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LITHOSTRATIGRAPHY OF THE PLEISTOCENE DEPOSITS OF GEORGIAN SECTOR OF THE BLACK SEA

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Abstract: Researches took place in the South of Georgia (Guria region). Studied geological sections lie 1.5-4 km from the present Black Sea coastline. Pleistocene marine sediments are represented by terraces located at different hypsometric levels with maximum height 120 m on the mountain of Tsvermaghala. Due to neotectonic movement, the Old Euxinic sediments are located at the higher hypsometric level than the younger Uzunlarian and Karangatian. In the region under study the background sediment of the base of Old Euxinic sections, are mud deposits, upward they gradually pass to fine and middle size sands. The base sediment probably was deposited in offshore zone at a depth until approximately 50 m. The Uzunlarian and Karangatian sediments are represented by typical shore zone sediments. Uzunlarian sediments unconformably overlie the inverted Miocene. The base of these sediments contains abrasion clay blocks of the before Pleistocene age. Chemical analysis of the Pleistocene and contiguous resent Black Sea shore sediments on metal content reveals similarity of feeding provinces. The higher contents of manganese and Nickel in the resent sediments are caused by anthropogenic factor. Stratigraphy of the studied region is based on the mollusk and ostracode faunistic complexes. Old Euxinic sedimentation conditions were more favorable for the fauna conservations than Uzunlarian and Karangatian ones, which contains very poor fauna and boundary between them is conventional.

Keywords: Pleistocene, sedimentology, stratigraphy, Georgia, Black Sea.

1. Introduction

Studies of Pleistocene deposits within the Georgian sector of the Black Sea have a long history. These studies started in the second half of the nineteenth century by R. Prendel. In the scientific works of the last century: D. Tsereteli (1966); Dj. Mamaladze (1975); P. Feodorov (1978); T. Kitovani (1989), are given some problems of the sea level changes, stratigraphy and lithology of marine terraces during the Pleistocene.

During the Pleistocene, the Black Sea was periodically either connected to the World Ocean, or it was a semi-isolated intercontinental basin. Paleogeographic epochs related to the transgression basins (Old Euxinic, Uzunlarian, Karangatian and the Black Sea) were defined by Andrusov (1905), Arkhangelsky and Strakhov (1932). Most of the scientists agree with these ideas. Feodorov (1963, 1978) made valuable contribution to studies of the Quaternary history of the Black Sea basin. He was the first to affirm a view on a double phase nature of the Black Sea transgressions. They started with water inflow from the Caspian Sea and continued as typical interglacial transgressions, which finally terminated in reconnection with the Mediterranean.

Pleistocene marine deposits are widespread in the central and northern part of the West Georgia seaboard. They are represented by marine terraces, located at different heights from the recent sea level, except the Kolkheti depression, where these deposits are deeply submerged. Stratigraphy of the Pleistocene marine deposits is based on the studies of Mollusk and Ostracode faunistic complexes being significant actual material for paleogeographic reconstructions.

2. Materials and Methods

We have studied structures of the sediments based on all the characteristic features of the layers and their surfaces which formed during the sedimentation.

Grain-size analysis was conducted for Uzunlarian and Karangatian deposits using sieve analyses.

Carbonate material was measured using calcimeter method.

Mineralogical analysis of samples was carried out for 0.18-0.01mm fraction. By means of immerse liquids heavy and light minerals were isolated in the polarizing microscope.

11 samples from different sections were analyzed on metal content. Percentage of Pb, Mo, V, Cr has been determined by method of spectral analysis. Percentage of Cu, Ni, Zn, Mn and Fe –by atomic-absorption method. Obtained results were compared to the adequate analyses of resent sediments of the same region and of the Black Sea.

3. Lithostratigraphy of the studied region

In the Guria region (mountain Tsvermaghala) Pleistocene marine sediments are represented by terraces located at different hypsometric levels with maximum height 120 m. During the Pleistocene, the maximum level of the World Ocean and the Black Sea didn't exceed 10 m.Thus , positive neotectonic movement took place simultaneous with the sea eustatic. Therefore in the sections of Tsvermaghala older sediments are located at higher hypsometric levels than the younger ones. This assumption concerns only shore and offshore (not deeper than 50m) sedimentation. As to deeper, offshore sedimentation, it proceeded in normal stratigraphic succession.

Based on studies, geological history of the Black Sea in Pleistocene was related with evolution of the Caspian and Mediterranean basins. At the end of Pliocene, Black Sea was not connected with Caspian basin and poorly connected with the Mediterranean Sea. Since the Old Euxinic, the World Ocean and Mediterranean transgression re-establishes connection between the Black and Caspian Seas. At the same time took place salification of the Black Sea, this period associates with the end of the Pliocene and beginning of the Pleistocene (Kitovani 1989).

