A Paleogene sequence in central North Caucasus: A response to paleoenvironmental changes

YURI O. GAVRILOV, EKATERINA A. SICHERBININA, and NIKITA G. MUZYLOV

The Paleocene-Eocene basin in the south of the former USSR occupied a large area that extended E-W over 3000 km. The northern periphery of the basin (Russian craton) was characterized by essentially terrigenous and biogenic siliceous-sedimentation, and the southern (Ciscaucasicus) region was dominated by carbonate nanofossiliferous sediments, giving way in some stratigraphic intervals to carbonate-terrigenous, terrigenous, and biogenic siliceous-terrigenous sediments. The proportion of different sediments varied considerably from age to age through the history of the basin; this variation is more clearly pronounced in North Caucasus. The lithostratigraphic subdivision remains roughly identical over the major part of the area. We choose the classical Paleocene-Eocene reference section at Khos River (Khabardino-Balkaria, central North Caucasus; Fig. 1) to characterize sediment variation through time. This section represents the deepest part of the water area. It is the most complete section of the area and evidently one of the best Paleogene sections of the world. Continuous exposures exist along the Khos River reaches.

The Paleogene stratigraphic scheme of the area based on foraminifera and nanofossil studies has been evaluated for many years (e.g., Subbotina 1968; Leocov & Alaminova 1964; Shatskaya 1970; Krasnennikov & Muzilov 1975; Muzilov 1981). In this study, we tried to use the zonal markers of both nanofossil and standard scales (Martin 1971; Okada & Bukry 1980). These latter, in turn, are easily recognized and provide a reliable framework for further studies.

The Khos river reach is a major tributary of the Okat River and one of the principal tributaries of the Terek and Kuban rivers. The Khos River is fed by many small tributaries. The river is characterized by a series of rapids and small waterfalls, which provide a habitat for a rich fish fauna. The river is also a popular destination for anglers and nature lovers. The river flows through a variety of terrains, including mountains, forests, and open plains. The river is an important source of water for the local population, providing drinking water and supporting agriculture.

The vegetation in the Khos River valley is diverse, with a mix of coniferous and deciduous trees. The area is home to a variety of wildlife, including birds, mammals, and fish. The river is also an important migration route for birds, with many species stopping over during their annual migrations.

The river is also a popular location for outdoor activities, with hiking, cycling, and camping being popular activities. The river is also a popular location for picnicking and family outings.

Overall, the Khos River is a beautiful and important natural resource, providing a variety of habitats and supporting a rich ecosystem. The river is a testament to the beauty and diversity of the natural world, and it is important that we continue to protect and conserve this precious resource.
Fig. 1. The Palaeocene succession of Khok River section with major nanofossil zonal markers.

Fm., and is present at the Kereta Fm., along with clinostratite.

Throughout the section OM is low, although initially it was higher, judging from sulphide nodules. Certain horizons, however, are considerably enriched in OM (sapropels of the Nalchik and Cherkess Fm., limestones and marls of the Kuma Fm., Fig. 1). Accordingly, OM-rich sediments are high in P, V, Ni, Co, Cr, Mo, etc. Significant biotic changes (involving a decline of nanofossil and planktonic foraminifera and disappearance of benthic foraminifera) accompanied OM accumulation (Muziyev et al. 1996).

The generally high carbonate content, resulting from high calcareous microplankton (mainly nanofossil) productivity, changed significantly throughout time. The CaCO₃ curve reflects two stages in the Palaeocene-Eocene sedimentation:

(i) The Palaeocene stage, with a clear trend in the content of carbonate matter. From the limestone-dominated Danian sequence through marls and carbonate-rich clays to upper Thetanian (CP8b Subzone) low-carbonate clays and champs. Accordingly, nanofossils, very abundant in the Danian-lower Thetanian, become rather diverse but not abundant in the upper Thetanian chalk sequence. Similar changes in carbonate matter from the Danian to Thetanian have been shown for coralline sediments in western Europe. Considering that similar trends of sediment changes characterize basins that are situated great distances apart, these trends might be related to eustatic sea-level changes, rather than to regional factors.

The general Palaeocene trend of changes in sedimentation is complicated by smaller-scale fluctuations in CaCO₃ content. The middle Palaeocene sequence (CP4-CP5a Zones, "pre-sapropel" stage) displays two positive CaCO₃ shifts separated by reduced carbonate accumulation in CP6-lowermost CP7 Zones. In the terminal Palaeocene (CP8b Subzone), clays with the lowest CaCO₃ content in pre-Oligocene sedimentation accumulated, evidently due to (i) reduced calcareous microplankton productivity coincident with siliceous microplankton productivity outburst, and (ii) a relative decrease in carbonate content owing to increased tergestine input, resulting in a thick sequence accumulated over a short time interval (CP8b Subzone).
carbontic sedimentation. In the Ypresian, two CaCO3, maxima are recorded, separated by a minimum during sapropel accumu-
lation. The lower Ypresian (CP9-CP11 Zones) likely corre-
sponds to a climatic optimum, judging from nanofossil assem-
blages dominated by warm-water species. Species diversity, 
however, is not very high.

The middle Eocene shows a great increase in nanofossil pro-
ductivity and species diversity (with a maximum in CP14.2 Sub-
zone), which caused constantly high CaCO3 contents (accompa-
nying by regional aridization), as established by paleoecologic stud-
ies), dropping only in the late Eocene.

This section is clearly rhythmic, consisting of strata several centimeters thick alternately higher or lower in calcareous matter (Milankovitch cyclicity). This rhyth-
micity is better pronounced in the Maastrichtian, Danian, and 
Lutetian (CP13 Zone), and becomes vague to visually almost in 
the aquas. Xena po (CP14 Zone).

In summary, in the benthic evolution two stages with distinctive depositional, geochemical, and biotic features stand out sharply 
against the general carbonate-terrigenous sedimentation: (i) up-
per Tertiary, beginning with a dramatic decrease in CaCO3, just 
before the accumulation of the sapropel bed (terminal CP9 Sub-
zone), followed by sapropel formation (CP8b-CP9b Subzone 
boundary) and accumulation of silicic acid-terrigenous sediments 
(CP9b Subzone), and (ii) Burdigalian (CP14 Zone), characterized 
by OM-rich sediments accumulated in a dysoxic to anoxic envi-
ronment. The main changes in the depositional environment 
were evidently related to eustatic sea-level changes, atmoic epis-
odes, climatic variations, and terrigenous input.

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