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CYCLIC UPPER CRETACEOUS-PALEOCENE ROCKS IN THE WESTERN FORE-BALKAN

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ABSTRACT

The Upper Cretaceous – Paleocene rocks in the transitional zone between the Western Fore-Balkan and the Moesian Platform in NW Bulgaria are established mainly in bore holes. The age of the rocks in one of the rare surface outcrops near Vladimirovo village, Montana District, is continuously interpreted as Late Cretaceous. The rocks are represented by robust, dense, highly fractured limestone in which a limestone quarry has been developed for many years. The present study represents paleontological evidence for the age of the rocks and emphasizes their cyclic structure. The dating of the rocks is made on the basis of calcareous nannoplankton. It shows that insignificant part of the limestones is of Late Cretaceous age, but the rest of the section belongs to the Lowest Paleocene nannofossil zones. The main portion of the limestones has clearly expressed cyclic structure. Well traceable flooding surfaces are developed, represented in the section as major bedding surfaces. The hierarchy of the cycles shows that these are most likely climatic cycles from the Milankovitch frequency band of 20 and 100 ka.

INTRODUCTION

Cherty limestones represent one of the widespread Upper Cretaceous - Paleocene lithofacies on the territory of the Fore-Balkan in North Bulgaria. It is related by most authors to the "Mezdra Formation" and is considered Lower Maastrichtian, analogically to the cherty limestones in the Moesian Platform. However, according to recent data, its stratigraphical range in the large territory of the East and West Fore-Balkan is Maastrichtian-Paleocene (Синьовски, Христова-Синьовска, 1993; Sinnyovsky, 1993; Синьовски, 1998; Вангелов, Синьовски, 2001; Стойкова и др., 2001; Sinnyovsky, 2002).

The most western outcrops of this lithofacies are near Vladimirovo village, Montana district, in the northern part of the transitional zone between the Fore-Balkan and the Moesian Platform (Fig. 1). These rocks are not well studied in the area. In the present study wider stratigraphical range and new data for their cyclic structure are proposed.

PREVIOUS WORKS

Degree of study of the surface outcrops

The earliest data for flint containing limestones near Lyuta village (now Vladimirovo) belongs to Златарски (1905). He reported findings of *Echinocorys vulgaris* Breyn., *"in the upper whitish or yellowish limestones"* on the left riverside of Ogosta River and he first accepted Senonian age. In his later overview on the Upper Cretaceous in Bulgaria he persists in his opinion that "*west of Vit River the Senonian Stage has been positively recognized only near Lyuta village on Ogosta"* (Златарски, 1910). The same opinion is supported in his work "The geology of Bulgaria" (Златарски, 1927).

Е. Бончев & Б. Каменов (1934) united the flint limestones in "chert containing horizon with Coraster Vilanovae". They included the studied limestones near Lyuta village into this horizon: *"Chert containing limestones have tangible presence between the rivers Iskar and Ogosta. The most western point, where we found them is Kovachevitsa hillok, west of Ogosta near Lyuta village".* They mention findings of echinoids in the quarry near Lyuta (now Vladimirovo) village but only the ammonite species *Pachydiscus neubergicus* v. Hauer is cited. In this work are published schematic profiles across Lyuta anticline, first named by the authors.

The geological mapping in scale 1:25 000 (Йорданов et al., 1962) did not change the notion about the age of the rocks. It is not changed in the geological map of Bulgaria in scale 1:100 000, map sheet Montana (Филипов et al., 1995a), where these rocks are related to the uppermost Campanian-Lower Maastrichtian. This age is accepted by Филипов (1995), following Йолкичев (1982, 1986).

Interpretation of drilling and geophysical data

Useful data on the subsurface structure of the area was obtained by deep petroleum drilling. Borehole P-8 Vladimirovo penetrated the Upper Cretaceous deposits and reached Albian marls of the Sumer Formation at 1800 m. Borehole P-1 Madan (4382 m) penetrated all rocks, from Quaternary to Lower Triassic, including about 600 m thick "Maastrichtian" limestones (Fig. 1).

