

Configuration of the Palaeogene deposits of southern Russia

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Radionova E. P., Khokhlova I. E. & Oreshkina T. V. 1999. — Configuration of the Palaeogene deposits of southern Russia, in Crasquin-Soleau S. & De Wever P. (eds), *Peri-Tethys: stratigraphic correlations 3*, *Geodiversitas* 21 (3) : 421-428.

ABSTRACT

Tectonic and eustatic history of the East European Plate strongly influenced the accumulation of Palaeogene sediments. Due to these factors, lower part of Palaeogene deposits is distributed in an elongated area with an axis stretches N-S, and the upper strata in an area that extends E-W. Micropalaeontological investigation of diversified Palaeogene lithofacies allowed us to subdivide and correlate Palaeocene and middle Eocene sediments of the East European (Russian) Plate and to propose the picture of its evolution during the Palaeocene-middle Eocene time.

KEY WORDS

Palaeogene,
microplankton,
stratigraphy,
palaeogeography.

RÉSUMÉ

Configuration des dépôts paléogènes de la Russie méridionale.

L'histoire tectonique et eustatique de la plaque est-européenne a profondément influencé l'accumulation des dépôts paléogènes. En relation avec ces deux facteurs, la partie inférieure des dépôts du Paléogène est répartie sur une aire allongée de direction N-S, et la partie supérieure avec une direction E-W. Les recherches micropaléontologiques sur différents lithofaciès du Paléogène nous permettent de diviser et de corréler les sédiments du Paléocène et de l'Éocène moyen de la plaque est-européenne (russe) et de proposer une image de son évolution durant le Paléocène-Éocène moyen.

MOTS CLÉS

Paléogène,
microplancton,
stratigraphie,
paléogéographie.

INTRODUCTION

Within the Russian Plate, Palaeogene deposits are classed into two lithologic types – Ukrainian and Volgian – differing essentially in lithology and stratigraphic range. Ukrainian-type sections are found to the west, and Volgian-type deposits, to the east of the Ulyanovsk-Saratov zone (Leonov 1964).

The Palaeogene deposits display an E-W zonation. As far north as the latitude of Volgograd, Palaeogene deposits are represented by all the series and show lithologic similarity to carbonate terrigenous, North Caucasus-type sections. In more northerly areas, Palaeogene sections are incomplete and are dominated by siliceous-terrigenous facies. The boundary of the area occupied by the southern, Caucasian facies coincides with the junction zone between the south flank of the East European craton and the post-Hercynian Scythian Plate.

The Figure 1 shows tectonic structure of the southern part of the Russian Plate. The diversity of Palaeogene lithologic associations is largely determined by the tectonic complexity of the study area, located in the junction zone. The North Donets thrust (Fig. 1: A) separating the East European craton and the Scythian Plate remained active throughout Cainozoic time. The southern slope of the platform is adjoined by Precambrian structures: the Ukrainian shield (Fig. 1: A) and the Voronezh uplift (Fig. 1: B) with the Dnieper-Donets aulacogen (Fig. 1: C) in-between, and by the Peri-Caspian Basin (Fig. 1: D). The Karpinsky swell (Fig. 1: E) is an E-W-trending marginal structure of the post-Hercynian Scythian Plate. This swell gives way westward to the orogenic Palaeozoic structure of the Donets area (Fig. 1: F), a constituent part of the Dnieper-Donets aulacogen (Milanovsky 1987).

The Ukrainian depression, filled by Ukrainian-type Palaeogene deposits, is a Meso-Cainozoic depression (Fig. 1: I) overprinting the south flank of the Voronezh Massif, of the Dnieper-Donets graben, and, partly, of the Ukrainian shield.

