

NEW DATA ON QUATERNARY STRATIGRAPHY OF THE KOZ'MINO BAY SHELF SEDIMENTS

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The sediments 33-meters thickness were found as a result of drilling of borehole “104”, made at the shelf of Koz'mino Bay 400-meters way from the shore on the depth of 5.3 m (Figure).

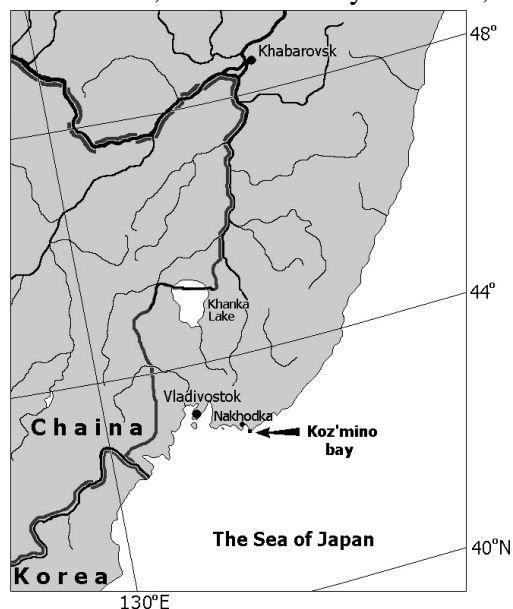
The upper part of the 5.1-meters section is represented by coarse marine sediments: pebbles, coarse sand, contained many sea-shells. The middle part of section, ranging between 5.1 and 19.1 m, was formed by interlaid, badly sorted diluvial and alluvial sediments: greenish-grey and brownish-yellow loams, clay sand, gravel and pebble, debris and pebble sediment.

The bottom 12.1-meters thickness layer, ranging between 19.1 and 31.2 m, includes firm clays, decayed mudstones of black and grayish-green color, enriched by organic.

Clays and mudstones of the upper part of the section are accumulated in mort-lake that is proved by diatom complex (19.2–19.6 m). There are different dominated epiphyte and bentic species of diatoms: *Eunotia* (*E. veneris*, *E. formica*, *E. praerupta*), *Pinnularia* (*P. brevicostata*, *P. hemiptera*), *Stauroneis* (*S. phoenicenteron*), *Tetracyclus emarginatus*, rare bentic-planktic and planktic forms *Tabellaria flocculosa*, *Aulacosira granulata*, *Cyclotella meneghiniana*. The upper layer of clays and loams is also accumulated in shallow fresh lake. It is shown in complexes of bentic and

epiphyte diatoms *Epithemia turgida* (31.4 %), *E. sorex*, *Gyrosigma* sp. (37.2 %), *Cymbella turgida* (3.5 %), *Rhopalodia gibba* (3.5 %), *Caloneis silicula*, *Gomphonema acuminatum*, *Stauroneis anceps*, *Fragilaria construens*, *Cocconeis placentula*, *Tabellaria fenestrata*.

At a depth of 26–28.1 m (possibly up to 31.2 m) fresh water genesis of sediments is changed to lagoon. Diatom complexes include not only fresh water species (*Fragilaria construens* – 20.8 %, *F. pinnata* – 13.1 %, *Cocconeis placentula* – 10.1 %, *Navicula lacustris* – 5.5 %, *Diatoma hiemale* – 3.0 %, *Cyclotella meneghiniana* – 2.5 %, *Rhoicosphenia curvata* – 1.5 %, *Cymbella turgida* – 0.5 %), but also bentic mezohalobes and brackish species (*Rhopalodia musculus* – 6.1 %, *Diploneis smithii* – 1 %, *Coconeis scutellum* – 2.0 %, *Nitzschia tryblionella* – 1.1 %, *Achnanthes brevipes*, *Mastogloia elliptica*, *Campylodiscus echenensis*, *Caloneis permagna*), planktic marine forms (*Chaetoceros* sp. – 24.2 %, *Hyalodiscus* aff. *radiatus*, *Thalassiosira bramaputrae*). Clay bed is underlayed at a depth of 31.2–33.2 m by lacustrine loams and gray clay sands, contained debris, small coarse pebbles, basalt gravels, dacites, green-stone rocks.



