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STRATIGRAPHIC MODEL OF THE MESOZOIC AND CENOZOIC OF THE WESTERN BLACK SEA BASIN

Detail stratiphication of the Mesozoic and Cenozoic of the Western Black Sea Basin has been carried out on the base of biostratigraphic, lithological, geophysical and seismic stratigraphy methods, and interpretation of the available data. Stratigraphic charts of the Mesozoic and Cenozoic deposits have been created. Sections are working out in detail and the peculiarities of the spatial and temporal structure of productive Mesozoic and Cenozoic deposits complex is taking into account. Regional stages, series, formations and packets have been allocated. Their correlation with International Stratigraphic Chart has been established. Their differences and similarities are demonstrated on the base of the correlation of Mesozoic and Cenozoic deposits of the northwestern shelf of the Black Sea.

The Mesozoic-Cenozoic sedimentary complex of the Western Black Sea Basin (WBSB) is represented by the Quaternary (1-3 km), Pliocene (0,5-1,2 km), Oligocene-Miocene (3-5 km), Paleocene-Eocene (3-6 km) and Cretaceous deposits of 16-km total thickness. This sedimentary complex has rather complicated structure and during its existence underwent numerous rebuilding of tectonic plans, inheritance of superimposed structures and inverse movements. The thickness of the Cenozoic deposits, which fill the deep-sea basin, gradually decreases from the center to its edges. The flexure amplitude of the bedding surface increases from recent sediments to old ones: for the base of the Quaternary it does not exceed 2 km, for the top of Maikopian it is 3-4 km, for the Eocene — 5-6 km, and for the base of Paleogene — 7-8 km. Undoubtedly, this points to a long-term and gradual, on the whole, consedimentary downwarping of the basin during the Cenozoic. Adjacent to the continental slope of the Western Black Sea Basin with its shelf occurs in the 100-200 km interval (Odessa area) and has a complicated geologic structure.

The Alpine structural-formation complex consists of the Krylovsky Trough, Kiliya-Zmeiny Uplift Zone, Marginal Escarpment, Karkinita — Northern Crimean Trough, and Kalamita — Central Crimean Uplift Zone (fig. 1).

The structure of the Mesozoic-Cenozoic sedimentary complex is of special interest, because sediments of the Lower and Upper Cretaceous, Paleocene, Maikopian and Neogene are promising for gas and oil. Thus, in the Karkinita North Crimean Trough the most part of explored and supposed hydrocarbon reserves is concentrated.

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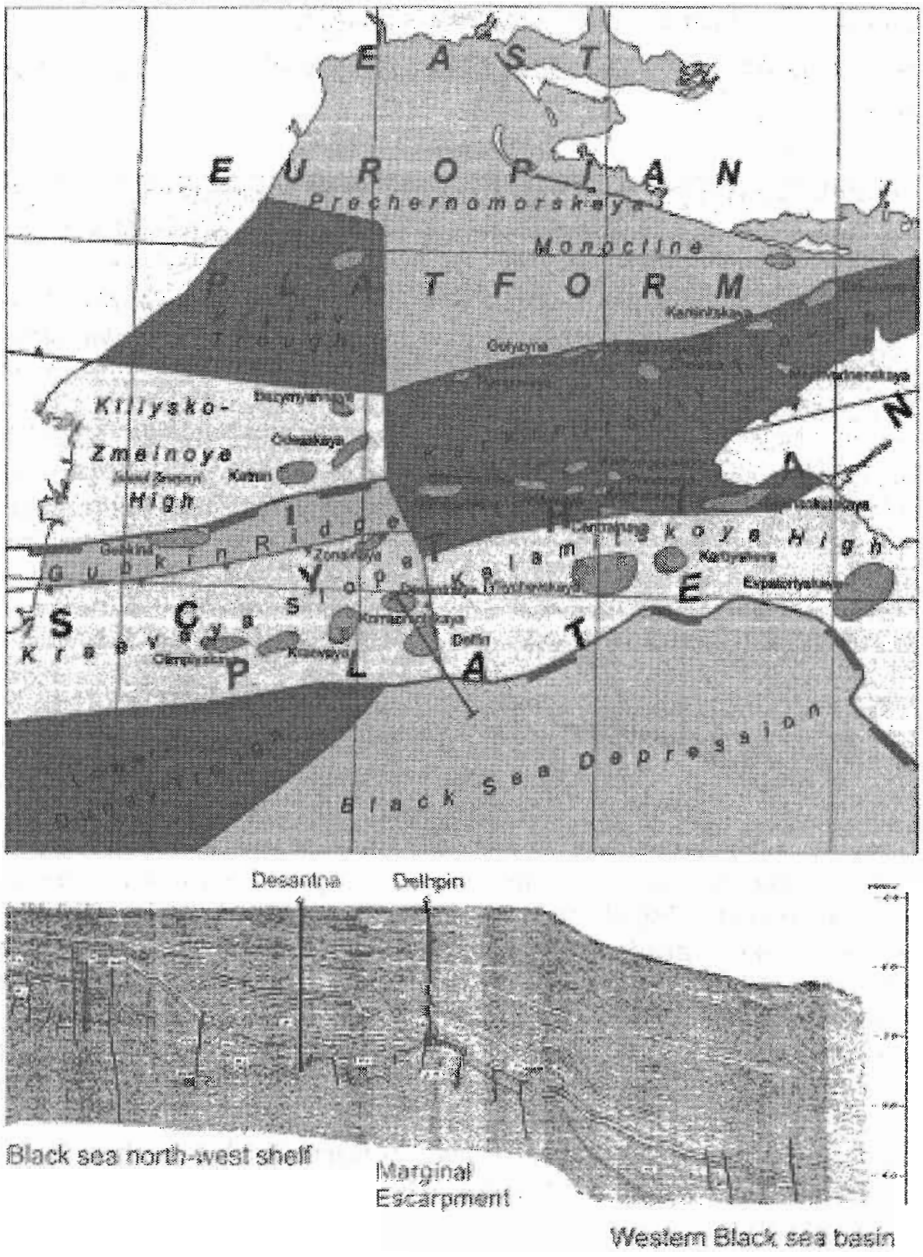
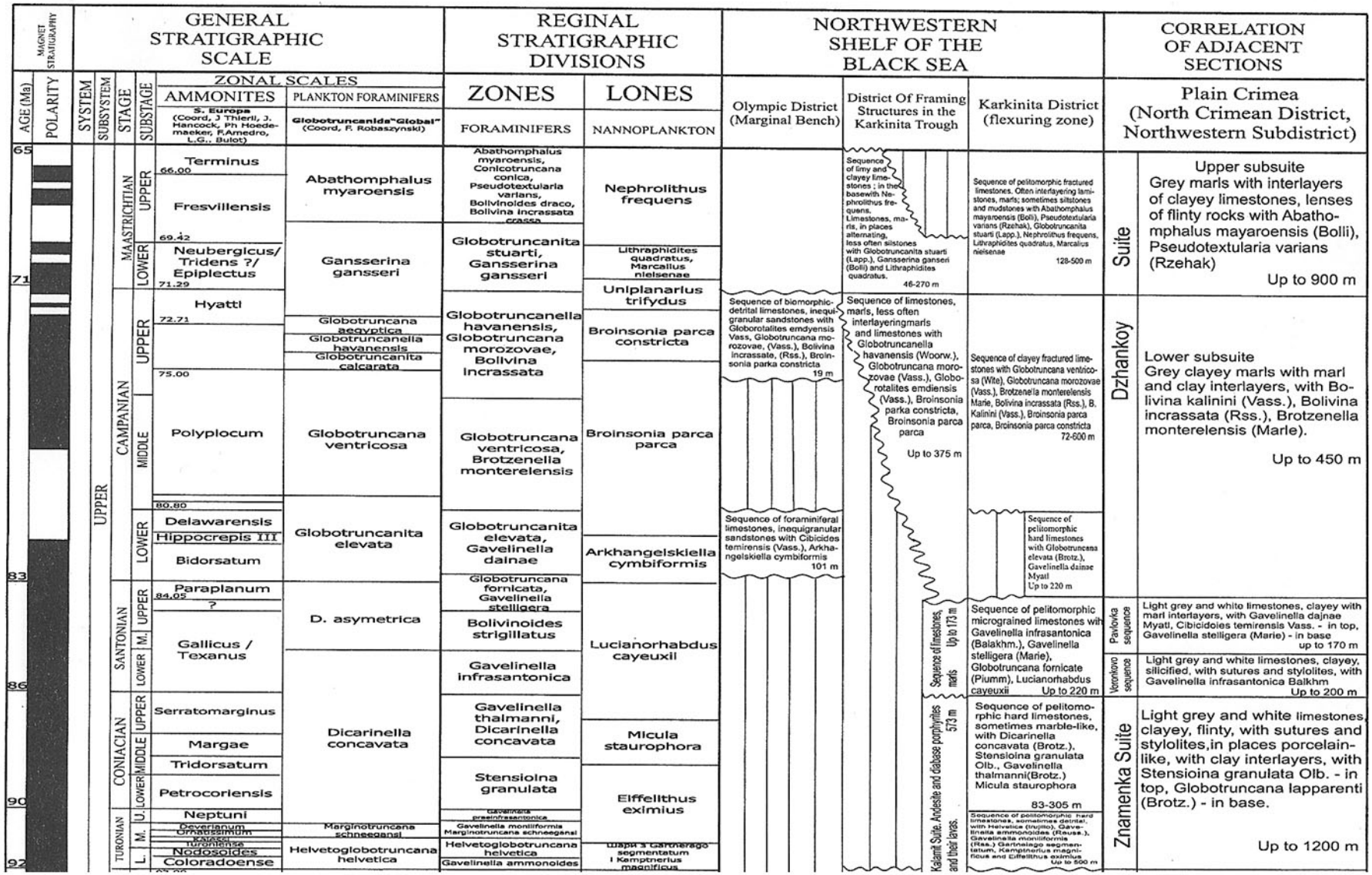