The great thickness of the Upper Cretaceous deposits was commented during the 60s. Атанасов (1961) noted that the 550-600 m thickness of the Maastrichtian near Vladimirovo is close to the thickness of the Senonian in the Lom Depression. Later Бончев (1971) assumed that "*a depression was formed here during the Late Cretaceous, approximately at the boundary between the plate and the Fore-Balkan, on which the Fore-Balkan was additionally moved*". The fault,

separating the Fore-Balkan from the Moesian Platform, was characterized as steeply inclined to the south thrust on the basis of drilling data from P-8 (Fig. 1). It was named Nivyanino fault (Бончев, 1971), and its eastern part - Lesura fault (Велчева et al., 1970).

Possibility of giving logical explanation about this thickness has been restricted by acceptation of Maastrichtian age as the basis for geological interpretation.

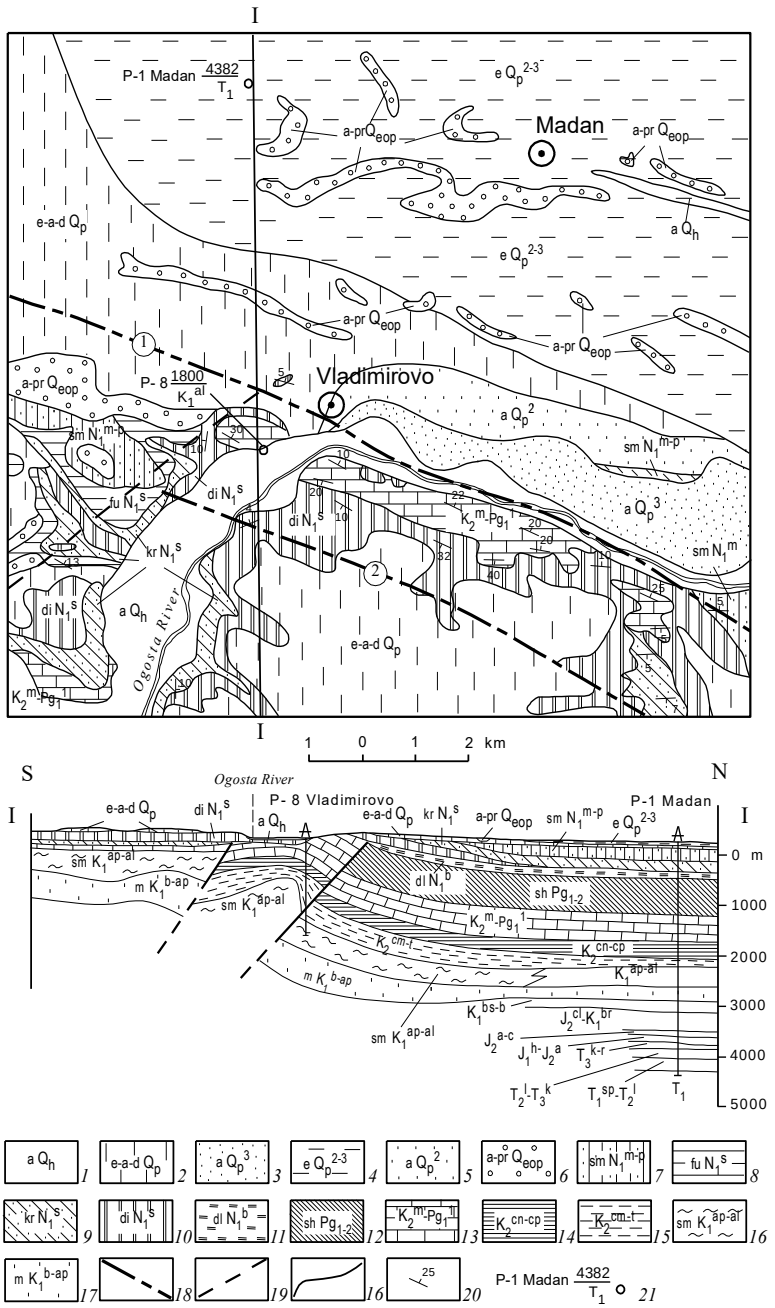

Figure 1. Geological map in scale 1:100 000 (after Филипов et al., 1995, with additional data): 1 – fluvial deposits (Holocene): gravel, sand, clay and reworked loess; 2 – eluvial-fluvial-deluvial deposits (Pleistocene): loess-like clays; 3 – fluvial deposits of the first and second terraces (Upper Pleistocene): gravel, sand and clays; 4 – aeolian deposits (Middle-Upper Pleistocene): loess; 5 – fluvial deposits of the third and fourth terraces (Middle Pleistocene): gravel, sands and clays; 6 – fluvial and fan deposits (Eopleistocene): boulders, gravel and coarse-grained sands; 7 – Smirnenski Formation (Meotian-Pontian):clays and sandstones; 8 – Furen formation (Sarmatian, Upper Bessarabian): detrital, oolitic and sandy limestones, sands and sandstones; 9 – Krivodol Formation (Sarmatian, Upper Volinian – Upper Bessarabian): clays with sandy and marly interbeds; 10 – Dimovo Formation (Sarmatian, Upper Volinian – Lower Bessarabian): sands, sandstones and detrital limestones; 11 – Deleina Formation (Badenian): clays with limestone, sandstone and gypsum interbeds; 12 – Shemshevo Formation (Paleocene - Eocene): clays and silty clays; 13 – "Mezdra Formation" (Maastrichtian - paleocene): Limestones with cherty concretion; 14 – Byalo Bardo + Knezha formations (Coniacian - Campanian): glauconitic sandstones, marls and clayey limestones; 15 – Sanadinovo Formation (Cenomanian - Turonian): marls, clayey