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About Gelasian Tier Stage Within Middle Volga Region (According To Palynological Data).

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ABSTRACT

The article presents the results of palynological studies of deposits of Gelasian tier within the Middle Volga region. Palynological study of these deposits has allowed to allocate seven palyno complexes, describing the biostratigraphic boundaries of Gelasian tier within the Middle Volga region.

Keywords: Quaternary system, Gelasian tier, Middle Volga, palynocomplexes, boundaries.

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INTRODUCTION

Currently timeslot of Quaternary system is extended from 1.8 to 2.6 million years. The structure of the system includes Gelasian tier as the lower part of Pleistocene [1, 2]. In this connection, there is a question of the situation of this stage in the stratigraphic scale of Russia, where there is no tiered division. In 2014, the scale has been proposed in which Gelasian tier is assigned to a new section of Pleistocene - paleo Pleistocene. [3].

Within the Middle Volga region Gelasian tier comprises Chistopol, Akkulaev and Biklyan layers. Thus, the lower boundary between the Neogene and Quaternary systems within the study area extends between the regional parts: Sokolsk and Chistopol layers that previously belonged to a single Akchagyl regional tier of the Neogene system. The upper limit of Gelasian tier is between Biklyan and omarskiy layers that form a single complex of deposits, sedimentation of which occurred during the period of regression of Akchagyl pool.

For the first time deposits related to the current Gelasian tier have been described in 50-60 years of XX century by G.I. Goretskiy on the Lower Kama and assigned to Akchagyl formations of Pliocene. [4] Under the guidance of N.V. Kirsanov a regional stratigraphic scale of Pliocene was developed, correlation of deposits of Middle Volga with deposits of the East of European part of Russia [5]. Later this scheme was detailed as a result of research carried out under the direction of E.A. Bludorova. The changes were made in sediment stratigraphy as well, to the one that now belongs to Gelasian tier [6].

Question of vegetation study on the basis of analysis of germ and pollen complexes and dismemberment of sediments of the studied area is discussed in the series of works. At various times, such research was conducted by V.V. Sauer, L.S. Karatkevich [4], T.A. Kuznetsova [7-11], N.Y. and S.V. Katz [12], L.M. Yataykin [13, 14], L.M. Yataykin V.T. Shalandina [15], L.L. Bayguzina [16] E.A. Bludorova, K.V. Nikolaeva [6] L.I. Linkina [17].

In the 2000s, as a result of the state geological survey, a new factual material occurred, later changes in stratigraphy of Neogene and Quaternary periods of the Middle Volga happened.

However, to date there is no single point of view on the palynological study of Chistopol and Biklyan layers, also in key sections, the issue of the relationship between Biklyan and Omarsk deposits in cuts is not fully resolved, which raises the question of the amount and the upper boundary of Gelasian tier within Middle Volga region. [18]

The results of palynological studies of deposits of Gelasian tier within the Middle Volga region (north of the Samara Bend), a comparison of the data with other studies in the region is presented.

MATERIAL AND METHODS

Pollen studies of sediments of Gelasian tier was conducted in 21 wells and two natural outcrops of the village Deukovo and in Biklyan career (Fig. 1). Deposits of Chistopol layers are distributed throughout the studied area, they were revealed in all investigated wells and outcrops. Akkulaev deposits opened only in the well 147, and Biklyan - in holes 85 and 30. The data obtained from these wells and outcrops were compared with the reference sections [19].

According to palynological analysis in the Neogene period (late Miocene - Pliocene) in the territory of the Middle Volga pollen flora was presented with pangolarctic (Picea, Pinus, Abies, Betula, Alnus, Myrica), American-Mediterranean-Asian (Juglans, Ostrya, Rhus, Liquidambar) , the US-Eurasian (Carpinus, Corylus, Quercus, Ulmus, Acer, Tilia, Fraxinus, Ilex, Fagus, Pterocarya), US-East Asian types (Tsuga, Carya, Nyssa, Keteleeria, Sciadopitys), whose representatives continue to exist here and during forming of sediments of Chistopol layers of Gelasian tier in Quaternary period.

But by the end of Chistopol time there is a significant reduction in types of woody plants due to loss of warm-loving forms in flora and by Akkulaev time in the flora are types mostly related to Euro-Asian (pangolarctic) and partly US-Eurasian geographic elements, i.e. the most cold-resistant.

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Changes in quantitative and qualitative composition of obtained palynocomplexes allows to set for tier borders and the borders between the layers. On the basis of palynological sediment analysis of Gelasian tier seven palynocomplexes have been allocated. These palynocomplexes were compared with palynocomplexes established in the previously examined sections in the studied and adjacent territories.