The N-S-trending Ulyanovsk-Saratov depression (Fig. 1: II), to which the Volgian-type Palaeogene

deposits are confined, is related with an inversion of vertical movements. This depression evolved in Late Cretaceous-Palaeocene time, and since the Eocene it has been involved in the N-S-trending uplifting zone, presently known as the Volgian uplift. Although the Ukrainian and Ulyanovsk-Saratov depressions occur closely in space, their Palaeogene infills differ essentially in structure, stratigraphic range, and lithologic type. The zone that separating these areas extends N-S along the East Ergeny swell (Fig. 1: 4) to Don-Medveditsa swell and Kirovsk swell, and is likely to reflect a deep mantle structure that trends roughly N-S.

Throughout the Palaeogene domain, the lower beds are distributed in an elongated area whose axis stretches N-S from Ulyanovsk to Volgograd, and the upper strata gravitate to an area that extends E-W from Kiev to Volgograd. The structural rearrangement responsible for this reorientation took place in the early to early-middle Eocene.

OBJECTIVES OF STUDY

The diversity of Palaeogene lithofacies throughout this all-important area renders their stratigraphic subdivision and correlation rather difficult. Despite the long history of the studies, the micropalaeontological coverage of these deposits remains incomplete and non-uniform. This refers primarily to the stratigraphy that is based on siliceous microfossils, which abound in the Palaeocene deposits of Volgian-type sections and in the Eocene strata of Ukrainian-type sections.

First, this study sets out to constrain the stratigraphic range of Palaeogene siliceous facies in the Ulyanovsk-Saratov depression.

Second, our aim is to improve the understanding of the structure and age of the Eocene deposits in the area where the Dnieper-Donets depression adjoins the Peri-Caspian Basin, and where the Eocene strata comprise both carbonate and siliceous facies, permitting a correlation of northerly (cratonic-type) and North Caucasian sections.

Sections and boreholes penetrating the Palaeogene deposits we have studied are shown

