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BIOMAGNETOSTRATIGRAPHY OF THE EASTERN GOBUSTAN'S PALEOGENE ROCKS

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ABSTRACT

On the territory of Azerbaijan, Paleogene deposits are widespread and often have facies alteration. To address the issues of stratigraphic, paleogeography, facies and paleoecological directions, a detailed stratigraphic basis of both the region as a whole and its individual sections is required. This article presents the results of joint magnetobiostratigraphic studies of the Paleogene deposits of the Greater Caucasus (Azerbaijan) in order to clarify the boundaries of the Paleocene, Eocene, Oligocene and Miocene. Biostratigraphically dated Paleogene deposits of the Khilmili, Pirakushkul, Dzhangi sections (southern slope of the Greater Caucasus) were chosen as the object of study. Paleomagnetic studies of the Paleogene deposits of Azerbaijan showed frequent reversals of the geomagnetic field of this period. The results of scientific studies of the southern slope of the Greater Caucasus confirmed this fact. We have identified two paleomagnetic zones: 1) Khorem (Maastrichtian 70 Ma - Eocene 45 Ma) (zones of reverse polarity prevail in it, but the upper part of the Paleocene has a direct polarity) and 2) Sogdiana (RN-Oligocene and Miocene - characterized by alternating direct and reverse polarity paleomagnetic field). In the Lower Paleocene, 2 subzones of direct polarity were distinguished: Danian and Selandian. The position of the R-zone made it possible to draw the boundary between the Danian and Selandian stages. The identification of a paleomagnetic zone of reverse polarity contributed to the determination of the boundary between the Selandian and Thanetian stages. This result was confirmed by identifying changes in the micro-faunistic composition of deposits and observing the nature of variations in micro-floristic complexes. Such a paleomagnetic zone of reverse polarity is the benchmark (plug) for establishing the boundary between the Mons and Thanetian stages.

KEYWORDS:
Paleomagnetism;
Southern slope of the Greater Caucasus;
Paleogene;
Magnetostratigraphic boundaries.

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Introduction

Paleogene deposits are widespread throughout the territory of Azerbaijan from the western borders to the Caspian Sea. We chose the region of the southern slope of the Greater Caucasus as the study area, where Paleogene deposits are well represented by the Khilmili, Pirakushkul and Dzhangi-Siyaki sections (fig.1)

For more than a hundred years, the microfauna and stratigraphy of the Paleogene deposits have been studied by many prominent researchers. Among them I. M. Gubkin (1914), D. V. Golubyatnikov (1915), A. A. Alizade, (1989), A. A. Alizade, S. A. Babaev, N. A. Mamedov, R. O. Goshgarli, Kh. Aliulla, S. A. Shikhlinsky (1989), M. A. Bagmanov (2005) and others. However, to clarify the stratigraphic position of these deposits, a number of studies are required.Paleogene sediments of the southern slope of the Great Caucasus have very little fauna and microfauna, and are rarely found in some strata. This, in turn, makes it impossible to give the exact stratigraphic age distribution, the boundaries between floors and half floors [4-8].

We know that it is possible to carry out accurate age distribution of rocks by the paleomagnetic method. Both paleomagnetic and paleontological studies were carried out in Paleogene-aged sediments of the studied area, and accurate age distribution was given between basement and half-floors.

Biostratigraphic features - The Paleogene-Paleocene, Eocene and Oligocene layers were studied in the article and each layer was considered separately.

The Khilmili section covers deposits corresponding to the upper Maikopian, faunistically characterized by ostracods. The deposits of the section, with a total

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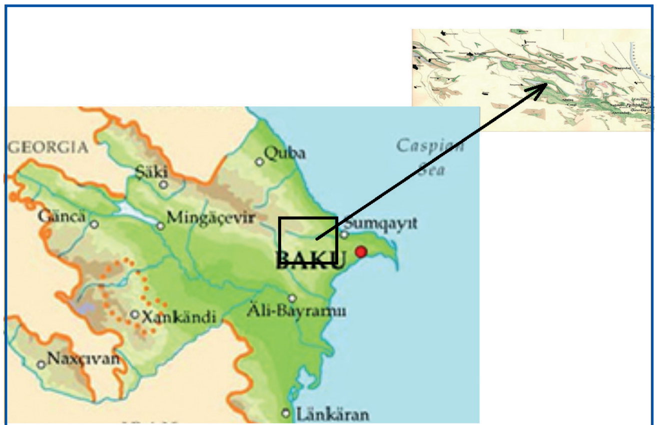

Fig. 1. Place of sampling

thickness of 185 m, are lithologically represented by dark clays from gray to black with layers of mica and the remains of tree trunks.

