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Palynostratigraphy of Upper Cretaceous and boundary Paleogene deposits in West Siberian Plain

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Abstract: The article presents the results of many years of studies of the Upper Cretaceous and Paleogene sediments in the territory of West Siberian Plain. The heterogeneous structure of these sediments in different regions of the plain is shown. The lithological and palynological characteristics of a number of studied wells drilled in different years in Omsk and Kulunda Depressions, in Baraba Lowland and Bakchar Basin are given. The obtained palynological data allowed to substantiate the age of the deposits and to make suggestions concerning their depositional environment, and to clarify the subdivision of geological section into formations. The sections of the Upper Cretaceous and Paleogene deposits in different lithofacial regions of the Western Siberia differ from each other in completeness, genesis, and paleontological characteristics. The Upper Cretaceous sediments in Western Siberia are represented by formations of both marine (Pokur, Kuznetzovo, Ipatovo, Slavgorod and Gan'kino Formations) and continental genesis (Lenkovo and Sym formations). The Paleogene sediments, with the exception of Oligocene, mostly have a marine genesis-these are Talitsa-, Marsyat-, Lulinvor-, Tavda- and Yurki formations, but there are also continental sediments (Ostrovnoje Formation). A large stratigraphic break in the Upper Cretaceous and Paleogene boundary deposits, covering a significant part of the Maastrichtian, Paleocene, Ypresian, and Lutetian stages of the Eocene, was established in the sourheast of the West Siberian Plain (Bakchar Basin, Baraba Lowland and Kulunda Depression). The most complete sections are located in the Omsk Depression, where the Upper Cretaceous Gan'kino Formation is covered by Talitsa and Lulinvor Formations of Paleogene age. The most important events occurring at the boundary of the Cretaceous and Paleogene in Western Siberia can be traced currently in a few sections located in the Trans-Ural area, since there was no sedimentation in the rest of the territory at that time.

Keywords: palynostratigraphy; Upper Cretaceous; Paleogene; boundary; deposits; West Siberian Plain

0 Introduction

Western Siberia is one of the largest sediment accumulation basins in the world. Here many deposits are associated to the Cretaceous and Paleogene sediments. The study of its stratigraphy and the development of a detailed biostratigraphic basis for this region are an important scientific task. The biota changes at the boundary of geological systems always attract a special attention of scientists. Cretaceous and Paleogene sediments are available for study only in the core of boreholes in Western Siberia, so, information on each section is of great value for researchers. The sections of the Upper Cretaceous and Paleogene deposits in different lithofacial regions of the Western Siberia differ from each other in completeness, genesis, and paleontological characteristics. The Upper Cretaceous sediments in Western Siberia are represented by formations of both marine (Pokur, Kuznetzovo, Ipatovo, Slavgorod and Gan'kino Formations) and continental

