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BIOSTRATIGRAPHY AND PALAEOENVIRONMENT OF THE UPPER CRETACEOUS FLYSCH SEDIMENTS OF THE MESTIA-TIANETI ZONE OF THE GREATER CAUCASUS FOLD SYSTEM

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Abstract: Detailed study of the assemblage composition of calcareous plankton contents (calcareous nannofossil and planktonic foraminifera) of the Late Cretaceous sediments of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of the Greater Caucasus fold system (GCFS) has been carried out for the first time in this region to define biozonation (Fig. 1). Within the limits of the Cenomanian-Maastrichtian 9 small foraminiferal and 19 nannoplankton biostratigraphic units (zones and subzones) have been established. Here are specified volume and age of lithostratigraphic units (successions) composing the Upper Cretaceous of the Mestia-Tianeti zone of GCFS: the Ukughmarti succession – CC9 (Early Cenomanian); the Ananuri succession - CC9-CC11 (Early Cenomanian-Early Turonian); the Margalitisklde succession - CC12-CC13 and planktonic foraminifera zones *Marginotruncana pseudolineiana-M. lapparenti* and *Marginotruncata sigali*. (Late Turonian-Early Coniacian); the Eshmakishevi succession - CC14-CC19 (Late Coniacian-Early Campanian) and zones *Archaeoglobigerina basquensis* and *Globotruncana arca* (upper part of the succession); the Jorchi succession - CC20-CC25a (Middle Campanian-Lower Maastrichtian), in the sediments of CC22c is established the small foraminiferal zone *Globotruncana ventricosa-Rugoglobigerina rugosa*; the Sabue succession - CC25b-CC26 and foraminiferal zone *Gansserina gansseri* (Late Maastrichtian). The analysis of the Late Cretaceous nannoplankton association of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of GCFS has shown the existence of four sedimentary cycles: Cenomanian-Early Turonian, Middle Turonian-Early Campanian, Late Campanian-Early Maastrichtian and Late Maastrichtian. During Cenomanian-Early Turonian the region represented a basin of isolated and regressive sea in the southern part of moderate cold-water belt. Since Late Turonian border of warm- and moderate cold-water belts moved to north. Transgression, started in Late Turonian, continued till Early Coniacian. In the middle of Early Coniacian sea shoaling is outlined. Sedimentation took place in a shallow and calm basin from Late Coniacian till the end of Santonian. Fact of sedimentation missins of the four nannoplanctonic zones CC19, CC20, CC21 and CC22a,b from the sections of the Zhinvali-Pkhoveli nappe and the analysis of the redeposited forms enablesenable to admit break in sedimentation caused by Early Campanian regression and Late Campanian transgression. The short-term Middle Maastrichtian regression was replaced by the Late Maastrichtian transgression.

Key words: Caucasus, Cretaceous, biostratigraphy, nannoplankton, small foraminifera, flysch

1. Introduction

Studied by us the flysch deposits The Late Cretaceous are spread in the junction area of two large geotectonic structures - fold system of the Greater Caucasus and the Transcaucasian intermontane area. Under the scheme of tectonic zoning of the Caucasus (Gamkrelidze and Gamkrelidze, 1977) it enters into the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of GCFS and is presented by flysch, flyschoid, normal sea and olistostrome facies. Due to considerable prevalence of "barren" (deprived of fossil fauna) rocks in these sediments, and also the extremely complicated tectonic structure, the detailed stratigraphy of Mesozoic-Cenozoic rocks of the Mestia-Tianeti zone of the GCFS still remains unsolved. Although the study of this region lasts for more than a century, its stratigraphic partition is restricted only to the lithostratigraphic units (formation and sub-formation); their