In the Uzunlarian and Karangatian the Black Sea was connected only with the Mediterranean basin, in New Euxinic epoch the last phase of Würmian glaciation provoked disconnection of these basins. At this time, the World Ocean and the Black Sea levels were approximately at -110 - -120 m marker.

4. Old Euxinic Sediments

Among the studied sediments the Old Euxinic are stratigraphically the oldest [section I-VII (Fig. 1)]. The Base of the Old Euxinic sediments lies at about 80-90 m height above the present sea level. Background sediments [section I-IV and VII (Fig. 1)] are represented by sandy-clay material; more than 50% of the grains size is less than 0.1mm. Colors varies from blue to brown, they probably were deposited at a depth approximately until 50 m. Presence of rusty pseudo-layers in clays is conditioned by pulsating inflow of pelitic fraction of magnetite into the sedimentary basin from adjacent volcanogenic and volcano-sedimentary formations of the western termination of Adjara-Trialeti, which is the main feeding province of the region under study. As for the coarse-grained material in the sections (sand, pebbles), they were delivered here by gravitation flows. That's why in most cases the coarse-grained material is graded and contact between layers is abrupt and somewhere disconformable. Within Tsvermaghala area sands with inclusions of pebbles conformably continue the Old Euxinic sediments. Changing of offshore facies by inshore facies is caused by activation of neotectonic movements; it is evidenced by considerably low hypsometric position of Uzunlarian sediments on the terrace steps and presence of relatively coarse-grained material. The roof of the Old Euxinic sediments lies at a height of 120 m.

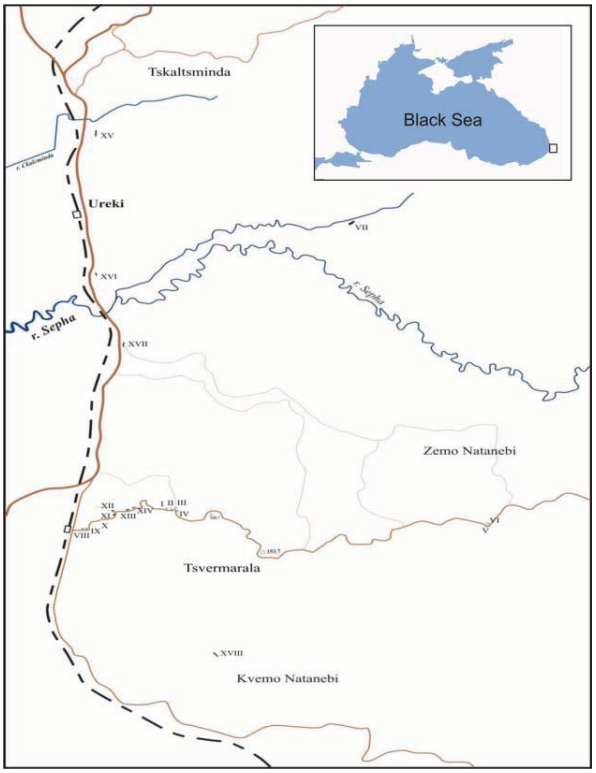

Fig. 1. Schematic map of the sections locations.

Section V and VI (Fig. 1) are located in 1.7 km to the West from above mentioned sections. Here Miocene layers of almost vertical bedding are covered by a horizontally bedded unit of coarse-grained sands - the sands are characterized by cross-bedded structure.

In the Old Euxinic ostracode complex (50 species) are observed degraded species from the Eopleistocene - *Tyrrhenocythere azerbaidjanica* (Liv.), *T. pseudoconvexa* (Liv.), occur new species *Cytherissa omparetica* Imn., *C. macelina* Imn. and for the first time after the Lower Pontian appear representatives of the genus Eucypris.

By the morphological features of ostracodes from the Old Euxinic sediments of the Guria region have been studied genetic relations between the Miocene-Pliocene and recent ostracodes. In ostracode composition besides the endemic species are identified ostracodes of the Mediterranean, Old Panonian-Pontian, Pontian and Aghchagilian-Apsheronian origin (Popkhadze 2004), gradually evolving throughout the Pleistocene. They underwent adaptation and alongside with Old Euxinic forms, they gave rise to the development of Pleistocene fauna.

5. Uzunlarian and Karangatian Sediments

The Uzunlarian and Karangatian sediments on the region under study are generally represented by coarse-grained sands and pebbles. The base of Uzunlarian deposits is located at an absolute height of 15-20 m, where inclusions of abrasion clay blocks of the before Pleistocene age are observed [section VIII-XVIII (Fig. 1)]. The mentioned sediments with angular unconformity overlie the inverted Miocene deposits.