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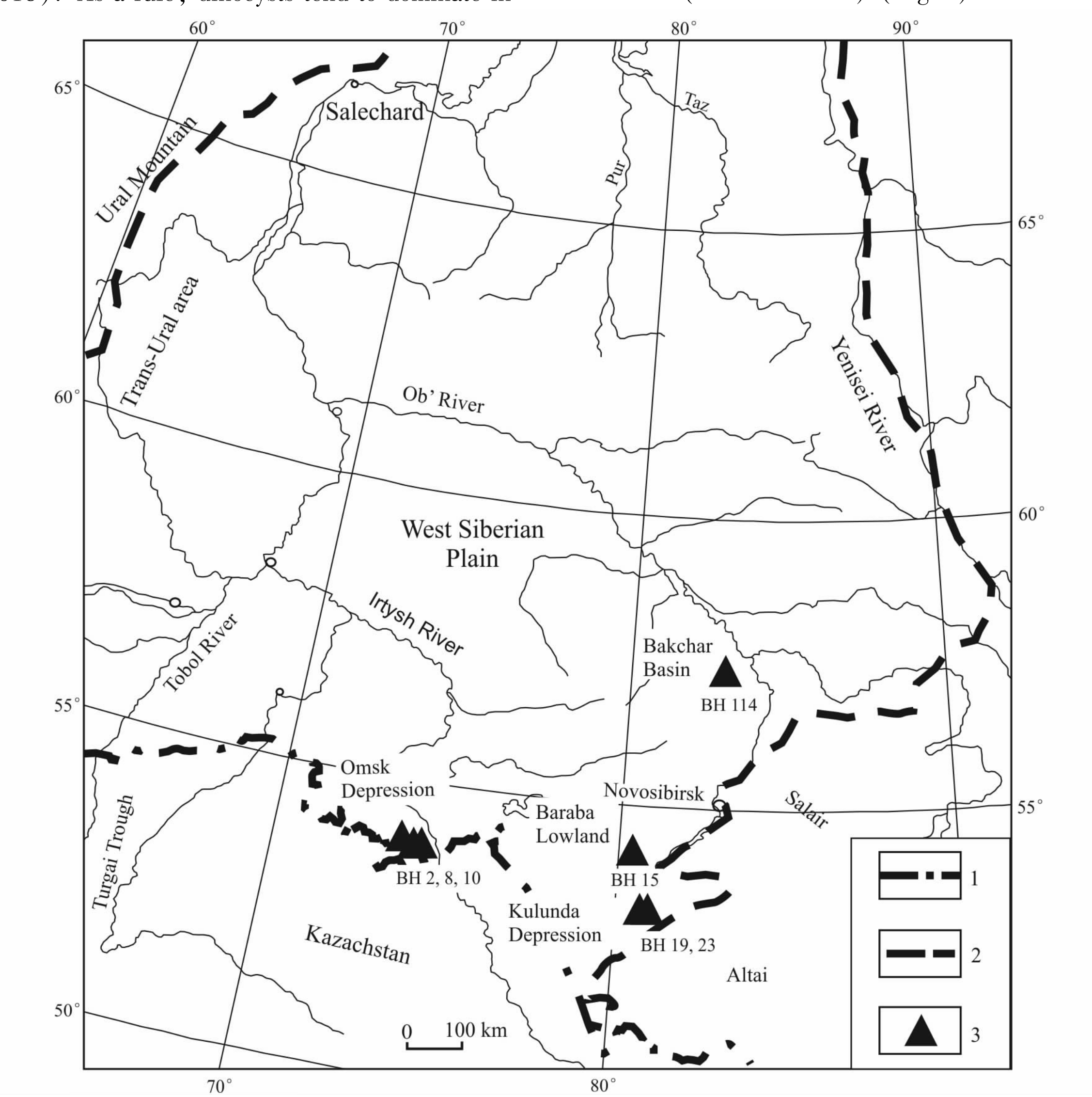
genesis (Lenkovo Sym formations). The Paleogene sediments, with the exception of Oligocene, mostly have a marine genesis - these are Talitsa, Marsyat, Lulinvor, Tavda, and Yurki Formations, but there are also continental sediments (Ostrovnoje Formation).

The most ancient Paleogene deposits (Danian age) in Western Siberia were established in the boreholes drilled in Trans-Ural area. The ages are confirmed by data of dinocysts: the layers with *Senoniasphaera inornata* were revealed in Talitza and Marsyat Formations. Their age was estimated in range of 63.2–65.5 Ma (Iakovleva & Aleksandrova, 2013; Vasilyeva, 2018). As a rule, dinocysts tend to dominate in Early Danien palynological assemblages. It is assumed that Paleocene marine basin occupied the territory of the modern Trans-Ural area and it was the deepest at this time (Vasilyeva, 2018).

1 Materials and methods

The core material for biostratigraphic studies were obtained from seven boreholes which open the Upper Cretaceous and Cenozoic deposits - BH 2, BH 8, BH 10 (Omsk Depression), BH 15 (Baraba Lowland), BH 19, BH 23 (Kulunda Depression) and BH 114 (Bakchar Basin) (Fig. 1).



1. Boundaries of Russia; 2. West Siberian Plain and its mountainous framework; 3. location of studied sections (boreholes).

Fig. 1 Scheme of West Siberian Plain

Palynological analysis. The material for palynological studies was extracted from the core of Boreholes BH 2 (46 samples), BH 8 (samples), BH 10 (47 samples), BH 15 (16 samples), BH 19 (5 samples), BH 23 (88 samples), and BH 114 (45 samples). The samples were treated following the procedure adopted in the Laboratory of Paleontology and Mesozoic and Cenozoic Stratigraphy of the Institute of Petroleum Geology and Geophysics of SB RAS. In order to determine the taxonomy of palynomorphs, a Zeiss Primo Star biological light microscope was used. Temporary slides of palynomorphs were studied at × 500 magnification. Microphotography of preparations was performed with an Axioskop 40 Zeiss microscope equipped with a digital camera. The collection of palynomorphs is stored in the Laboratory of Paleontology and Stratigraphy of the Mesozoic and Cenozoic, Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch, Russian Academy of Sciences (Novosibirsk).

