CRETACEOUS/TERTIARY BOUNDARY IN THE CARPATHIAN TYPE UPPER CRETACEOUS NEAR THE VILLAGE OF KLADORUB, VIDIN DISTRICT

Dimitar Sinnyovsky, Boris Valchev, Dimka Christova-Sinnyovska

University of Mining and Geology "St. Ivan Rilski", Sofia 1700, Bulgaria

ABSTRACT

The present study of the Kladorub Formation, which is a part of the "Carpathian type Upper Cretaceous", revealed a new K/T boundary interval section in Bulgaria. The studied interval comprises the boundary nannofossil zones of the Cretaceous and Paleocene - Micula prinsii and Biantholithus sparsus. Between these boundary zones, a 4 cm dark layer was established, marking the great change in the calcareous nannoplankton. The lithological analyses of the boundary interval between – 2.75 m to +4.00 m showed that this part of the section is represented mainly by siltstones and minor limestones and marks.

INTRODUCTION

The Cretaceous/Tertiary boundary is marked by a giant impact event 65 million years ago. It is expressed by a few centimetres thin layer, recognized worldwide by an iridium and associated trace metal spike, shocked quartz, microtektites and rare minerals. This layer was first established by Alvarez et al. (1980). It marks the great change in the Earth floras and faunas – major plankton extinction (more than 90 % of the calcareous nannoplankton and planctonic foraminifers that are in the beginning of the nutrient chain), about 60 % of angiosperm species, many groups of echinoids, corals, warm water molluscs and primitive mammals. This level also marks the final extinction of ammonites, belemnites, rudistid and inoceramid bivalves, nerineid and actaeonellid gastropods, marine reptiles, dinosaurs etc. (Barnes et al., 1996).

During the last decade a gradual transition between Cretaceous and Paleogene deposits has been established in many Bulgarian sections from the Fore-Balkan and Stara Planina structural zone.

The present investigation is devoted to a new outcrop of the Cretaceous/Tertiary boundary interval on the territory of the West Fore-Balkan, established in the rocks of the so called "Carpathian type Cretaceous" in Vidin district.

PREVIOUS RESEARCH

The Cretaceous/Tertiary boundary interval was established in different facial types in Bulgaria: limestone-marl periodites near Byala, Varna district (Stoykova, Ivanov, 1992) and Ljuti dol, Vratsa district (Sinnyovsky, 2001; Стойкова и др., 2000); turbidites near Emona, Bourgas district (Sinnyovsky, Stoykova, 1995), Kozichino and Aytos Pass (Sinnyovsky, Vangelov, 1997) and Marash river south of Kotel (Стойкова и др., 2000); a cyclic limestone succession near Moravitsa (Синьовски, 1998) and Mezdra (Стойкова и др., 2000), Kozya river, Razkrachenitsa and Chudnite skali (Вангелов, Синьовски, 2000; Sinnyovsky, 2001). Nevertheless, the boundary is geochemically proved only in three of these outcrops – the first one near Bjala (Preisinger et al., 1993a,b), the outcrop near Moravitsa, west of Mezdra town (Синьовски, 1998) and the outcrop along Kozya river, east of Chudnite skali (Вангелов, Синьовски, 2000; Sinnyovsky, 2001).

The sedimentary rocks in the surroundings of the village of Kladorub were first described as "Lutetian" by Берегов (1937) who accepted the overturned beds as normal and considered younger age for the "shales" as compared to the "sandy complex". Later they have been included into the so-called "Sinaya Cretaceous", "Banat Cretaceous" or "Carpathian type Cretaceous".

The term "Sinaya Cretaceous" was introduced by Ст. Бончев (1923) for Senonian flysch deposits along Timok River. В. Цанков (in Цанков et al., 1960) cited the opinion of prof. Filipescu that these rocks were very similar to the "Banat type Cretaceous" and differ significantly from the "Sinaya Cretaceous" in Romania. In this paper, the rocks SE of Kladorub are described as 'bluish marls with interbeds of sandy marls' of Maastrichtian age. This is the first age determination of the rocks and is proved by ammonites, inoceramids and globotruncanides.