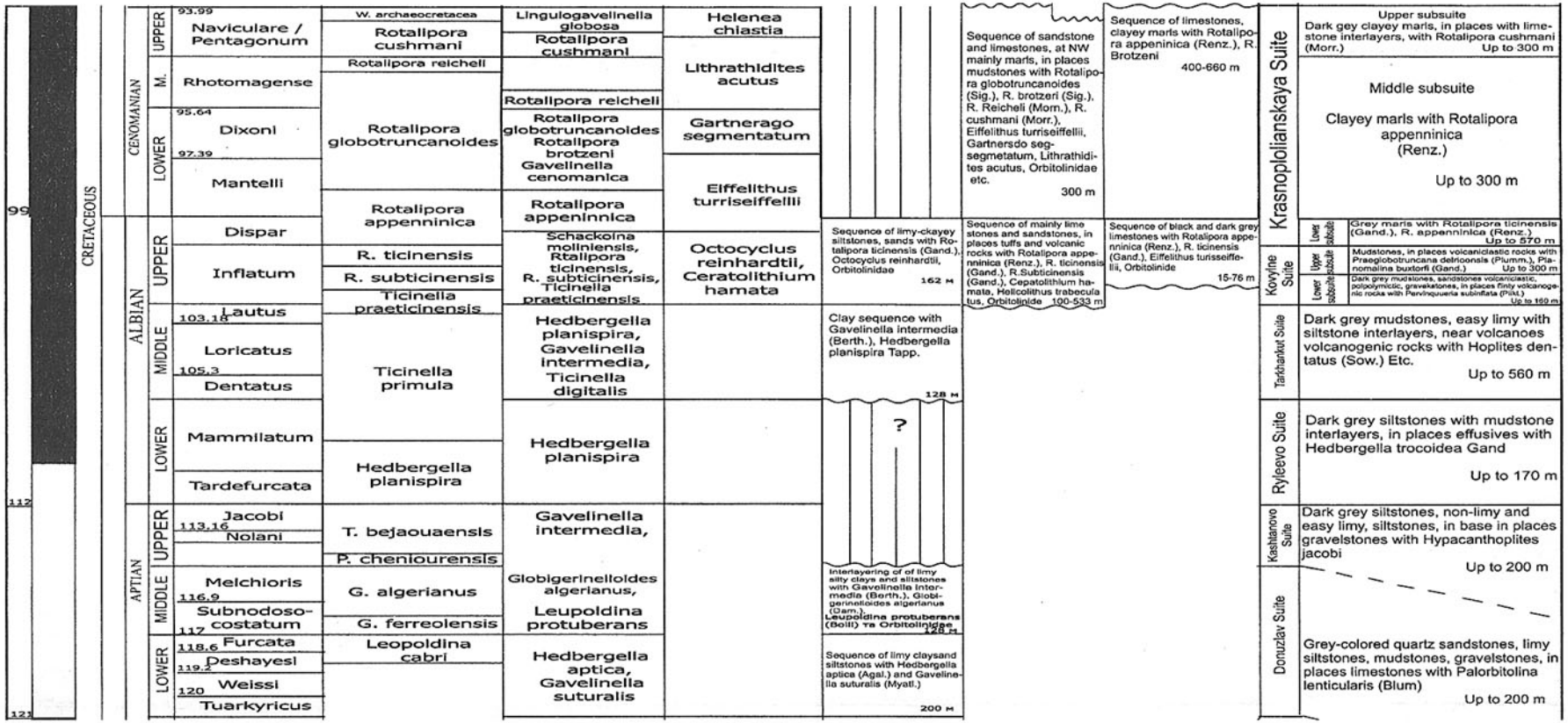
Fig. 1. **Tectonic map and seismic section of the Northwestern Black Sea (by "Sevmorneftegeofizika" [10])**

Considerable thickness of sedimentary deposits, presence of clayey-carbonaceous rocks, reservoir rocks, fluid traps and structural forms determine a high resource potential of the region.

Taking into consideration the riftogenic nature of the Black Sea Basin, considerable thickness of sediments and favorable conditions for hydrocarbon accumulation, we can consider the continental slope also to be highly promising.

In this aspect, a creation of a chronostratigraphic model of the Mesozoic-Cenozoic sedimentary complex of the Black Sea shelf and continental slope,


GENERAL STRATIGRAPHIC SCALE
REGINAL STRATIGRAPHIC DIVISIONS
NORTHWESTERN SHELF OF THE BLACK SEA
CORRELATION OF ADJACENT SECTIONS
MAGNET STRATIGRAPHY
AGE (Ma)
POLARITY
SYSTEM
SUBSYSTEM
STAGE
SUBSTAGE
ZONAL SCALES
AMMONITES
S. Europa (Coord. J Thierll, J. Hancock, Ph Hoedemaeker, F.Amedro, L.G., Bulot)
PLANKTON FORAMINIFERS
Globotruncanide "Global" (Coord. F. Robaszynski)
ZONES
FORAMINIFERS
LONES
NANNOPLANKTON
Olympic District (Marginal Bench)
District Of Framing Structures in the Karkinita Trough
Karkinita District (flexuring zone)
Plain Crimea (North Crimean District, Northwestern Subdistrict)
UPPER
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
Terminus
Fresvillensis
Neubergicus/ Tridens ?/ Epiplectus
Hyatti
Polyplocum
Delawarensis
Hippocrepis III
Bidorsatum
Paraplanum
Gallicus / Texanus
Serratomarginus
Margae
Tridorsatum
Petrocoriensis
Neptuni
Deveriarum
Ornatissimum
Kaasci turonicense
Nodosoides
Coloradoense
Abathomphalus myaroensis
Gansserina gansseri
Globotruncana aegyptica
Globotruncanella havanensis
Globotruncanita calcarata
Globotruncana ventricosa
Globotruncanita elevata
D. asymetrica
Dicarinella concavata
Marginotruncana schneegansi
Helvetoglobotruncana helvetica
Abathomphalus myaroensis, Conicotruncana conica, Pseudotextularia varians, Bolivinoides draco, Bolivina incrassata crassa
Globotruncanita stuarti, Gansserina gansseri
Globotruncanella havanensis, Globotruncana morozovae, Bolivina incrassata
Globotruncana ventricosa, Brotzenella monterelensis
Globotruncanita elevata, Gavelinella dainae
Globotruncana fornicata, Gavelinella stelligera
Bolivinoides strigillatus
Gavelinella infrasantonica
Gavelinella thalmanni, Dicarinella concavata
Stensioina granulata
Gavelinella praeinfrasantonica
Gavelinella monliformis
Marginotruncana schneegansi
Helvetoglobotruncana helvetica
Gavelinella ammonoides
Nephrolithus frequens
Lithraphidites quadratus, Marcalius nielsenae
Uniplanarius trifydus
Broinsonia parca constricta
Broinsonia parca parca
Arkhangelskiella cymbiformis
Lucianorhabdus cayeuxii
Micula staurophora
Eiffellithus eximius
Lapparenti segmentatum
Kamptnerius magnificus
Sequence of biomorphic-detrital limestones, inequigranular sandstones with Globorotalites emdyensis Vass, Globotruncana morozovae, (Vass.), Bolivina incrassate, (Rss.), Broinsonia parka constricta
19 m
Sequence of foraminiferal limestones, inequigranular sandstones with Cibicides temirensis (Vass.), Arkhangelskiella cymbiformis
101 m
Sequence of limy and clayey limestones ; in the basewith Nephrolithus frequens. Limestones, marls, in places alternating, less often silstones with Globotruncanita stuarti (Lapp.), Gansserina ganseri (Bolli) and Lithraphidites quadratus.
46-270 m
Sequence of limestones, marls, less often interlayeringmarls and limestones with Globotruncanella havanensis (Woorw.), Globotruncana morozovae (Vass.), Globorotalites emdiensis (Vass.), Broinsonia parka constricta, Broinsonia parca parca
Up to 375 m
Sequence of limestones, marls Up to 173 m
Kalamit Suite. Andesite and diabase porphyrites 573 m
Sequence of pelitomorphic fractured limestones. Often interlayering lamistones, marls; sometimes siltstones and mudstones with Abathomphalus mayaroensis (Bolli), Pseudotextularia varians (Rzehak), Globotruncanita stuarti (Lapp.), Nephrolithus frequens, Lithraphidites quadratus, Marcalius nielsenae
128-500 m
Sequence of clayey fractured limestones with Globotruncana ventricosa (Wite), Globotruncana morozovae (Vass.), Brotzenella monterelensis Marie, Bolivina incrassata (Rss.), B. Kalinini (Vass.), Broinsonia parca parca, Broinsonia parca constricta
72-600 m
Sequence of pelitomorphic hard limestones with Globotruncana elevata (Brotz.), Gavelinella dainae Myatl
Up to 220 m
Sequence of pelitomorphic micrograined limestones with Gavelinella infrasantonica (Balakhm.), Gavelinella stelligera (Marie), Globotruncana fornicate (Piumm), Lucianorhabdus cayeuxii
Up to 220 m
Sequence of pelitomorphic hard limestones, sometimes marble-like, with Dicarinella concavata (Brotz.), Stensioina granulata Olb., Gavelinella thalmanni(Brotz.) Micula staurophora
83-305 m
Sequence of pelitomorphic hard limestones, sometimes detrital, with Helvetica (Trujillo), Gavelinella ammonoides (Reuse.), Gavelinella monliformis (Rss.) Gartnelago segmentatum, Kamptnerius magnificus and Eiffellthus eximius
Up to 500 m
Suite
Upper subsuite
Grey marls with interlayers of clayey limestones, lenses of flinty rocks with Abathomphalus mayaroensis (Bolli), Pseudotextularia varians (Rzehak)
Up to 900 m
Dzhankoy
Lower subsuite
Grey clayey marls with marl and clay interlayers, with Bolivina kalinini (Vass.), Bolivina incrassata (Rss.), Brotzenella monterelensis (Marle).
Up to 450 m
Pavlovka sequence
Light grey and white limestones, clayey with marl interlayers, with Gavelinella dajnae Myati, Cibicidoles temirensis Vass. - in top, Gavelinella stelligera (Marie) - in base
up to 170 m
Veronkovo sequence
Light grey and white limestones, clayey, silicified, with sutures and stylolites, with Gavelinella infrasantonica Balkhm
Up to 200 m
Znamenka Suite
Light grey and white limestones, clayey, flinty, with sutures and stylolites,in places porcelain-like, with clay interlayers, with Stensioina granulata Olb. - in top, Globotruncana lapparenti (Brotz.) - in base.
Up to 1200 m


