

COMPLEX OF MICROFAUNA OF PALEOGENIC SEDIMENTS AND RECONSTRUCTION OF THE BIONOMY OF THE BASIN BASED ON THE CUT OF KHILOMILLI IN THE GOBUSTAN REGION OF SOUTH-EAST CAUCASUS

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Summary. The paper is devoted to the biostratigraphic subdivision of the Paleogene deposits in Southeastern Gobustan. The subdivision was carried out on the basis of materials obtained from the Khilomilli section. Foraminiferal studies were conducted on samples collected from this section. The stratigraphic division of the Paleogene deposits in the studied area is thoroughly substantiated by foraminiferal data and traced throughout the Khilomilli section. Based on the rich foraminiferal assemblages within the section, the detailed stage- and zone-level subdivision of the Paleogene sequence was established. According to the microfaunal evidence, the Paleogene deposits are divided into the Paleocene, Eocene, and Oligocene series and their respective stages. It was determined that the rocks of the Danian and Thanetian (Paleocene), Ypresian, Lutetian, Bartonian, and Priabonian (Eocene), as well as the Rupelian (Oligocene) stages are represented in the Khilomilli section. Continuous tracing of the microfauna across the section allowed a precise interpretation of the complex composition of zones and changes within them. The distribution of foraminifera by zones was followed, and their development across the stages was described. At the same time, deposits of the Selandian stage were not detected in the section. Comprehensive data on the bionomy of the basin have also been provided.

Keywords: *Foraminifera, fauna, Paleocene, Eocene, Oligocene, plankton, basin, Paleogene, microfauna*

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Introduction

Gobustan is one of the areas in Azerbaijan where the Paleogene deposits are widely distributed. These deposits participate in the formation of the entire geological structure in the region (Ахмедов, 1957). Since the Paleogene deposits are also related to several mineral deposits, clarification of their stratigraphic subdivision scheme is essential (Fig. 1) (Халилов, Мамедова, 1984).

The microfauna of these deposits were studied by micropaleontologists Aghalarova D.A., Jafarov J.I., Khalilov D.M (Халилов, 1962), Veber V.V., Voroshilova A.G. and others (Ворошилова, 1967). The Paleogene deposits sharply differ in lithological composition both horizontally and vertically across regions and are characterized by diverse fossil faunas (Вебер, 1930). Based on microfauna, the Paleo-

gene deposits are divided into Paleocene, Eocene and Oligocene subdivisions and stages (Babayev və b., 2015).

Materials and Methods

The researches were conducted in Gobustan district of the Southeastern Caucasus. In this area, the Paleogene deposits of the Khilomilli section were studied. For the purposes of studying the complex microfauna of the Paleogene deposits in Gobustan district and restoration of the basin bionomy, 16 samples were collected from the Khilomilli section, and their paleontological analysis was conducted, stage and zonal subdivision of foraminifera of the Paleogene deposits of Gobustan district were provided on the basis of the identified rich foraminiferal assemblage (Ализаде, 1989).



Collection of microfauna was carried out using a Nikon SMZ18 microscope, and images were obtained using a ZEISS Stemi 508 scanning electron microscope. The sample was studied using micropaleontological analysis. The sequential distribution and zonal subdivision of microfauna of the Paleogene deposits were observed in the Khilmilli section (Fig. 2).

The Paleocene. The Paleocene is divided into the Danian, Selandian, and Thanetian stages in the studied region. These deposits belong to the Ilkhydagh and Sumgayit successions.

The Lower Paleocene. The Danian stage. The Ilkhydagh succession belongs to this stage. The deposits of the Danian stage of the Khilmilli section of Gobustan are subdivided into two zones from bottom to top: *Globoconusa daubjergensis* and *Acarinina incostans*.

The deposits of *Globoconusa daubjergensis* zone conformably lie over the Maastrichtian sediments on the right bank of the Qozluchay, 1-1.5 km east of the Khilmilli village. Here, the Danian deposits consist of thinly interbedded, commonly found coarse-grained, hard, yellowish sandstones and thinly bedded gray, dark grey marly clays (Fig. 2). *Eponides trumpyi*, *Heterohelix irregularis*, *Globigerina varianta*, *G. moskvini*, *G. pseudobulloides*, *Bairdia ilaroensis*, etc. were determined from these deposits (Allahverdiyeva, 2014).