limestones and siltstones; 16 – Sumer Formation (Aptian - Albian): marls, clayey limestones, sandstones; 17 – Mramoren Formation (Barremian - Aptian): marls, clayey limestones and siltstones; 18 – fossilized reverse fault: 1 – Nivyanino fault; 2 – boundary fault between 'Devene' and Kutlovitsa' units; 19 – supposed fault; 20 – lithostratigraphical boundary; 21 – borehole with depth in meters and reached stratigraphical unit

If one calculates the sedimentation rate on the basis of about 600 m thickness of the Maastrichtian Stage (Fig. 1, borehole P-1 Madan), it could be about 100 Bubnoff (m/Ma), which is too high for platform deposition.

GEOLOGICAL SETTING

The investigated area is in the northern periphery of the so called "Vladimirovo-Markovo Folded Zone (Йовчев, Балуховски, 1961) or "Vladimirovo-Markovo Transitional Zone" (Bončev, 1966). It is disposed between the real Fore-Balkan and the Moesian Platform (Fig. 1). Бончев (1971) called this zone "folded-blocky strip Vladimirovo-Rakita". Two adjacent folds are described in this area – Lyuta anticline (Бончев, Каменов, 1934), called later Vladimirovo anticline, and southern situated Gradeshnitsa syncline (Богданов, 1971). The former is considered to be a "horst-anticline" by Попов et al. (1960), Атанасов (1961), Бончев (1971).

This zone is interpreted in different ways on the neighbor map sheets of the geological map of Bulgaria in scale 1:100 000, where the investigated outcrops are disposed. On map sheet Byala Slatina the "Vladimirovo-Markovo (Transitional) Zone" is considered as separate tectonic unit of the same rang as the Moesian Platform and the Western Fore-Balkan (Филипов et al., 1995a,b). The Vladimirovo anticline, ranging from Vladimirovo village on map sheet Montana east to Lesura village on map sheet Byala Slatina, is described as a constituent part of this zone. On map sheet Montana the same zone is interpreted as part of the so-called "Devene unit", overthrusted over the "Moesian microcraton" to the north (Цанков, 1995). It is restricted by two faults, fossilized under Neogene deposits – Nivyanino fault from the north and the boundary fault with "Kutlovitsa unit" from the south (Fig. 1). The map sheet is crossed diagonally by the so called "Madan Regional Lineament" constituent of the Tvarditsa System with orientation 30-40º (Филипов и др., 1995b).