CRETACEOUS
99
112
123
CENOMANIAN
UPPER
M.
LOWER
ALBIAN
UPPER
MIDDLE
LOWER
APTIAN
UPPER
MIDDLE
LOWER
93.99
Naviculare / Pentagonum
Rhotomagense
95.64
Dixoni
97.39
Mantelli
Dispar
Inflatum
103.18
Lautus
Loricatus
105.3
Dentatus
Mammilatum
Tardefurcata
Jacobi
113.16
Nolani
Melchioris
116.9
Subnodoso-costatum
117
Furcata
118.6
Deshayesi
119.2
Weissi
120
Tuarkyricus
W. archaeocretacea
Rotalipora cushmani
Rotalipora reicheli
Rotalipora globotruncanoides
Rotalipora appenninica
R. ticinensis
R. subticinensis
Ticinella praeticinensis
Ticinella primula
Hedbergella planispira
T. bejaouaensis
P. cheniourensis
G. algerianus
G. ferreolensis
Leopoldina cabri
Lingulogavelinella globosa
Rotalipora cushmani
Rotalipora reicheli
Rotalipora globotruncanoides
Rotalipora brotzeni
Gavelinella cenomanica
Rotalipora appenninica
Schackoina moliniensis, Rtalipora ticinensis, R. subticinensis, Ticinella praeticinensis
Hedbergella planispira, Gavelinella intermedia, Ticinella digitalis
Hedbergella planispira
Gavelinella intermedia,
Globigerinelloides algerianus,
Leupoldina protuberans
Hedbergella aptica, Gavelinella suturalis
Helenea chiastia
Lithrathidites acutus
Gartnerago segmentatum
Eiffelithus turriseiffellii
Octocyclus reinhardtii, Ceratolithium hamata
Sequence of limy-ckayey siltstones, sands with Rotalipora ticinensis (Gand.), Octocyclus reinhardtii, Orbitolinidae
162 m
Clay sequence with Gavelinella intermedia (Berth.), Hedbergella planispira Tapp.
128 m
?
Interlayering of of limy silty clays and siltstones with Gavelinella intermedia (Berth.), Globigerinelloides algerianus (Dam.), Leupoldina protuberans (Bolli) ra Orbitolinidae
128 m
Sequence of limy claysand siltstones with Hedbergella aptica (Agal.) and Gavelinella suturalis (Myatl.)
200 m
Sequence of sandstone and limestones, at NW mainly marls, in places mudstones with Rotalipora globotruncanoides (Sig.), R. brotzeri (Sig.), R. Reicheli (Morn.), R. cushmani (Morr.), Eiffelithus turriseiffellii, Gartnersdo segsegmetatum, Lithrathidites acutus, Orbitolinidae etc.
300 m
Sequence of mainly lime stones and sandstones, in places tuffs and volcanic rocks with Rotalipora appenninica (Renz.), R. ticinensis (Gand.), R.Subticinensis (Gand.), Cepatolithium hamata, Helicolithus trabeculatus, Orbitolinide 100-533 m
Sequence of limestones, clayey marls with Rotalipora appeninica (Renz.), R. Brotzeni
400-660 m
Sequence of black and dark grey limestones with Rotalipora appenninica (Renz.), R. ticinensis (Gand.), Eiffelithus turisseiffellii, Orbitolinide
15-76 m
Krasnoplianskaya Suite
Upper subsuite
Dark gey clayey marls, in places with limestone interlayers, with Rotalipora cushmani (Morr.)
Up to 300 m
Middle subsuite
Clayey marls with Rotalipora appenninica (Renz.)
Up to 300 m
Kovylne Suite
Lower subsuite
Grey marls with Rotalipora ticinensis (Gand.), R. appenninica (Renz.)
Up to 570 m
Upper subsuite
Mudstones, in places volcaniclastic rocks with Praeglobotruncana delrioonsis (Plumm.), Pianomalina buxtorfi (Gand.)
Up to 300 m
Lower subsuite
Dark grey mudstones, sandstones volcaniclastic, polpolymictic, gravelstones, in places finty volcanogenic rocks with Pervinqueria subinflata (Pilat.)
Up to 160 m
Tarkhankut Suite
Dark grey mudstones, easy limy with siltstone interlayers, near volcanoes volcanogenic rocks with Hoplites dentatus (Sow.) Etc.
Up to 560 m
Rylceevo Suite
Dark grey siltstones with mudstone interlayers, in places effusives with Hedbergella trocoidea Gand
Up to 170 m
Kashlanovo Suite
Dark grey siltstones, non-limy and easy limy, siltstones, in base in places gravelstones with Hypacanthoplites jacobi
Up to 200 m
Donuzlav Suite
Grey-colored quartz sandstones, limy siltstones, mudstones, gravelstones, in places limestones with Palorbitolina lenticularis (Blum)
Up to 200 m

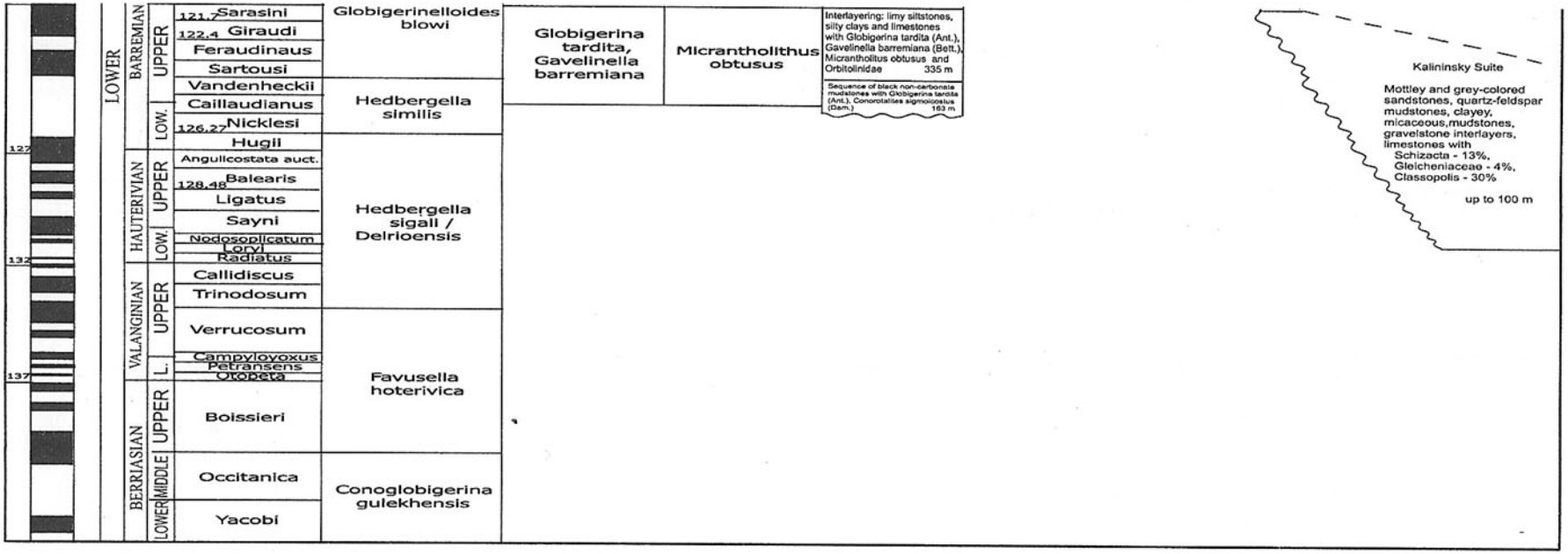


Fig. 2. **Regional stratigraphic chart of the Cretaceous deposits of the Black Sea northwestern shelf**

reconstruction of sedimentation evolution, determining of space-time regularities of the facies distribution of especially productive rock masses, acquires a special importance as a basis for sedimentary and lithogeodynamic models.

The analysis of modern stratigraphic data testifies to the heterochronism and heterogeneity of the Black Sea northwestern shelf and adjoining continental slope. The Mesozoic sequence is represented by three systems. The stratigraphy of the Triassic and Jurassic is not studied well enough, but that of the most spread Cretaceous and Cenozoic deposits, due to their perspectivity, is studied better. On the continental slope, the Triassic-Lower Jurassic deposits are represented by terrigenous-flysch and flysch-like facies, those of the Middle Jurassic — by interbedding of sandstones, siltstones and mudstones with gravellites and tufas, and those of the Upper Jurassic — predominantly by deep-gray argillites, organic limestones, marls, and clays. The Lower Cretaceous sediments of the northwestern shelf and continental slope are characteristic terrigenous and clayey rocks, and the Upper Cretaceous deposits are characteristic carbonate rocks. Preliminary interpretation of geologic-geophysical evidences and detailed paleontological and lithological study of Cretaceous-Cenozoic sediments of the shelf anticline uplifts proved a complicated mosaic structure of the Cenozoic lithofacial complexes.

To develop a stratigraphic model, the available biostratigraphic data on various fossil groups was considered, core samples were reinterpreted on microfaunal evidences, the actual paleontological base was analyzed, and stratification of the Mesozoic-Cenozoic sections was revised for all structures of the NW shelf and adjacent territories. At this, biostratigraphic data were correlated with lithological and geophysical evidences.

The created regional stratigraphic schemes of the Cretaceous, Paleogene, Neogene, and Quaternary systems and recognized main development stages of the NW shelf of the Black Sea are based on the integral analysis of geological-geophysical data and comprehensive stratigraphic division of the Mesozoic and Cenozoic sediments [3-6, 10, 15, 19, 26, 29, 40-42]. The correlation with coeval formations of adjacent regions shows similar and different features of the NW shelf and another structures of the Crimean-Caucasian region.

MESOZOIC. ***CRETACEOUS SYSTEM.*** For the stratigraphic division of the Cretaceous of the NW Black Sea shelf and development of stratigraphic schemes, the international "biological" standards were used, which were incorporated into the chronostratigraphic scheme of Western Europe [13]. To determine the limits of stratigraphic divisions, standard logging data were used too.

The oldest sediments penetrated by boreholes on the NW Black Sea shelf are the Lower Cretaceous rocks. They were drilled in the small number of boreholes. The most complete section of the Lower Cretaceous formations (Barremian-Albian) was found only in one borehole — Olimpiyska-400. The rest of boreholes, as re-interpretation of the available data demonstrated,

were stopped in the Upper Albian rocks (another investigators dated those formations as Triassic or Jurassic) (fig. 2).

The Upper Cretaceous sediments are drilled almost in all structures of the NW Black Sea shelf.

Three structural-facial districts (SFD) are recognized on the NW Black Sea shelf on the features of stratigraphic and lithological composition and development character (see the Scheme): Olimpiysky, Framing structures of the Karkinita Trough, and Karkinita Trough. The boundaries of the districts are of tectonic nature.

The Olimpiysky SFD occupies the western part of the Marginal Escarpment in the western part of the shelf. In its boundaries, the Lower Cretaceous sediments are represented by the Upper Barremian, Lower and Middle Aptian, Middle (?) and Upper Albian, sedimentation breaks are in the Late Aptian and Early Albian. The Upper Cretaceous sediments are the Lower and Upper Campanian. Sedimentation breaks are in the Cenomanian, Turonian, Coniacian, Santonian, and Maastrichtian.

The Framing structures of the Karkinita Trough SFD includes the Kalamita Rampart and a number of uplifts (Odessa, Bezimenne, Flangove, Karkinita, Southern Flank, Eupatoria, etc.), which are different in the completeness of the cretaceous section [7, 10]. The Lower Cretaceous formations are represented by the Upper Albian (microfaunal zones *Rotalipora appenninica*, R. *ticinensis* and R. *subticinensis*. The Upper Cretaceous sediments are rocks of the Lower Cenomanian, Campanian and Maastrichtian. Sedimentation breaks are in the Turonian, Coniacian, and Santonian.

The Karkinita SFD occupies properly the Karkinita Trough. The Lower Cretaceous sediments are there the Middle and Upper Albian (zones *Rotalipora appenninica* and *R. ticinensis*). The Lower cretaceous formations in that district are of all ages of the Upper Cretaceous. A sedimentation break of tectonic nature is observed at the boundary of the Upper Cenomanian — Lower Turonian; it is a rather thick redeposited sequence (up to 100 m).

LOWER CRETACEOUS. The Lower Cretaceous sediments are composed mainly of terrigenous rocks, at some stratigraphic level with significant content of tuffaceous and volcanogenic matter. The boreholes penetrated over 1,000-m thickness. In the majority of the sections, the detailed stratigraphic division is possible at the level of stages and zones.

The most complete section of the Lower Cretaceous in the district and within the NW Black Sea shelf is drilled by b/h Olimpiyska-400 that is situated in the western part of the Marginal Escarpment. The Barremian, Aptian and Albian rocks, which lithological composition is mostly similar to those in Fore-Dobrogea, represent it [2, 24].

On the rest of the shelf that is probably bounded from the Olimpiysky SFD by the Odessa Fault, the Upper Albian rocks are drilled mainly.

Barremian stage. The Barremian sediments on the NW Black Sea shelf are recognized only in the Olimpiysky District; their total thickness is 650 m.

The lower portion of the Upper Barremian consists of dark grey to black non-carbonaceous mudstone with з *Conorotalithes cf. bartensteini* B e t

t., *C. aff. sigmoicostus* D a m, *Gavelinella cf. barremiana* B e t t., *Lamarcina cf. lamplugi* (S c h e r l.), *Ophtalmidium cf. gaultinum* D a m, *Quinqueloculina minima* T a p p., *Globuligerina cf. tardita* (A n t).