In the Khilmilli section, the deposits of the *Acarinina incostans* zone of the Danian stage are distributed together with the deposits of the underlying zone (Fig. 3) (Allahverdiyeva, 2012).

In this section, the deposits of the *Acarinina inconstans* zone conformably lie over the deposits of the lower zone occurring in the same lithofacies, reaching thicknesses of up to 20 m, and are characterized by *Eponides trumpyi*, *Heterohelix irregularis*, *H. pumilia*, *H. crinita*, *H. midwayensis*, *Acarinina inconstans*, etc.

The Upper Paleocene: The Selandian and Thanetian stages are distinguished within the Sumgayit successions.

The deposits of the Selandian stage were not been detected in the Khilmilli section.

The Thanetian stage deposits were subdivided from bottom to top, into the *Globorotalia conicotruncata*–*Acarinina subsphaerica* and *Globorotalia aequa*–*Acarinina clara* zones (Халилов, Мамедова, 1984).

In contrast, our studies of the Khilmilli section reveal that, the sequence is subdivided from bottom to top into the *Acarinina subsphaerica* and *Acarinina acarinata* zones within the Thanetian stage.

According to our researches, the Thanetian stage is subdivided into two zones in the Khilmilli section from bottom to top: *Acarinina subsphaerica* and *Acarinina acarinata*.

Acarinina subsphaerica zone is represented by greenish-gray, dark gray, and gray marly clays in the Khilmilli (50 m) section and they are replaced upward by sandstone interbeds within brick-red to greenish-gray clays. *Globorotalia compressa*, *Acarinina subsphaerica*, *Globigerina varianta*, *G. triloculinoidea*, *Ammodiscus incertus*, *Rhabdammina cylindrica*, *Glomospira corona*, etc. are distributed in these sediments. The Upper Paleocene lies over the layers of the Danian stage in the Khilmilli section transgressively. (Allahverdiyeva, 2014)

The *Upper Acarinina acarinata* zone of the Thanetian stage is represented by alternation of interbeds of brick-red, reddish-brown, and greenish-gray clays with sandstone interlayers in the Khilmilli section. The thickness of these deposits varies between 10-100 m, and they lie conformably over the underlying sediments. *Globigerina triloculinoidea*, *G. eoceanica*, *G. quadrilobulinoidea*, *G. nana*, *G. compressaformis*, *G. velascoensis*, *Globorotalia chapmani*, *G. occlusa*, *Acarinina intermedia*, *Ac. primitiva*, *Ac. acarinata*, *Glomospira corona*, etc. are distributed in these deposits (Fig. 4).

The Eocene. The Qovundagh succession belongs to the Eocene in the Southeastern Caucasus. The Qovundagh succession is divided into lower, middle, and upper horizons based on field color. According to the local subdivision, the Ypresian stage belongs to the Lower Qovundagh, the Lutetian and Bartonian stages belong to the Middle Qovundagh, and the Priabonian stage belongs to the Upper Qovundagh. These sediments are mainly characterized by the planktonic foraminifera.

The Qovundagh sediments of the Paleogene are oil-bearing in the region (Aghayeva et al., 2023).

The Lower Eocene sediments are separated within the Ypresian stage and subdivided from bottom to top into three microfaunal zones:

Globorotalia subbotinae, *Globorotalia marginodentata*, and *Globorotalia aragonensis*.

The deposits of the *Globorotalia subbotinae* zone lie conformably over the Upper Paleocene deposits in the Khilmilli section. They are represented by alternations of thin-bedded gray clays with rare sandstone interbeds. The thickness is 10 m. *Anomalina* ex. gr. *affinis*, *Globorotalia marginodentata*, *Gl. subbotinae*, *Bolivina aduncoscostata longa*, *Acarinina interposita*, *Globigerina triloculinoidea*, etc. were distributed here (Fig. 4).

In the Khilmilli section, since the *Globorotalia marginodentata* and *Globorotalia aragonensis* zones could not be distinguished, this zone lies transgressively over the sediments of the lower zone.

The Middle Eocene. The Lutetian and Bartonian Stages. It is characterized by the instability of the Qovundagh lithofacies and its thickness.

Acarinina bullbrooki, *Acarinina rotundimarginata*, and *Hantkenina alabamensis* zones are distinguished in the Lutetian stage of this region.