2 Results

We studied the Cretaceous-Paleogene sequence in some boreholes, drilled in the south (Omsk, and Kulunda Depression, Baraba Lowland) and southeast of the Western Siberia (Bakchar Basin) (Fig. 1). It was established that the most complete sections are located in the Omsk Depression, where the Upper Cretaceous sediments are covered by Talitsa and Lulinvor Formations of Paleogene age. The significant stratigraphic breaks in the Cretaceous and Paleogene sequence were found in the southeast of the Western Siberia: in Bakchar Basin, Baraba Lowland and in Kulunda Depression.

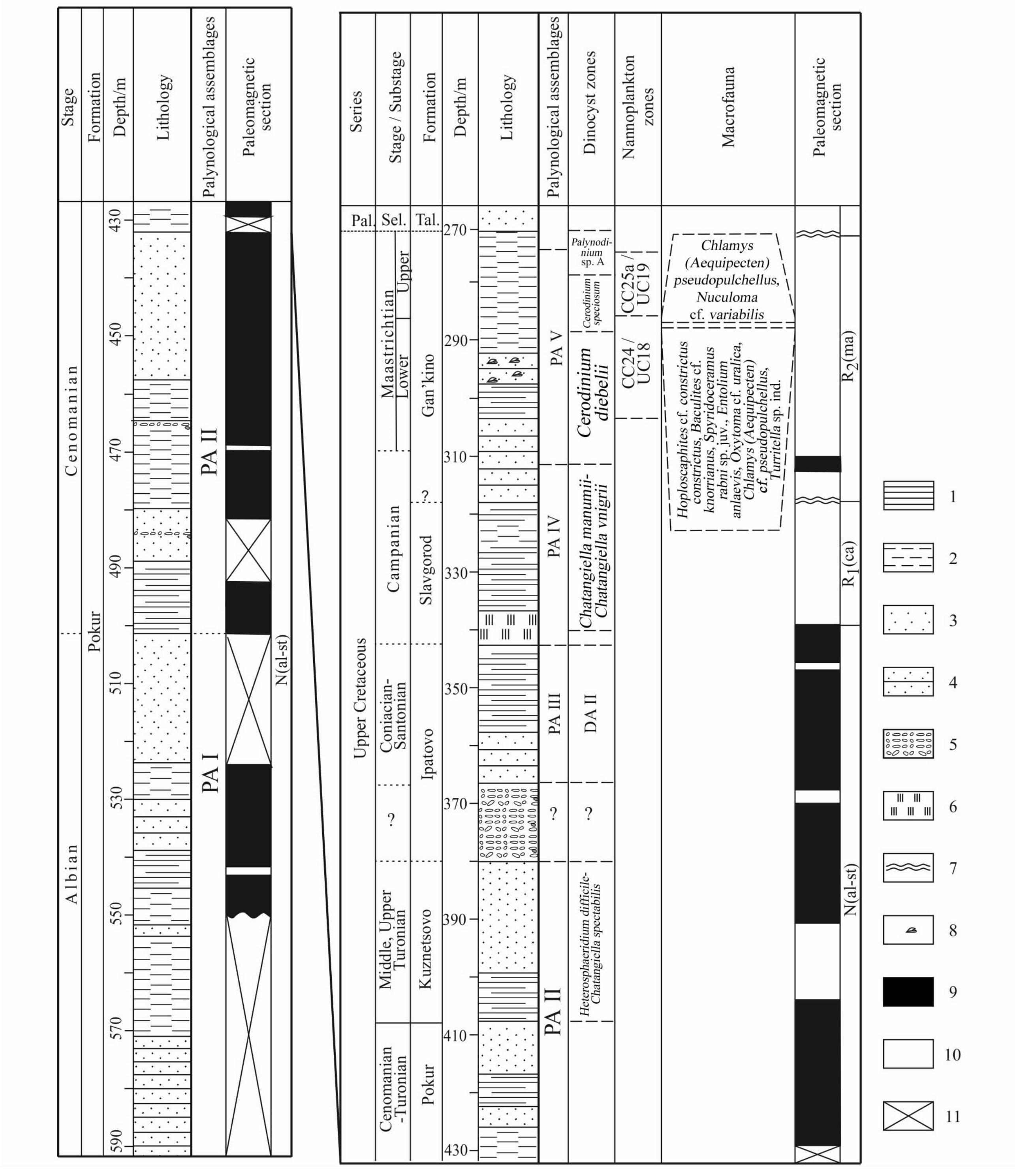
Omsk Depression. The cores of boreholes 2, 8 and 10 were studied in this territory (BH 2, 8, 10; Fig. 1). Generalization of the biostratigraphic and magnetostratigraphic data on three boreholes has made it possible to establish specific structural features of the Upper Cretaceous and boundary Paleogene sediments. The age of the Upper Cretaceous member has been substantiated from the Albian to the Maastrichtian on the basis of dinocysts, spores, and pollen (Plate I), nannoplankton and macrofauna in BH 8 (Lebedeva *et al.*, 2013) (Fig. 2). The Pokur, Kuznetsovo, Ipatovo, Slavgorod and Gan'kino formations have been subjected to the palynological analyses. Eight biostratigraphic units with dinocysts and five units with palynological assemblages have been identified.