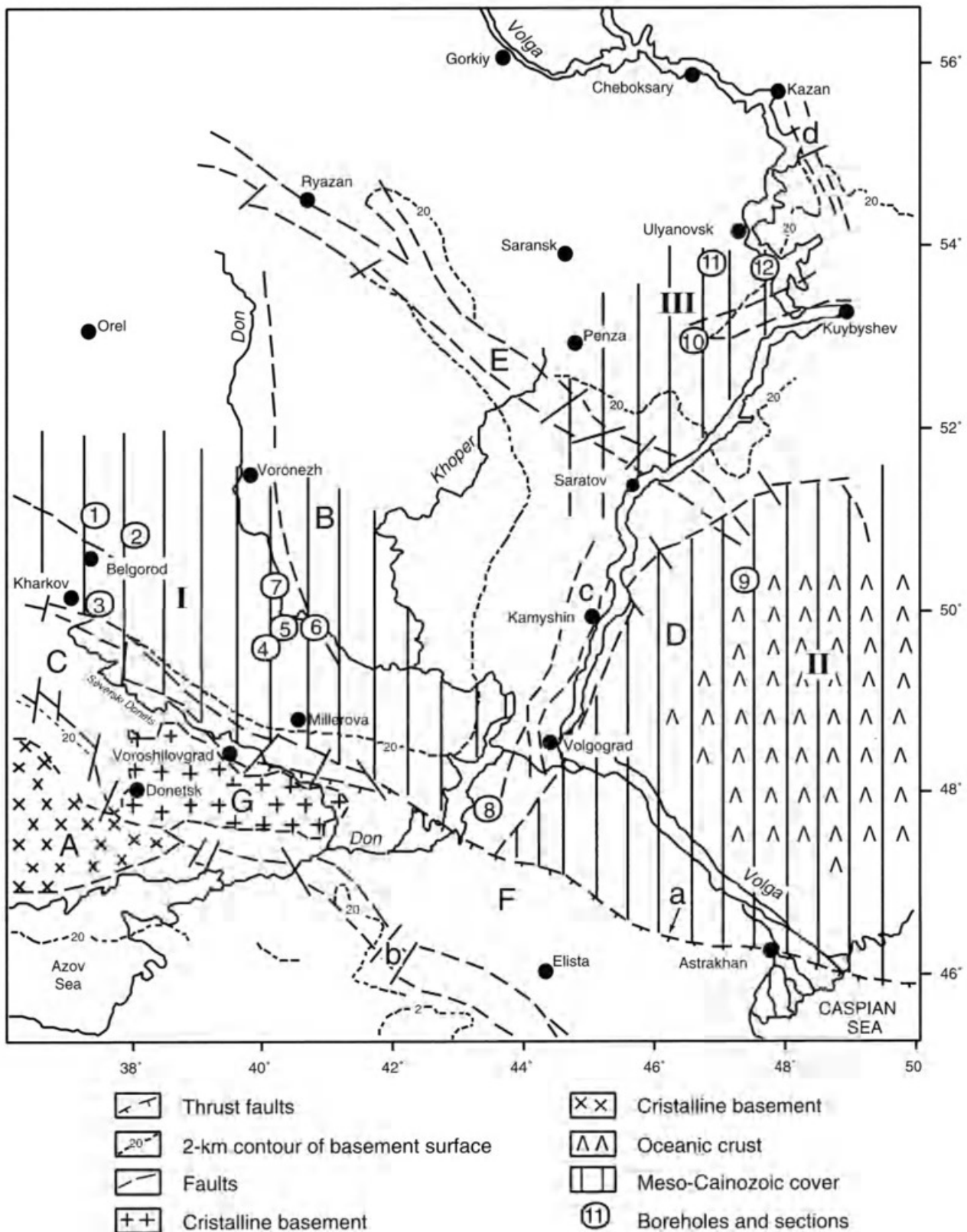


FIG. 1. — Scheme showing main tectonic structures of the southern part of Russian platform, after Geodynamic map of the USSR and adjacent seas (Anonymous 1988) and Milánovský (1987). Boreholes and sections: 1, Stariy Saltov; 2, Yaruga; 3, Strelech'e; 4, Kanemirovka; 5, Sergeevka; 6, Rudavka; 7, Boguchar; 8, Veshenskoe; 9, Uzen; 10, Smishlyayevskaya Gorka; 11, Vodoratsky Quarry; 12, Sengeley. Precambrian structures of the Russian Plate: A, Ukrainian shield; B, Voronezh uplift; C, Dnieper-Donets aulacogen; D, Peri-Caspian Basin; E, Pachelma trough; F, Karpinsky swell; G, Donets folded area. Meso-Cainozoic structures: I, Ukrainian syncline; II, Peri-Caspian Basin; III, Ulyanovsk-Saratov syncline. Cainozoic meridional structures: b, East Ergensky swell (horst); c, Don-Medveditsa swell (modern Volgian uplift); d, Kirovsk swell.

in Figure 1. These are type sections in two areas that are crucial to Palaeogene stratigraphy in the central Ulyanovsk-Saratov depression (Sengeley, Smyshlyaevskaya Gorka, Kuroedovskie Vyselki quarry, and Vodoratsky quarry sections) and along the NE flank of the Ukrainian depression (246 Stary Saltov, 230 Strelechie, 5-93 Boguchar, and 9540 Rudaevka holes and Yaruga, Sergeevka, and Kantemirovka sections).

STRATIGRAPHIC SUMMARY OF PALAEOCENE DEPOSITS (VOLGIAN-TYPE PALAEOGENE STRATA)

Volgian-type Palaeogene deposits (Leonov 1964) have a siliceous-terrigenous composition and show a distinct cyclicity. It is customarily believed that in this region Palaeogene deposits have a complete stratigraphic range and pass continuously into lower Eocene strata.