In the Khilmilli section, the deposits of *Acarinina bullbrooki* zone consist of alternation of gray clay layers. Thin, fine-grained clayey sandstone layers are occasionally encountered among them. Thick-bedded (5 m) clay lies at the lower part of this zone. Total thickness is 19 m. *Acarinina bullbrooki*, *Anomalina simplex*, *Globigerina eoceanica*, *Asterigerina bartoniana*, *Tritaxilina indentata* were detected here.

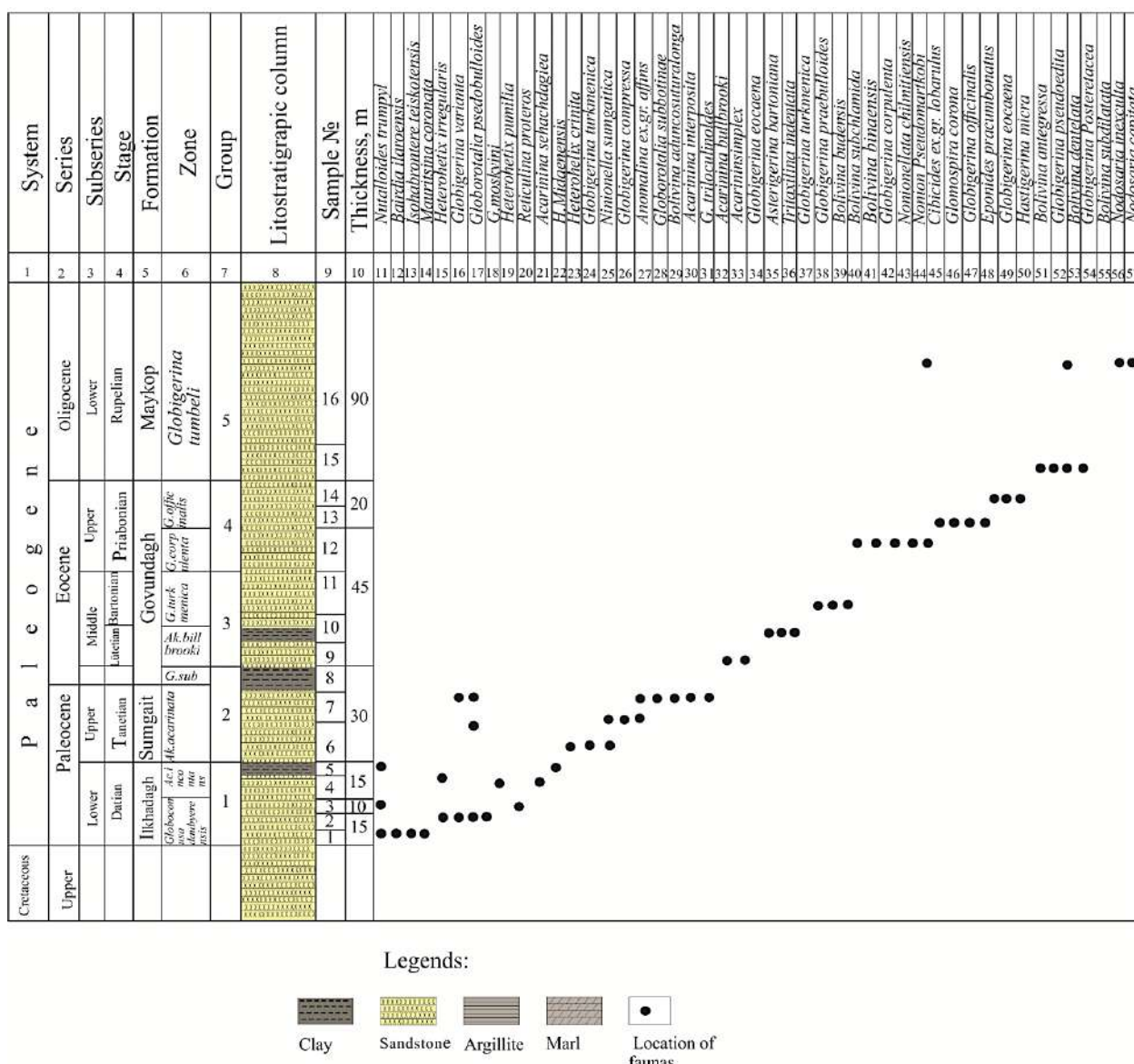


Fig. 3. Distribution of the microfauna in the Khilmilli section

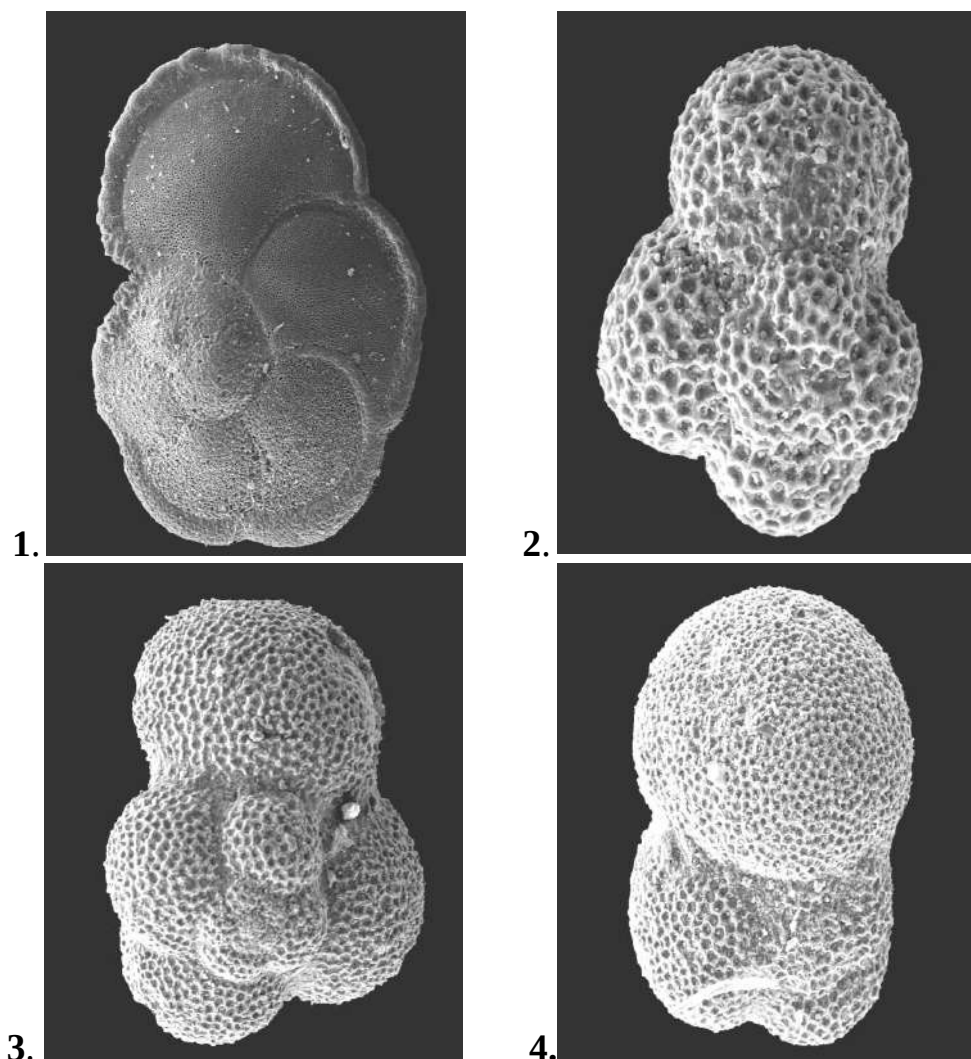


Fig. 4. Microfaunal Complex of the Paleogene Sediments:
1 – *Globorotalia marginodentata* Subbotina; 2 – *Globigerina eoceanica*; 3 – *Globigerina bulloides* Orbigny; 4 – *Acarinina acarinata* Subbotina

The *Globigerina turkmenica* zone is distinguished in sediments of the Bartonian stage. This zone is well developed in the Khilmilli section. It is composed of thin to medium (10-30 cm) sandstone interbeds alternating with greenish-gray, reddish, marly clays, and sandy clays. *Globigerina turkmenica*, *G. praebulloides*, *Bolivina budensis*, *Hastigerina micra*, *Globigerina ouachitaensis*, *Nonion adgerensis*, *Cibicides ungerianus*, etc. are distributed in these deposits.

In the Khilmilli section, the sediments of this zone lie over the sediments of the lower zone transgressively. *Acarinina rotundimarginata* and *Hantkenina alabamensis* zones have not been distinguished in the Khilmilli section.