The joint application of biostratigraphic and magnetostratigraphic methods has made it possible to reveal stratigraphic interruptions in the studied sedimentary member and to estimate their scope (Fig. 2). In the Pokur Formation, a break is possible in the upper part of the section in Boreholes 10 and 2 and in the Albian sediments in Boreholes 8 and 10. The lower Turonian is not observed in the Kuznetsovo Formation in the BH 8 section, as follows from the absence of the Eurydinium saxoniense local zone. The found stratigraphic break at the boundary between the Slavgorod and Gan'kino formations covers the Campanian and partially the lower Maastrichtian (Fig. 3).

In the boundary Cretaceous-Paleogene deposits in BH 8, the interval of the break is estimated from the upper Maastrichtian to the middle Selandian (Iakovleva *et al.*, 2012). In Boreholes 2 and 10, the longer break corresponds to a large part of the Maastrichtian-Selandian. Thanetian age of the Lower Lyulinvor Subformation in the Russkaya Polyana District has been substantiated by comparison of the dinocyst assemblages from the Paleogene sediments in the Borehole 2 section with the data on dinocysts published earlier (Iakovleva *et al.*, 2012; Lebedeva & Kuzmina, 2018).

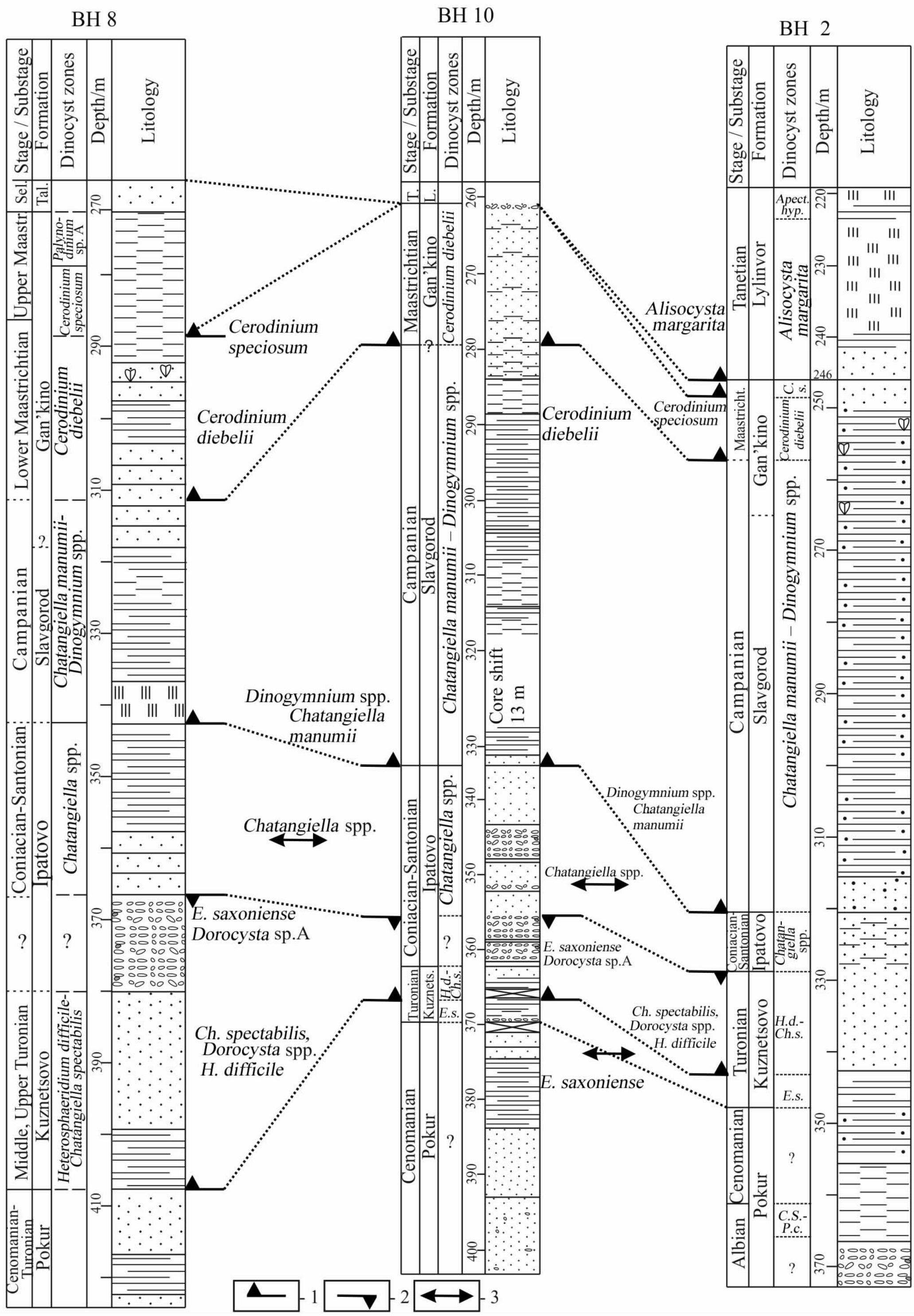