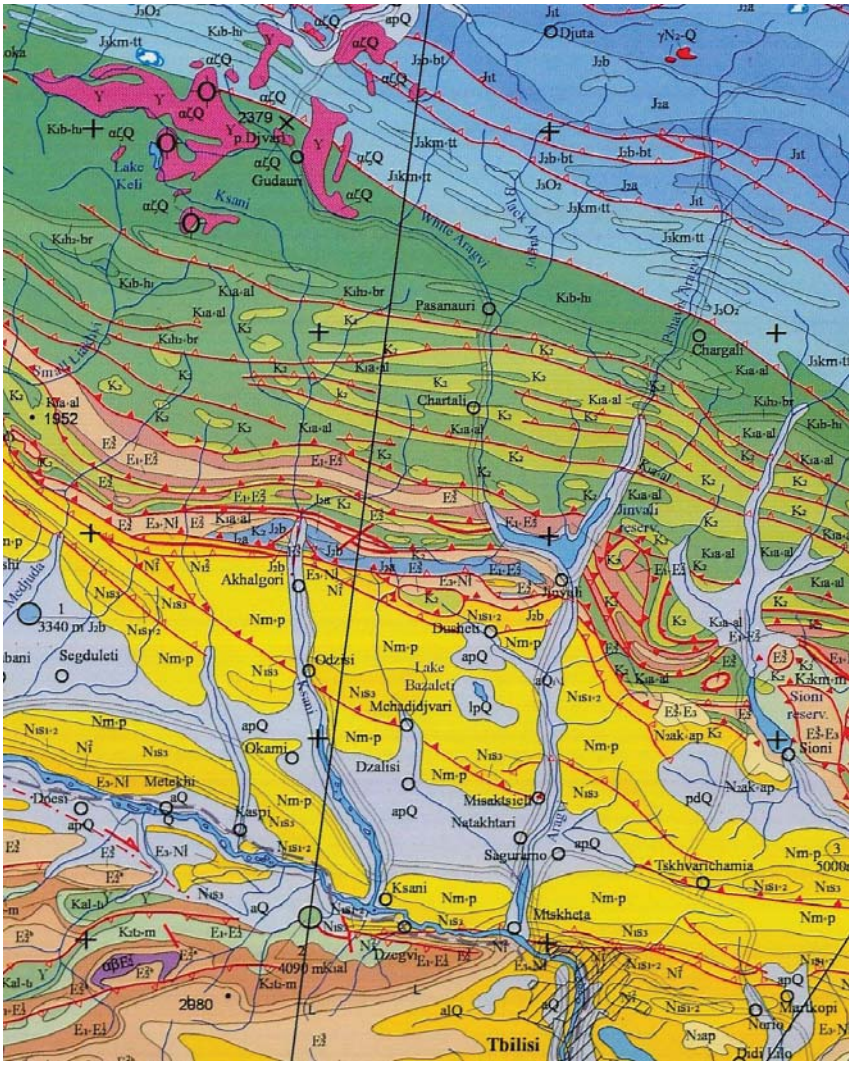

Fig. 1. Geological map of the studied region

age has been defined by scanty faunistic data and on the basis of their stratigraphic position. That's why the question of age and volume of these formations are still in dispute for some researches. The first data concerning the stratigraphy of these sediments were published by Rengarten (1924) and Vassoevich (1933). Later on, they developed the stratigraphic schemes being substantially specified by several generations of researchers: Vassoevich (1941), Tsagareli (1954), Mrevlishvili (1957), Adamia (1958), Kandelaki (1975), Leonov (1975,1981), Gamkrelidze and Gamkrelidze (1977), Gambashidze (1970, 1981, 1991), Gamkrelidze et al. (1985), Giorgobiani and Zakaraia (1980) et al., who made a valuable contribution to study of geological structure of the region.

2. Materials and methods

For the detailed stratigraphic division of the Upper Cretaceous sediments of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone GCFS, and for specifying the volume and age of the formations, in the facies of Sadzeguri-Shakhveli and Zhinvali-Pkhoveli nappes the sections of the Ksani and Aragvi river basins (the rivers Aleura, Sakanaphe, Arkala, Didi Jakha, Patara Jakha; near the villages Sadzeguri, Korinta, Ananuri, Muguda, Avenisi, Pavleuri) have been studied.

The researches were based on the extensive material collected by the authors during the field works (2007-2009). More than 700 samples in total were obtained from the 11 layer-by-layer studied sections of the Late Cretaceous and the bordering sediments. The sampling interval ranged range from 0.3m to 5.0m. Nannoplankton and small foraminifera were studied from the same samples.

Samples for the calcareous nannofossils were processed in the laboratory of the Institute of Geology of Georgia. Suspension slides were prepared using a standard method of decantation and they were studied under the light microscope Amplival, at 1200x magnification.

Biostratigraphic data were correlated with the standard nannoplankton "CC" zones by Sissingh (1977) and Perch-Nielsen (1985).

The samples for foraminiferal analysis were treated in the laboratory and washed with glacial acetic acid and copper vitriol.

3. Results

The Upper Cretaceous flysch in the Mestia-Tianeti zone GCFS starts with the Ukughmarti formation. It continues the succession of underlying Navtiskhevi suite without visible unconformity. But in some areas its transgressive position is observed. The suite is represented by polymictic. This formation was first described by Vassoevich (1933); it is represented by polymictic sandstones, marls, clay shales, argillites, sandy limestones and lenses of polymictic gravelstones and breccia-conglomerates (in the lower part of the formation). The rocks contain a considerable admixture of pyroclastic material.

The identification of the belemnite species *Neohibolites ulthimus* d'Orb., Inocerames *Inoceramus crippsi* Mant., *I. cf. cuneiformis* Orb. and rare small foraminiferas *Anomalina cenomanica* Brotz., *Hedbergella planispira* (Tapp.), *Thalmanninella evoluta* Sig., *T. appeninnica* Renz. previous researchers (Rengarten,1941; Tsagareli,1954; Gambashidze, 1981) took the suite into Early Cenomanian. Data got by studying nannoplankton proved this decision.