The Palaeocene deposits are subdivided into the Syzran, Saratov (= Kamyshin), and Tsaritsyn formations. The last is assigned to uppermost Palaeocene-lowermost Eocene. However, sections in the lower and upper reaches of the Volga are difficult to correlate. The Syzran Formation is a rather diverse and intricately built complex of clay-siliceous and sand sediments as thick as 150-180 m, grading into each other laterally from area to area. In the lower reaches of the Volga, the lithologic division into the lower (clay-gaize) and upper (sand) member is quite consistent. In the middle reaches of the Volga, the formation in places becomes tripartite, with a sandy middle member, although in places the formation consists almost entirely of diatomite and gaize [gaize (= opoka) biogenic kryptogene siliceous sediment with clayey admixture]. The Saratov (= Upper Saratov, Kamyshin) Formation is often bipartite (with the lower member consisting of gaize, and the upper, of sand), its thickness not exceeding 20-30 m. In the Volga's lower reaches, the base of this formation contains a distinct intercalation of tobacco-coloured sapropel-like clay.

The sandy Tsaritsyn Formation in the Volga's lower reaches is clearly rhythmic and consists of sandy gaize and sandstone. In the Volga middle

reaches, this formation overlaps erosionally the underlying deposits, is made up of thin sand stone with occasional leaf casts, and thickens to 40-60 m.

The lithologic uniformity and cyclicity, the correlation of faunal remains with particular lithofacies, the commonly poor preservation of siliceous plankton due to diagenetic transformation of organic opal, all handicap the stratigraphic subdivision of Palaeocene deposits.

Stratigraphic range of the lithostratigraphic units (formations) is highly disputable. In this study, the paper by Khokhlova & Oreshkina (this volume) sets out to define more precisely the stratigraphic range of Palaeocene deposits in the Volga's middle reaches.

STRATIGRAPHIC SUMMARY OF EOCENE DEPOSITS (UKRAINIAN-TYPE PALAEOGENE STRATA)

The Dnieper Basin displays: (1) a reduced stratigraphic range and limited distribution of the lower Eocene strata; (2) a chiefly sandy composition of all the horizons except two: "Kiev" Horizon represented by a clay-marl member with glauconite, and the lower part of the "Kharkov" Horizon, which shows diatomite intercalations in the clay-sand member.

The correlation of stratigraphic units of the Dnieper-Donets Palaeogene strata largely depends on the dating of the "Kiev" and "Kharkov" beds. Initially, the "Kharkov" sandstones were correlated with the Lattorian ones based on mollusks (Sokolov 1903). On these grounds, the "Kharkov" Member was assigned to the Oligocene, and the "Kiev" Member, to the upper Eocene. Later, "Kiev" was moved into the middle Eocene, and "Kharkov", into the upper Eocene (Makarenko *et al.* 1987). In some works, especially in those dealing with tectonics, this view persists still. However, after the Kiev Formation yielded the middle Eocene foraminifera assemblage of the *Globorotalia rotundimarginata* zone (Grigyalis *et al.* 1988), the stratigraphic range of the "Kiev" and post-"Kiev" strata in the stratotype area (Dnieper Basin near Kiev) became a subject of revision, and new