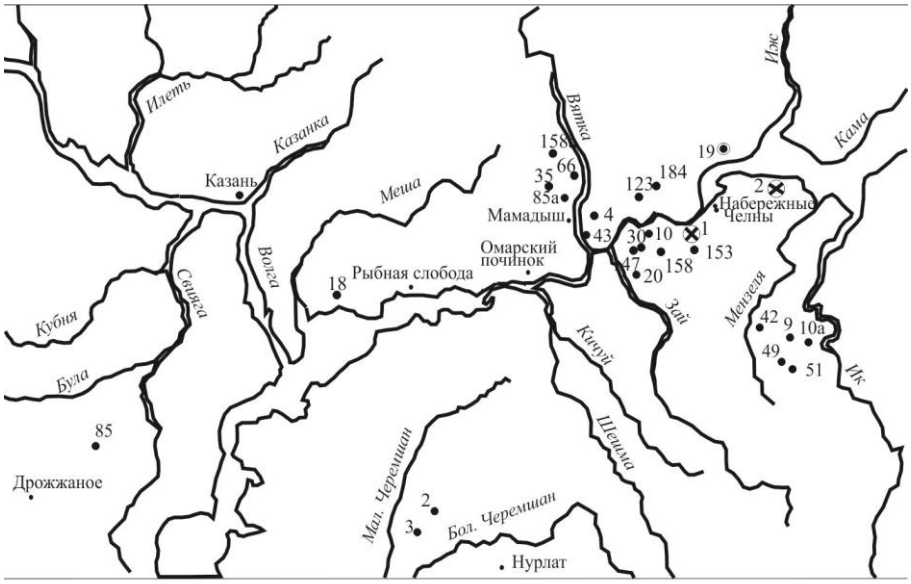

Figure 1. Map of factual material

● - Palynologically characterized sections
✖ - Outcrops: 1 – near Biklyan village
2 – near Deukovo village

THE CHARACTERISTICS OF THE STUDIED DEPOSITS

Within the Middle Volga Chistopol, Akkulaev, Biklyan layers are attributed to Gelasian tier.

Chistopol layers first described as "Chistopol horizon" by G.I. Goretskiy on the Lower Kama near Chistopol [4]. Deposits are represented with gray, dark gray, bluish gray, sometimes grayish-brown, brown, micaceous interbedded with silt and sand and sand gray, brownish-gray clays. Genesis is lake andalluvial and inundable. Absolute marks of the sole of the 20.0 - 25.0 to 100.0 m. The thickness of the deposits varies from 5.7 to 95.0 m.

The deposits contain rich fauna of freshwater ostracods: Cyprides littoralis (Brady), Limnocythere tenuireticulata Suz., L. luculenta Liv., Cypria candonaeformis (Schw.), C.arma Schn., Cytherissa aff. bogatschovi (Liv.), Candoniella albicans (Brady), Ilyocypris bradyi Sars., et al., and in the upper part of sections the role of representatives of brackish water is increasing, as well as molluscs (Valvata piscinalis Műll., V. cristata, V ,. antique Sow. Dithyna tentaculata L. [6].

In the test wells (wells. 9, the interval Sec. 22.4 -52.4 m) L.N. Stepanov defined a rich set of ostracods: Cyprides littoralis (Brady), Limnocythere tenuireticulata Suz., L. luculenta Liv., L. longa Neg, L. flexa Neg., Cypria arma Schn., Cytherissa aff. bogatschovi (Liv.), Candona danataensis Roz., C. fabaeformis (Fisch.), Candoniella subellipsoida (Schar.), C. marcida Schr., Ilyocypris bradyi Sars., I. gibba (Ramd.), Leptocythere nalivkini Step., Candona convexa Liv., C. angulata Műll., C. ivachnencoe Schn. the presence of which indicates the Chistopol age of deposits. V.V. Silantiev in well. 9 (range, Ch. 22,4-52,4 m), 10a (in the range of 35,0-54,2 m) defined shellfish: folding - Dreissena polymorpha (Pallas) and gastropods - Valvata (Cincina) piscinalis (Műll.) , Viviparus cf. viviparus L., Limnea palustris (Műll.).

In the palynological respect these deposits are characterized by frequent changes palynocomplexes noticed by different authors [4, 6, 17].

Chistopol layers are characterized by reverse magnetization and are compared with orthozone r-Matuyama. The boundary between the Sokolsk layers of Pliocene and Chistopol layers of Pleistocene are traced along the border of orthozones n-Gauss and r-Matuyama, the upper limit of Chistopol horizon is compared with the beginning of the reunion episode [6].