The Khilmili section consists of Paleocene, Eocene and lower Oligocene strata. In Paleocene sediments, gray, greenish-gray, reddish-brown marly clays with rare limestone, gravelite and conglomerate in interlayers are *Globoconusa daubyerensis, Acarinina inconstans, Nutalloides trumpyi, Heterohelix irregularis, Globigerina varianta, Bairdia ilaroensis etc.* determined.

In the Eocene floor, it is represented by greenish gray, dark gray, gray clays, marly clays, and in these sediments *Globorotaliacompressa, Acarininasubsphaerica, Globigerina varianta, G. triloculinoides, Ammodiscusincertus, Rhabdamminacylindrica, Glomospira corona etc.* is spread. In the Khilmili section, the Upper Paleocene lies transgressively on the Denmark floor.

The Ypresian sediments lie conformably on the upper Paleocene sediments and are represented by the alternation of rare thin-plate gray clays in the interlayers. Here *GloborotaliasubbotinaeAnomalina ex. Gr. affinis, Bolivinaaduncosutura longa, Acarininainterposita, Globigerina triloculinoides etc.* is spread (fiq. 2).

Acarininabullbrooki, Ac.rotundimarginata, Globigerina eocaenica, Hantkeninaaragonensis and *Globorotaliarotundimarginata, Globigerapsissubconglobatus* and *Hantkeninaalabamensis* were identified in the Lutetian sediments. Among them, there are layers of small-grained clayey sandstone.

In the Khilmili transect, the sediments of the upper Eocene Priabonian floor were *Globigerina corpulenta, G.eocaena, G. officinalis, Globigerapsis index, Bolivina antegressa, Nonion pseudomartkobi, Nonionella chilmiliensis, Cibicides lobatulus etc., Nonionellata chilmiliensis, Glomospira corona, Hastigerina micra determined.*

The Rupelian floor of the Oligocene department lies suitably on the Priabonian and is expressed by gray, greenish-gray, dark gray low-galin thin layers of clay. Layers of yarosite and manganese oxide are noted on these clays. Clays are characterized by *Globigerina eocaena, G. postcretasea, Hastigerina micra, Ammosphaeroidina caucasica, Nonion pseudomartkobi, Bolivina dentalata, B.antigressa, Nodosaria inexculta, N. capitata.*

The Pirakishkul section (total thickness 616.5 m) is located near the Pirakishkul village of the same name on the southeastern flank of the East Dzhangi syncline. The studied Oligocene deposits are underlain by Eocene deposits, but the line of contact cannot be traced. This contact is hidden under the scree (8 m).According to the section, the Maykop series of rocks is subdivided into 2 sections (from bottom to top). The lower section (553 m thickness) is represented by clays (from gray to brown), sandstones, and dolomitic limestone at the base. The upper section (63 m thick) is represented by lilac and brown clays with layers of platy sandstone and concretions. The contact of the Maykop deposits with the underlying Eocene deposits is smoothly marked by the disappearance of such forms of foraminifers as Subbotinaeocenicairregularis and *Globorotaliapraebulloides* and *a sharp decrease in the number of individuals of Globigerina ofisinalis Subb.*

In the Selandian and Thanetian floors, sandstones with intermediate layers of brick-red, reddish-brown, and greenish-gray clays. *Globigerina triloculinoides, G. eocaenica, G. quadritriloculinoides, G. nana, G. compressaformis, G. velascoensis, Globorotalia chapmani, G. occlusa, Acarinina intermedia, Ac. primitiva, Ac. acarinata, Glomospira corona etc.* are common [1,2,7,8].

The sediments of the Ypresian floor are represented by gray, dark gray clays. *Globorotaliamarginodentata, G. subbotinae, Acarininaacarinata* are recorded in these clays.