Ukugmarti formation contains association of nannofossils that is characteristic for the zone of *Eiffellithus turriseiffelii* (Fig.2). Because of *C. kennedy's* absence in the association (marking species of the upper subzone of *Eiffellithus turriseiffelii's zone*) and continuous occurrence of *H.albiensis* (according to its disappearing the lower subzone of the zone is determined) up to the layers of the zone CC11, dividing of *Eiffellithus turriseiffelii* zone into subzones failed. Though existence of *Corollithion exiguum, Quadrum intermedium* and *Diloma galei* (species appearing in Cenomanian) in the layers of Ukugmarti formation allow us to time the formation to the upper- Early Cenomanian subzone -CC9c. As for *H.albiensis*, its joint occurrence with above noted species, as in subsequent zones with *M. decoratus* and *Q. Gartneri,* indicate its secondary occurrence in corresponding deposits.

The Ananuri formation conformably rests on top of the Ukughmarti formation in all the studied sections. It is distinctly divided into three parts. The Lower Ananuri sub succession is built up of silicified aleurolites, fine-grained sandstones, sandy limestones, clay marls, lenses of black flint and siderite concretions. Gambashidze (1970) in the section of the village Muguda in the sediments of the sub-formation, has defined the Early Cenomanian microfauna *Thalmaninella appenninica* (Renz.), *Rotalipora cushmani cushmani* (Morr.), *Reophax minuta* (Tapp.)*, Anomalina brotzeni* Kell.

According to nannoplankton these deposits correspond to upper part of the subzone CC9c and lower part of the zone CC10 (FO *Microrhabdulus decorates* to FO *Quadrum gartneri).*

The Middle Ananuri sub-formation is distinguished by its black color and is presented by black flints, silicified sandstones, silicites and concretions of black flint. It corresponds to the upper part of the zone CC10.

The Upper Ananuri sub-formation is more light coloured. It is built by silicified sandy limestones, sandy marls, marls, limestones, siliceous rocks and tuffs. Due to its stratigraphic position and to solitary findings of the Early Turonian *Inoceramus labiatus* Schloth. and *Globotruncana inflata* Bolli in the upper part of the record, some researchers attribute the lower sub-formation to the Late Cenomanian, and the middle and the upper subformation - to the Early Turonian (Gambashidze 1984; Kandelaki 1975;). According to other scientists only the upper part of the record can be considered as Early Turonian (Vassoevich 1933; Tsagareli 1954; Adamia 1958, et al.).

According to our data, lower parts of Upper Ananuri subsuite belong to Late Cenomanian zone CC10, and the other part – to the zone CC11 (FO *Quadrum gartneri* to FO *Lucianorhabdus maleformis*) of Early Turonian. In Upper Ananuri suite sediments, according to foraminifera the zone *Whiteinella archaeocretacea* is established. Besides the index-species, here are recorded *W. brittonensis* (Leoblich et Tappan), *W. baltica* Dauglas et Rankin*, W. aprica* (Leoblich et Tappan), *Dicarinella imbricate* (Mornad) *D. hagni* (Scheib.), *Praeglobotruncana helvatica (Bolli), Heterohelix*