Akkulaev layers in rank of horizon are marked by V.L. Yahimovich in the Bashkir Urals [20], and then mapped on the Lower Kama. They are presented by lagoon-sea, mainly clay formations. Power of deposits from 7.5 to 12 m.

Deposits of the horizon are well marked by the presence of marine fauna: bivalves Cerastoderma, Mactra and gastropods Cerithium. Palynologically the horizon is characterized by spruce complex. Deposits are back magnetized and compared with the era Matuyama (episode Reunion) [6].

Biklyan layers for the first time were identified as the horizon by G.I. Goretski in the Lower Kama near village Biklyan and are characterized as precipitation of Akchagyl freshened basin on the stage of regression [4].

In sections the deposits show sandy silt at the bottom, at the top - gray, dark gray and almost black clay. Most of the cuts, especially in the Lower Kama, are composed of dark gray, sometimes black, taupe, brown, silty, thin-interbedded with siltstones clays. The lower parts of sections are sandy – we can see tan, brown, gray, fine-grained, quartz, at the base with a mixture of gravel and pebble material of carbonate rocks sands. In the valleys of rivers Volga and Sviyaga Biklyan deposits are partially blurred, and they are present as separate fields. Basically sands deposits are composed of brownish-gray quartz with streaks of gray clay and sandy gray clay.

Absolute marks of the sole from 72.0 to 181.4 m. The highest levels of occurrence are typical for Eastern Zakamye and Volga region of Republic of Tatarstan. Power of deposits ranges from 3.0 m on the upper edge portions of paleovalleys to 68.0 m in the lower reaches of large paleovalleys.

Fauna of Biklyan deposits is close to Chistopol one. The deposits contain almost the same types of freshwater and brackish-water fauna, but typical marine representatives are completely absent.

The sections provide a set of molluscs: Viviparus sinzovi Pavl., V. turritus Bog., Valvata piscinalis (Műll.), V. cristata Műll., Pisidium amnicum (Műll.), Dreissena polymorpha (Pall.) And ostracods: Candoniella subellipsoida (Schar .), Cyclopris laevis (Műll.), Cypria candonaeformis (Schw.) and others. Biklyan layers are characterized by spruce-pine-grassy palynocomplex with a predominance in the overall composition of subshrubs and grass pollen [4, 6].

In the paleomagnetic relation Biklyan deposits correlate with orthozone of reverse magnetization r-Matuyama from the beginning of straight magnetization of Reunion to the beginning or middle part of the episode Olduvai [17].

BIOSTRATIGRAPHIC BOUNDARIES OF GELASIAN LAYER

Chistopol layers. Power of sediments of Chistopol layers ranges from 3 m in the outcrop at the village Deukovo up to 92 m in the well 3. The absolute level of occurrence of the sole of horizon from 17 m (well 4) to +92 m (well 42), the roof +42 meters (well 43) to 148 m (well 184).

Palynological analysis of Chistopol layers of Gelasian tier showed frequent changes of palynocomplexes, due to changes in climatic conditions. Here five palynocomplexes have been allocated. It is necessary to note that in dedicated palynocomplex the pollen of trees and shrubs content is unstable. Dominance of pollen of wood group (48-98%) is characteristic for bottom layer. In the upper part increase in the pollen content of herbaceous plants is up to 61%. The number of spores varies from 1 to 29%.

The obtained palynocomplexes are compared with palynocomplexes allocated earlier in the Pliocene Chistopol horizon sediments. Deposits of Gelasian tier previously belonged to them.

The first - the spruce-pine palynocomplex is highlighted in gray, grayish-brown, brown and dark brown clay in sections of well 10 in the range of 36-62 m, well 9 in the range of 63,9-78 m, well 85 in the interval 26-55 m, well 3 in the interval 17,6-110 m, well 18 in the interval 38,9-84,5 m (Fig. 2). Among the woody plants in the complex pollen of softwood dominates: Pinus (average 63%) and Picea (average 20%, but in individual specters it is increased to 53%). The content of pollen of small-leaved Betula makes up 26% (sometimes 40-70%), Alnus - up to 8%. The amount of pollen of broadleaf plants (Quercus, Ulmus, Fraxinus, Carpinus, Corylus, less Pterocarya, Tilia, Fagus, Acer), as well as Tsuga and Abies in average does not exceed 6%. In the group of herbaceous plants in the whole complex, noted the predominance of pollen grasses - Fabaceae, Caryophyllaceae, Apiaceae, Rosaceae, Ranunculacea, Brassicacea, etc. - average 50%. Pollen of xerophytes is rarer: Chenopodiaceae (average 15%) and Artemisia (average 10%). In some samples, the high content of pollen Ericales is found (up 31%), which is apparently due to the waterlogging area because together with an increase in pollen of ericales high levels of spores of sphagnum moss are observed (77%).