Baraba Lowland. Cretaceous and Cenozoic deposits from Borehole 15 (BH15, Fig. 1) were studied on palynology. A significant break at the border of Cretaceous and Paleogene was revealed. The Gan'kino Formation is exposed at the base of BH 15 section. It contains the dinocyst assemblages of the Campanian age (Kuzmina *et al.*, 2003). These sediments overlapped by upper part of Lulinvor Formation with dinocyst assemblages, including a species-index of the

Charlesdowniea coleothrypta Zone (Middle Ypres, ~51.7–51.3 Ma). Thus, there was no sediment accumulation on this territory during Maastricht and up to the Middle Ypres. In this territory, the upper part of Gan'kino Formation, Talitsa Formation and lower part of Lulinvor Formation fall out of the section.



1. Clay; 2. silt; 3. sand; 4. sandstone; 5. gravel stone; 6. silica clay; 7. stratigraphic breakdown; 8. geomagnetic field polarity; 9. normal; 10. reversed; 11. lack of information; Abbreviations: (Pal.) Paleogene; (Sel.) Selandian; (Tal.) Talitsa.

Fig. 2 Magnetobiostratigraphic section of Upper Cretaceous deposits of Borehole 8 (BH 8) in Russkaya Polyana District



1. Appearance of a taxon; 2. disappearance of a taxon; 3. characteristic taxon; Abbreviations: (Sel.) Selandian; (Tal) Talitsa; (E. saxoniense) Eurydinium saxoniense; (H. difficile) Heterosphaeridium difficile; (Ch. spectabilis) Chatangiella spectabilis.

