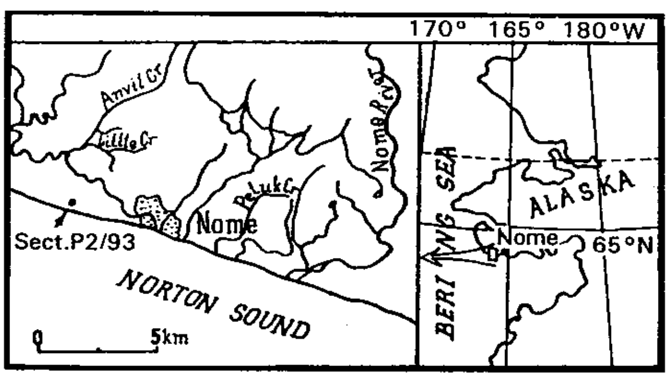

Fig. 1. Location of Section P2/93

From the bottom up are revealed (Fig. 2):

	Thicknes (m.)
1. Gray poorly-sorted sand with very rare pebbles	0.6(visible)
2. Gravel and pebbles, well rounded, 2-3 cm in diameter. Lenses of light gray medium-grained sand up to 5-8 cm in thickness	0.3
3. Medium fine-grained sand. In the upper part of the layer the sand grades to lay	0.6

4. Dark brown, poorly-sorted sand	0.2
5. Dark brown compact peat	0.3
6. Dark gray loam	0.8
7. Soil	0.3
The average thickness	5.8

Six samples were taken from this section for diatom analysis. The mass of each sample was 25 grams. Loosening of sediment and cleaning of the diatom valves was carried out by a course of boiling the samples in distilled water with an addition of 30% hydrogen peroxide (H_2O_2) for 40 minutes. Separation (isolation) of the diatoms was accomplished by a course of elutriation of sediment and repeated rinses (8-10) of the politic fraction every 2 hours. Because the concentration of diatoms in the sand is minimal, the sediment was enriched by centrifuging it at a speed of 1500 revolutions per minutes in a heavy liquid with a specific gravity of 2.6 for 15 minutes. The enriched sediment was diluted with distilled water to 50 ml in volume. The preparation was made from 0.2 ml enriched solution, which was placed on a microscope slide. The sediment was fixed to the slide with a cover plate (18x18 mm) and annealing resin.