PRESENT RESULTS

The limestones near Vladimirovo village are the most western outcrops of the cherty carbonates, commonly related to "Mezdra Formation". The main purpose of this investigation is more precise dating of the rocks and study of their cyclic origin.

The limestone sequence is composed of robust, dense, beige to light-gray or cream limestones with small brown to light-gray cherty concretions. They are well bedded and intensively fractured with bioturbated bed surfaces. On the basis of nannofossil investigation of 59 samples is proved that the carbonate sequence includes both Maastrichtian and Paleocene rocks. Most of the samples contain poor or no nannoflora. Nevertheless Maastrichtian and Paleocene parts of the section are easily recognized due to several marl interbeds below and above Cretaceous/Tertiary boundary, containing rich nannofossil assemblages. These assemblages are composed of characteristic Upper Cretaceous nannofossils below and Paleocene nannofossils above the K/T boundary, differing nearly 100 % in their taxonomic content, due to the great change of the nannofossil taxonomic composition at this boundary.

The outcrops are located mainly on the southern riverside of Ogosta River between Vladimirovo and Gradeshnitsa villages, but the largest outcrop is in the quarry on the left riverside, west of Vladimirovo village. Subject of the present study are the outcrops in three areas: the quarry and its surroundings, the outcrop west of the river in the SW part of the map and the outcrops south of the river between Vladimirovo and Gradeshnitsa.

Figure 2. Bedding surfaces (the arrows) in the Maastrichtian part of the section south of Ogosta River near Vladimirovo village – probable boundaries between 100 ka Milankovitch cycles, composed of 5 layers corresponding probably to 20 ka Milankovitch cycles

Maastrichtian

The Maastrichtian Stage occupies the lower parts of the outcrops on both riversides of Ogosta River. It generally builds up the core of the Lyuta anticline.

Only the lowest few meters of the section north of Ogosta River belong to the Maastrichtian. This is a restricted 3 m high outcrop, west of the western entrance of Vladimirovo village. The samples from the marl interbeds contain poor Upper Cretaceous assemblage with typical Upper Maastrichtian nannofossil markers *Micula murus* (Martini) and *Lithraphidites quadratus* Bramlette & Martini.

Deluvial deposits cover the overlying 10-12 m interval of the section. The above exposed carbonates contain Lower Paleocene nannofossils and the Cretaceous/Tertiary boundary falls into the covered interval.

The beds on the southern riverside are inclined to the SW and the rocks get older from west to east along the river. The cyclic limestones 500 m east of the bridge are of Late Maastrichtian age (Fig. 2). In this outcrop is established well-expressed cyclicity corresponding probably to 20 and 100 ka Milankovitch cycles. The Cretaceous/Tertiary boundary is located some 30 m above the base of the outcrop. The boundary layer, marking this boundary in many outcrops in the country and all over the world, has not been found.

The total thickness of the exposed part of the Maastrichtian Stage is about 30-40 m.