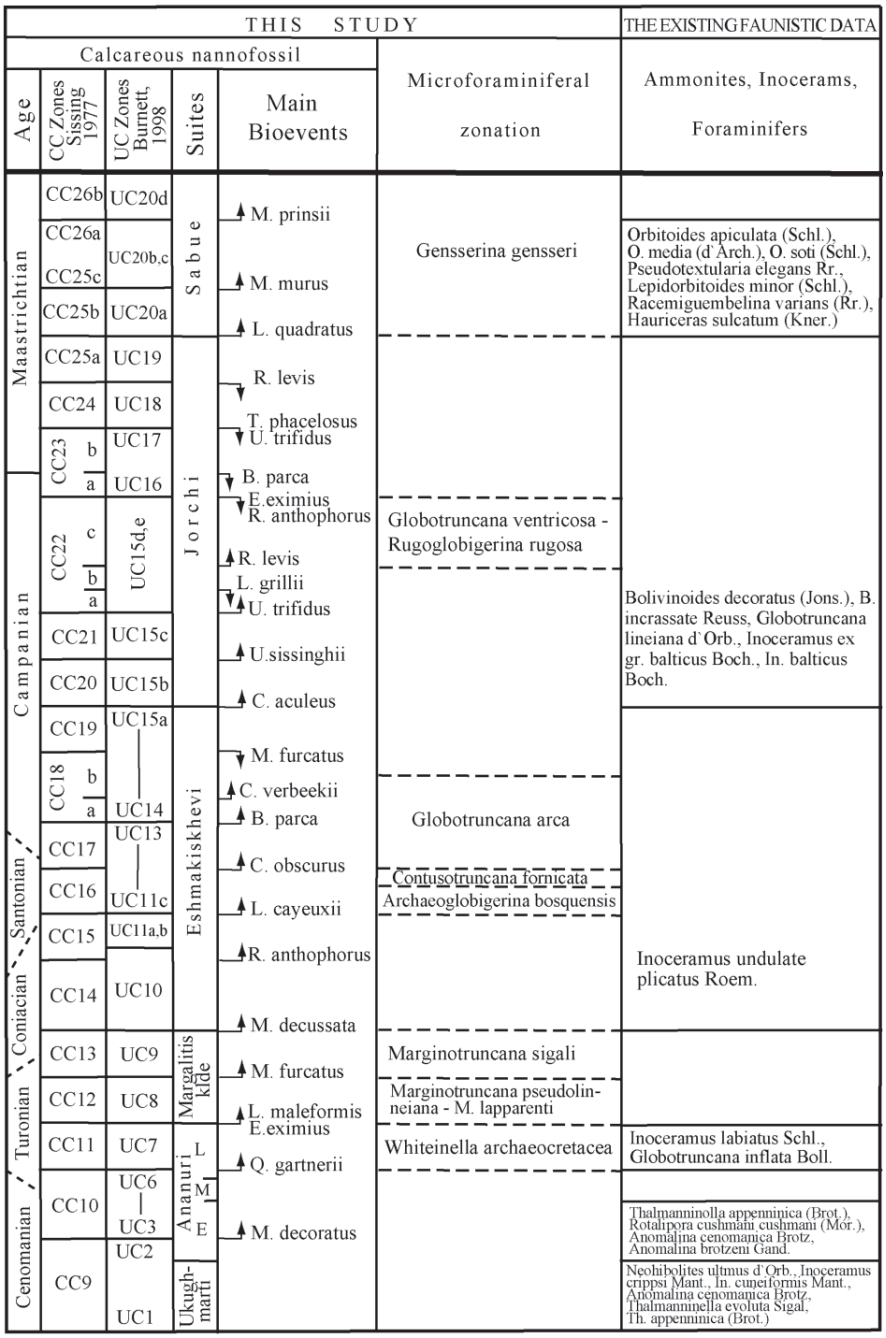

Fig. 2. Biostratigraphy of the Late Cretaceous flysch sediments of the Zhinvali-Gombori subzone.

moremani (Cush.), *H. reussi*(Cush.), *Hedbergella delrionensis* (Carsey). *H. planispira*(Tappan). On the basis of all above noted, we assume that formation of Middle Ananuri sub-formation took place (together with bottom part of Upper Ananuri suite) by the end of Late Cenomanian, and the main part of Upper Ananuri sub-formation – in Early Turonian.

The Margalitisklde formation is characterized by red colorcoloring and carbonaceous. In the structure of the formation marls and limestones predominate, whereas clay shales and sandy limestones are subordinate components. The succession in places shows coarse-clastic rocks passing in ascending section into alternation of limestones and marls. In the majority of sections, the succession conformably rests the upper band of the Ananuri formation. In some places, especially in the southern facies zones, transgressive bedding is observed. Varentsov (1950), based on finding of *In-*

oceramus brongniarti Mant. I. *inconstans* Woods in the Ksani river-gorge has considered the formation as Upper Turonian. The same opinion share Vassoevich (1933) and Kandelaki (1975). However, some scientists due to the replacement of red limestones of the Margalitisklde formation by of lithographic limestones of the Eshmakiskhevi formation in the Ksani and Aragvi river-gorges (where the thickness of the formation considerably decreases) specify the changes of age boundaries of red limestones and date it as Early Turonian (Rengarten 1929; Tsagareli 1954;). According to Gambashidze (1981), it corresponds to the Late Turonian and Coniacian.

Observations showed that Margalitisklde formation includes nannoplankton zones CC12 (FO *Lucianorhabdus maleformis* to FO *Martasterithes furcatus*) and CC13 (FO Martasterithes furcatus to FO *M.decussata*). The zone (CC12) by the planktonic foraminifers corresponds to a zone *Marginotruncata pseudolineiana-M. lapparenti*, where for the first time occurred the double-keel forms of the genus *Marginotruncana*. The given foraminifer zone is dated as the Late Turonian.

According to small foraminifera in sediments of the zone CC13 was determined zone of *Marginotruncata sigali.* Some explorers (Burnett 1998; Lees 2002; Hradeska at al. 1999.) have dated the zone CC13 as the Middle Turonian-Early Coniacian. As well, as in the lowermost layers zone CC13 by foraminifera were found typical Coniacian *Marginotruncata marginata,* (Reuss), *M. sigali* (Reichel), *Dicarinella concavata* etc. we refer the zone CC13 to the Early Coniacian. Thereby, Margalitisklde suite is dated as late Turonian-Early Coniacian.

The Eshmakiskhevi formation conformably overlies the sediments of the Margalitisklde formation and it is presented by rhythmical alternation of lithographic limestones, marls and shales.

Here, are observed the interlayers of sandy slates which in places pass into the coarse-grained sandstones and microconglomerates. The age of the formation varies. Some scientists refer that the formation is of Upper Turonian-Early Senonian age (Rengarten 1929; Tsagareli 1954); Others, relate it to the Coniacian-Santonian (Vassoevich 1933; Kandelaki 1975). Varentsov (1950), based on the findings of *Inoceramus undulate plicatus* Roem in the Ksani river-gorge, dates it as Coniacian and finally Gambashidze (1981) considers it of the Santonian age.