The resulting spruce-pine palynocomplex resembles IV - pine palynocomplex of V.V. Sauer, L.S. Karatkevich and VI - pine palynocomplex of E.A. Bludorova and K.V. Nikolaeva. Despite the undeniable similarity of palynocomplexes there is a difference, which manifests itself in a slightly higher content of spruce pollen.

Second - pine-fir palynocomplex is highlighted in gray-brown, dark gray clay in sections of well 10a in the range of 42,3-54 m; well 51 in the range 34,8-65,9 m; well 18 in the range of 36,9-38,9 m (Fig. 2); well 4 in the range of 40,5-72 m; well 147 in the range of 28-80 m (Fig. 3); well 158 in the range of 40-46 m; well 2 in the range of 41,8-44,2 m; well 30 in the range of 72-91 m (Fig. 4); well 158a in the range of 84,1-103,9 m, as well as in the interior of interbedded, brown, gray-brown and sand gray and grayish-brown clays in sections of well 43 in the range of 11,9-43,5 m; well 49 in the range of 21,2-69,6 m; well 42 in the range of 9,9-56 m; well 35 in the range of 35,5-40,8 m; well 123 in the range of 34,5-102 m; well 184 in the range of 20-80 m; well 153 in the range of 8-55 m. Picea pollen dominates the palynocomplex (average 70%) and the content of pollen Pinus is being reduced on average to 14%. Less of Abies pollen (up to 15%) and Tsuga, Betula Alnus do not exceed 7%. The average content of the pollen of broad-leaved trees 5%, but in some specters it reaches - 11-14% (mostly Tilia, Quercus, Carpinus, Corylus) Rarely pollen was identified Ulmus, Nyssa, Juglans, Carya, Fagus, Acer, Pterocarya. The group of herbaceous plants is dominated either by pollen grasses (Fabaceae, Caryophyllaceae, Apiaceae, Rosaceae) - 60%, or xerophytes: Chenopodiaceae (57%), Artemisia (21%) or Ericales (23%). In a smaller number pollen of Poaceae and Cyperaceae is found, and very rarely – Ephedra. In the group of spore-bearing plants in the palynocomplex it is difficult to identify a dominant, as in different wells germs of mosses dominate: Sphagnum or Bryales, or ferns Polypodiidae subclass.

The closest in composition to this palynocomplex are V - pine-fir palynocomplex of V.V. Sauer, L.S. Karatkevich and VII - pine-broadleaved-fir palynocomplex of E.A. Bludorova and K.V. Nikolaeva. It should be noted that the role of pollen of broadleaf species both in palynocomplex of V.V. Sauer, L.S. Karatkevich and in the palynocomplex determined by us is not as noticeable as indicated for palynocomplex received by E.A. Bludorova and K.V. Nikolaeva.

Third - spruce-pine palynocomplex is found in light and dark brown clays in sections of wells 51 In the range of 25,3-34,8 m; well 158 In the range of 32-40 m; and well 20 in the range of 58-70 m and also in the thick of interbedding of gray-brown sand, brown-gray clay and gray-brown loam in section of well 35 In the range of 25,5-35,5 m. Pollen Pinus (average 50%) and somewhat less Picea (21%) are prevalent in palynocomplex. One can meet pollen Tsuga, Abies, Keteleeria, Betula, Alnus of broadleaf species (Ulmus, Tilia, Pterocarya, Acer, Nyssa, Corylus) up to 5%. Among herbaceous plants in the whole complex xerophytes pollen (Chenopodiaceae and Artemisia) and a group of herbs prevail. High levels of Ericales pollen in the individual specters likely reflects waterlogging of territory, which also is indicated by an increase in spores of sphagnum moss. In much smaller quantities fern spores of subclass Polypodiidae and green moss are found.

This palynocomplex is comparable to two palynocomplexes allocated earlier this VI - spruce-pine palynocomplex of V.V. Sauer, L.S. Karatkevich and IX - pine palynocomplex of E.A. Bludorova and K.V. Nikolaeva, which, however, differs from the latter with slightly larger spruce pollen content, and accordingly, the smaller pine.