The term "Carpathian type Cretaceous" was introduced in the Bulgarian geological literature by Ц. Цанков (1961,1963) to substitute the term "Sinaya Cretaceous" and to distinguish the Cretaceous rocks exposed north of the line Vrushka Chuka – Kiryaevo – Rakovitsa - Rabisha – Kladorub from the Cretaceous sediments in the West Balkan. This type Upper Cretaceous was mentioned by В. Цанков (1968).

Ц. Цанков (1961) described the relationships between the South Carpathian and Balkan structures in the area using



Figure 1. Geological map and geological section A-A of the studied area near Kladorub village, Vidin district (after Sinnyovsky & Petrov, 2000 with additional data): 1 – fluvial deposits; 2 – Dimovo Formation (Sarmatian): sandstones and limestones; 3 – Staropatica Formation (Eocene): conglomerates, sandstones and shales; 4 – Kladorub Formation (Upper Campanian – Upper Paleocene): siltstones, silty limestones and marls; 5 – Simeonovo Formation (Aptian): Urgonian limestones; 6 – West Balkan Carbonate Group: Javorets, Ginci and Glogene Formations (Callovian – Berriasian): micrite nodular limestones; 7 – Polaten Formation (Bajocian-Bathonian): carbonate sandstones and sandy limestones; 8 – Kiper Formation (Bajocian-Bathonian): sandstones and conglomerates; 9 – Belogradchik Pluton (Paleozoic): granites; 10 – lithostratigraphic boundary; 11 – reverse fault; 12 – normal fault; 13 – line of geological section; 14 – dip and strike: a) inclined, b) horizontal, c) overturned, d) vertical

stratigraphic data from the report on the geological mapping of Връблянски et al., carried out in 1959.

Further paleontological determinations of the ammonite fauna and biostratigraphic subdivision of the Maastrichtian near Kladorub were made by Tz. Tzankov (1963,1964). He described an about 90 m long outcrop of overturned 35-45° to the north beds of 'ash-gray or gray-greenish silty marls' along Vrubska bara, south of the village of Kladorub. Rich macrofossil and microfossil assemblages proved Maastrichtian age of these rocks. The macrofossils are represented by inoceramids with prevailing *Inoceramus regularis* d'Orbigny,

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Inoceramus balticus Böhm and Inoceramus impressus d'Orbigny, and ammonites Baculites anceps leopoliensis Nowak. Diplomoceras cylindraceum (Defrance), Hauericeras sulcatum (Kner), Pseudokossmaticeras brandti Pseudokossmaticeras (Redtenbacher), galicianum Pseudokossmaticeras (Favre), galicianum tercense (Seunes), Pachydiscus gollevillensis (d'Orbigny), neubergicus (Hauer), determining Pachydiscus the Maastrichtian Constrictus Zone. The other ammonites determined in this association are of longer stratigraphic range. The author reported also a rich Maastrichtian microfossil assemblage composed mainly of representatives of the general Anomalina and Globotruncana.

Later Tzankov (1972) named these rocks "Kladorub Complex". According to Тенчов, Йолкичев (1993) this is a nude name. The rank of the Kladorub Formation was pointed by Филипов et al. (1995), but the name "Kladorub Formation" was used for small outcrops near Rakovitsa village on the geological map of Bulgaria, Sheet Zaechar and Bor (Дечева et al., 1990), and near Kladorub village – on Sheet Vidin (Филипов et al., 1992). This name was qualified by Тенчов (1993) as a nude name. All of these authors did not argue the Maastrichtian age and lithological characteristics of the unit.

During the field season 1998, the mapping team of Geology and Geophysics Enterprise, Sofia, provided 4 samples for nannofossil analyses. It was found that three of the samples are of Maastrichtian age but the fourth one contained Upper Paleocene nannoflora. Thus, the stratigraphic range was amended to Maastrichtian – Upper Paleocene (Sinnyovsky, Petrov, 2000).