The Lutetian floor is represented by gray, dark gray clays. In these clays, *Acarininaacarinata, Globorotaliamarginodentata, G. subbotinae, Globigerina triloculinoides, G. eocaenica, G. compressaformis, Acarininaacarinata, Cibicidesfelix, Anomalina ex. Gr. affinis etc.* is recorded.

Globigerapsis index, Gglobigerina turkmenica, G. eocaena, G. tetracamarata, Cibicides eocaenicus, Nonion pseudomartkobi are widely distributed in the dark gray clays with interlayers of sandstones in the Priabonian floor (fiq. 3.).

In the Pirakuşkul section, the sediments of the Rupelian floor are green-gray, *Nonion pseudomartkobi, Globigerina tetracamerata, Globigerapsis index, Cibicides eocaenus* are found in green clays. The total thickness of lower Maykop sediments reaches 215 m in this section.

The Dzhangi settlement is located near the village of the same name. The section consists of Eocene, Oligocene sections, and its thickness is 289 m. Lithologically, it consists of dark gray sheet clays and sandy clays.

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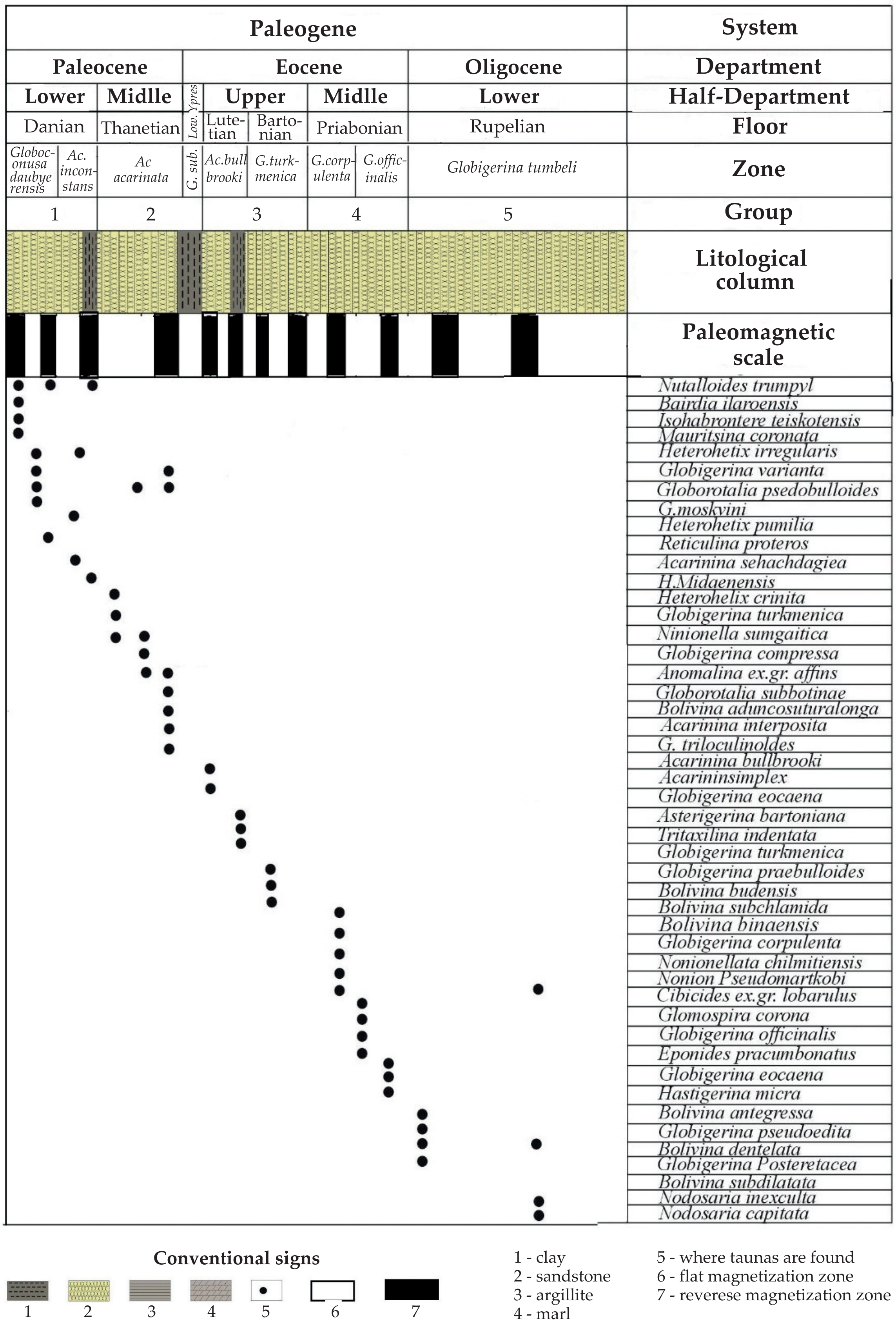