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Fourth - broad-pine-fir palynocomplex is identified in the thick of alternation of dark gray and gray-brown clays and gray sands in sections of well 10a in the range of 25,7-42,3 m; well 9 In the range of 24,7-63,9 m; well 35 In the range of 19,7-25,5 m; well 158a In the range of 70,6-84,1 m, and also in gray and dark gray clays in section of well 30 in the range of 35-72 m (Fig. 4); well 2 In the range of 40,8-41,8 m and well 20 in the range of 33-45 m.

The complex is characterized by the predominance of pollen Picea (average 56%), Pinus (average 18%), and broadleaf species on average up to 26% (up to a maximum increase of 58%). Prevalent in this group is Tilia pollen (to 58%), Quercus (26%), Ulmus (12%) and Corylus (6%). Small amounts of pollen Juglans, Carpinus, Pterocarya, Fagus, Acer, Fraxinus, Nyssa, Ostrya are found. In the group of herbaceous plants the role of xerophytes strengthens: Artemisia (average 36%), Chenopodiaceae (average 23%), the pollen Ephedra (up to 2%) in the individual specters there is a lot of pollen Poaceae (22%) and Cyperaceae (up to 16%). Among spore plants green mosses and ferns of Polypodiidae division prevail.

This palynocomplex is confidently compared with VII - broad-pine-fir palynocomplex identified by V.V. Sauer, L.S. Karatkevich.

Fifth - pine-fir palynocomplex identified in dark gray, gray-brown clays with streaks of sand and yellowish brown loams in sections of well 10a in the range of 7-25,7 m; well 9 In the range of 10,2-24,7 m; well 51 In the range of 2-25,3 m; well 2 In the range of 22-40,8 m; well 158a In the range of 36,2-70,1 m; well 20 in the range of 20-33 m and prom. Deukovo in the range of 9-12,25 m; prom. Biklyan in the range of 2,3-8,9 m. Palynocomplex is characterized by the dominance of pine pollen: Picea (average 67%) and Pinus (average 19%). The average content of the pollen Abies, Betula, Alnus, Tsuga and broad-leaved trees - 7%, the latter is represented mainly by pollen Tilia, Quercus and Corylus. Less common pollen is Ulmus, Carpinus, Nyssa, Pterocarya. Among herbaceous plants wild grasses are predominant, among which mainly pollen families Fabaceae, Caryophyllaceae, Apiaceae, Rosaceae, Asteraceae (average 45%) are found. Also there is a lot of xerophytes pollen: Chenopodiaceae and Artemisia (average to 28%) and Ericales (average 27%). In the group of spore-bearing plants germs of moss dominate:

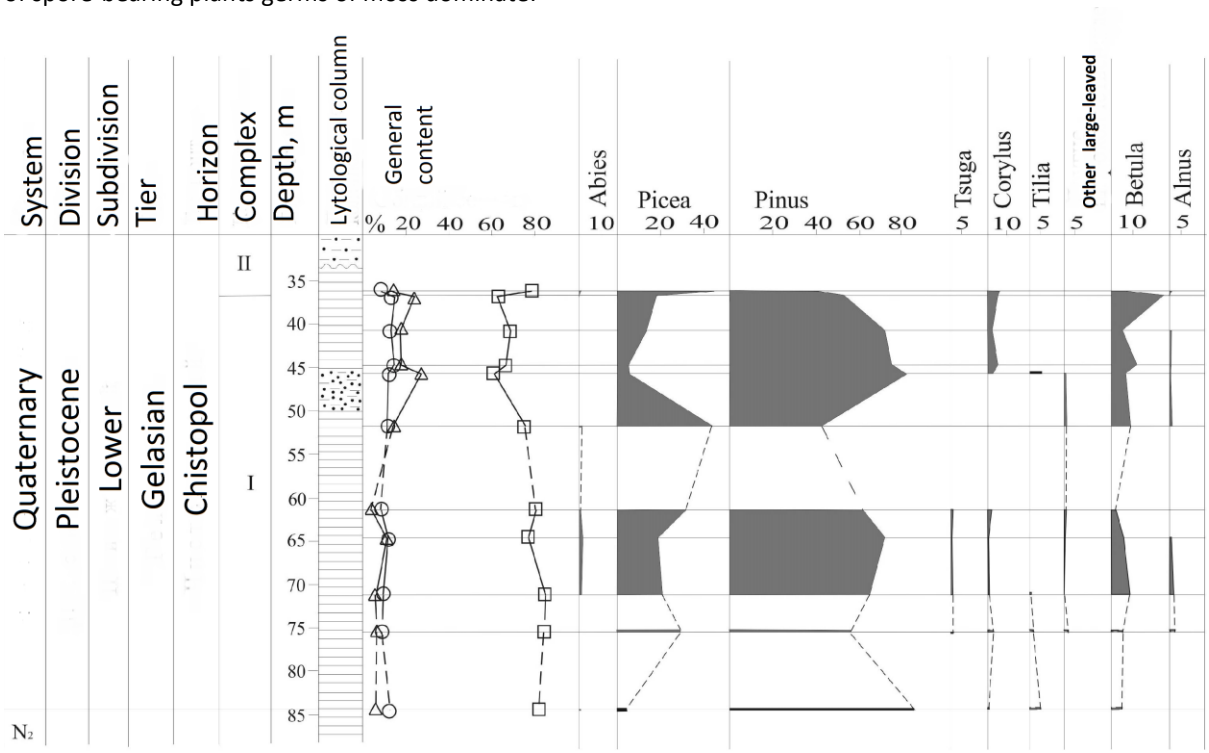

Figure 2: Germ and pollen diagram of deposits of Gelasian tier of open well 18 near village Sr. Devyatkovo

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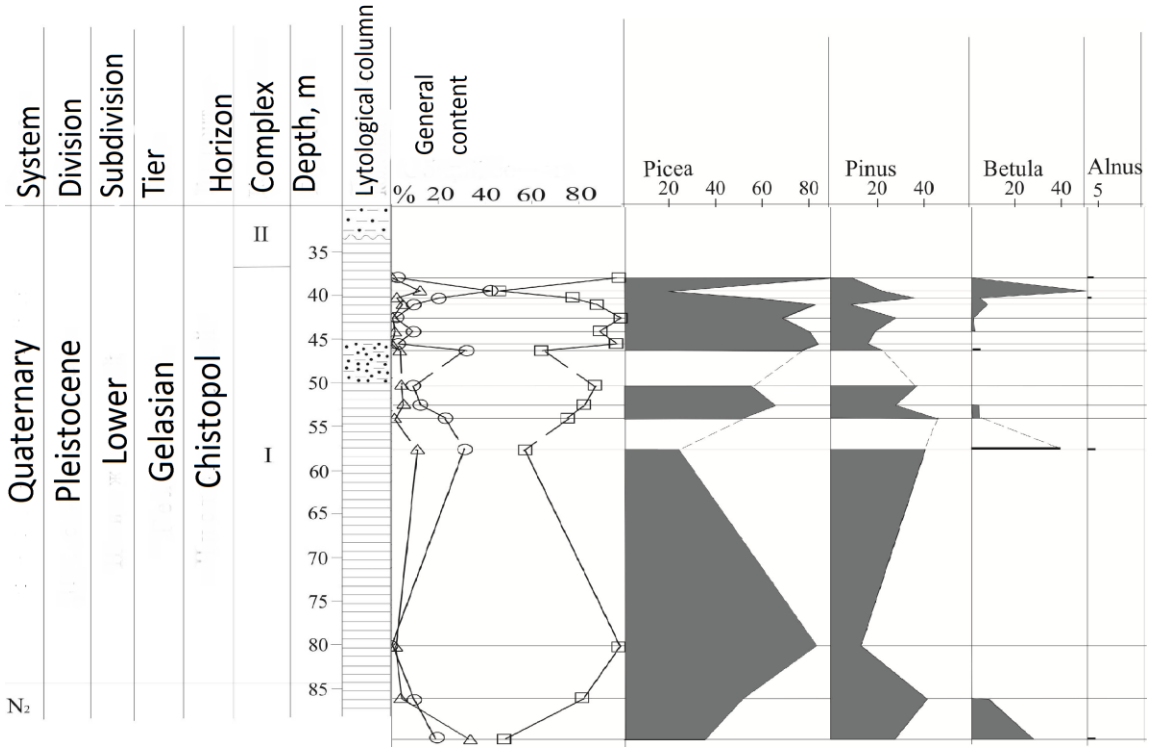

Figure 3: Germ and pollen diagram of sediments of Gelasian tier of opened wells 147 near village Nizhnee Afanasovo.