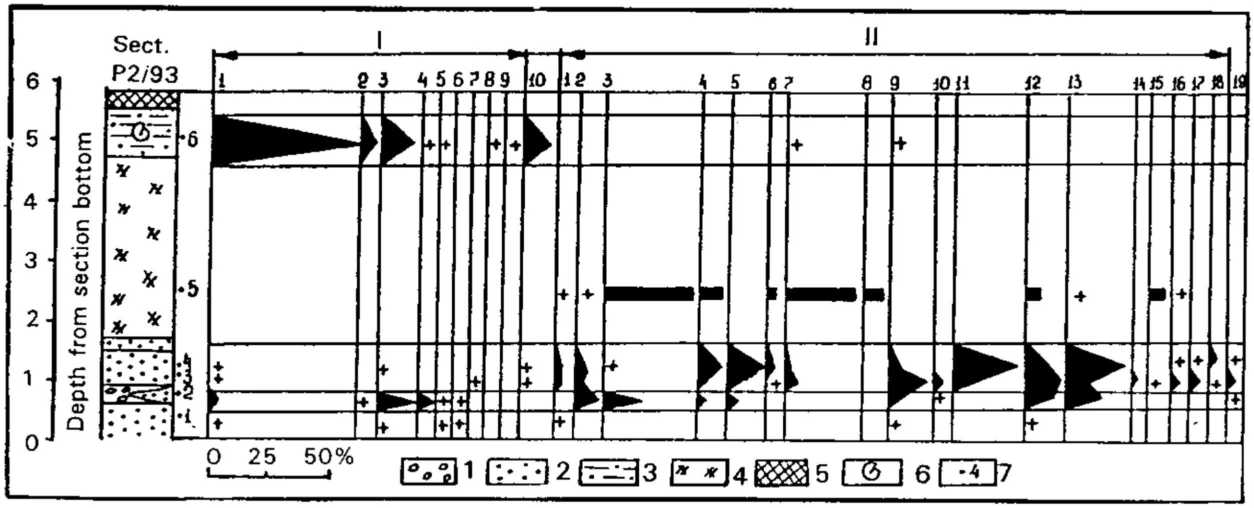

Fig. 2. Column of the section P2/93
1 - pebble (beach) gravel; 2 - sand; 3 - loam; 4 - peat; 5 - soil; 6 - shells; 7 - sample number and location. *Diatoms*: **Group I (marine)**: 1 - *Paralia sulcata* (Ehr.) C1.; 2 - *Coscinodiscus marginatus* Ehr.; 3 - *Thalassiosira gravida* C1.; 4 - *Th. kryophila* (Grun.) Iorg.; 5 - *Th. bramaputrae* (Ehr.) Hakansson el Locker; 6 - *Pyxidiculla turris* (Grev. et Arnott) Strel. et Nikolaev; 7 - *Diploneis interrupta* C1.; 8 - *Trachyneis aspera* C1.; 9 - *Cocconeis scutellum* Ehr1; 10 - *Navicula marina* Ralfs. **Group II (freshwater)**: 1 - *Eunotia praerupta* Ehr.; 2 - *E. praerupta* var. bidens (W.Sm.) Grun.; 3 - *E. triodon* Ehr.; 4 - *E. papilio* (Grun.) Hust.; 5 - *E. praerupta* var. musciocola P. Boye; 6 - *E. monodon* Ehr.; 7 - *E. valida* Hust.; 8 - *E. fallax* A. C1.; 9 - *Navicula amphibola* C1.; 10 - *N. mutica* Kuetz.; 11 - *N. crucicula* (W. Sm.) Donl.; 12 - *Pinnularia viridis* (Nitzsch.) Ehr.; 13 - *P. lata* (Breb.) W. Sm.; 14 - *P. borealis* Ehr.; 15 - *P. microstauron* (Ehr.) C1.; 16 - *Caloneis silicula* var. alpina C1.; 17 - *Cymbella hybrida* Grun.; 18 - *Stauroneis anceps* Ehr.; 19 - *Hantzschia amphioxys* (EHR.) Grun.

For a statistical analysis of the correlation (ratio) of the diatom species, 250 valves were counted in horizontal transits across the cover plate under a magnification of x800. In cases when the concentration of diatoms in the solution did not allow a count of 250 valves, it was correspondingly converted to (expresses as) a general percentage of the make-up of valves, out of which 250 valves make up 100%.

DIATOM COMPLEXES

Complex I. From Bed 1. - The concentration of diatoms is no greater than 2-3 thousand valves per gram of sediment. This complex contains individual marine sublittoral diatoms *Paralia sulcata, Thalassiosira bramaputrea,* and the neritics *Thalassiosira gravida* and *Pyxidicular turris*. Individual freshwater diatom species of the genera *Eunotia, Navicula,* and *Pinnularia* (Fig. 2) were also discovered.

Complex II. Characteristic of the deposits of Bed 2. - The concentration of diatoms is 2-3 million valves per gram of sediment. The complex has a mixed composition and is made up of marine (21%) and freshwater diatoms

(79%). The marine group is dominated by the neritic species *Thalassiosira gravida* (14%) and *Thalassiosira kryophila* (4%), and the sublittoral species *Paralia sulcata* (5%). The freshwater group is dominated by *Eunotia praeruptavar. bidens* (10%), *E. praeruptavar. musciocola* (4%), *E. Trodon* (15%), *Pinnularia lata* (16%), and *P. viridis* (12%).

Complex III. From Bed 3. - The diatom concentration is 5-7 million valves per gram of sediment. This complex contains almost no marine diatoms (1.7%). Of the freshwater diatoms the predominant species are the benthics *Pinnularia viridis* (up to 16.8%), *P. Lata* (up to 26.6%), *Navicula amphibola* (up to 14.6%), *N. Crucicula* (up to 26.2%), *E. Praeruptavar. muscicola* (up to 16%), *E. Valida* (up to 3.9%), and *Cymbella hybrida* (up to 4.3%).

Complex IV. From sample P2/93-5 from the peat layer. The diatom concentration is 3-4 million valves per gram of sediment. This complex contains no marine diatoms. The freshwater group of diatoms is dominated by *Eunotia triodon* (32.5%), *E. papilio* (9.1%), *E. monodon* (2.6%), *E. valida* (28.5%), *E. fallaz* (7.8%), *Pinnularia viridis* (5.2%), and *P. microstauron* (6.5%).