According to our data Eshmakiskhevi suite envolves nannoplankton zones CC14 (FO *M. decussata* to FO *Reinhardtites anthophorus*), CC15 (FO *R. Anthophorus* to FO *L. cayeuxii*),CC16 (FO *L. cayeuxii* to FO *C.obscurus*),CC17(FO *C.obscurus* to FO *B. parca),* CC18 (FO *B. parca* to LO *M. furcatus*), CC19 (LO *M. furcatus* to FO *C.aculeus)* and is dated as Late Coniacian-Early Campanian. Small foraminiferas were found on the second part of the suite.

In the sediments, corresponding to zone CC16, on the basis of small foraminiferas were detrmined zones *Archaeoglobigerina basquensis* and *Contusotruncana fornicata* (Late santonian). For the first zone are characterized *A. cretacea* (d'Orb*.), Whiteinella baltica* Dougl. et Ran., *Hedbergella planispira* (Tapp.), *Valvulineria lenticulata* (Reuss*), Verneulina muensteri* Reuss, *Gavelinella pertusa* (Mors.), *Stensioina granulate* (Olb*.), S. exsculpta* (Reuss). *A. cretacea* (d'Orb*.), Whiteinella baltica* Dougl. et Ran., *Hedbergella planispira* (Tapp.), *Valvulineria lenticulata* (Reuss*), Verneulina muensteri* Reuss, *Gavelinella pertusa* (Mors.), *Stensioina granulate* (Olb*.), S. exsculpta* (Reuss). From the second zone are met *Gontusotruncana fornicatea* (Plum.), *G. arcaformis* Masl., *Globotruncana bulloides* Mart., *G. linneiana* (d'Orb.), *Praebulimina reussi* (Mor.), *Eponides concinna* Brotz., *Cibicides ribbingi* Brotz., *Reussela praecursor* Knips.

In layers corresponding to the nannoplankton zones CC17 and CC18, by planktonic foraminifera the zone *Globotruncana arca* (Early Campanian) is established; it comprises *Rugoglobigerina kelleri* (Subb.), *Archaeoglobigerina cretacea* (d'Orb.), *Globorotalites micheliana* (d'Orb.), *Cibicides beaumontianus* (d'Orb.), *Stensioina exculpta gracilis* Brotz., *Valvulineria lenticulata* (Reuss)*, Bolivinoides strigillatus* (Champ.).

The Jorchi formation is built up by medium-layered arenaceous limestones alternating with violet, red, green and greenish-grey marls and marly shales. This formation has been allocated by Vassoevich (1941), who attributed the Jorchi formation to the Lower Campanian based on the presence of the *Inoceramus ex. gr.balticus B*ochm. and *I. balticus B*ochm. at the boundary of the layers of the Jorchi and Eshmakiskhevi formation. Tsagareli (1954) regards it as Santonian-Lower Campanian; Kandelaki (1975) and Gambashidze (1981), based on the presence of small benthic foraminifera *Bolivinoides decoratus* (Jons.), *Boliniva incrassate*

Reuss stratigraphically positioned the formation to the Campanian.

We determined Nannoplanktonic zones in Jorchi suite: CC20 (FO *C. aculeus* to FO *U. sissinghii*), CC21 (FO *U. sissinghii* to FO *U. trifidus*), CC22 (FO *U. trifidus* to LO *E. eximius*), CC23(LO *E.eximius* to LO *U. trifidus*), CC24(LO *U. trifidus* to LO *R. levis*) and subzone lower part of the zone CC25a (LO *R. levis* to FO *L. quadrates*). From above, age of Jorchi suite is defined as Middle Campanian-Early Maastrichtian.

By foraminifers in the sediments, corresponding to nanoplanktonic subzone CC22c the Late Campanian zone *Globotruncana ventricosa-Rugoglobigerina rugosa* is established. Besides the index-species here are registered *Globotruncana stuartiformis* (Dalb.), *Heterohelix pulchera* (Brotz.), *Bolivinoides culverensis* Barr., *B. Pustulata* Reuss, *Cibicides beaumontianus* (d'Orb.), *Stensioina pommerana* Brotz., *Osancularia cirdieriana* (d'Orb.).

The Sabue formation is bedded transgressively on different horizons of Jorchi suite. It is represented by alternation of medium- and thick-layered limestones, arenaceous limestones, marls, marl shale and clay shales. Here are observed interlayers of microconglomerates, fine-pebbly conglomerates, gravelstones, breccias and sandstones.

The presence of large benthic foraminifera - *Orbitoides apiculata* (Schlumb.), *O. media* (d'Arch.), *O.soti* (Schlumb.), *Lepidorbitoides minor* (Schlumb.), etc., small benthic foraminifera - *Pseudotextularia elegans* Rz., *Racemiguembelina varians* (Rz.) and ammonites - *Hauriceras sulcatum* (Kner.) attribute a Maastrichtian age the Sabue formation.