Fig. 2. Distribution of the paleomagnetic scale and microfauna Khilmili section

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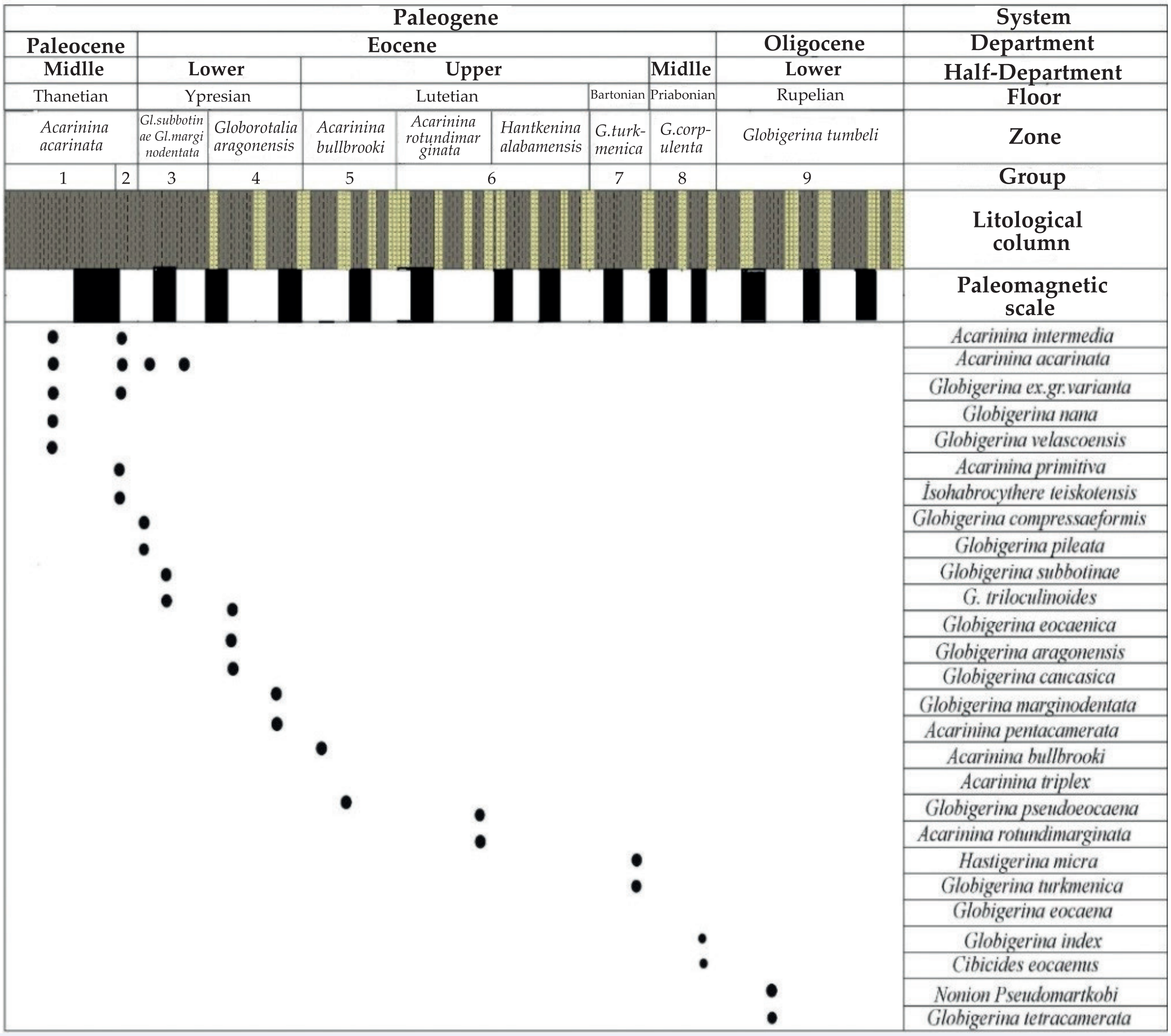