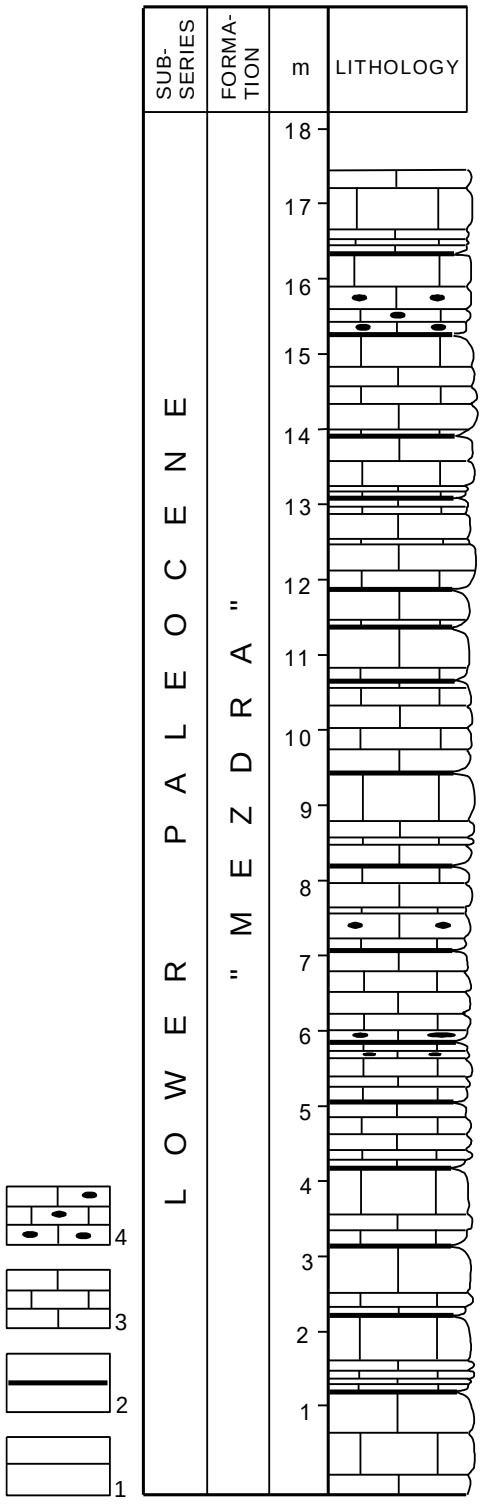

Figure 3. The lowest portion of the Paleocene section shows cyclic structure with major bedding surfaces restricting probably 100 ka Milankovitch cycles, each composed of mean 4,7 layers, probably corresponding to 20 ka Milankovitch cycles

Paleocene

The Paleocene part of the carbonate sequence is well exposed on both riversides of Ogosta River. Its thickness is more than 60 m. In this stratigraphical level is developed the limestone quarry. At the upper western edge of the quarry is exposed the transgressive boundary between the studied carbonate sequence and the Sarmatian limestones of Dimovo Formation.

The Paleocene is represented by robust, light gray to cream limestones with brown to gray cherty concretions. The beds are 20-40 cm thick, separated by well-developed bioturbated bedding surfaces. A well-exposed 18 m section between the lowermost Paleocene beds above the covered K/T boundary interval has been investigated for cyclic elements. The rocks in this interval are naturally weathered with well-developed bedding surfaces (Fig. 3).

Totally 70 limestone beds have been measured with thickness between 8 and 65 cm. The most common thickness is 20, 25 and 30 cm. According to the field methodology of Schwarzacher & Ficher (1982) the bedding surfaces are divided into two groups – common and major. Common bedding surfaces are traceable in the frame of a singular outcrop whereas the major bedding surfaces could be followed between different outcrops. Totally 15 major bedding surfaces are recognized in the studied interval. Statistical processing shows that the mean number of the beds between the major bedding surfaces is 4.7. This allows assumption that the common bedding surfaces separate beds, corresponding to 20 ka Milankovitch cycles. They are grouped into bundles, separated by major bedding surfaces and probably corresponding to 100 ka Milankovitch cycles. This type of cyclicity was recognized in the Paleocene part of the same lithofacies near Mezdra town (Синьовски, 1998).

The outcrop in the SW part of the map is situated near Boychinovtsi town north of the bridge on Ogosta River. It is situated along the abandoned railway to the former Ogosta Enterprise. The outcrop is 10 m high of well-bedded limestones with cherty concretions. The nannofossil content allows dating this interval as Lower Paleocene.

CONCLUSION

Present results show that most of the cherty concretion limestones, representing the widespread lithofacies in the Fore-Balkan, known as “Mezdra Formation”, in their most western outcrops near Vladimirovo village, are of Paleocene age. This outlines a more complete notion about their stratigraphical range in the Fore-Balkan and confirms the version that in large territories this lithofacies is formed for a long period including the whole Maastrichtian age and part of the Paleocene Epoch. These limestones show elements of cyclicity, controlled most probably by the climatic Milankovitch cycles. Their lower distinctness is an evidence for comparatively distal sedimentation in contrast to the Mezdra region, where the clearly cyclic limestones are formed in the shallowest part of the epicontinental Maastrichtian-Paleocene Sea.

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