On the basis of our data in Sabue formation sediments is established the planktonic foraminiferal zone *Gansserina gansseri*. Besides the index-species here are registered *Rugoglobigerina macrocephala* Bronn., *R. hexacameratta* Bronn., *R. pennyi* Bronn.

In the sediments of the Sabue succession the occurrence of the species *Lithraphidites quadratus, Micula murus and Micula prinsii,* has enabled to allocate here the same named, which correspond biostratigraphic units applicable to those in Sissingh's (1977) zones - CC25b, CC25c and CC26.

4. Discussion

The analysis of the Late Cretaceous nannoplankton and foraminifers association of the Zhinvali-Gombori subzone of the Mestia-Tianeti zone of GCFS has shown the existence of four sedimentary cycles: Cenomanian-Early Turonian, Middle Turonian-Early Campanian, Late Campanian-Early Maastrichtian and Late Maastrichtian (Fig. 3).

On the territory of Georgia contained in the Late Albian pool there were is established some large sites of a land, where the Cenomanian sediments with the washout rest on the underlying formations (Gambashidze, 1981).

The beginning of the first cycle gets the better of Early Senomanian transgression. All is a situation the calm course of sedimentation at the end of the Albian was disturbed by pulses of the Austrian phase of orogeny and senomanian transgression took place against the background of tectonic moviments. On existence of a land before Senomanian indicates secondary occurrence of *Hayesites albiensis* (which existed from the end of Aptian up to Early Albian). Presence of this species in sediments of Ukugmarti and Ananuri formation, it is explained with, that couldhave been deposited in Senomanian only after land emergence in Late Albian.

Nannoplanktonic complexes are represented evenly as by deep-water- so shallow–water species in the sediments of Ukugmarti and Lower Ananuri formations, indicating near shore basin. Starting from Middle Ananuri subformation, quantity of deep-water species sharply reduces in nannofaccilies' association, and till the end of Upper Ananuri subformation shallow-water nannoplanktonic forms dominate in succession. This is also proved by complexes of foraminiferas (*Hedbergella, Whiteinella, Dicarinella).*

May consider that the scales of Cenomanian transgression weren`t great. For the benefit of this assumption there is a fact that in spite of transgressive Basin of Cenomanian sea of Zhinval-Gombori formation still remained isolated. There of given evidence specific character of nannoplankton association in these sediments. The Cenomanian-Early Turonian (the Ukughmarti and Ananuri formations) by complex are characterized by the mixed complexes of warm- (*Watznaueria barnese, W.ovata, W. biporta, Eprolithus moratus, Ruciano-lithus irregularis, Quadrum intermedium*) and cold-water forms (*Stradneria crenulata*, *Tranolithus phacelosus, Lithraphidites carniolensis, Placozygus fibuliformis, Broinsonia matalosa, B. signata, Glaukolithus diplogramus, Eiffellithus*