Fig. 3. Distribution of the paleomagnetic scale and microfauna Pirakishkul section

Globorotalia aragonensis, Eponides trumpymagnocamerata, Heterohelix pumilla, Ammodiscus incertus was determined in bentonite clays and rarely in marly clays with sandstone in the Ypresian level of Dzhangi cross section (fiq.4).

Over the Lower Eocene, relatively thin (5-10 cm) brownish-brown, greenish-gray oily clays alternate with the least thick (4-8 cm) fine-grained sandstones.In these sediments *Globigerina ex. gr.bacuana, Heterohelixpumilla, Ammodiscusincertus, Acarininapentacamerata* are widespread. In the Lutetian floor, gray, dark gray, thin-layered, tabular oily clays are characterized by *Globigerina corpulenta, G.praebulloides, G. inflata, G. officinalis, G. eocaenica* [7, 8, 15, 16].

The Oligocene sediments lying conformably on top of the Eocene are represented by dark-gray, gray, yellowish-brown, brown, thin-layered clays with a thin layer of sandstone. For the first time, from our analysis, these rocks *Globigerina eocaenica, G. inflata, G. officinalis, G. postcretacea, G. praebulloides,, Hormosina ovulum, Baggina turkmenica, Nonion pseudomartkobi, N. dosularensis, Eponides umbonatus, Glomospira corona, Cibicides pseudoungerianus, C. perlucidus, C.amphisyliensis, C. dutemplei, C. lopjanicus, C. almaensis etc.* has been determined (fiq.5)

Methods and Magnetic mineralogy

For reliable paleomagnetic constructions, first of all, it is necessary to establish the nature of natural remanent magnetization, the primacy of the identified natural residual magnetization (NRM) component, the

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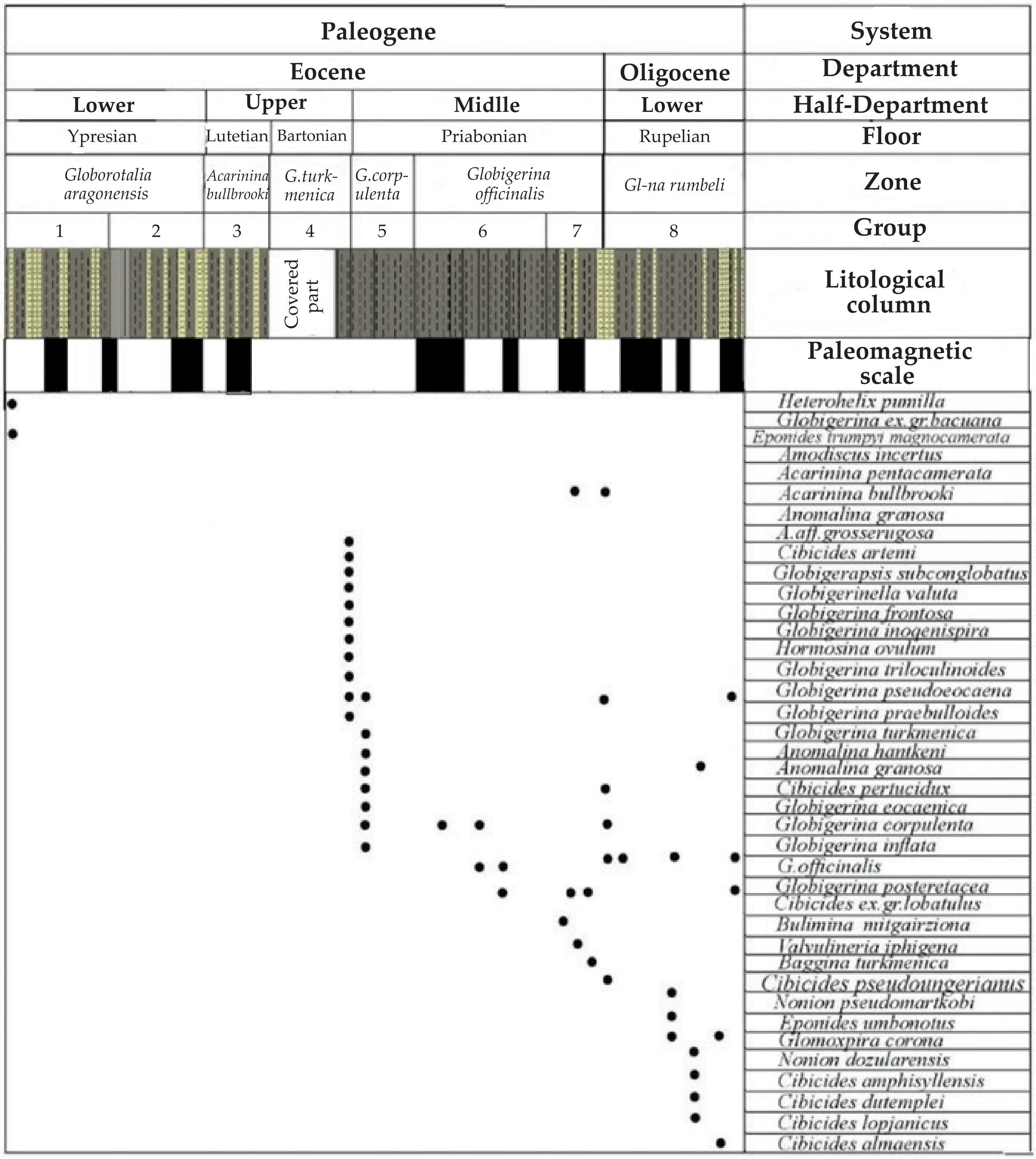