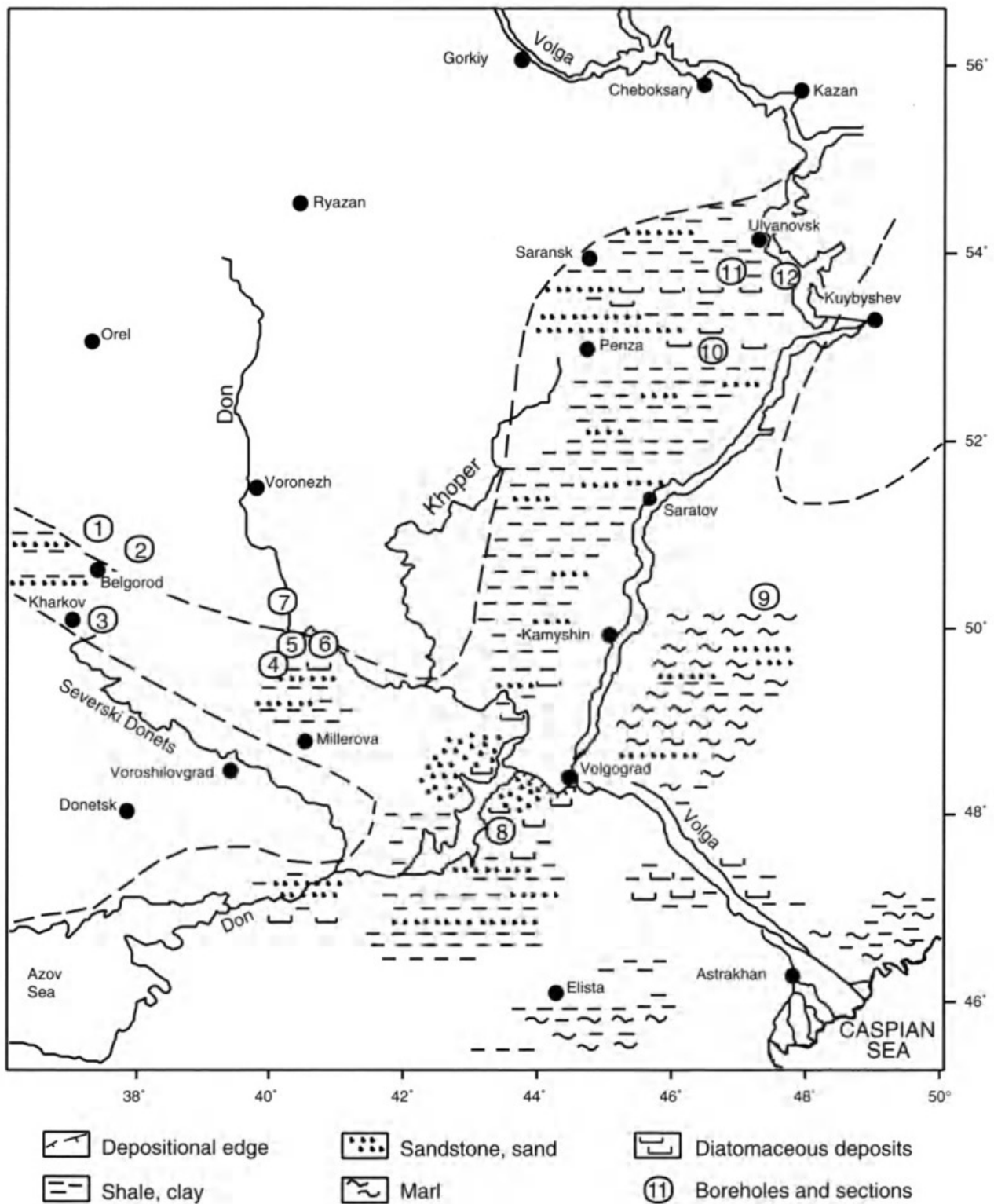


FIG. 2. — Upper Palaeocene (Thanetian) palaeogeographic scheme.

variants of their correlation with more northerly and easterly areas began to appear.

This correlation, however, is restrained by the fact that Eocene deposits change in lithology toward the northeast parts of the Ukrainian depression,

where the chiefly carbonate strata in the correlates of the Kiev Formation become replaced by clay-sand deposits. In that area, another litho-stratigraphic scheme is used (Sokolov 1965).