Fig. 3 Dinocyst correlation of borehole sections in Russkaya Polyana District

Bakchar Basin. The Upper Cretaceous and Cenozoic sediments were studied in Borehole 114 (BH 114, Fig. 1). The section is represented by alternations of shallow marine and alluvial-delta iron ore beds with partings of marine and continental deposits. As a result, four local zones with dinocysts and seven local zones with spore and pollen were identified and the age of deposits varying from Campanian to Quaternary was substantiated. Dinocysts in this area were studied for the first time. The boreholes exposed deposits of the Slavgorod, Gan'kino, Jurki, Novomikhailovka, Lagerny Sad, and, probably, Abrosimovka formations and Upper Miocene (?)-Quaternary deposits. The boundary between the Slavgorod and Gan'kino formations is conditional since there are no lithological data for confirmation. This is possibly due to a break at the Campanian-Maastrichtian boundary, the presence of which is not confirmed by palynological data, but it is assumed from paleomagnetic correlations (Gnibidenko *et al.*, 2015).

In BH 114, the Upper Cretaceous sequence ends with layers with *Cerodinium diebeli* (Gan'kino Formation, Maastricht). The Paleocene sediments were not found: the Gan'kino Formation overlapped by the sandy rocks of the Yurki Formation (regressive facies of the Eocene Tavda Sea) with Bartonian dinocyst complex *Rhombodinium ornatum* (*Kisselevia ornata*) and the Middle Eocene spore and pollen assemblages *Castanopsis pseudocingulum*, *Castanea crenataeformis*, *Nyssa crassa* (Lebedeva *et al.*, 2017).

Specific trends in the distribution of the different assemblages of microphytofossils or morphotypes of dinocysts in the studied Upper Cretaceous and Cenozoic deposits caused by transgressive-regressive cycles and climate changes were revealed. On the basis of biostratigraphic data and the biofacies analysis, the time of the regressive phase of the basin development in this area resulting from local tectonic movements were clarified (Kazanskii, 1963). The traces of the shallowing of the Late Cretaceous sea were established in studied core sections in the middle part of the Slavgorod Formation. The transgression trend is recorded in the Campanian-Maastrichtian boundary deposits.

Kulunda Depression. In the south of the Kulunda Depression, the continental Upper Cretaceous and Paleogene deposits in boreholes 19 and 23 (BH 19, 23, Fig. 1), were studied. According to palynological data, the age of the Lenkovo Formation is estimated as Cenomanian-Turonian, and the Sym Formation is Campanian-Maastrichtian. Paleocene deposits in BH 19 and BH 23 were not found: Upper Cretaceous sediments in BH 19 is covered by the layers with spore and pollen assemblages presumably of Middle Eocene age with *Tricolporopollenites pseudocingulum*, *Castanopsis pseudocingulum*, *Castanea crenataeformis*. In BH 23, the Upper Cretaceous Sym Formation overlapped by Middle Eocene sediments containing spore and pollen assemblages with *Tricolporopollenites cingulum*, *Castanopsis pseudocingulum*, *Castanea crenataeformis* (Lutet-Barton) and *Tricolporopollenites cingulum*, *Tricolpopollenites liblarensis*, *Quercus gracilis* (Barton) (Lebedeva *et al.*, 2019). A part of the continental Ostrovnoye Formation was detected, corresponding to the Middle Eocene (Lutet-Barton) in BH 19 and BH 23.

As a result, a large stratigraphic gap in the Upper Cretaceous and Paleogene boundary deposits, covering a significant part of the Maastrichtian, Paleocene, Ypresian, and Lutetian stages of the Eocene, was established in the southeast of the West Siberian Plain (Bakchar Basin, Baraba Lowland). The events occurring at the boundary of the Cretaceous and Paleogene in Western Siberia can be traced currently in a few sections located in the marginal zone (Trans-Ural area), since there was no sedimentation in the rest of this territory at that time.

References

Gnibidenko Z N, Lebedeva N K, Levicheva A V. 2015. Magnetostratigraphy of the Campanian- Maastrichtian Bakchar Basin (southeastern West Siberia). *Russian Geology and Geophysics*, **56**(11): 1652-1661.

Iakovleva A I, Aleksandrova G N. 2013. The problem of dinocyst zonation of the Paleocene-Eocene deposits of Western Siberia. *Byulleten Moskovskogo Obchestva Ispytatelei Prirody*, *Otdel Geologii*, **88**(1): 59-81.

Iakovleva A I. 2012. Age refinement of Lyulinvor Formation in the southwestern Siberia based on palynological and paleomagnetic data. *Byulleten Moskovskogo Obchestva Ispytatelei Prirody*, *Otdel Geologii*, **87**(3): 53-87.