The upper part of the Upper Barremian is interlayering limy siltstone, limy-silty clay, silty limestone with foraminifers Lenticulina cf. eichenbergi B a r t. et B r a n d., Globuligerina tardita (A n t.), *Gavelinella barremiana* B e t t. and nannoplankton *Micrantholithus obtusus*, Discorhabdus ignotus, *Manivitella pematoidea*, *Lithraphidites carniolensis*, *Braarudosphaera regularis*, *Nannocomus* sp.

Aptian stage. The Aptian sediments in the considered region are represented by two substages — Lower and Upper. The Lower one consists of limy clay, siltstone, limestone with foraminifers *Gavelinella suturalis* (M y a t l.), *Hedbergella aptica* (A g a l.). Over, a thin interlayering occurs — silty clay and clayey-limy siltstones with foraminifers *Gavelinella cf. intermedia* (B e r t h.), *Leupoldina cf. protuberans* (B o l l i), *Globigerinelloides algerianus* (D a m) and *Orbitolinidae*.

These sediments transgressively covers the Barremian sediments and are overlaid by the Middle Albian rocks with break.

Albian stage. The Albian sediments are widespread on the NW Black Sea shelf and adjacent territories. They are represented by terrigenous-carbonate formations, less often by volcanogenic and volcanogenic-sedimentary. Their thickness increases southward from few meters to 530 m in the Odessa Fault zone. Almost everywhere they transgressively occur over older rocks. They are covered (conformably or with break) by the Cenomanian deposits, less often younger rocks.

Till the last time the age of these sediments was disputable on geological and geophysical data — from Jurassic to Albian. Our investigations have shown and faunistically proved that they belong to the Upper Albian.

UPPER CRETACEOUS. The Upper Cretaceous deposits are widespread on the NW Black Sea shelf. All six stages represent them. The rock composition is mainly carbonate, and in the top and especially in the bottom of section often terrigenous. Their thickness ranges between hundreds to 2,000 m. The three-member division is reliably proven for the Campanian and Cenomanian stages. In some cases zones are recognized, less often an undivided sequence of large stratigraphic volume [25 et al].

Cenomanian stage. Cenomanian sediments are widespread in the region under consideration. They are marl, limestone, sandstone, which transgressively, less often without break occur over Upper Albian deposits and mostly discordantly are covered by the Turonian rocks Their thickness varies from terms of meters (near northern margin of the shelf up to 658 m in the Mikhailovka Depression.

The stage volume is mainly reduced. Only in the deepest parts of the mentioned above depression all three substages can be recognized.

Turonian and Coniacian stages. The Turonian stage is composed of light grey solid limestone, fractured, with *Marginotruncana schneegansi* B o l l i, *Praeglobotruncana imbricata* (M o r n.) and *Eiffilithus eximius*. The

Turonian sediments with discordance (probably, tectonic) occurs on the Upper Cenomanian rocks and with break under Upper Coniacian ones.

The Coniacian sediments form a sequence of light grey massive limestone, fractured, with sutures and stylolites. They contain the typical Coniacian nannoplankton species, *Micula staurophora* and Upper Coniacian foraminifers *Gavelinella infrasantonica* (B a l a k h m.) etc.

Santonian stage. These rocks within NW Black Sea shelf are light grey porcelain-like easy silicified limestone with *Gavelinella infrasantonica* B a l a k h m., *Stensioina granulata granulata* (O l b.), *S. cf. granulata perfecta* K o c h., *Osangularia whitei whitei* C a r b. and *Lucianorhabdus cayeuxii.* The maximum thickness of the Santonian deposits is about 628 m. The Santonian rocks mostly conformably rest over the Coniacian and are covered by the Campanian.

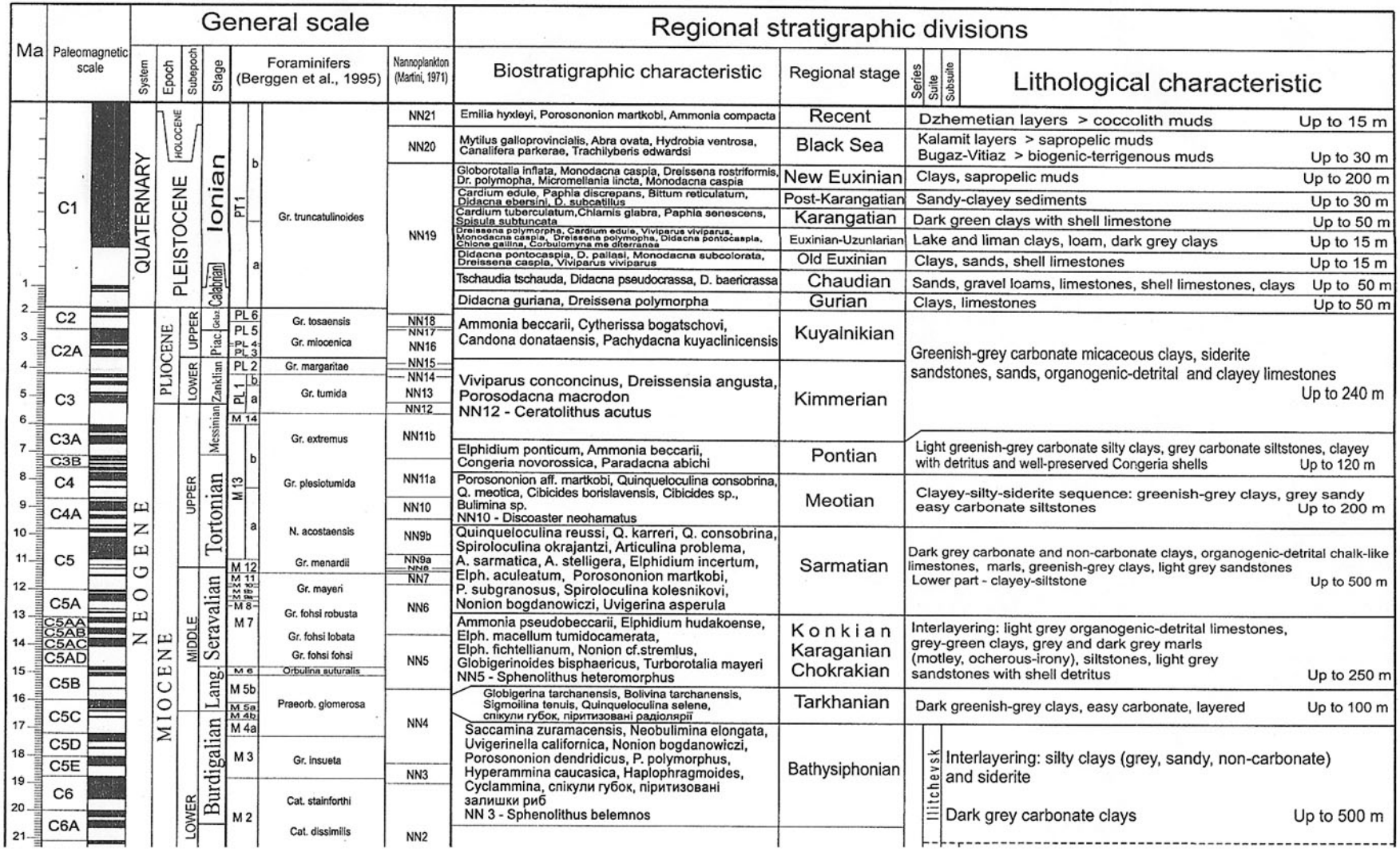
Campanian stage. The Campanian rocks occur over large areas on the NW Black Sea shelf. They are mainly limestones with foraminifers *Globorotalites emdyensis* V a s s., *Cibicides aktulagayensis* V a s s., *Brotzenella cf. menneri* (K e l l.), *Globotruncana morozovae* V a s s. and nannoplankton *Broinsonia parca constricta* and *Prediscospaera stovery.* The deposits discordantly cover the Upper Santonian and are overlaid, conventionally, by the Paleocene formations.

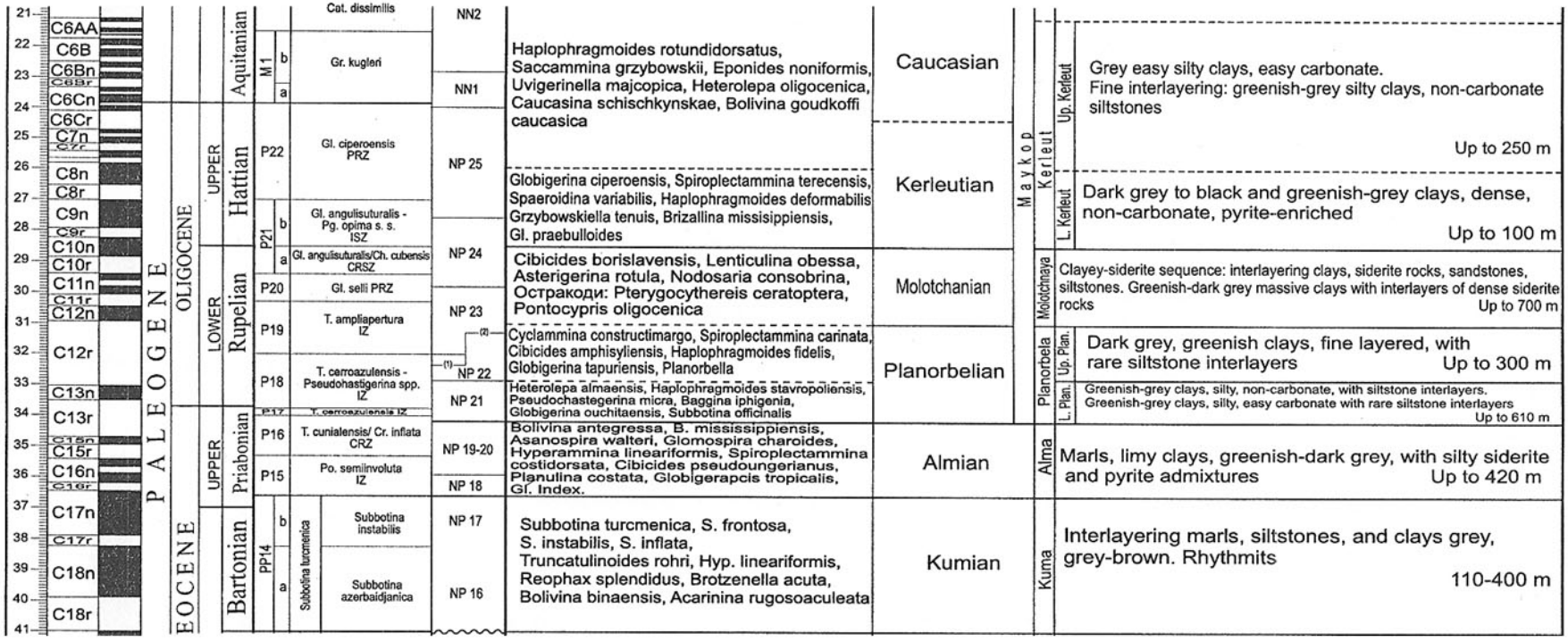
Their thickness is about 600 m. The Campanian rocks form three substages, the Middle and Upper ones are most spread. In both cases, two-member division is possible.