Sections VIII-XIV are located on Tsvermaghala and represent successive continuation of Uzunlarian and Karangatian deposits from the base to highest point on about 60-70 m absolute height. As it was mentioned the sediment are mainly composed with coarse-grained sand and relatively rare pebbles alternation. Sand grain median size (Md) varies from 0.4 to the 2 mm. Pebble median size reach 7.8 mm. Pebbles are well rounded and oriented to the West. Contact between layers is usually abrupt or eroded, but gradual transition of uninterrupted sedimentation process is also observable. From the above it can be concluded that the positive tectonic movement was largely compensated with sea level rise (transgression) followed with abundant inflow of solid drift to the shore zone.

Section XV is located at a height of 20m, 5.2 km to the North from Tsvermaghala. Sediments are represented by coarse-grained sands and pebbles, herein, 10-15% of pebbles are granitoids, limestones and sandstone from Anatolian upland, the nearest river which delivers such kind of material to the shore zone is r. Chorokhi. It has to be mentioned that resent dynamic system of the Chorokhi River is located between the Chorokhi and Natanebi river-mouths; in Karangatian alluvium delivered into the shore zone by the Chorokhi River extended 10 km farther to the North.

Section XVIII is situated in 2.5 km southwards of Tsvermaghala, at a height of 34 m. It is represented by typical shore sediments, crossbedded sands are indicative of the wave-cut zone.

Karangatian as well as Uzunlarian sediments contain very poor fauna that's why boundary between them is conventional.

In the Uzunlarian time takes place transition from the Caspian type saline basin to the desalinated marine basin. The sediments are dated by mollusk fauna and ostracodes. In total 13 species of the genera *Candona, Eucypris, Criptocyprideis, Cyprideis, Tyrrhenocythere are found here.*

Beginning of the Late Pleistocene coincides with the Karangatian transgression. The ostracode complex is represented by 21 species of genera *Aglaiocypris, Ilyocypris, Candona, Eucypris, Leptocythere, Callistocythere, Carinocythereis, Aurila, Loxoconcha, Semicytherura, Xesteleberis.* Development and distribution of fauna during the Karangatian is in relation with the reestablished connection between the mentioned basin and the Mediterranean. In the beginning and at end of the Karangatian marine fauna is poor, but the middle of the period is signified with diversity of fauna.

6. New Euxinic and Holocene Age

During the last maximum phase of the Würmian glaciation (about 17 thousand years ago) absolute mark of the Black Sea level was at a depth of -110 – -120 m. It was an isolated basin (New Euxinic basin). The New Euxinic sediments are represented by coarse-grained terrigene deposits.

As a result of post-Glacial transgression (Flandrean) volumes of alluvial material delivered to the sea by the rivers couldn’t compensate high rate of

the transgression. Due to the above mentioned process the coastal line moved far into the recent land (Tvalchrelidze, 1998).

At the beginning of Holocene, the Black Sea connected to the Mediterranean when its level was at the -42 – -38 m mark. During the Holocene against the general background of the Flandrean transgression low amplitude transgressive (the New Black Sea I and II and Nimphean) and regressive (intermediate and Phanagorian) phases are distinguished.

In the Holocene, maximum level of the Black Sea – +3.0 – +3.5 m is fixed during the New Black Sea I transgressive phase (about 6000-5000 years ago), as for the minimum level –14.0 - -16 m it is indicated during the Phanagorian regression (about 3200-2600 years ago).

The Black Sea-side of Georgia gained its contemporary appearance after the Nimphean transgressive phase (about 2000-1800 years ago). The decisive role in its formation had low amplitude eustatics of the sea, volumes of river alluvium, litho- and morphodynamics of the coastal zone, submarine canyons etc.

In Western Georgia the marine New Euxinic sediments practically are not exposed on the surface. In these sediments is described mollusk fauna, but ostracodes are not studied. Desalination of the basin at the expense of disconnection from the sea caused impoverishment of macrofauna. According to different researchers the basin was similar to the recent Caspian Sea by the comparatively poor fauna and less salinity. Lacustrine-marine basin was substituted by the Black Sea basin. In Georgia the Black Sea stage is divided into two parts: the Old Black Sea and New Black Sea stages. It is dated by mollusk fauna, ostracodes are not studied.

7. Mineralogical characteristics of the sediments

Description of the sections shows that Old Euxinic deposits are mainly represented by bluish wet plastic heavy sandy-clays, with sparse interlayers of rusty fine-grained sands end inclusion of isolated well-rounded gravel granules. In the mentioned sediments, carbonate content is 9-10%, almost the same as carbonate content of recent sediments in the south-eastern part of the Black Sea. Its content as well as in recent sediments depends on carbonate-bearing terrigene material delivered from the feeding provinces and on marine fauna. Old Euxinic dark bluish clays are represented by minerals of montmorillonite group and in less amount chlorite, hydromica and quarts are present. As for the existence of rusty interlayers in Old Euxinic sediments, their mineralogical content is mainly the same as of the clays, but admixing of pelitic fraction of magnetite raises Fe content in the mentioned layers.