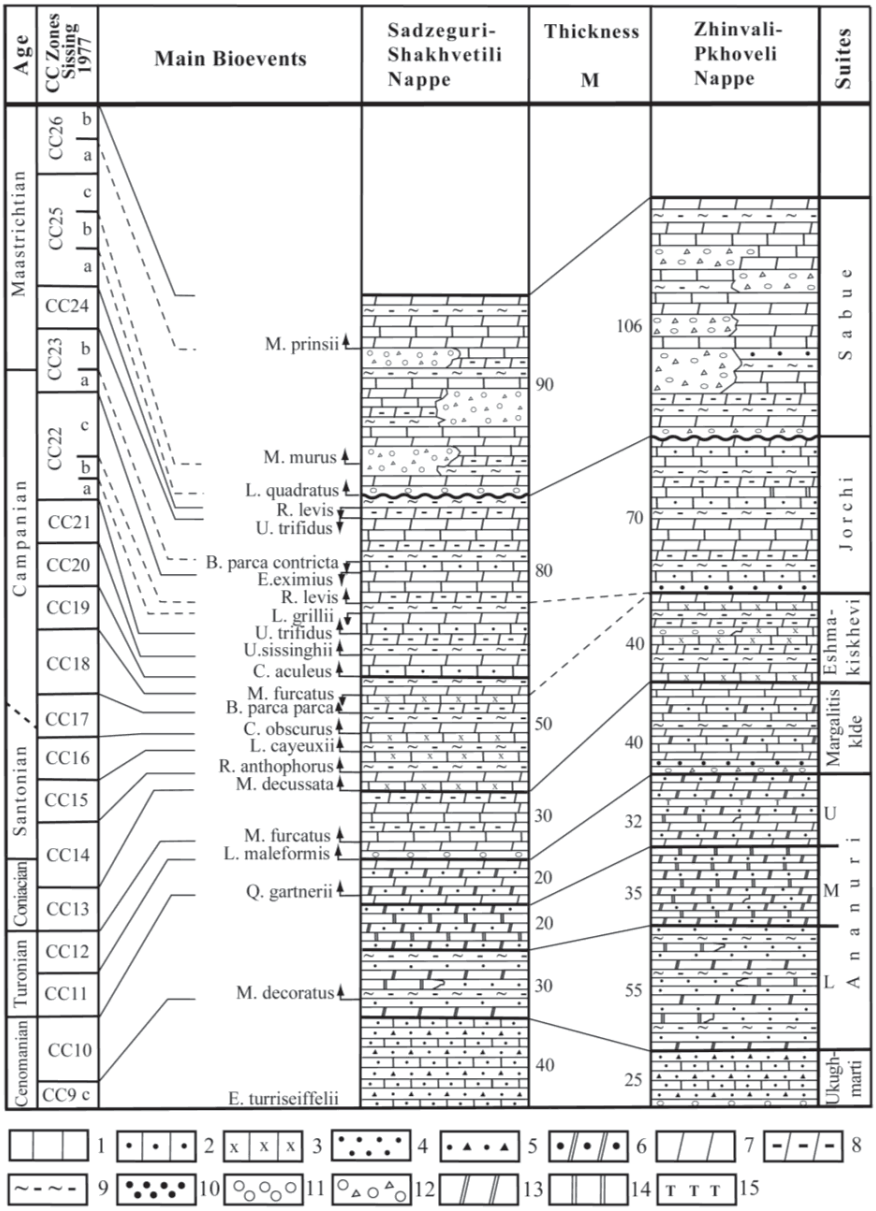

Fig. 3. Litho- and Biostratigraphical correlation for the Late Cretaceous sediments of the Sadzeguri-Shakhvetili and Zhinvali-Pkhoveli nappes of the Zhinvali-Gombori subzone. 1. Limestones; 2. Sandy limestones; 3. Lithographic limestones; 4. Sandstones; 5. Polymictic sandstones; 6. Silicified sandstones; 7. Marls; 8. Marly shales; 9. Clay shales; 10. Gravelstones; 11. Microconglomerates; 12. Breccia-conglomerates; 13. Siliceous rocks; 14. Black flint; 15. Tuffs.

turriseiffelii, Microstaurus chiastius, Zeugrhabdotus bicrescenticus, Prediscosphaera columnata), though the last ones exceed both in species and quantitative respect. On this ground we can assume that by that time the region was located on the border of warm and reasonably cold waters.

The second cycle starts with Late Turonian transgression and coinsides with the pick of maximal eustatic transgression (UZA 2.5) (Haq et al., 1987). Margalitisklde formation sediments are characteriside by rich nannofocillies. In the association of the zone *Lucianorhabdus maleformis* (CC12) took place abrupt renewal of species. Besides the new species: *Lucianorhabdus maleformis, Placozygus Fibuliformis, Eprolithus aff. Rarus, Helicolihus anceps, Acuturris scouts*, there are also species in common for the end of the Early and the beginning of Late Cretaceous: *Loxolithus armilla, Chiastozygus anceps, Nannoconus regularis, N.elongata,*

Zeugrhabdotus burvellensis, Gartnerago chiasta, etc., however in the sediments of the previous successions they are absent. Hence, there appears possibility to assume the existence of the isolated basin and increasing regression during the Cenomanian-Early Turonian sea. Transgression in the beginning of the Middle Turonian provided the connection of the given basin with the open sea, being favorable for the migration of the above mentioned species. Apparently, the transgression continued during the Early Coniacian as well.

From the migrated species in the sediments of the zone *Martasterithes furcatus* (CC13) have already been fixed the species preferring deep water conditions: *Broinsonia enormis, Tranolithus gabalus, Gartnerago segmentatum,* etc. There appear new forms: *Marthasterites furcatus, M. inconspicuous, M. crassus, Micula swastika, Lithastrinus septenarius* - species preferring warm climate. It points to the northward advance of the boundary between the warm- and moderately cold belts. From the second half of the zone the amount and variety of nannofossils sharply reduced. Many transient species disappeared. In the corresponding sediments of the Margalitisklde formation already appeared coarse-grained sandstones. That points to the shoaling of the basin, apparently caused by the beginning of eustatic regression, both of UZA3 supercycle and UZA3.1. cycle (Haq et al., 1987).

In the association of the zone (CC14) sharply decreases quantity of the species preferring deep water conditions: *Watznaueria, Eiffellithus, Cyclagelosphaera, Stradneria, etc.* Begin to dominate the shallow water forms: *Quadrum, Micula, Marthasterites, Rucianolithus, Eprolithus, Microrhabdulus,* etc. Such parity proceeds up to the Early Campanian indicating the existence of a shallow, calm sea basin during the deposition of the Eshmakiskhevi formation; the succession is represented by the monotonous strata of lithographic limestones with interlayers of grey and variegated marls. However, at the end of the formation dominate granular, arenaceous limestones with interlayers of microgreywacke carbonate sandstones. Retreat of the sea is well expressed. Here, the formation is terminated by the nannoplankton zone -CC18 and without visible unconformity is overlapped by the subzone CC22c of the Jorchi formation. The uninterrupted sedimentation of the succession is observed in the sections of the Zhinvali-Pkhoveli nappe (rivers Ksani, Arkala, etc.), the layers of the zone CC18 are replaced by the upper subzone of the zone *Uniplanarius trifidus* (CC22c). Extended, in consequence of rising, land around cordilleras, after submersion of Zhinval-Gombori subzone, again was covered by the sea, causing a break in sedimentation and fall-out of the nannoplancton zones CC19, CC20, CC21 and CC22a,b from the sections.