Maastrichtian stage. These sediments are also widespread on the NW Black Sea shelf. They are various limestones, less often marl and limy sandstone, or interbedding of those rocks with foraminifers *Rugoglobigerina rugosa* O r b., *Pseudotextularia varians* R z e h., *Angulogavelinella caucasica* V a s s. and nannoplankton *Uniplanarius trifidus* and *Nephrolithus frequens.* The maximum known thickness is 450 m [23].

CENOZOIC. ***PALEOGENE SYSTEM. PALEOCENE. The Belokamenkian regional stage*** (Lower Paleocene, Danian) is defined in the Paleocene, which consists of the Gromovo suite with two subsuites: lower and upper ones [10, 18, 23]. By plankton foraminifers and nannoplankton, the age of the stratons is substantiated, and a correlation is made with divisions of the International Stratigraphic Scale. It has been proved that the Belokamenkian regional stage is diachronous: the Early Paleocene — the dawn of the Late Paleocene. The development periods of the Paleocene basin are reflected in it: Danian (Early — Late), relatively long (~3,8 Ma); and Zelandian, which duration is not over ~ 1 Ma. In the *Katchian regional stage* (Upper Paleocene, Zelandian, Thanetian), the Lazurnoye suite up to 200 m thick is defined, which has three-component structure (fig. 3).

The Paleocene formation is characterized by a complicated spatial-temporal structure that reflects various sedimentation stages under different conditions depending on the morphology and mobility of the basin's bottom and its elements (shelf zone, continental slope) as well as sedimentation cyclicity with sedimentation cycles of various rank of the corresponding stratons.


General scale
Regional stratigraphic divisions
Ma
Paleomagnetic scale
System
Epoch
Subepoch
Stage
Foraminifers (Berggen et al., 1995)
Nannoplankton (Martini, 1971)
Biostratigraphic characteristic
Regional stage
Series
Suite
Subsuite
Lithological characteristic
QUATERNARY
NEOGENE
PLEISTOCENE
HOLOCENE
Ionian
Calabrian
PLIOCENE
Piac.
Zankl.
MIOCENE
UPPER
LOWER
MIDDLE
Messinian
Tortonian
Seravalian
Lang.
Burdigalian
C1
C2
C2A
C3
C3A
C3B
C4
C4A
C5
C5A
C5AA
C5AB
C5AC
C5AD
C5B
C5C
C5D
C5E
C6
C6A
PT1
b
a
PL 6
PL 5
PL 4
PL 3
PL 2
PL 1
M 14
M 13
M 12
M 11
M 10
M 9
M 8
M 7
M 6
M 5b
M 5a
M 4b
M 4a
M 3
M 2
Gr. truncatulinoides
Gr. tosaensis
Gr. miocenica
Gr. margaritae
Gr. tumida
Gr. extremus
Gr. plesiotumida
N. acostaensis
Gr. menardii
Gr. mayeri
Gr. fohsi robusta
Gr. fohsi lobata
Gr. fohsi fohsi
Orbulina suturalis
Praeorb. glomerosa
Gr. insueta
Cat. stainforthi
Cat. dissimilis
NN21
NN20
NN19
NN18
NN17
NN16
NN15
NN14
NN13
NN12
NN11b
NN11a
NN10
NN9b
NN9a
NN8
NN7
NN6
NN5
NN4
NN3
NN2
Emilia hyxleyi, Porosononion martkobi, Ammonia compacta
Recent
Dzhemetian layers > coccolith muds
Up to 15 m
Mytilus galloprovincialis, Abra ovata, Hydrobia ventrosa, Canalifera parkerae, Trachilyberis edwardsi
Black Sea
Kalamit layers > sapropelic muds
Bugaz-Vitiaz > biogenic-terrigenous muds
Up to 30 m
Globorotalia inflata, Monodacna caspia, Dreissena rostriformis, Dr. polymopha, Micromelania lincta, Monodacna caspia
New Euxinian
Clays, sapropelic muds
Up to 200 m
Cardium edule, Paphia discrepans, Bittum reticulatum, Didacna ebersini, D. subcatillus
Post-Karangatian
Sandy-clayey sediments
Up to 30 m
Cardium tuberculatum,Chlamis glabra, Paphia senescens, Spisula subtuncata
Karangatian
Dark green clays with shell limestone
Up to 50 m
Dreissena polymorpha, Cardium edule, Viviparus viviparus, Monodacna caspia, Dreissena polymopha, Didacna pontocaspia, Chione gallina, Corbulomyna me diterranea
Euxinian-Uzunlarian
Lake and liman clays, loam, dark grey clays
Up to 15 m
Didacna pontocaspia, D. pallasi, Monodacna subcolorata, Dreissena caspia, Viviparus viviparus
Old Euxinian
Clays, sands, shell limestones
Up to 15 m
Tschaudia tschauda, Didacna pseudocrassa, D. baericrassa
Chaudian
Sands, gravel loams, limestones, shell limestones, clays
Up to 50 m
Didacna guriana, Dreissena polymorpha
Gurian
Clays, limestones
Up to 50 m
Ammonia beccarii, Cytherissa bogatschovi, Candona donataensis, Pachydacna kuyaclinicensis
Kuyalnikian
Greenish-grey carbonate micaceous clays, siderite sandstones, sands, organogenic-detrital and clayey limestones
Up to 240 m
Viviparus conconcinus, Dreissensia angusta, Porosodacna macrodon
NN12 - Ceratolithus acutus
Kimmerian
Elphidium ponticum, Ammonia beccarii, Congeria novorossica, Paradacna abichi
Pontian
Light greenish-grey carbonate silty clays, grey carbonate siltstones, clayey with detritus and well-preserved Congeria shells
Up to 120 m
Porosononion aff. martkobi, Quinqueloculina consobrina, Q. meotica, Cibicides borislavensis, Cibicides sp., Bulimina sp.
NN10 - Discoaster neohamatus
Meotian
Clayey-silty-siderite sequence: greenish-grey clays, grey sandy easy carbonate siltstones
Up to 200 m
Quinqueloculina reussi, Q. karreri, Q. consobrina, Spiroloculina okrajantzi, Articulina problema, A. sarmatica, A. stelligera, Elphidium incertum, Elph. aculeatum, Porosononion martkobi, P. subgranosus, Spiroloculina kolesnikovi, Nonion bogdanowiczi, Uvigerina asperula
Sarmatian
Dark grey carbonate and non-carbonate clays, organogenic-detrital chalk-like limestones, marls, greenish-grey clays, light grey sandstones
Lower part - clayey-siltstone
Up to 500 m
Ammonia pseudobeccarii, Elphidium hudakoense, Elph. macellum tumidocamerata, Elph. fichtellianum, Nonion cf.stremlus, Globigerinoides bisphaericus, Turborotalia mayeri
NN5 - Sphenolithus heteromorphus
Konkian
Karaganian
Chokrakian
Interlayering: light grey organogenic-detrital limestones, grey-green clays, grey and dark grey marls (motley, ocherous-irony), siltstones, light grey sandstones with shell detritus
Up to 250 m
Globigerina tarchanensis, Bolivina tarchanensis, Sigmoilina tenuis, Quinqueloculina selene, спікули губок, піритизовані радіолярії
Tarkhanian
Dark greenish-grey clays, easy carbonate, layered
Up to 100 m
Saccamina zuramacensis, Neobulimina elongata, Uvigerinella californica, Nonion bogdanowiczi, Porosononion dendridicus, P. polymorphus, Hyperammina caucasica, Haplophragmoides, Cyclammina, спікули губок, піритизовані залишки риб
NN 3 - Sphenolithus belemnos
Bathysiphonian
Ilitchevsk
Interlayering: silty clays (grey, sandy, non-carbonate) and siderite
Dark grey carbonate clays
Up to 500 m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C6AA
C6B
C6Bn
C6Cn
C6Cr
C7n
C8n
C8r
C9n
C10n
C10r
C11n
C11r
C12n
C12r
C13n
C13r
C15r
C16n
C17n
C17r
C18n
C18r
PALEOGENE
EOCENE
OLIGOCENE
UPPER
LOWER
UPPER
Aquitanian
Hattian
Rupelian
Priabonian
Bartonian
M1
b
a
P22
P21
b
a
P20
P19
P18
P16
P15
PP14
b
a
Subbotina turcmenica
Cat. dissimilis
Gr. kugleri
Gl. ciperoensis PRZ
Gl. angulisuturalis - Pg. opima s. s. ISZ
Gl. angulisuturalis/Ch. cubensis CRSZ
Gl. selli PRZ
T. ampliapertura IZ
T. cerroazulensis - Pseudohastigerina spp. IZ
T. cerroazulensis IZ
T. cunialensis/ Cr. inflata CRZ
Po. semiinvoluta IZ
Subbotina instabilis
Subbotina azerbaidjanica
NN2
NN1
NP 25
NP 24
NP 23
(2)
(1)
NP 22
NP 21
NP 19-20
NP 18
NP 17
NP 16
Haplophragmoides rotundidorsatus, Saccammina grzybowskii, Eponides noniformis, Uvigerinella majcopica, Heterolepa oligocenica, Caucasina schischkynskae, Bolivina goudkoffi caucasica
Globigerina ciperoensis, Spiroplectammina terecensis, Spaeroidina variabilis, Haplophragmoides deformabilis Grzybowskiella tenuis, Brizallina missisippiensis, Gl. praebulloides
Cibicides borislavensis, Lenticulina obessa, Asterigerina rotula, Nodosaria consobrina, Остракоди: Pterygocythereis ceratoptera, Pontocypris oligocenica
Cyclammina constructimargo, Spiroplectammina carinata, Cibicides amphisyliensis, Haplophragmoides fidelis, Globigerina tapuriensis, Planorbella
Heterolepa almaensis, Haplophragmoides stavropoliensis, Pseudochastegerina micra, Baggina iphigenia, Globigerina ouchitaensis, Subbotina officinalis
Bolivina antegressa, B. mississippiensis, Asanospira walteri, Glomospira charoides, Hyperammina linearifformis, Spiroplectammina costidorsata, Cibicides pseudoungerianus, Planulina costata, Globigerapcis tropicalis, Gl. Index.
Subbotina turcmenica, S. frontosa, S. instabilis, S. inflata, Truncatulinoides rohri, Hyp. linearifformis, Reophax splendidus, Brotzenella acuta, Bolivina binaensis, Acarinina rugosoaculeata
Caucasian
Kerleutian
Molotchanian
Planorbelian
Almian
Kumian
Maykop
Kerleut
Up. Kerleut
L. Kerleut
Molotchnaya
Planorbela
Up. Plan.
L. Plan.
Alma
Kuma
Grey easy silty clays, easy carbonate.
Fine interlayering: greenish-grey silty clays, non-carbonate siltstones
Up to 250 m
Dark grey to black and greenish-grey clays, dense, non-carbonate, pyrite-enriched
Up to 100 m
Clayey-siderite sequence: interlayering clays, siderite rocks, sandstones, siltstones. Greenish-dark grey massive clays with interlayers of dense siderite rocks
Up to 700 m
Dark grey, greenish clays, fine layered, with rare siltstone interlayers
Up to 300 m
Greenish-grey clays, silty, non-carbonate, with siltstone interlayers.
Greenish-grey clays, silty, easy carbonate with rare siltstone interlayers
Up to 610 m
Marls, limy clays, greenish-dark grey, with silty siderite and pyrite admixtures
Up to 420 m
Interlayering marls, siltstones, and clays grey, grey-brown. Rhythmits
110-400 m