Uzunlarian and Karangatian are mainly represented by shore facies. The source province of the coarse-grained, sandy-pebbly terrigene material was Anatolian upland (the Chorokhi river basin) and western termination of Ajara-Trialeti fold system.

Psephitic material is mainly represented (90%) by magmatic rocks: basalts, hornblende-basalts, plagio-basalts, olivine-potassic basalts, trachybasalt, dacite, quartz porphyrites, ash tuffs, granitoid, aplites and etc. Sedimentary rocks are in comparatively less amount: sandstones, limestones.

In the Uzunlarian and Karangatian coastal deposits content of the heavy fraction varies from 40 to 85% and is represented by magnetite (limonite)-pyroxene association. From heavy minerals pyrite, hornblende, epidote, biotite, zircon, hematite and etc are also present.

Light fraction is represented by feldspar (mainly plagioclase) quartz, calcite, chrysolite and etc.

8. Result of the chemical analysis

11 samples from Pleistocene deposits were analyzed on metal content. Percentage of Pb, Mo, V, Cr has been determined by method of spectral analysis. Percentage of Cu, Ni, Zn, Mn and Fe –by atomic-absorption method. Obtained results were compared to the appropriate analyses of the resent sediments from the same region of the Black Sea (Tab. 1). This analysis reveals similarity of feeding provinces of Pleistocene and modern basins. The higher content of Manganese and Nickel in the resent sediments is the result of human activity.

9. Conclusions

In the South Georgia (Guria region) Pleistocene marine sediments are represented by terraces located at different hypsometric levels. On the mountain of Tsvermaghala due to neotectonic movement the Old Euxinic sediments are located at the higher hypsometric level than the younger Uzunlarian and Karangatian.

Table 1. Result of the chemical analysis.

Samples		Fe	Cu	Zn	V	Cr	Mn	Mo (10^{-4})	Pb	Ni
Pleistocene	1 Section 16	5,6	0,006	0,009	0,054	0,016	0,075	<1	0,0012	0,007
	2 Section 17	4,4	0,004	0,007	0,041	0,014	0,08	1	<0.001	0,005
	3 Section 17	4,8	0,005	0,008	0,064	0,025	0,145	1	0,0023	0,007
	4 Section 9	5	0,006	0,008	0,018	0,02	0,03	1	<0.001	0,006
	5 Section 10	4,8	0,006	0,007	0,05	0,027	0,09	1	0,0023	0,007
	6 Section 13	5,3	0,005	0,007	0,05	0,035	0,04	1	0,0014	0,008
	7 Section 2	4,5	0,005	0,009	0,042	0,029	0,04	1	0,0021	0,006
	8 Section 2	5,1	0,005	0,009	0,054	0,027	0,045	1	0,0024	0,006
	9 Section 6	4,5	0,009	0,016	0,1	0,16	0,03	1	0,0015	0,007
	10 Section 6	2,5	0,01	0,012	0,11	0,24	0,02	<1	0,001	0,007
	11 Section 6	3,8	0,008	0,01	0,078	0,2	0,025	<1	0,0012	0,008
Recent	Profile 1	6,2	0,008	0,012	0,029	0,057	0,144	0,76	0,0015	0,012
	Profile 2	6,6	0,008	0,012	0,024	0,051	0,147	0,93	0,0024	0,012
	Profile 3	6,4	0,007	0,013	0,021	0,028	0,218	0,33	0,0013	0,011
	Profile 4	5,8	0,007	0,01	0,02	0,027	0,269		0,0013	0,01
Average	Pleistocene sediments	4,6	0,006	0,009	0,06	0,072	0,056	1	0,0017	0,006
	Modern sediments	6,3	0,008	0,012	0,024	0,041	0,195	0,6733	0,0016	0,011

The base of Old Euxinic sediments were deposited in offshore zone at a depth until approximately 50 m. Gradual transition of the mentioned sediments from offshore to inshore facies is the result of positive neotectonic movements.

Uzunlarian and Karangatian sediments unconformably overlie the inverted Miocene and are represented by typical shore zone sediments. Observable thickness of these sediments on m.
Tsvermaghala is 40-45 m, thus positive tectonic movement was compensated with sea level rise followed with abundant inflow of solid drift to the shore zone.

In Karangatian alluvium from Anatolian upland delivered into the shore zone by the r. Chorokhi extended 10 km farther to the North then nowadays.

Chemical analysis of the Pleistocene and the resent Black Sea shore sediments on metal content reveals similarity of feeding provinces.

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