Fig. 4. Distribution of the paleomagnetic scale and microfauna Jangi section

correspondence of the primary component to the time of formation of the studied rocks, and to determine the NRM carrier minerals [3, 9, 12, 14].

For paleomagnetic studies, the samples were taken in those places where the occurrence elements of the layers were confidently measured. Field and laboratory studies were carried out according to the method generally accepted in paleomagnetism. The relative error in determining natural residual magnetization and χ averaged 5-10 %. Natural residual magnetization (NRM) and magnetic susceptibility (χ) of the studied rocks vary within (6-150) × 10^{-3} A/m and (0.25-2.50) × 10^{-3} SI units, respectively.

To identify magnetic minerals-carriers of

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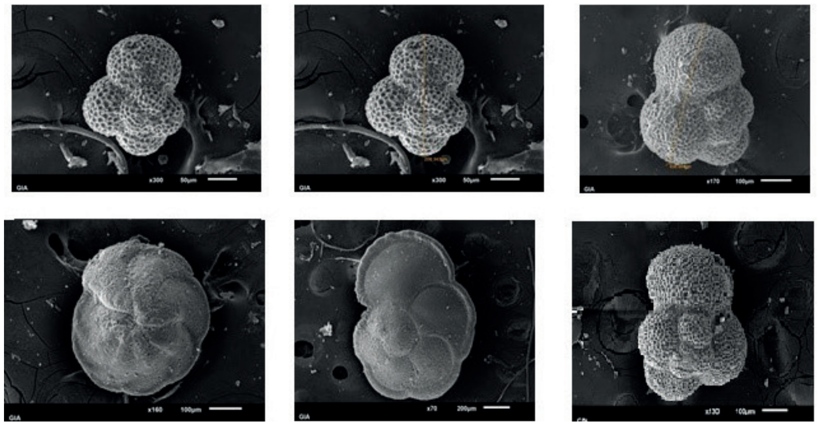

Fauna
1 and 2 - Globigerina officinalis, Subbotina;
3 - Globigerina eocaenica, Terquem;
4 - Globoratalia araqonensis, Nutall;
5 - Globoratalia mardinodentata, Subbotina;
6 - Globoratalia bulloides, Orbigny