Kazanskii Y P. 1963. Melovye i paleogenovye osadochnye formatsii Srednego Priob'ya Cretaceous and Paleogene Sedimentary formations in the Middle Ob River. *Novosibirsk Izdatel'stvo Sibirskogo Otdeleniya Akademii Nauk SSSR*, **18**: 354.

Kuzmina O B, Volkova V S, Lebedeva N K. 2003. Upper Cretaceous and Cenozoic microphytofossils and magnetostratigraphy of the southeastern part of the West Siberian Lowland. *Russian Geology and Geophysics*, **44**(4): 348-363.

Lebedeva N K, Aleksandrova G N, Shurygin B N, *et al*. 2013. Paleontological and magnetostratigraphic data on Upper Cretaceous deposits from borehole no. 8 (Russkaya Polyana District, Southwestern Siberia). *Stratigraphy and Geological Correlation*, **21**(1): 48-78.

Lebedeva N K, Kuzmina O B, Sobolev E S, *et al*. 2017. Stratigraphy of Upper Cretaceous and Cenozoic deposits of the Bakchar iron ore deposit (Southwestern Siberia): new data. *Stratigraphy and Geological Correlation*, **25**(1): 76-98.

Lebedeva N K, Kuzmina O B. 2018. Palynostratigraphy of the Upper Cretaceous and Paleogene deposits in the south of Westen Siberia by example of Russkaya Polyana Boreholes, Omsk Trough. *Stratigraphy and Geological Correlation*, **26**(1): 80-108.

Vasilyeva O N. 2018. Dinocysts and biostratigraphy of Paleogene of the Trans Ural area, Turgai trough and Caspian Depression: PhD Thesis. Novosibirsk: IPGG SB RAS.

Explanation of Plate

Plate I

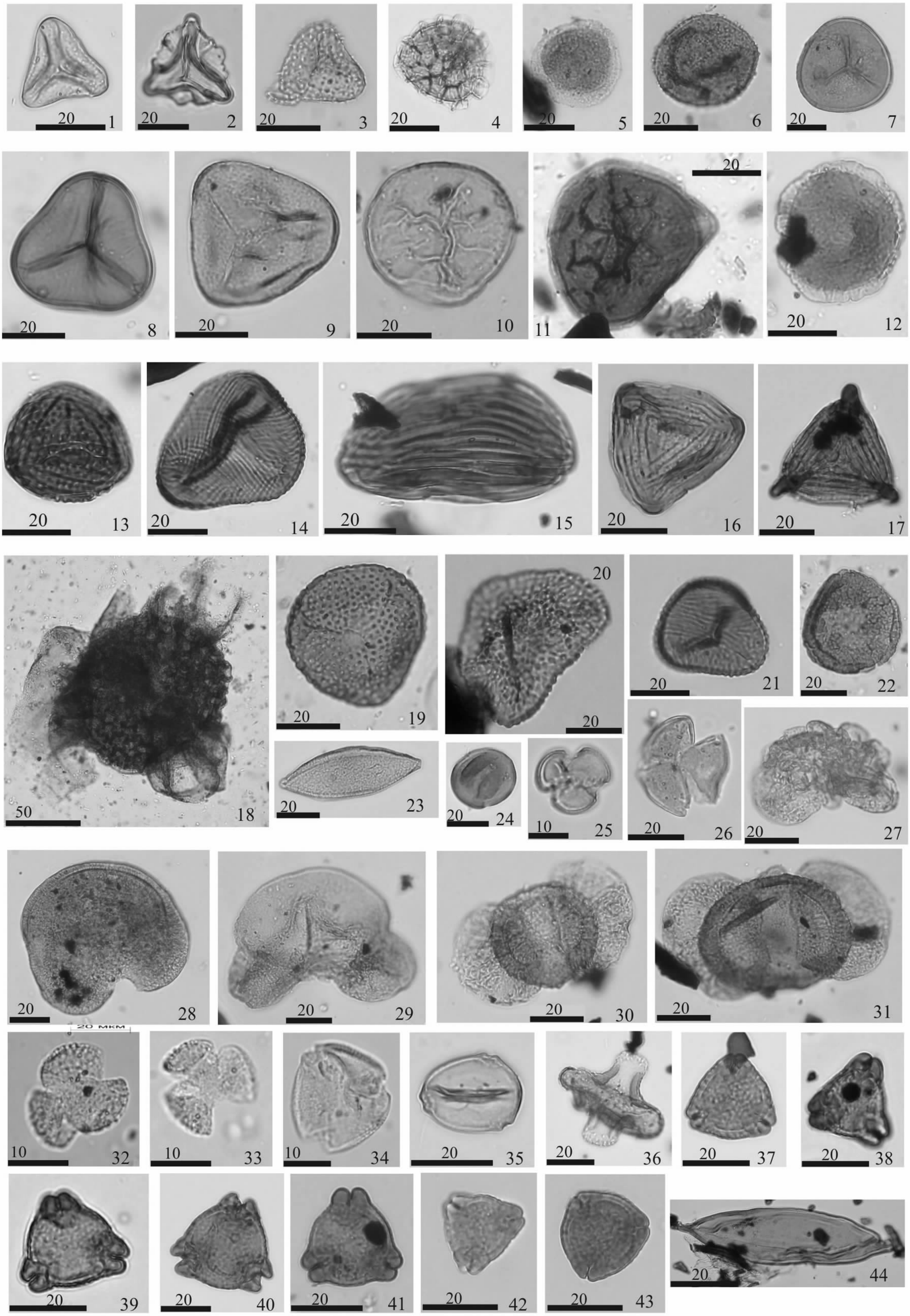
Palynomorphs from the Upper Cretaceous sediments of Borehole 10 (BH 10) in the Russkaya Polyana District. Magnification is shown in microns (μm).