During the research 16 samples were studied by pollen method ranging between 12.8 and 32.6 m. Eleven of them are saturated by palynological spectrum.

The spore and pollen spectra at a depth of 29.6–29.7 m is characterized by predominance of small-leaved and broad-leaved plants: *Betula* (28.0 %), *Quercus* (18.2 %), *Ulmus* (18.9 %), rare *Corylus* (8.3 %), *Carpinus* (4.9 %), *Tilia*, *Syringa*, *Fraxinus*, *Aralia*, *Juglans*. There are pollens of conifers *Pinus* s/g Haploxyton (5.7 %), *Pinus* s/g Diploxyton (3.8 %), rare *Larix*, Cupressaceae, exotic species for Primorye *Tsuga* and Taxodiaceae.

Dominating pollens among herbaceous are pollens of *Artemisia* (62.9 %). In smaller amounts or single are Gramineae, Cyperaceae, Chenopodiaceae, Rosaceae, Ericales, Compositae, *Thalictrum*. The spore group, viz *Sphagnum*, Polypodiaceae and *Osmunda* was found in this complex.

The second spore and pollen spectra is located at a depth of 28.0–28.1 m. In comparison with the first spectrum amount of conifer pollen is increased: *Picea* sect. *Omorica* (29.1 %), *Abies* (7.1 %), *Pinus* s/g Haploxyton (7.4 %), *Pinus* s/g Diploxyton (9.5%), *Larix*, Cupressaceae, *Tsuga* (11.9 %), Taxodiaceae (2.1 %). Pollens of broad-leaved trees are following: *Quercus* (7.4 %), *Ulmus* (4.4 %), *Carpinus* (2.4 %), *Corylus* (2.4 %), exotic species for Primorye – *Zelkova*, *Fagus*. Small-leaved species are presented by *Betula* (specimen of arborous are 9.8 %), *Salix* and *Alnus*. Pollens of herbaceous and spore group are not numerous.

Time of lagoonal sediments accumulation might be correlated with the warm period of Eopleistocene or, not excepting, Early Pleistocene due to the presence of exotic pollens of *Tsuga* and Taxodiaceae in the first and second spore and pollen spectra, located at the bottom of clay layer ranging between 28–29.7 m. High level of clay sediments lithification that is presented in decayed argillites and siltstones points at the Eopleistocene. Japan sea-level was about –41–43 m.

The third spore and pollen spectra were found at a depth of 26.1 m. It is characterized by sharp decrease and change of species. Pollens of frigid bushes, presented by *Alnaster* (44.2 %), and small-leaves trees as *Alnus* (19.5 %), *Betula* (15.9 %) and *Salix* (3.5 %) are dominating. Pollens of *Ulmus* (2.2%) are only one among broad-leaved species. Amount of coniferous pollens is also decreased: *Picea* sect. *Omorica* (10.6 %), *Picea* sect. *Eupicea* (2.2 %). *Pinus* s/g Diploxyton, *Pinus* s/g Haploxyton are single. Percentage of herbaceous pollens is increased up to 45.4 % with domination of *Myriophyllum* (45.3 %) and *Artemisia* (28.7 %). Gramineae, Cyperaceae, Scrophulariaceae, Ericales, Chenopodiaceae (7.5 %), Rosaceae, Ranunculaceae, *Thalictrum*, *Sanguisorba*, Umbelliferae, Compositae are subordinated. Polypodiaceae (57.6 %) and *Sphagnum* (28.3 %) are dominated among the spore species. Botrychium, Bryales (13.0 %) are also presented in this spectrum. The third pollen spectrum, characterized by domination of alder pollens and almost absence pollen of broad-leaved trees, are correlated with colder conditions and aridity of climate during the lacustrine sediments accumulation at a depth of 26.1 m (possibly, ranging up to 24 m). It might be corresponded to the second – cold – period of Pleistocene – “Rudnevskiy” glacial horizon of Quaternary sediments Scheme of Primorye (Korotky et al., 1980, Golubeva, Karaulova, 1983; Climatic..., 1996).