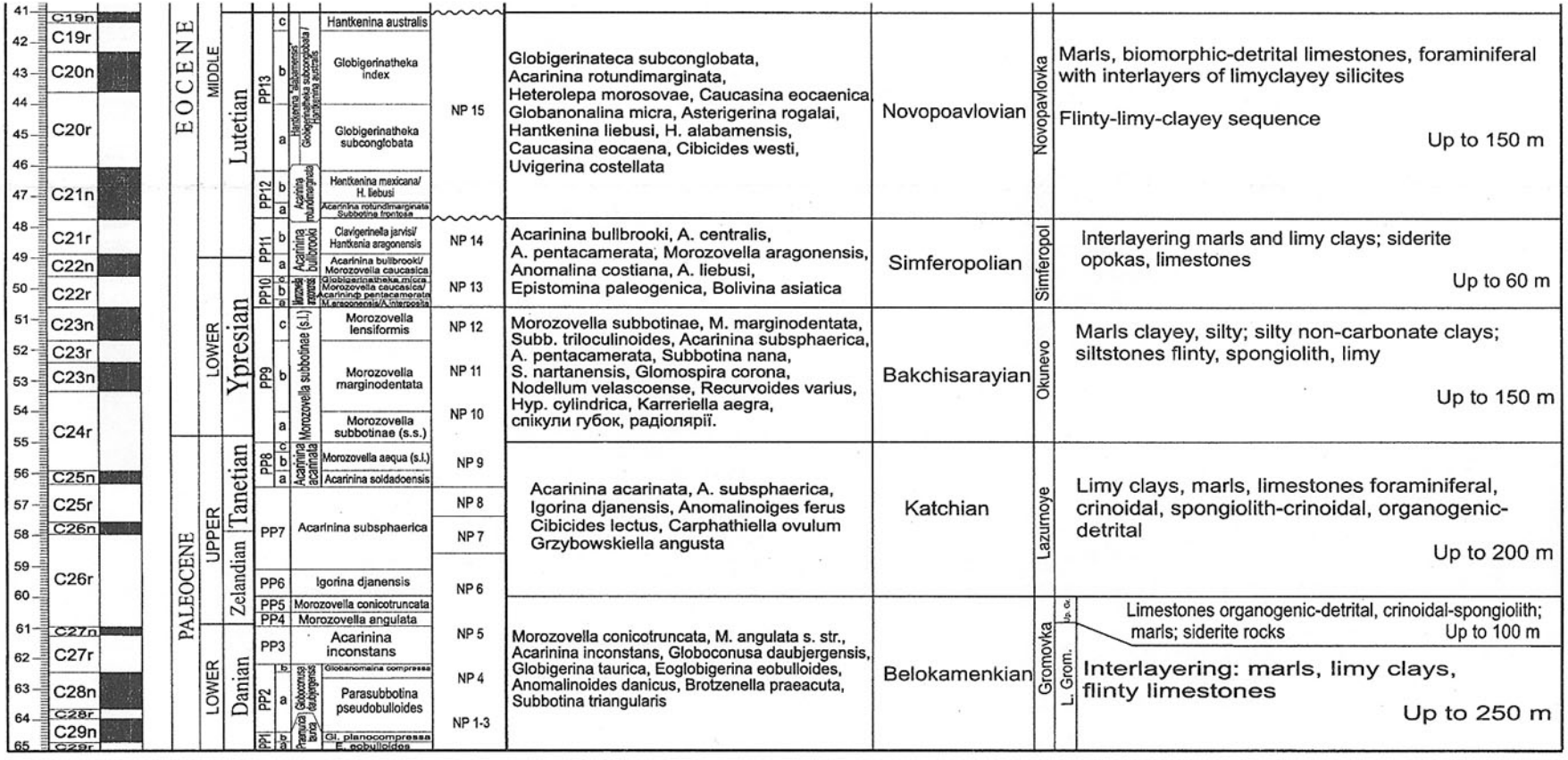

Fig. 3. **Stratigraphic chart of the Cenozoic deposits of the western Black Sea basin**

EOCENE. Bakhchisaraian regional stage (Lower Eocene, Ypresian). A feature of the Okunevka suite is prevailing in the section greenish-grey clay, marl and grey limestone (up to 170 m thick). The Bakhchisarain time was the beginning of new stage of the transgression sedimentation cycle, carbonate-clayey on deep water, relatively steady shelf locations of the marine basin, where geomorphological, tectonic, and hydrological agents did not have a discrete influence over sedimentation processes. The marine transgression northward was insignificant that was evidenced by the absence or low thickness (up to 10 m) of limestone-spongolite sediments in boreholes on the adjacent lands near the Black Sea.

Simferopolian regional stage (Middle Eocene, Lutetian). The Simferopolian suite consists of two lithocomplexes: marl-limy-clayey (lower), siltstone-siderite-clayey. During that development stage of the Eocene basin, changes in the sedimentation conditions happened on the northwestern shelf, when sediments (spongolite, opoka) accumulated under conditions of relatively cooling water masses and transgression-regression fluctuations.

Novopavlovkian regional stage (Middle Eocene, Lutetian). The Novopavlovka suite is characterized by prevailing silica-carbonate-clayey rocks with siderite in the lower portion of the section, and limy-marl-clayey sediments in the upper one.

Kumian regional stage (Middle Eocene, Bartonian) is a peculiar thick formational complex of the upper part of the Middle Eocene that occurs in the Crimean-Caucasian region and is a rather characteristic straton within the northwestern shelf. The Kuma suite, which corresponds in its volume to the Kumian regional stage, consists of greenish-grey and grey-brown marl with interlayers of carbonate clay and siltstone. A presence of rhythmites is a feature of the Kumian regional stage. The Middle Eocene accumulation of clayey-carbonate and carbonate muds had a clear cyclic tendency, when in the end of each of time intervals mentioned above (Simferopolian, Novopavlovkian, Kumian), carbonate forming gradually increased. The recognized breaks in sedimentation reflect the critical stage in the regional development and complete the transgression-regression cycle.

Almian regional stage (Upper Eocene, Priabonian). The Alma suite is a marl-clayey formation with characteristic lamination both the rocks and bios. Their matter composition evidences that in the Late Eocene time mainly abyssal low-carbonate-clayey mud accumulation prevailed on the northwestern shelf of the Black Sea under steady hydrodynamic and mainly reduction physical-chemical conditions. Comparisons of the Alma suite of the shelf and adjacent northern coastal regions and Crimea demonstrate the different biolithofacial conditions and rather individual development history of those regions. In the same time, an analysis of the taxonomic composition of foraminifers and regularities of their distribution in the Almian section of the NW shelf demonstrates that they have many common with foraminiferal complexes from sediments of the Popele and Bystritsa suites (Ukrainian Carpathians), with which significant hydrocarbon accumulations are related.

OLIGOCENE. The stratigraphic structure of the Oligocene of the NW shelf consists of three transgression-regression cycles. Those are regional

stages in the stratigraphic scheme: Planorbelian, Molotchnaya, Kerleutian, and in part Caucasian. From biostratigraphic data, the age of the Planorbelian and Molotchnaya regional stages is Rupelian, and that of the Kerleutian is Chattian. Generally, the age range of the Maikopian rock complex covers the Rupelian-Burdigalian (the Oligocene-Lower Miocene) [20].

The *Planorbelian regional stage* (Lower Oligocene, Rupelian) is determined in the volume of the Planorbelia suite with two subsuites. Planorbelian sediments occur everywhere on the shelf, and we found them on the continental slope [6, 9]. On seismostratigraphic data their thickness reaches up to 1,500 m.

Molotchnaya regional stage (Lower Oligocene, Rupelian). The Molotchnaya suite is represented by interlayering clay, siltstone, sandstone, and siderite rocks.

Kerleutian regional stage (Upper Oligocene, Chattian). Two subsuites are recognized in the volume of the Kerleut suite. The lower one consists mainly of dark grey, almost black clay, the upper one is an interlayering of clay, siltstone, sandstone [11, 17].

An analysis of the biolithostratigraphic and structural-tectonic constituents shows that the Oligocene sediments of the Southern Oil-Gas-Bearing Province are in a joint zone of different paleosedimentological districts. If the NW shelf is a typical relatively marine basin of average salinity with typical biocoenotic groups of planktonic and benthic microorganisms that northward their substitution is observed with shallow-water marine brackish biocoenoses, which characterize a morphostructurally differentiated basin with different conditions of sedimentation and different history of geological development.

NEOGENE SYSTEM. MIOCENE. Proceeding from the analysis of the Neogene section of the Black Sea's NW shelf and its correlation with sections of adjacent territories, the model of stratigraphic structure was created for the first time, and the recognized stratons of the regional stage rank is described: Caucasian and Bathysiphonian of the Lower Miocene; Tarkhanian, Chokrakian, Karaganian, Konkian of the Middle Miocene, and Sarmatian of the Middle-Upper Miocene; Meotian, Pontian, Kimmerian, Kuyalnikian of the Upper Miocene-Pliocene. The facial and spatial-temporal changes of chronostratigraphic divisions were cleared for the NW shelf and continental slope of the Western Black Sea Depression. In the supposed stratigraphic scheme for the Neogene, the Mediterranean Neogene scale was used as international, aspects for substantiation of the stratigraphic divisions were considered for the Eastern Parathetys and its constituent part — the Neogene of Southern Ukraine [1, 20, 27-31].

Caucasian regional stage (Lower Miocene, Aquitainian). We conventionally relegate the upper potion of the section of the Upper Kerleut subsuite and the lower part of the Illitchevsk suite to this regional stage. The upper part of the Upper Kerleut subsuite is clayey-siltstone thin-laminated rock complex with penurious foraminifer complex. The section is gradually substituted with dark grey clay of the Illitchevsk suite with rare benthic

foraminifers in its lower part, where sponge spicules, diatoms and piritized fish skeleton remnants prevail, which give very problematic dating of the sediments. The Caucasian regional stage on the available evidences is diachronous — Chattian-Aquitanian. Therefore, the conventionality of the Miocene-Oligocene boundary in the sections of the NW shelf clearly reflects the general discussion character of the boundary in the Eastern Parathetys [21, 28].

Bathysiphonian regional stage (Lower Miocene, Burdigalian). The Illitchevsk suite corresponds to this regional stage on the NW shelf. It is represented by interlayering greenish-grey sandy clay, non-carbonate siltstone with siderite, dark grey clay (easy carbonate and carbonate). The Bathysiphonian regional stage corresponds in Plain Crimea and coastal regions to the Sakaraulian and Katsakhurian regional stages with Arabat, Korolevo, Chernobaivka suites and Komrat and Karzhin layers. The age of the Bathysiphonian regional stage is Early Miocene.

Tarkhanian regional stage (Middle Miocene, Langhian). Its sediments occur in sections of the almost all boreholes on the shelf and continental slope of the Black Sea. They with break cover the Maikopian sediments and are covered by carbonate-clayey Chokrakian-Karaganian-Konkian deposits. They are interlayering greenish-grey, dark grey clay, siltstone, marl. Clay sometimes contains an admixture of siltstone, easy carbonate or non-carbonate. Their visual appearance is similar to the Maikopian ones. Foraminifers and nannoplankton evidence that the Tarkhanian regional stage spans the end of the Early — Middle Eocene.