Fig. 5. Types of fauna found in the samples

Table 1

Paleomagnetic directions and paleomagnetic poles of the Paleogene

		Area coordinates		Direction *Jn*				Paleomagnetic Pole			
		φ	λ	D_{av}	j_{av}	K	α_{95}	Φ	Λ	θ_1	θ_2
Paleocene	Khilmili	40.5	49.27	355 165	38 -35	9 31	10 8	76 63	240 211	14 9	9 7
	Pirakushkul			25 210	51 -32	18 33	8 9	76 64	201 206	12 10	10 9
Eocene	Khilmily	40.5	49.27	348 198	47 -41	26 30	10 5	68 77	244 254	17 5	10 4
	Pirakushkul			10 178	40 -60	17 20	10 9	64 75	270 170	11 10	8 12
	Dzhangi			350 211	45 -33	19 21	9 11	68 72	237 206	10 11	9 10
Oligocene	Khilmily	40.5	46.27	21 198	59 -44	10 10	11 7	76 72	280 159	14 9	10 8
	Pirakushkul			18 211	52 -33	.7 9	8 11	74 68	264 198	8 10	6 9
	Dzhangi			14 196	54 -39	10 11	6 10	74 72	259158	8 6	107

magnetization, thermomagnetic studies were carried out. The results of thermomagnetic analysis revealed maghemite with T=325-425 °C and magnetite with T=580-600 °C.

To isolate the magnitude and direction of natural residual magnetization, all rock samples were subjected to magnetic cleaning in an alternating magnetic field, thermal cleaning, and cleaning of viscos remanent magnetization. Stable components of natural magnetization, isolated during magnetic cleaning, have on average the same directions, close to the pre-folded magnetization, determined by the method of remagnetization of plane crossing. This indicates the stability of the primary NRM component. The primary magnetization of NRM is 50-70 %, it is maintained in all cleaning methods. The secondary unstable viscous component (VRM) is 30-60 % [3, 11, 13, 14].

Table 1 lists Paleogene paleomagnetic directions and paleomagnetic poles.

Palaeomagnetic results

Thus, field and laboratory paleomagnetic studies of the Paleogene and Miocene rocks of the southern slope of the Greater Caucasus made it possible to determine the directions of natural residual magnetization and the nature of primary remanent magnetization, as well as to prove the synchronism of NRM during the formation of these rocks. Based on these studies, paleomagnetic zones of direct and reverse polarity were identified.

Paleomagnetic data made it possible to clarify the age of a number of geological formations. Thus, the