The spore and pollen complex, ranging between 20.9–23.9 m, was found in lacustrine sediments. It is characterized by domination of broad-leaved and small-leaved pollens. Broad-leaved species are following: *Ulmus* (up to 27.9 %), *Quercus* (up to 10.5 %), *Carpinus* (up to 10.2 %), in less amounts *Juglans*, *Corylus*, *Aralia*, *Syringa*, *Tilia*, *Fraxinus*, *Fagus*. Small-leaved spectrum is formed by *Betula* sect. *Albae* up to 27.9 %, *Alnus* and *Salix*. Among the coniferous

species dominators are *Pinus* s/g Haploxyton (up to 14.3 %); less *Picea* sect. *Omorica* (up to 5.9 %), *Pinus* s/g Diploxyton (up to 8.2 %), *Abies* (up to 2 %), *Larix* (up to 5.7 %), *Tsuga*, Cupressaceae, Taxodiaceae. *Artemisia* is still dominated among the herbaceous. It is suggested that sediments accumulation was during warming period due to the prevailing of broad-leaved forms. Perhaps, it might be correlated with warm period of middle Pleistocene, the beginning of this period – “Khankaiskiy” interglacial horizon of Quaternary sediments Scheme of Primorye (Korotky et al., 1980, Golubeva, Karaulova, 1983; Climatic..., 1996).

The spore and pollen complex of the upper horizon of clay layer (interval 19.2–19.6 m) is characterized by decreasing diversity of broad-leaved species and their pollens: *Corylus* (9.8 %), *Ulmus* (4.3 %); *Quercus*, *Carpinus*, *Tilia* are single. *Betula* pollens are dominated among others (generally *Betula* sect. *Albae* – 21.3 %), *Alnus* (17.4 %), *Picea* sect. *Omorica* (13.1 %). Pollens of *Larix* (5.9 %), *Abies* (3.6 %), *Pinus* s/g Haploxyton (5.2 %), *Picea* sect. *Eupicea*, *Pinus* s/g Diploxyton, exotic *Tsuga* are subordinated. *Artemisia* (53.7 %) and Cyperaceae (22.5 %) are dominated herbaceous pollens. Peculiarity of herbaceous complex is occurrence of aquatic species pollens such as *Trapa*, *Nuphar*, *Nymphaeae*. Polypodiaceae (96.2 %) was found among the spore group, rare *Sphagnum*. Spectrum corresponds to the beginning of glacial period of first part of Middle Pleistocene – “Shmakovski” glacial horizon of Quaternary sediments Scheme of Primorye (Korotky et al., 1980; Golubeva, Karaulova, 1983; Climatic..., 1996).

The spore and pollen complex is located in lowest alluvial sediments of middle layer (interval 14.6–16.2 m). This spectrum is differ from previous by its structure. Thus, amount of conifers pollens are larger due to pollens of Cupressaceae (up to 48.1 %). Taxonomic structure of the rest conifers is the same. Broad-leaved species are presented by *Ulmus* (20.4–49.5 %), less percentage of *Juglans*, *Tilia*, *Fraxinus*, *Quercus*, *Corylus*, *Carpinus*, *Phellodendron*, *Acer*, *Fagus*, *Aesculus* and *Myrica*. Pollen of *Betula* (up to 16.2 %), *Alnus* and *Salix* are belonged to the small-leaved group. Generally, this complex is corresponded to the valley flora, which was flourished at the beginning of warm period in the second half Middle Pleistocene – “Sungachskiy” horizon of Quaternary sediments Scheme of Primorye (Korotky et al., 1980, Golubeva, Karaulova, 1983; Climate..., 1996).

References

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