The Upper Eocene. The Priabonian Stage. The Priabonian deposits are subdivided

into *Globigerina corpulenta* and *Globigerina officinalis* zones. In the Khilmilli section, the *Globigerina corpulenta* zone is represented by sandstone interbeds alternating with dark-gray clays. *Globigerina corpulenta*, *G. eoceanica*, *G. inflata*, *G. praebulloides*, *Globigerapsis index*, *G. ouachitaensis*, *Bolivina caucasensis*, *Nonion rotulum*, *Anomalina hantkeni*, *A. granosa*, *Cibicides perlucidus* were detected in these sediments. The thickness is 60 m.

In the Khilmilli section, the deposits of the *Globigerina officinalis* zone lie over the *Globigerina corpulenta* zone conformably. *Cibicides ex. gr. lobatulus*, *Glomospira charoides*, *Globigerina officinalis*, *G. eoceanica*, *Eponides praeumbonatus*, *Hastigerina micra*, *Bolivina antegressa* were distributed in sandstone interlayers within gray, green, and reddish-brown

clays (up to 20 m thick) in the sediments related to this zone.

The Oligocene. The Rupelian stage. The Oligocene deposits make up the lower part of the Maykop deposits in the Southeastern Caucasus.

The deposits of the Rupelian stage conformably lie over the Priabonian deposits in the Khilmilli section. *Globigerina tumbeli* zone was distinguished in these deposits. The deposits of the described zone are characterized by gray, greenish-gray, and dark gray thin clay layers. Yarosite and Manganese oxide layers are observed on these clays. These clays are characterized by the presence of *Globigerina tumbeli*, *Glomospira charoides*, *Ammodiscus incertus*, *Ammosphaeroidina caucasica*, *Nonion pseudomartkobi*, *Bolivina dentalata*, *Nodosaria inexculta*, *N. capitata*.

Bionomy of the basin

The Southeastern Caucasus developed under an independent and distinct geotectonic condition. During the Paleogene period, volcanic activity occurred at different times with varying intensity across different regions. The Eocene, particularly the Middle Eocene basins had distinct paleogeographic landscape and bionomic condition in the regions of Azerbaijan. Products of intermittently submarine-erupting volcanoes in various areas played a significant role in sedimentation processes, in the modification of basin parameters, and in some regions, in the deterioration of its ecological conditions. Since geological events occurred with different intensities across regions, the species and genus composition of biotas, as well as the number of their individuals varies significantly on areas (Babayev və b., 2015).

During the Paleogene period, light-colored clays, minor clay-carbonate mixtures, and sandy sediments were deposited in the basin in the Southeastern Caucasus. Benthic and planktonic foraminifera were widely developed in the basin, whereas conditions were unfavorable for macrofauna. During the Paleogene period, the development of the microfauna of Azerbaijan proceeded in four distinct stages: The Paleocene–Early Eocene, The Middle Eocene,

The Late Eocene, and The Early Oligocene. Changes in the composition of complexes and foraminiferal morphology were observed throughout these stages (Герасимов, Мещеряков, 1964).

During the Lutetian stage of the Middle Eocene, the part of the Upper Koun and the lower layers of the Middle Koun, and during the Bartonian age, the lower part of the Middle Koun and the Upper Koun were deposited in the basin in the South-Eastern Caucasus. When the Koun formation was deposited in basin, bionomic conditions began to recover. The rhythmic alternating layers of the Koun formation are thicker compared to Paleocene rhythms. It can be assumed that the sea depth also decreased slightly. As a result of these changes, no fauna other than benthic and planktonic microfauna developed in the basin (Bağmanov, 2005).

Conclusions

Based on researches carried out in the Khilmilli section of the Gobustan region in the South-Eastern Caucasus, the following results were obtained:

- The stratigraphic subdivision of the Paleogene deposits was established using the rich foraminiferal assemblages identified from the samples collected in the Khilmilli section. It was determined that the Khilmilli section contains rocks belonging to the Paleocene, Eocene, and Oligocene series. In particular, deposits corresponding to the Danian and Thanetian (Paleocene), Ypresian, Lutetian, Bartonian, and Priabonian (Eocene), as well as the Rupelian (Oligocene) stages are present. At the same time, deposits of the Selandian stage were not detected within the section.