GEOLOGICAL SETTING

The Kladorub Formation crops out SE of Kladorub Village as a narrow, 2 km long and 300 m wide strip trending NW-SE. The outcrops are restricted along Vrubska bara, Tonov dol and Ciganskiya dol SE of the village (Fig. 1). The outcrop along Vrubska bara, described by Ц. Цанков (1964) and pointed as "type section" of the unit (Tzankov, 1972), is almost totally covered. Nevertheless, the unit is well exposed along Ciganskiya dol, 1,3 km E-SE of this outcrop. The beds are overturned with strike and dip 200-220°/30-60°.

According to previous investigations, the Kladorub Formation comprises sandy and silty marls of Maastrichtian-Paleocene age.

The lower boundary of the unit is a reverse fault along the boundary with the Paleozoic granite of Belogradchik pluton (Fig. 1). The upper boundary with the Eocene conglomerates of Staropatica Formation is unconformable. The eastern boundary is a normal fault with Jurassic rocks – Polaten Formation and the West Balkan Carbonate Group. Neogene terrigenous sediments of the Dimovo Formation cover the unit to the west.

RESULTS

This paper presents preliminary results on the K/T boundary interval, obtained during the 2001 field season in the frame of

the research program of the University of Mining and Geology "St. Ivan Rilski". Subject of the study is the fine-grained carbonate-siltstone sequence of the Kladorub Formation which crops out SE of the village of Kladorub, Vidin District.



Figure 2.. Section of the K/T boundary interval in Kladorub Formation, situated in the valley of Ciganskiya dol, 1.3 km SE of Kladorub village, Vidin district: 1 – compact bioclastic limestone beds; 2 – siltstones, silty limestones, hypolimestones and marls; 3 – dark-colored K/T boundary layer; 4 – sample

The corrected stratigraphic range of the unit provides a good opportunity to establish a new gradual transition across the K/T boundary in Bulgaria.

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The first sampling in Ciganskiya dol, carried out in the beginning of the summer of 2001, revealed three important facts: 1) wider stratigraphic range of the sequence (Upper Campanian – Uppermost Paleocene); 2) discrepancy between the former lithological description of the unit and the present results; 3) uninterrupted section – relatively well exposed and without significant faults and folds. All these facts allowed to: 1) establish the K/T boundary layer; 2) revise the lithological composition of the Kladorub Formation; 3) refine the biostratigraphical subdivision of the Campanian – Paleocene interval on the basis of calcareous nannoplankton and planktic foraminifera.

The present study presents new data about the position of the K/T boundary layer and the lithology of the investigated boundary interval.

K/T boundary. Detailed lithological and paleontological studies were focused on the K/T boundary interval, restricted within 7 m (Fig. 2). It is located about 50 m North of the reservoir catchment in Ciganskiya dol. Three nannofossil zones are present in the investigated boundary interval – the top of the uppermost Maastrichtian Micula prinsii Zone, the lowermost Paleocene NP 1 Biantholithus sparsus Zone and NP 2 Cruciplacolithus tenuis Zone.

The presence of the two boundary zones allowed locating a dark, 4 cm thick layer, marking sharp change in the calcareous nannoplankton assemblages.

The samples below this layer contain rich nannofossil association represented by more than 50 Cretaceous species. most abundant forms are: Micula decussata The (Vekshina), Micula wastika Stradner & Steinmetz, Watznaueria barnesae (Black), Cribrosphaerella ehrenbergi (Arkhangelsky), Gartnerago obliguum (Stradner), Broinsonia enormis (Shumenko), Arkhangelskiella cymbiformis (Vekshina), Microrhabdulus decoratus (Deflandre), Eiffellithus turriseiffeli (Deflandre), Kamptnerius magnificus Deflandre. Chiasmozygus litterarius (Gorka), Prediscosphaera cretacea (Arkhangelsky), Prediscosphaera columnata Perch-Nielsen, Prediscosphaera microrhabdulina Perchgrandis Perch-Nielsen, Nielsen, Prediscosphaera Ceratolithoides aculeus (Stradner), Zygodiscus spiralis Bramlette & Martini etc. All Upper Maastrichtian markers are also present Lithraphidites quadratus Bramlette & Martini, Nephrolithus phrequens Gorka, Micula murus (Martini). Micula prinsii (Perch-Nielsen).