1. *Gleicheniidites senonicus*, depth 376.85 m.
2. *Clavifera* sp., depth 266.65 m.
3. *Ornamentifera echinata*, depth 271.3 m.
4. *Lycopodiumsporites* sp., depth 276.01 m.
5. *Velosporites triquetrus*, depth 369 m.
6. *Osmundacidites* sp., depth 280.6 m.
7. *Todisporites minor*, depth 364.9 m.
8. *Biretisporites* sp., depth 376.85 m.
9. *Concavissimisporites punctatus*, depth 401.5 m.
10. *Rouseisporites laevigatus*, depth 401.5 m.
11. *Rouseisporites reticulatus*, depth 401.5 m.
12. *Dictyotosporites* sp., depth 401.5 m.
13. *Cicatricosisporites pacificus*, depth 401.5 m.
14. *Cicatricosisporites cuneiformis*, depth 401.5 m.
15. *Cicatricosisporites stoveri*, depth 401.5 m.
16. *Anemia exilioides*, depth 369 m.
17. *Appendicisporites macrorhyzus*, depth 364.9 m.
18. *Balmeisporites glenelgensis*, depth 401.5 m.
19. *Foveosporites cenomanicus*, depth 401.5 m.
20. *Foraminisporis asymmetricus*, depth 401.5 m.
21. *Cicatricosisporites minutaestriatus*, depth 401.5 m.
22. *Kornilovites* sp., depth 383.2 m.
23. *Ginkgocycadophytus* sp., depth 276.01 m.
24. *Eucommiidites* sp., depth 401.5 m.
25. *Tricolpites albiensis*, depth 275.6 m.
26. *Tricolpites* sp., depth 320.85 m.
27. *Rugubivesiculites* sp., depth 262.3 m.
28. *Cedrus cristata*, depth 369 m.
29. *Cedripites parvisaccatus*, depth 401.5 m.
30. *Podocarpidites multesimus*, depth 401.5 m.
31. *Podocarpidites* sp., depth 401.5 m.

32, 33. *Retitricolpites* sp., depth 376.85 m.

34. *Nyssapollenites* sp., depth 364.6 m.
35. *Triorites harrisii*, depth 276.01 m.
36. *Aquilapollenites unicus*, depth 264.65 m.
37. *Trudopollis protrudens*, depth 264.65 m.
38. *Ocullopollis* sp., depth 273.65 m.
39. *Trudopollis nonperfectus*, depth 276.01 m.
40. *Trudopollis ordinatus*, depth 276.01 m.
41. *Trudopollis bulbosus*, depth 280.6 m.
42. *Trudopollis baculotrudens*, depth 321.75 m.
43. *Ocullopollis* sp., depth 332.25 m.
44. *Lancetopsis* sp., depth 269.30 m.

Plate I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