As it was shown above, to subdivide the western-

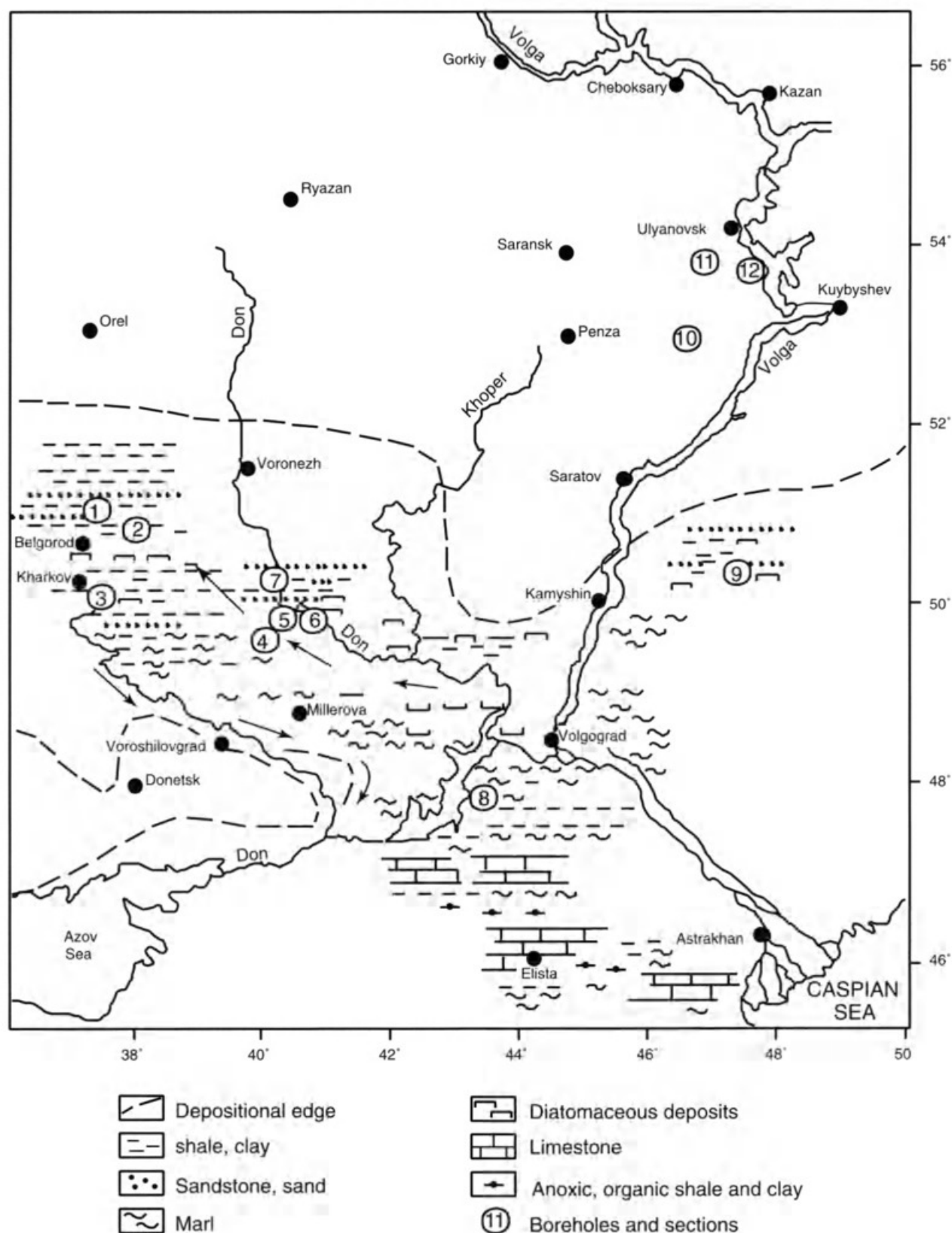


FIG. 3. — Middle Eocene (Bartonian) palaeogeographic scheme.

most section that we have studied (Boguchar), which is located in the Volga-Don interfluvium, the lithostratigraphic scheme from the North

Caucasus can be applied (Kurlaev & Akhlestinina 1988). In this area, the correlates of the Kuma Forma-

tion are recognised, with Bartonian anoxic events associated in eastern Peri-Tethys. The issues of stratigraphic range and facies changes in the Eocene deposits of the eastern flank of the Ukrainian depression are addressed in the paper of Khokhlova *et al.* (this volume).