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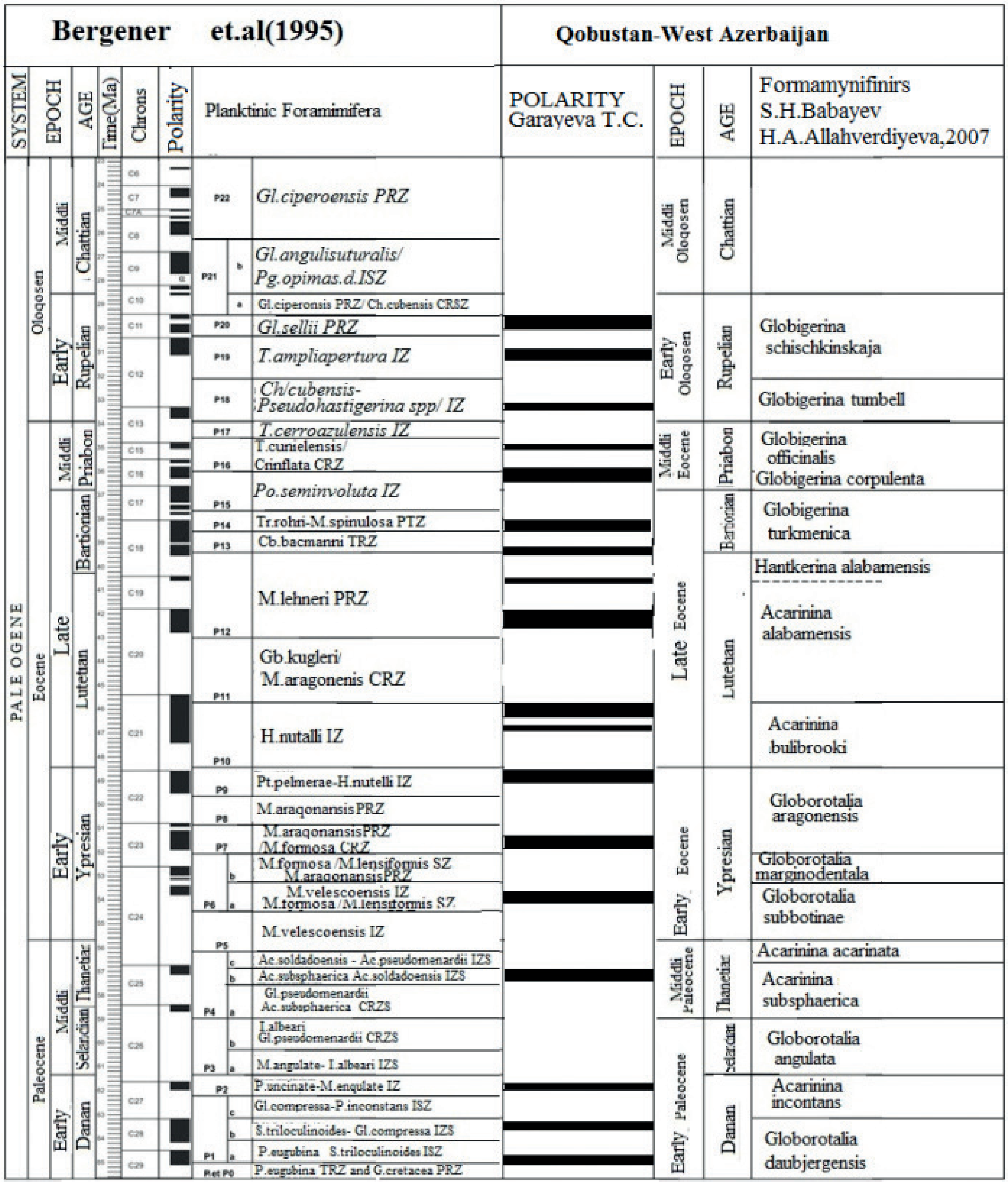

Fig. 5. Scheme of paleomagnetic-stratigraphic correlation of the Paleogene

lower part of the Khadum Formation, which according to geological data is attributed to the Early Oligocene, according to paleomagnetic data, is a Late Eocene formation. In all studied sections of the Paleogene, at the boundary of the Upper Eocene - Lower Oligocene, an R-paleomagnetic zone was distinguished, along which the boundary between the stages was drawn. The coordinates of the paleomagnetic pole calculated for this sequence are characteristic of the Upper Eocene paleopoles (fiq. 6) [9, 10, 14].

The beginning of the Oligocene in Azerbaijan is fixed due to a new cycle of sedimentation, in which

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the sediments are more terrigenous than the underlying Upper Eocene deposits. At the beginning of the Oligocene, in many regions of Azerbaijan, a transgressive overlap of the layers of the Eocene and older deposits is recorded. In some places, basal conglomerates developed, while in others, clayey sediments developed, apparently, on a denuded, almost flat land surface.

Thus, starting from the end of the Middle Eocene, especially in the Upper Eocene and Oligocene, extensive synclinal troughs gradually turned into their opposite - uplifts, forming complex folded structures[12,13,14].

Conclusion

Based on detailed paleomagnetic studies, it has been established that:

- the values of the magnetic susceptibility vary depending on the remoteness of the drift sources and the type of the source itself. This makes it possible not only to quickly carry out the lithological division of sediments, but also to judge the change in the rate of sedimentation in the same type of sediments. It also becomes possible to determine the sources of demolition to the given area of terrigenous and volcanogenic material.
- in the studied area in the Paleogene deposits, the allocation of regional biolithomagnetostratigraphic benchmarks (the border of Danian and Selandian, Selandian and Thenetian, Thenetian and Ypresian, Ypresian and Lutetian, Lutetian and Bartonian, Bartonian and Priabonian, Priabonian and Rupelian) is substantiated. A comprehensive study contributed to the clarification of the stratigraphic position of the proposed lithofacies, reference geological bodies, detailed subdivision of deposits, identification and substantiation of reference sections.
- the obtained data on magnetic properties correlate Cenozoic stratigraphic units within oil and gas structures and determine their volume, which is used for prospecting and exploration for oil and gas.

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