- A zonal subdivision of planktonic foraminifera within the Paleogene deposits was presented. The distribution of foraminifera across the zones was traced, and their evolutionary development was described. The complex composition of zones and changes observed within them were thoroughly interpreted. In addition, comprehensive data on the bionomy of the basin was provided.

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КОМПЛЕКС МИКРОФАУНЫ ПАЛЕОГЕНОВЫХ ОТЛОЖЕНИЙ И РЕКОНСТРУКЦИЯ БИОНОМИИ БАССЕЙНА НА ОСНОВЕ РАЗРЕЗА ХИЛЬМИЛЛИ В ГОБУСТАНСКОМ РАЙОНЕ ЮГО-ВОСТОЧНОГО КАВКАЗА

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Резюме. Статья посвящена биостратиграфическому расчленению палеогеновых отложений Юго-Восточного Гобустана. Расчленение выполнено на основе материалов, полученных из разреза Хильмилли. По образцам, отобранным в данном разрезе, проведены исследования фораминифер. Стратиграфическое подразделение палеогеновых отложений изучаемой территории детально обосновано по данным фораминифер и прослежено по всему разрезу Хильмилли. На основе богатых ассоциаций фораминифер в разрезе установлено подробное деление палеогеновой толщи на этажи и зоны. Микрофаунистические данные позволили разделить палеогеновые отложения на палеоценовый, эоценовый и олигоценовый отделы и их стратиграфические подразделения. Установлено, что в разрезе Хильмилли присутствуют породы датского и танетского (палеоцен), ипрского, лютетского, бартонского и приабонского (эоцен), а также рупельского (олигоцен) ярусов. Прослеживание микрофауны по разрезу позволило точно интерпретировать комплексный состав зон и изменения, происходящие в их пределах. Выявлено распределение фораминифер по зонам и описано их развитие по стратиграфическим уровням. В то же время в разрезе не обнаружены отложения зеландского яруса. В работе также приведены обоснованные сведения о биомии бассейна.

Ключевые слова: Фораминиферы, фауна, палеоцен, эоцен, олигоцен, планктон, бассейн, палеоген, микрофауна

CƏNUB-ŞƏRQİ QAFQAZIN QOBUSTAN VİLAYƏTİNDƏ PALEOGEN ÇÖKÜNTÜLƏRİNİN XİLMİLLİ KƏSİLİŞİNDƏ KOMPLEKS MİKROFAUNASI VƏ ONA ƏSASƏN HÖVZƏ BİONOMİYASININ BƏRPASI

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Xülasə. Məqalə Cənubi-Şərqi Qobustanın Paleogen çöküntülərinin biostratigrafik bölgüsünə həsr edilmişdir. Bölgü Xilmilli kəsilişindən götürülmüş materiallar əsasında aparılmışdır. Kəsilişdən götürülmüş nümunələrin əsasında foraminiferlərin tədqiqatı aparılmışdır. Tədqiq olunan ərazidə Paleogen çöküntülərinin stratigrafik bölgüsü foraminiferlərə görə ətraflı əsaslandırılmış və Xilmilli kəsilişində izlənilmişdir. Kəsilişdə Paleogen çöküntülərinin zəngin foraminifer assosiasiyası əsasında mərtəbə və zonal bölgüsü verilmişdir. Paleogen çöküntüləri mikrofauna vasitəsilə Paleosen, Eosen və Oligosen şöbələrinə və mərtəbələrə bölünür. Müəyyən edilmişdir ki, Xilmilli kəsilişində Danimarka, Tanet, (Paleosen) İpr, Lütet, Barton, Priabon (Eosen), Rupel (Oligosen) mərtəbələrinin süxurları iştirak edir. Kəsiliş üzrə mikrofaunanı izləməklə zonaların kompleks tərkibi və onlardakı dəyişikliklər dəqiq şərh edilmişdir. Foraminiferlərin zonalar üzrə paylanması izlənmiş və onların mərtəbələr üzrə inkişafı təsvir edilmişdir. Eyni zamanda kəsilişdə Zeland mərtəbəsinin çöküntüləri aşkar edilməmişdir. Hovzənin bionomiyası haqqında da əsaslı məlumat verilmişdir.

Açar sözlər: Foraminiferlər, fauna, Paleosen, Eosen, Oligosen, plankton, hovza, Paleogen, mikrofauna