The Late Campanian transgression is related to the beginning of the third sedimentation cycle. Here Jorchi formation is mainly represented by marly limestones and marly sandstones. Nannoplanktonic zones, singled out here, and also associations of foraminiferas are mainly planktonogenic. In sediments, relevant to the zone CC22c warm-water taxons *Uniplanarius, Ceratolithoides, Watznaueria, Micula, Marthasterites, Globotruncana stuartiformis, Globotruncana ventricosa* dominate, indicating the relationship of the basin with the Tethys.

According to nannoplankton, Jorchi formation is relevant to the zones CC22c, CC23, CC24 and CC25a in all studied successions. The last generally, especially in the limits of Zhinval-Pkhoveli sheet, is either missing or is met just in lower layers. Transgressive Sabue formation, in the given successions, starts with the subzone CC25в (the fourth sedimentation cycle). Exception represent just some areas in the River Ksani basin, where Sabue formation starts with the zone CC25c. Absence of CC25a and CC25b in the upper part of the subzone, before Maastrichtian transgression, probably was related to the Late Laramian rising and erosion. This is well manifested in the sediments of Sabue formation, represented by coarse-grained material.

Thus on the basis of the detailed analysis calcareous nannofossil and planktonic foraminifera all standard zones (CC) of the Late Cretaceous are identified junction in connection adjournment of the Zhinvali-Gombori subzone of the Mestia-Tianeti zones of the Greater Caucasus fold system (GCFS) are established all standard zones (CC) of the Late Cretaceous. It has allowed to specify an age range, volume and capacity lithostratigraphic units, composing the Upper Cretaceous of the Mestia-Tianeti zones. The recovered of the mainly paleoclimatic and paleogeographic the moments of the Late Cretaceous in this part GCFS.

5. Conclusions

Thus, based on the detailed analysis of nannofossils and planktonic foraminifera in the sediments of

the Zhinvali-Gombori subzone of the Mestia-Tianeti zone GCFS, all standard Late Cretaceous zones (CC) are established. It has allowed updating of age range, volume and thickness of lithostratigraphic units composing the Upper Cretaceous of the Mestia-Tianeti zone. Sedimentation of the Ukughmarti formation took place in the Early Cenomanian, in the upper part of the zone Eiffellithus turriseiffelii (CC9). The Ananuri formation covers the period from Early Cenomanian (upper part) to Early Turonian and corresponds to the zones CC9-CC11. The Margalitisklde formation is dated as Late Turonian-Early Coniacian; it corresponds to the zones CC12-CC13 by nannoplankton and to *Marginotruncana pseudolineiana-M. lapparenti and Marginotruncata sigali* by planktonic foraminifera. The Eshmakishevi formation covers nannoplankton zones CC14-CC19 and is dated as Late Coniacian-Early Campanian.

In the upper part of the succession by foraminifers are established the zones *Archaeoglobigerina basquensis* and *Globotruncana arca*. The Jorchi succession corresponds to the Middle Campanian-Lower Maastrichtian zones CC20-CC25a. By foraminifers in the sediments of the subzone CC22c is established the zone *Globotruncana ventricosa-Rugoglobigerina rugosa*. The Sabue succession corresponds to the zones *Lithraphidites quadratus, Micula murus* and *Micula prinsii* - their total volume is synchronous to that of CC25b-CC26 and is dated as Late Maastrichtian. By foraminifers in them the zone *Gansserina gansseri* is established.

For this part of GCFS are reconstructed the main paleoclimate and paleogeographic events of the Late Cretaceous. Here has been established the existence of four sedimentary cycles: Cenomanian-Lower Turonian, Middle Turonian-Early Campanian, Late Campanian-Early Maastrichtian and Late Maastrichtian. In the Cenomanian-Early Turonian there was a basin of isolated, regressive sea in the southern part of the moderately cold-water belt. From the Late Turonian the boundary between the warm- and moderately cold-water belts moved to the north. Transgression that started in the Late Turonian lasted till the Early Coniacian. In the middle part of the Early Coniacian is outlined shoaling of the basin. From the Late Coniacian to the end of the Santonian sedimentation took place in the shallow, calm marine basin. The omission of the nannoplankton CC19, CC20, CC21 and CC22a, b zones from the sections of the Zhinvali-Pkhoveli nappe and the analysis of the redeposited forms enables to admit break in sedimentation caused by Early Campanian regression and Late Campanian transgression. At the end of the Middle Maastrichtian took place a short-term regression that was replaced by the Late Maastrichtian transgression.

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