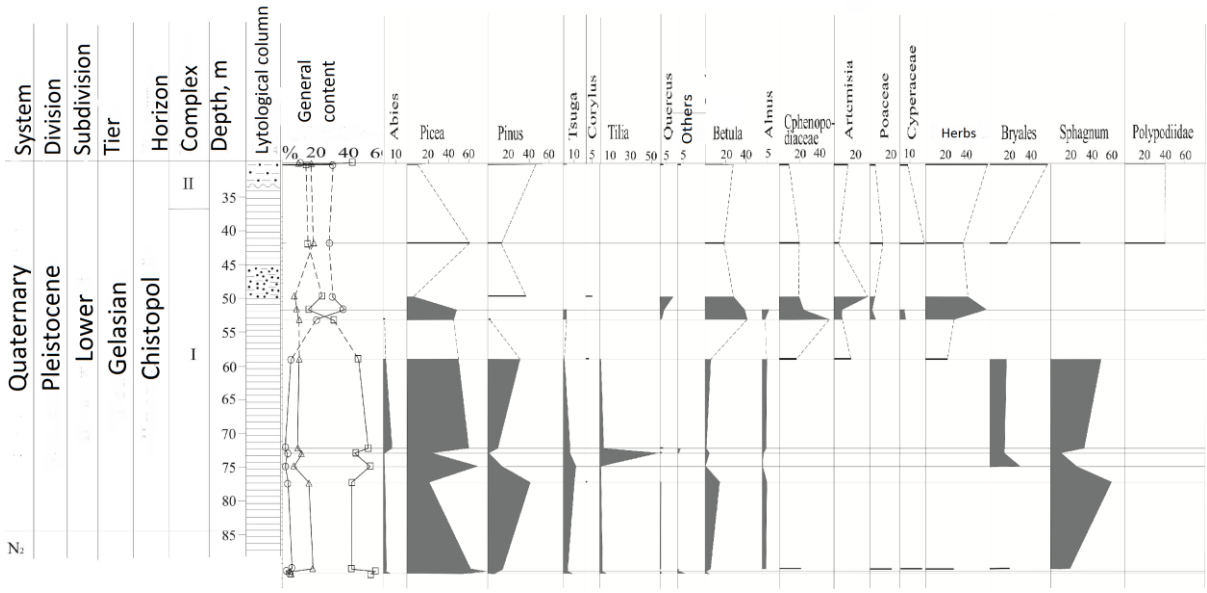

Figure 4: Germ and pollen diagram of deposits of Gelasian tier of open well 30 near village Novoe Afanasovo.

Sphagnum and Bryales, ferns occupied the second position from the subclass Polypodiidae.

The closest in composition to V - pine-fir palynocomplex is XI - fir palynocomplex allocated by E.A. Bludorova and K.V. Nikolaeva, although it differs from it with somewhat higher content of pine pollen.

Akkulaevlayers of sediment are revealed in the section of well 147. The thickness of the layer is 13 m. The sole of layer is located at the absiolute altitude of 120 m, and roof +133 m. The deposits are presented by alternation of clays, mostly brown and gray-brown and reddish-brown and gray-brown loams.

These deposits are characterized by the ***sixth - fir palynocomplex*** that is identified in the thick of clays alternation mainly brown and grayish-brown and reddish-brown and gray-brown loams in the section of well 147 In the range of 15-28 m (Fig. 3) as a part of which pollen of woody plants dominates (65-97%). The content of grass and subshrubs pollen ranges from 2 to 32%, germs - from 1 to 14%. Among the arboreal plants pollen Picea dominates (average 78%) and a small amount of Pinus (average 18%) and Betula (7%). Rarely pollen Alnus, Tilia, Corylus and Ulmus is found. In the group of herbaceous plants there is more pollen of wild grasses: Asteraceae, Caryophullaceae, Apiaceae and others. Spore plants are represented by mosses: Bryales and Sphagnum.

The resulting palynocomplex is well comparable to the VIII - spruce palynocomplex isolated by V.V. Sauer, L.S. Karatkevich and XII - spruce palynocomplex by E.A. Bludorova and K.V. Nikolaeva. Deposits of Akkulaev layers are well marked by the presence of marine fauna. These deposits are back magnetized and compared with the era Matuyama (episode Reunion) and correspond to akkulaevskim layers of the Cis-Ural region [21].

Biklyan layers. Palynologically Biklyan sediment layers were studied in sections of two wells - 85 and 30. The deposits are represented by gray and brownish-gray clays. Power of deposits ranges from 2.5 m (well 85) to 17 m (well 30, Fig. 4). Absolute marks of the sole occurrence varies from +76 m (well 85) to +97 m (well 30), and, accordingly, of the roof - from 78 m to 114 m.

Biklyan layers are characterized by the ***seventh - spruce-pine-grassy palynocomplex*** isolated in a layer of gray and brownish-gray clays in sections of well 85 In the range of 23-25,5 m and well 30 In the range of 18-35 m. Palynocomplex is featured by the prevalence in the general composition of pollen of grass and subshrubs (33-79%). Pollen of wood makes up 15-51%, and the content of germs ranges from 7 to 29%.