The composition of the Paleocene nannofossil association is entirely different. The taxonomical diversity in the first samples +5 and +10 cm above the boundary is drastically reduced. There are single reworked forms represented by the most abundant Cretaceous species *Micula decussata* (Vekshina), *Watznaueria barnesae* (Black), *Arkhangelskiella cymbiformis* (Vekshina) and some other species. Nearly 95% of the nannofossil association is represented by the survivors *Braarudosphaera bigelowi* Gran & Braarud and *Thoracosphaera operculata* Bramlette & Sullivan. *Cyclagelosphaera reinhadrtii* Markalius inversus (Deflandre) and *Neocrepidolithus dirimosus* Perch-Nielsen are also relatively frequently encountered survivors.

The new Paleocene species Biantholithus sparsus (Bramlette & Martini) appears immediately above the boundary layer between +5 and +10 cm. Thus, the lower boundary of NP 1 Biantholithus sparsus is marked by both the disappearance of the Cretaceous species and the appearance of the zonal marker. Cyclagelosphaera alta Perch_Nielsen is another Paleocene species appearing in this interval. The first specimen was found in sample KLA+0.75 m. The thickness of the NP 1 Biantholithus sparsus is 2.40 m (Fig. 2). The first appearance of Cruciplacolithus intermedius (van Heck & Prins) marks the lower boundary of the NP 2 Cruciplacolithus tenuis. The lower level of the zone is characterized by the presence of another cruciplacoliths Cruciplacolithus primus Perch_Nielsen, appearing just below the zonal boundary, Cruciplacolithus tenuis (Stradner), Cruciplacolithus asymmetricus (van Heck & Prins) and Coccolithus cavus Hay & Mohler.

Lithology of the Kladorub Formation. So far the rocks of the Kladorub Formation, based on field determinations, have been described as different types of marls – sandy, silty and calcareous with rare limestone interbeds (see "Previous research"). The present granulometrical study of several samples from the K/T boundary interval shows high terrigenous content.

Only two of the investigated samples may be classified as marls: sample KLA -0.75 - very silty marl with 28.49% CaCO₃, 26.92% clay and 43.51% silt, and sample KLA +2.10 - silty marl with 33.40% CaCO₃, 26.40% clay and 39.40% silt.

Three of the samples are classified as siltstones: the boundary layer, sample KLA +0.05 – clayey-carbonate siltstone with 51% silt, 27.85% CaCO₃, 13.65% clay and 7.50% sand; sample KLA –0.05 – sandy-carbonate-clayey siltstone with 50% silt, 17.90% CaCO₃, 20.05% clay and 12.05% sand; sample KLA +3.50 – clayey-carbonate siltstone with 52.30 % silt, 31.55% CaCO₃, 14.60% clay and 1.55% sand.

The interval immediately above the K/T boundary layer is more carbonate. Sample KLA +0.20 is classified as clayey-silty limestone with 63.60% CaCO₃, 17.80% silt, 18.10% clay and 0.50% sand. Sample KLA –2.75 is a mixed type, classified as clayey-silty hypolimestone: 49.20% CaCO₃, 25.16% silt, 24.65% clay and 0.77% sand.

These samples show that carbonate and silt components are predominant in most of the samples, but the variation of the clay component is critical for determining the rock as marl or siltstone. On the basis of these results it may be concluded that the main rock type in the boundary interval of the Kladorub Formation is not marl but siltstone.

CONCLUSION

The present results confirm the unique opportunity for complex investigation of the K/T boundary interval in Bulgaria. After the recent publications on the boundary layer from several facial types in the Fore-Balkan and Stara Planina structural zone, this outcrop provides opportunities for detailed study of this boundary in fine-grained terrigenous rocks. The section of Kladorub Formation is the most complete boundary

section in Bulgaria, covering a well-exposed, complete stratigraphic interval from the Upper Campanian to the uppermost Paleocene. The nannofossil evidence for the K/T boundary interval allows further biostratigraphic, geochemical, sedimentological and mineralogical investigations. This section is a good basis for future correlation of the boundary in different facial environments.

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