Chokrakian, Karaganian, Konkian regional stages (Middle Miocene, top of the Langhian — Serravallian) have been drilled known on numerous structures of the NW shelf and Western Black Sea Depression. Due to limited volumes of core samples, it is today impossible to recognize each of these regional stages on the shelf through their biological, lithological and geophysical features. Therefore, a non-divided clay-limestone sequence is shown in the scheme (Fig. 3), which are clearly traced as an uniform formational complex. On the shelf, Marginal Escarpment, continental slope of the Western Black Sea Depression, the Chokrakian-Karaganian-Konkian sequence consists of grey, light, cavernous limestones with shell detritus, interlayers of siltstone and massive dark grey marl. The thickness of the sequence is up to 250 m. The age of the Chokrakian, Karaganian, Konkian sediments is Middle Miocene.

Sarmatian regional stage (Middle-Upper Miocene, Upper Serravallian — Lower Tortonian) is penetrated almost in all boreholes on the NW shelf and dragged on the continental slope of the Black Sea.

Geophysical data enable to recognize three lithostratons almost on all uplifts. The lower one is dark-colored clay-siltstone with rare limestone and sandstone interlayers. The middle lithostraton is limestone-clay with significantly increased content of organogenic-detritic limestone, with characteristic greenish-grey color of clay. The upper lithostraton is clayey — interlayering of dark grey carbonate clay, marl with and without

carbonates, siltstone and limestone. The thickness of the Sarmatian sediments ranges between 50 and 560 m.

Different notions exist about age of the Sarmatian regional stage. If the majority of geologists accepts the Late Miocene that the newest examination suppose to date the Sarmatian as the end of Middle Miocene (Serravallian) — Late Miocene (Tortonian) that embraces the interval of 9,6-12,8 Ma [13]. I.e., the duration of the Sarmatian is 3,2 Ma.

The *Meotian regional stage* (Upper Miocene, Tortonian) has been drilled in fact on all uplifts of the NW shelf. Its section consists of interlayering limestone, clay, 20-400 m thick. The Meotian sediments cover with break the Miocene, Oligocene rocks and occur beneath the Pliocene-Quaternary ones. From plankton foraminifers and nannoplankton [8] the Lower Miocene (Tortonian) age is justified for the Meotian formations of the NW shelf and continental slope, which accumulated during 1,9 Ma.

Pontian regional stage (Upper Miocene, Messinian). The Pontian-Messinian sequence is present in almost all sections of the NW shelf. But its stratification, in part concise recognition of the Pontian sediments, is complicated due to the practical absence of core samples and standard logging data. The thickness analysis shows that the upper portion of the section is represented (in sludge) by greenish-grey carbonate clay, siltstone grey, carbonate, clayey with detritus and whole mollusk shell of 40-60 m thick.

The limestone-marl Pontian sediments up to 10 m thick have been found on the NW shelf in the Bug, Dnieper, Dniester Limans, on the Odessa Bank by ship drilling; we also have traced them on the continental slope [5, 15, 39].

Comprehensive studies by V.N. Semenenko and co-authors [22] determined the position of the Pontian of the Eastern Parathetys in magnetochronological scale. It correlated with Mediterranean stages. Accordingly these data, the Pontian regional stage was the upper division of the Miocene correlating with upper portion of the Tortonian — Messinian, its age 7,5-6,5 Ma.

PLIOCENE. Kimmerian, Kuyalnikian regional stages (Upper Miocene-Pleistocene, Messinian-Helazian). Though almost all boreholes on the NW shelf gives geophysical data on the presence of the Kimmerian-Kuyalnikian sediments, the available evidences do not enable detailed stratification of the sequence. The thickness of the sequence varies. So, it is 95 m in b/h Olimpiyska-400, up to 60 m on the Shmidt Uplift, 30-40 m on the Stormove Uplift. On the shelf this part of the section in numerous boreholes consists of greenish-grey, carbonate clay, siderite sandstone with ostracodes and rare foraminifer and mollusk shells. On the continental slope it is dark, almost black clay. In the Karkinita Trough the Pliocene age of Kimmerian-Kuyalnikian sediments is determined by foraminifers, nannoplankton and mollusks [5].

QUATERNARY SYSTEM. PLEISTOCENE-HOLOCENE. The Pleistocene and Holocene sediments on the NW shelf and continental slope of the Black Sea are stratified applying the event principle [8, 9, 16, 34-38].

The determined regional stratons correspond to certain stages of climatic-eustatic events and cover transgression-regression cycles in the whole. This complex of terrigenous laminated rocks has a monocline dipping towards the Black Sea Depression. Sediments of the shelf, continental slope and abyssal depression are clearly recognized. Intraformational discontinuities and breaks are observed in them as well as a significant proportion of alluvial and continental deposits. Unlike the adjacent coastal territories, where numerous local horizons are recognized, the stratigraphic division of the Quaternary sediments is carried out of the regional level (regional stage). The Gurian, Chaudian, Old Euxinian, Euxinian-Uzunlarian, Karangatian, Post-Karangatian, New Euxinian, Black Sea regional stages are recognized in the Pleistocene-Holocene. Each of these stages has transgression-regression cycles, which relations in the section reflect the corresponding epochs of the basin development.

The Kimmerian sediments consist of non-carbonaceous clayey muds—dark green-grey, olive with interlayers of diatomic and siderite mud. The Kuyalnik section is also non-carbonaceous siltstone, silty and diatomic clay enriched with amorphous silica. The Chaudian sediments contain cyclites with interlayers of carbonate muds in the bottom.

The inherited nature of cyclic sedimentation is observed in the Old Euxinian, when clayey with sand lens and interlayers of turbidites, thin-layered high-carbonaceous coccolith and clayey-sapropelic muds. Clay and silty clay dominate in the Karangatian; they are enriched with organic matter, with gradation texture that is a feature of the top of the Karangatian section. Non-carbonate or easy carbonate muds with highly carbonaceous interlayers are characteristic of the transgressive New Euxinian cycle.

The Black Sea sediments are represented by thin interlayering of terrigenous non-carbonate, easy carbonate, pelitic and aleuropelitic muds with poor organic matter; sapropel-like, sapropelic-clayey and sapropelic muds, high-carbonate, microlayered nannofossil muds with high organic content. This cycle clearly demonstrates a climatic influence. Since the Late Pliocene, the well-known period of alternating glacial and interglacial conditions begins, and the shelf either uplifts over the sea level at large areas or covers with sea water. Such climatic cyclicity is clearly evident in the matter composition and structure of the rocks. Dominating sediments of the Quaternary section accumulated in transgressive (Chaudian, Karangatian, New Euxinian) and regressive (Post-Chaudian, Post-Karangatian, Early Euxinian) phases. The inherited development of main structural-geomorphologic elements and sedimentation cyclicity are clearly observed.

A significant part of the Pliocene-Pleistocene complex of the NW part of the Black Sea consists of an abyssal fan. Seismics and evidences of d/v "Glomar Challenger" have identified older (Lower Pleistocene and Post-Miocene) fans of Danube and Dnieper. We have identified fan sediments in the Paleocene-Eocene sediments of the Karkinita Trough and Marginal Escarpment. Therefore, the Cenozoic development of the fans was periodical and inherited. The same periodicity is observed also in the influence of

gravitational flows and slides on the shelf and its marginal part over sedimentation process, and on the continental slope turbidite flows too.

In general, the Pleistocene-Holocene history of the shelf has signs of the marine basin cyclic development that repeats with various time intervals, changes in the sea level due to periodical connections with the Mediterranean, climatic and tectonic factors. The hydrological factor is also of big importance depending on sea level fluctuations and river drainage.

The Pliocene-Quaternary stage, especially recent sedimentation, has factors of the sedimentation environment and types of sedimentation complexes similar to the Paleogene and Neogene ones. The inherited nature of cyclic marine sedimentogenesis is traced through the Cenozoic. In the facial structure of the Black Sea horizon we see recent analogs of the systems, which have features of former environments, e.g., potentially petroleum-producing formations (sapropelic, carbonate-terrigenous formations).

Recent sedomentogenesis on the shelf and continental slope of the Black Sea is an active analog of the Paleogene and Neogene facial systems, in part the Oligocene domanik complex that can be a model for reconstruction of Cenozoic sedimentogenesis.

On the continental slope adjacent to the northwestern shelf in the aquatory of the Crimean Megaanticlinorium, the age of rocks has been determined that proves identity of the stratigraphic Mesozoic-Cenozoic sequence (fig. 1). Sedimentary rocks are represented by the Upper Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary rocks. The Paleocene, Eocene, Oligocene and Miocene deposits were identified at the southern continental slope of Crimea. The Oligocene and Early Miocene sediments are transgressively overlying Cretaceous and Paleocene-Eocene sediments of the Foros area. The younger Miocene and Quaternary rocks are also transgressively overlying the Jurassic deposits of the Yalta-Gurzuf and Alushta Blocks. These data enable us to give a new interpretation of the structure of the western and central blocks of the Crimean continental slope. Earlier, this part of the slope was considered to be the marginal part of the Crimean Megaanticlinorium, but new biostratigraphic data make it possible to consider that this part can be a jointing zone of peripheral structures of the Black Sea Basin and Crimean Megaanticlinorium, and identified Paleogene deposits, in particular, are the structures of the north slope of the West Black Sea basin.

Forming of a continental slope is the process that does not occur at the same time, to which testifies lithological and microfaunal composition of rocks. In the Triassic and Jurassic on the continental slope deposition of sediments occurred, which formed small rhythmic flysch deposits of considerable thickness and volcanogenic terrigenous complex. The Cretaceous phase is characterized by the development of carbonate tufa rocks and limestones containing biogenic silica. Volcanic activity is characteristic of this period. The beginning of the Paleogene in the Black Sea Region is characterized by the changing sedimentation regime and decreasing tectonic activity. There were a general increase in the depth of sedimentation, as the systematic composition of plank-

tonic and benthos foraminifers from the drilled rocks testifies. We should notice that composition of rocks and association of foraminifers, contained in them, is similar to the Paleocene, Oligocene bio- and lithofacies of the Kertch Peninsula, Black Sea northwestern shelf, and Carpathians. The latitudinal correlation by such factors as type of sediments, composition of litho- and biofacies and thickness testifies to the presence of genetic connection of the Paleogene deposits of Crimea (Kertch and Tarkhankut Peninsulas), the northwestern shelf, continental slope of the Black Sea and Carpathians. Very likely, it was the only sufficiently deep structural-geomorphologic segment of the Tethys basin that stretched from the Caucasus through the Black Sea Depression, Romania and Carpathians.

In the south part, in the boundaries of the economic zone of Turkey, the Black Sea continental slope is composed, according to obtained bio- and lithostratigraphic data, of the Upper Cretaceous (Turonian, Maastrichtian), Paleogene (Lower-Middle Eocene) and Miocene (Middle Miocene and Sarmatian) deposits. The subflysch Cretaceous and Paleogene deposits have many common features and are similar to the rocks of the northwestern shelf and continental slope of the Black Sea's northern part. In the south part of continental slope, as early as in the Mesozoic, existed deep sea basin. There is an observed inheritance of deep-sea sedimentation in the Eocene and partly in the Miocene. That is to say, in the south segment of the Black Sea basin, which stretches from Adjaro-Triolettia through Pont to the Balkan Mountains, there existed, during the definite geologic intervals, sedimentation conditions similar to those of the north segment.