Herbaceous plants in palynocomplex are presented by pollen Chenopodiaceae (average 32%), Artemisia (average 26%), Poaceae and Cyperaceae (average 13%), herbs (Fabaceae, Rosaceae, Asteraceae, Caryophyllaceae, Apiaceae and others.) - an average of 31%. The arboreal pollen are dominated by coniferous plants: Picea (average 30%) and Pinus (average 34%). The contents of Betula pollen is an average of 19%. Among other plants of woody group pollen Quercus, Tilia, Carpinus, Ulmus, Corylus, Alnus, Salix, Abies and Tsuga can be found. In the group of spore-bearing plants germs of Bryales prevail.

The received palynocomplex differs in prevalence of pollen of subshrubs and grass, and it is well comparable to VIIIa - grass-pine-birch palynocomplex isolated by V.V. Sauer, L.S. Karatkevich and XIV - spruce, pine and birch palynocomplex of E.A. Bludorova and K.V. Nikolaeva.

SUMMARY

Thus, the boundaries of Gelasian tier within the Middle Volga are quite reliably installed according to the change of palynocomplexes. The lower limit of Gelasian tier is fixed according to the change of pine-fir palynocomplex - established for sediments of Sokolsk horizon of Pliocene - the spruce-pine [17]. At the end of the Pliocene (Sokolsk time) moderately warm and humid conditions established in the territory. Pine and spruce forests dominated. At the beginning of Chistopol time weather becomes drier, pine forests continue to exist, but pine becomes the dominant breed in them [22].

Intra-tier border between Chistopol and Akkulaev layers is well marked by lagoon-marine formations with marine fauna. Palynological boundary is set by the change of pine-fir palynocomplex with spruce one. In Akkulaev time in the Middle Volga region maximum development of Akchagyl transgression is observed, that reflected on the change in climatic conditions, which reflects spruce palynocomplex. It was a time of maximum spread on the territory of the dark coniferous spruce taiga. By this time, the most heat-loving forms drop from flora. These forms are related to pangolarctic (Myrica), the American-Eurasian (Fraxinus, Ilex, Fagus, Pterocarya, Acer), American-Mediterranean-Asian (Juglans, Ostrya, Rhus, Liquidambar) and American - East Asian (Carya, Nyssa, Keteleeria, Sciadopitys) geographical elements. As a result, the most cold-resistant genes

remain. They belong to the Euro-Asian (pangolarctic) and partly American-Eurasian geographic elements. The climatic conditions at the time were wet and cool enough.

Deposits of Gelasian tier are crowned by Biklyan layers that on the territory of the Middle Volga region are characterized by the spruce-pine-grassy palynocomplex with a predominance in the overall composition of pollen of subshrubs and grass. Here the replacement of dark coniferous taiga with spruce-pine woodlands happens. Open spaces were occupied by sagebrush and mixed grass haze associations. At this time, waters of Akchagyl transgression retreat to the south, the temperature pattern is reduced, and the flow of humid mass from the Atlantic is reduced and becomes dry enough that is reflected in the composition of the selected palynocomplex.

At present, in the territory of the Middle Volga region upper boundary of Gelasian tier is drawn between Biklyan and Omar layers, but the issue of the relationship between Biklyan and Omarska deposits in sections is still not fully resolved [18]. In Omar layers L.S. Karatkevich, V.V. Sauer [6], and N.Ya. Kats S.V. Kats [12] identify broad-pine-fir complex, characterized by a predominance of pollen spruce among woody plants (66%). Content of pine pollen (23%), hemlock (up 25%) and broad-leaved trees (oak, linden, hornbeam, maple, hazel, elm and others is somewhat smaller - about 21%). According to the authors, Omar complex was formed in a relatively warm and humid climate. Thus, the boundary between Biklyan and Omar horizons (layers) is fixed by change of the cold dry palynocomplex with warm and humid one.

CONCLUSION

Conducted palynological analysis of sediments of Gelasian tier, as well as a compilation of previous research allowed to justify indication of the lower and upper border of tier and the boundaries between layers within tier. Lower-tier border runs along the change of pine-fir palynocomplex (Sokolsk layers of Pliocene) - spruce-pine (Chistopol layers of Gelasian tier of Pleistocene). Intra-tier borders between the layers are as well palynologically characterized. The border between Chistopol and Akkulaev layers is drawn along the pine-fir palynocomplex change with the spruce one, which higher in the section is replaced by spruce-pine-grassy palynocomplex that characterizes deposits of Biklyan layers. The upper limit of Gelasian tier is drawn along the change of spruce-pine-herbaceous (cold and dry) with broad-pine-fir (warm and wet) palynocomplex.

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