PALAEOGEOGRAPHY

The Figures 2 and 3 present palaeogeographic maps showing distribution of Palaeocene (upper Thanetian) and middle Eocene (Bartonian) deposits for the southern part of the former USSR.

In late Palaeocene time, the Volga Region and Peri-Caucasian basins formed a single, shallow-water, highly productive marine basin with siliceous sedimentation (Fig. 1). Distanov (1964) proposed that Palaeocene sediments of the Middle Volga Region accumulated in a large gulf of an inland sea, with an intense upwelling process. The diatomites may have accumulated in marginal parts of palaeodeltas. Another viewpoint is that there existed seaway(s) between the Volga and West Siberian basins. This is suggested by the similarity of the faunas and floras. For example, the West Siberian assemblage consists of 100 diatom species (Anonymous 1974). More than 80% species are common with those of the Middle Volga palaeobasin.

The Middle Volga Region sagged mainly in the biosilica accumulation. Pure diatomites near the town of Sengiley contain abundant radiolarian assemblages of *Buryella tetradica* Foreman, *Tripodiscinus sengilensis* Kozlova and regional zones established by Kozlova (1984) and related to the late Palaeocene. In the northern Peri-Caspian Basin, upper Palaeocene rich radiolarians complex accompanied by nannoplankton of NP8 zone are present. In Cis-Caucasia, this level correlates to the Goryachy Klyuch and Abaza formations that contain abundant yet poorly preserved radiolarian assemblages. The entire basin had identical radiolarian assemblages, although the assemblages of the *Buryella tetradica* Foreman and *Petalospyris foveolata* Ehrenberg, in the Middle Volga sections contain

a significant number of widespread tropical species.

In early Eocene time, the gulf (or seaway) that existed on the site of the middle and partly, lower reaches of the Volga, disappeared. Marine environment gave way to continental, which persisted in the Middle Volga Region into Eocene and Oligocene times. In the Dnieper-Donets Basin, lower and lower-middle Eocene strata consist of alternating terrigenous nearshore marine and continental facies. The marine basin survived only in the south – on the site of the Peri-Caspian Basin and Cis-Caucasia.

A new vast transgression was confined to the upper Lutetian-Bartonian. The outline of the basin, however, changed significantly (Fig. 3). In late Lutetian time, carbonate-terrigenous strata of the Kiev Formation were widespread in the Dnieper-Donets depression. The "Greenish Kiev Marlstone" has long been correlated with the glauconite-rich marls and limestones of the Keresta Formation in Cis-Caucasia, which contain similar foram and nannofossil assemblages. The Bartonian strata differ significantly between the southern and northern parts of the basin. Along the north and south margins of the Dnieper-Donets Basin and along the north margin of the Peri-Caspian Basin, widespread are deposits enriched in organic silica, whereas in the central part of the basin carbonate-clay sediments of the Kuma Formation, partly or entirely anoxic, were laid down. In the Volga-Don interfluvial, siliceous facies giving way to the Kuma facies were attributed to the existence of the Millerovo seaway between the Donets basement high and the east slope of the Voronezh Basin (Leonov 1964).

The palaeogeography of the South Russia Basin with biosiliceous accumulation changed drastically from N-S at the time of the Selandian-lower Thanetian transgression to W-E during the Lutetian-Bartonian transgression.

Acknowledgements

The authors are very grateful to Prof. D. Lazarus (Berlin, Germany) and Prof. K. Nigrini (Canmore, Canada) for their careful reading and their help in the rewriting of the paper.

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*Submitted for publication on 22 April 1997;
accepted on 30 June 1998.*



Oreshkina, Tatiana V, Khokhlova, Irina E, and Radionova, Eleonora P. 1999.
"Configuration of the Palaeogene deposits of southern Russia." *Géodiversitas*
21(3), 421–428.

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