1. *Barg I.M.* Biostratigraphy of the Upper Cenozoic . — Dniepropetrovsk, 1993. — 196 p.

2. *Catuneanu O.* Geology of the Black Sea Romanian Shelf of North-Dobrugean type // Useful resources Revue Roumaine de Geologie. — Bucuresti, 1994. — Vol. 38. — P. 53-65.

3. *Emelyanov E.M., Shimkus K.M.* To the issue of investigation of deep sea sediments of the Black Sea // Oceanology. — 1962. — Vol. 2, № 6. — P. 1040-1049.

4. *Geology* of USSR shelf. Lithology. — Kiev: Nauk. Dumka, 1985. — 189 p.

5. *Geology* of USSR shelf. Stratigraphy. — Kiev: Nauk. Dumka, 1984. — 184 p.

6. *Geology* of USSR shelf. Tectonics. — Kiev: Nauk. Dumka, 1987. — 150 p.

7. *Gordiyevitch V.A., Bondarenko V.G., Plotnikova L.F., Nazarov N.V.* New data on geology of the Black Sea shelf by drilling results for the Illitchivsk structure // Tect. & Strat. — 1984. — Is. 25. — P. 60-65.

8. *Gozhik P.F., Maslun N.V., Baiysarovish I.M.* Geological model of Laspian canyon of Crimean continental slope // Dokl. AN USSR. Issue B. — 1990. — № 7. — P. 88-97.

9. *Gozhik P.F., Maslun N.V., Ivanik O.M.* Features of the stratigraphic structure of the Anthropogenous sediments at the Black Sea's northwestern shelf // Tectonics and stratigraphy. — 2005. — Is. 34. — P. 103-115.

10. *Gozhik P.F., Maslun N.V., Plotnikova L.F., et al.* Mesocenozoic stratigraphy of the the Black Sea's northwestern shelf. — Kiev, 2006. — 171 p.

11. *Gozhik P.F., Mitropolsky O.Yu., Maslun N.V., Tsychotska N.N.* Lithofacial model of Neozoic sediments as a background for studying processes of lithogenesis and oil and gas accumulation factors of the Black Sea Basin // Tectonic and accumulation of oil and gas on continental shelf: Proceedings of International Conference. — 2000. — P. 45-47.

12. *Gozhik P.F., Mitropolsky O.Yu., Maslun N.V., Tsychotska N.N.* Peculiarities of sedimentogenesis in the Black Sea Depression in the Neozoic period // Geology and mineral resources of the Black Sea. — Kiev, 1999. — P. 210-214.

13. *Handenbol J., Thierry J., Farley M. et al.* Cretaceous biochronostratigraphy // Mesozoic and Cenozoic Sequence Stratigraphy of European Basins (En De Gracianski, P.-C., Handenbol, J., Jacquin at al.) / SEPM Spec. Publ. 60. — Oklahoma, 1998. — 786 p.

14. *International* Stratigraphic Guide / Ed. Hedberg H.D. — New York: John Wiley and Sons Inc, 1976. — 200 p.

15. *Ivannikov A.V., Inozemtsev Y.Y, Maslakov N.A., Maslun N.V., Pyatkova D.M., Stupina L.V.* Stratigraphic research of Black Sea continental slope and shelf // Geology and mineral resources of the Black Sea. — Kiev, 1999. — P. 245-254.

16. *Maslun N.V., Inozemtsev Yu.I., Orovetsky Yu.Yu.* The Lower Cenozoic sediments of the Crimean continental slope, Black Sea. — Kiev, 1989. — 35 p. — (Prepr. / IGN NASU; 89-13).

17. *Maslun N.V., Ivanik M.M., Shumnik A.V., Tsykhotska N.N., Kliushina G.V.* Biolithostratigraphic structure of the Olimpiyske Uplift — a constituent of the geological model of the Marginal Escarpment of the Black Sea northwestern shelf // Paleontological investigations in Ukraine: history, recent state and outlooks. — K.: IGN NASU. — 2007. — P. 206-211.

18. *Maslun N.V., Tsychotskaya N.N.* Sedimentation cyclicity of the Paleocene deposits of northwestern shelf of the Black Sea // Geol. Journ. — 2001. — № 1-2. — P. 125-129.

19. *Moroz S.A., Sulimov I.N., Gozhik P.F.* Geological structure of the Northern Black Sea. — Kiev: Nauk. dumka, 1995. — 184 p.

20. *Nosovsky M.F.* Regional stratigraphic scale for the Maikopian sediments of Plain Crimea // Geol. Journ. — 2003. — № 3. — P. 137-145.

21. *Nosovsky M.F.* Upper Oligocene of Southern Ukraine // Bull. Mosc. Natur. Soc. Dept. Geol. — 2003. — Vol. 78, is. 1. — P. 49-53.

22. *Pevzner M.A., Semenenko V.N. Vangengeym E.A.* Position of the Pontian of the Eastern Parathetys in the magnetochronological scale // Stratigrraphy. Geol. Correlation. — 2003. — Vol. 11. — № 5. — P. 72-81.

23. *Plotnikova L.F., Maslun N.V., Ivanik M.M., Tsychotska N.N., Shumnik A.V.* Cretaceous-Paleocene stratigraphy and geological development peculaties of western part of northwestern Black Sea shelf // Geol. Journ. — 2003. — № 2. — P. 27-38.

24. *Plotnikova L.F., Yakushin L.M., Ishchenko I.I.* Detailed stratification of the Lower Cretaceous sediments of the northwestern Black Sea shelf // Biostratigraphic criteria for division and correlation of the Phanerozoic sediments of Ukraine. — Kiev, 2005. — P. 75-79.

25. *Plotnikova L.F., Yakushin L.M., Ishchenko I.I.* New data on stratigraphy of the Cenomanian deposits of the northwestern Black Sea shelf // Modern directions of the recent Ukrainian geological science — K.: IGS NASU, 2006. — P. 249-254.

26. *Samsonov V.I., Lytskiv S.S., Chepijko A.V.* Peculiarities of the geodynamics of the South-East region of Ukraine related to the perspective of oil and gas contamination // Resources of Crimea and bordering waters (oil and gas). — Simferopol: Tavriya-Plus, 2001. — P. 131-137.

27. *Semenenko V.N.* Neogene terraces of the Black Sea coast and continental slope // Geological problems of the Black Sea. — Kiev, 2001. — P. 245-252.

28. *Semenenko V.N.* Stratigraphic correlation between Upper Miocene and Pliocene of the Eastern Parathetys and Thetys. — Kiev: Nauk. Dumka, 1987. — 230 p.

29. *Semenenko V.N.* Stratigraphic correlation between Upper Miocene and Pliocene of the Eastern Thetys and Parathetys and Thetys. — Kiev: Nauk. Dumka, 1987. — 230 p.

30. *Semenenko V.N.* The Upper Miocene molasses of the Alma Trough // Geol. Journ. — 2003. — № 2. — P. 39-57.

31. *Semenenko V.N.* Marine Quaternary dements of the Azov — Black Sea Basin // Main results in Quaternary studies and principal investigation directions in XXI Cnt. — SntPtb.: VSEGEI, 1998. — P. 208.

32. *Shnyukov J.F, Grigoriev A.V. Maslun N.V., Sobolevskiy Y.S. Desbastilar M.K., Pyatkova D.M., Orovetsky Y.Y.* Mesozoic and Neozoic sediments of Southern continental slope of the South Sea // Geol. Journ. — 1991. — № 2. — P. 123-129.

33. *Shnyukov E.F, Lutsiv Ya.K., Inozemtsev Yu.I.* Geological structure of the Quaternary sediments in the Odessa-Dniester Region of the Black Sea // Study of the geological history and recent sedimentary processes in the Black and Baltic Seas. — Kiev: Nauk. dumka, 1984. — Pt. 2. — P. 54-60.

34. *Shnyukov E.F. et al.* Geological studies in 44 trip of SV "Academician Vernadsky" in the Black Sea. — Kiev, 1993. — 75 p.

35. *Shnyukov E.F. et al.* Stratigraphic, lithological-petrographic and hydrochemical studies in 51 trip of SV "Mikhail Lomonosov" in the Black Sea. — K., 1990. — 51 p. — (Prepr. / IGS NASU; 90-9).

36. *Shnyukov E.F., Dovgy S.A., Starostenko V.I., Gozhik P.F. et al.* Geological evaluation of the submarine cable trace Sevastopol-Zatoka. — Kiev, 2002. — 120 p.

37. *Shnyukov E.F., Maslun N.V., Inozemtsev Yu.I., Orovetsky Yu.Yu.* New data on the geological structure of the continental slope in Southern Crimea // Geol. Journ. — 1990. — № 3. — P. 88-98.

38. *Shnyukov E.F., Shcherbakov I.B., Shnyukova E.E.* Paleoisland arch of the Northern Black Sea. — K.: DMG NASU, 1997. — 288 p.

39. *Shnyukov J.F, Maslun N.V., Inozemtsev Y.Y, Orovetsky Y.Y.* New data on geological structure of the continental slope of Southern Crimea // Geol. Journ. — 1990. — № 3. — P. 88-98.

40. *Stratigraphic* Codex of Ukraine. — Kiev, 1997. — 39 p.

41. *Stratigraphic* scheme of the Phanerozoic formations of Ukraine for geological maps of new generation. Graphic attachments. — Kiev, 1993.

42. *Tugolesov D.A, Gorshkov A.S., Meysner L.B. et al.* Tectonics of the Mesozoic sediments of the Black Sea. M.: Nedra, 1985. — 150 p.

По комплексу методов — биостратиграфическому, литологическому, геофизическому, сейсмостратиграфическому, переинтерпретации имеющихся материалов выполнена детальная стратификация отложений мезозоя и кайнозоя северо-западного шельфа и Западно-черноморской впадины. Созданы схемы стратиграфии мезозойских и кайнозойських отложений. Особое внимание уделено детализации разрезов и особенностям пространственно-временного строения продуктивных мезокайнозойских породных комплексов. Выделены разноранговые стратоны — регионяруса, свиты, пачки, слои. Проанализировано их соотношение с подразделениями Международной стратиграфической шкалы. Корреляция мезокайнозойских отложений северо-западной части Черного моря со структурами Крымско-Кавказской области позволила установить подобие и различие в особенностях их строения.

На підґрунті біостратиграфічного, літологічного, геофізичного, сейсмостратиграфічного методів, переінтерпретації наявних матеріалів виконано детальну стратифікацію відкладів мезозою та кайнозою північно-західного шельфу і Західно-Чорноморської западини. Створено схеми стратиграфії мезозойських та кайнозойських відкладів. Особливу увагу приділено деталізації розрізів та особливостям просторово-часової будови продуктивних мезокайнозойських породних комплексів. Виділено різнорангові стратони — регіояруси, світи, пачки, верстви. Показано їх співвідношення з Міжнародною стратиграфічною шкалою. За кореляцією мезокайнозойських відкладів північно-західного шельфу Чорного моря та структур Кримсько-Кавказької області встановлено їх подібність та відмінності.