Complex V. Characteristic of the loam layer (Fig. 2). The diatom concentration is 3-4 million valves per gram of sediment. Marine diatoms make up the fundamental ecological composition of the complex (91.7%). The dominant species in the complex are the sublittoral *Paralia sulcata* (60.4%) and *Navicula marina* (10.4%), the neritic *Thalassiosira gravida* (10.4%), and the oceanic *Cosinodiscus marginatus* (6.2%).

BIOSTRATIGRAPHY AND PALEOGEOGRAPHY

There is very little information about Complex I because of the scarcity of diatom finds. It may only be assumed that Bed 1 formed in the wave-cut zone of the sea. The absence of diatoms suggests that those having smaller dimensions were washed away during sedimentation of the coarse- to medium-grained sand.

An analysis of the ecological structure of Complexes II and III shows that the quantity of marine diatoms falls from 21% (Bed 2) to 1.7% (Bed 3). The dominance in the marine group of sublittoral-neritic diatoms species attests to the nearshore shelf genesis of the sediments. The river influx of a terrigenous component played an important role in the formation of the sediments. The marine diatoms fall into a group of northern-boreal species and area a characteristic element of the Bering Sea provincial flora in the shallow-water zone of the shelf. The absence of arctic-boreal elements (*Bacterosira fragilis, Thalassiosira nordenshkedoldii, Achnanthese taeniata*), which are a component of the flora of the Bering and Chichi Seas, attests to the fact that the average annual temperature of the water surface layer was slightly higher than today's. The general ocean circulation and seasonal fluctuations in salinity were close to today's. Apparently, the formation of Beds 2-4 occurred at a time of abatement of the first phase of transgression, which we correlate to phase 5e of the oxygen isotope scale of Shackleton and Opdyke.

Undoubtedly, the formation of the peat bog was connected with a brief regression of the sea and cooling of the climate. Attesting to this is the short-term dominance of the cold water flora *Eunotia (E. valida, E. triodon, E. papilio)*, characteristic of transpolar tundra bogs. Modern bog flora in the vicinity of the village of Nome are made up of more temperate representatives of the genus *Eunotia (E. Monodon, E. lunaris, E. praerupta)*. We tie the formation of the peat bog with the cold regressive phase 5d.

Complex V, consisting of up to 91.7% marine diatoms, undoubtedly reflects transgressive conditions. This is the second phase of early Pleistocene transgression, which we correlate to stage 5c. Playing an important role in the structure of the complex is the oceanic *Coscinodiscus marginatus*, whose modern natural boundaries encompass the open expanses of the Pacific Ocean south of 60° north latitude at normal oceanic salinity of 33.5%.

Not less important is the discovery of *Navicula marina* - a south-boreal species, characteristic of open shallow water expanses of the shelf. In modern times the natural habitat of the population of *Navicula marina* encompasses the southern regions of the Kamchatka shelf, the southwestern shelf of the Sea of Okhotsk, and the shelf of the Sea of Japan. Therefore, the mean annual temperatures of the Nome area were at least 2-3°C warmer than those of today. It is precisely that fact which is a basis to connect the formation of Bed 6 with the transgressive phase 5c.

We may conclude that the formation of Bed 5 was tied to the Simpsonian transgression, but the sediments, which were formed at the time of that cycle have a glaciomarine origin (Carter et al., 1986, 1988), while the climatic conditions were close to modern. However, the allegation of similarity does not agree with analysis of the diatom flora.

Throughout all the samples where diatom flora were discovered, one of the most dominant is the sublittoral *Paralia sulcata* (Fig. 2). This species is characteristic of the sandy zone of shallow shelf with a depth of about 20 m. constituting for it an optimal ecological niche. The sediments of Beds 2 and 6 were formed exactly at these depths, and Bed 5 formed during regressive phase 5d, when sea level was lowered not less than 20 m lower than today's. Subsequently, the beds with marine diatom flora were raised by tectonic uplift to an elevation of up to 25 m above sea level.

SUMMARY

The formation in one section of two beds with marine diatoms, relating to the phases 5e and 5c, permit the conclusion that the Pelukian transgression may scarcely be correlated only with phase 5e. The stratigraphic volume of the Sangamon and Pelukian beds, in all certainly, must coincide, because they reflect the same paleoclimatic rhythms, characteristic of an interglacial epoch. The age interval of the Pelukian transgression encompasses the period between 125-95 ka. In this version, the boundary between the Sangamon and Wisconsinan is at 95 ka.

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