

Lithostratigraphy of the Upper Cretaceous Series in a part of the Krayshte area (Southwest Bulgaria)

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М. Иванов, К. Стойкова, И. Загорчев, Е. Горанов – Литостратиграфия верхнемеловой серии в части Краиштенской области (Юго-Западная Болгария). Установлено, что верхнемеловые осадочные породы в области Краиште распространены гораздо шире, чем считалось до сих пор. Их возраст определен по известковым нанофоссилиям, которые доказали принадлежность пород к разным отделам кампанского яруса.

Приведена характеристика четырех новых официальных литостратиграфических единиц. Горнокозницкая свита представлена грубыми силикокластическими породами. Ее вероятный возраст – раннекампанский. Горногабрешевская свита сложена ритмическими турбидитами ранне-позднекампанского возраста. В Углярской свите преобладают тонкозернистые породы: мергели, тонколаминированные глинистые сланцы и глинистые известняки. Их возраст тоже кампанский. Все три перечисленные свиты широко представлены в исследованной области. Четвертая (Шабаницкая) свита развита ограничено в ее восточной части. Она сложена нелитифицированными силикокластическими и смешанными гипо-породами, в том числе и неморскими отложениями: онкоидными известняками и строматолитовыми образованиями позднекампанского возраста.

Накопление верхнемеловых осадочных пород происходило по всей вероятности в тектонически обусловленном асимметрическом бассейне (бассейн Бабушница – Фуча – Zagorchev et al., 2006). В его восточной части шло отложение очень разнообразных пород. Северная окраина бассейна перекрыта трансгрессивно грубокластическими последовательностями. На них залегают преимущественно морские отложения, которые в западном направлении постепенно замещаются мергельными и карбонатными породами, видимо переходящими к северу в известняковую последовательность, типичную для западных частей верхнемелового бассейна на территории Сербии.

Abstract. The Upper Cretaceous sediments in Krayshte area are reported to have a wider distribution than previously considered. They are dated using calcareous nannofossils, proving the presence of different parts of the Campanian Stage.

Four new formal lithostratigraphic units are introduced and characterized. The Gorna Koznitsa Formation consists of coarse siliciclastic rocks and is probably of Early Campanian Age. The Gorno Gabreshevo Fm. is represented by rhythmic turbidites of Early to Late Campanian Age. The Uglyartsi Fm. is dominated by fine grained sediments – marls, finely laminated claystones and clayey limestones. Its age is Campanian, too. These three units are widespread in the area. The last unit, Shabanitsa Fm., is locally developed in the eastern part of the area. It is built up by loose siliciclastic and mixed hypo-rocks, including non-marine sediments – oncooid limestones and stromatolites of Late Campanian Age.

The Upper Cretaceous sediments were deposited most probably in a tectonically controlled asymmetric basin (Babushnitsa-Fucha basin – Zagorchev et al., 2006). The sediments in the eastern parts of the basin exhibit the greatest variety. The coarse clastic sequences cover progressively over the northern board of the basin, and are covered by predominantly marly depos-

its. Westwards, they are gradually replaced by marly and carbonate sediments that probably pass to the north into the limestone sequences typical for the western parts of the basin on the territory of Serbia.

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Key words: lithostratigraphy, Upper Cretaceous, Campanian, calcareous nannofossils, Krayshte, SW Bulgaria.

Introduction

The presence of Upper Cretaceous rocks in the eastern part of the Strouma tectonic unit (Krayshte area) has been reported only recently in the Konyavska Mountain, at the western board of the Palaeogene Bobovdol graben (Stoykova et al., 2003). Further studies (Zagorchev et al., 2006) found a considerably wider occurrence, and a continuation into known outcrops on the territory of East Serbia. The present paper aims to publish the results of a more detailed research of the Upper Cretaceous strip, traced mostly in the Konyavska Mountain between the villages of Gorna Koznitsa and Golema Foucha, and farther to the NW at Uglyartsi and Blateshnitsa to Dolna Vrabcha (Fig. 1).

In all papers prior to the two publications cited above, and on all geological maps (including this of the scale 1:100 000), the Upper Cretaceous rocks have been referred to the Palaeogene (Upper Eocene or Oligocene) and/or Upper Jurassic – Lower Cretaceous. Several informal units have been described mostly following Beregov (Берегов, 1935) and Dimitrov (Димитров, 1931), as belonging to the Palaeogene on the basis of correlations with proven Palaeogene sediments from the Bobovdol graben (Zagorchev, 1993; Zagorchev, Динкова, 1991):

- “variegated conglomerate formation (probable Upper Eocene?)” of coarse clastic rocks, mostly red conglomerates and sandstones;
- “sandstone formation” (flyschoid terrigenous sediments);
- “shale-sandstone formation” of rhythmically alternating shales and sandstones;
- “bituminous-marly formation” of finely bedded and laminated marls rich in organic matter that have been correlated with the uppermost Oligocene marls with *Smerdis macrurus*.

The Upper Cretaceous calcareous nannoplankton has been initially found in several samples during the geological mapping on the scale 1:25000 in 2002–2003. Four informal Upper Cretaceous (Campanian to Lower Maastrichtian) units have been distinguished, and namely, basal breccia-conglomerate, flyschoid, limestone-marly and sandstone-marly formation (Stoykova et al., 2003). Later geological mapping in the area performed by P. Milovanov, D. Sinnyovski and collaborators has confirmed our results.

Our own field and laboratory data allow to trace the Upper Cretaceous formations in a wider area, and to establish with higher precision the volume and chronostratigraphic range of the lithological bodies. As a result, we are now able to introduce a scheme of formal lithostratigraphic units.

Description of the lithostratigraphic units

Four Upper Cretaceous formal lithostratigraphic units (formations) easily distinguishable in the field are introduced here. The type area of all four formations is the eastern and western slopes of the Konyavska Mountain (Fig. 1). Some of the lithostratigraphic bodies are traced also to the west near the village of Dolna Vrabcha. The formations are as follow (from base to top): Gorna Koznitsa, Gorno Gabreshovo, Shabanitsa and Uglyartsi Formation.

Gorna Koznitsa Formation (new formation: Горнокознишка свита, нова свита)(Fig. 2, Pl. I, 1–2)

Previous uses and synonyms. The rocks of this formation have been previously referred to a “variegated conglomerate formation” situated at the base of the Palaeogene section in the Bobovdol graben, and attributed to the probable Upper Eocene (Zagorchev, 1993). The formation corresponds to the “basal breccia-conglomerate formation” of Stoykova et al. (2003) and to the “coarse conglomerate and breccia” (Zagorchev et al., 2006) with a Late Cretaceous (Early Campanian?) age.

Name. The name of the formation comes from the village of Gorna Koznitsa (Kyustendil District), the type section being situated to the North of this village.

Defining features. The formation consists mostly of reddish or brownish polygenic breccia and conglomerate interbedded with coarse sandstones (Pl. I, 1–2). The clasts are of different size: from 3–4 cm to 1–1.2 m, and a varying composition: metamorphic rocks, granitoids, quartz, Palaeozoic schists, quartzites and limestones; red, probably Permian and Triassic sandstones, Triassic and Jurassic limestones,

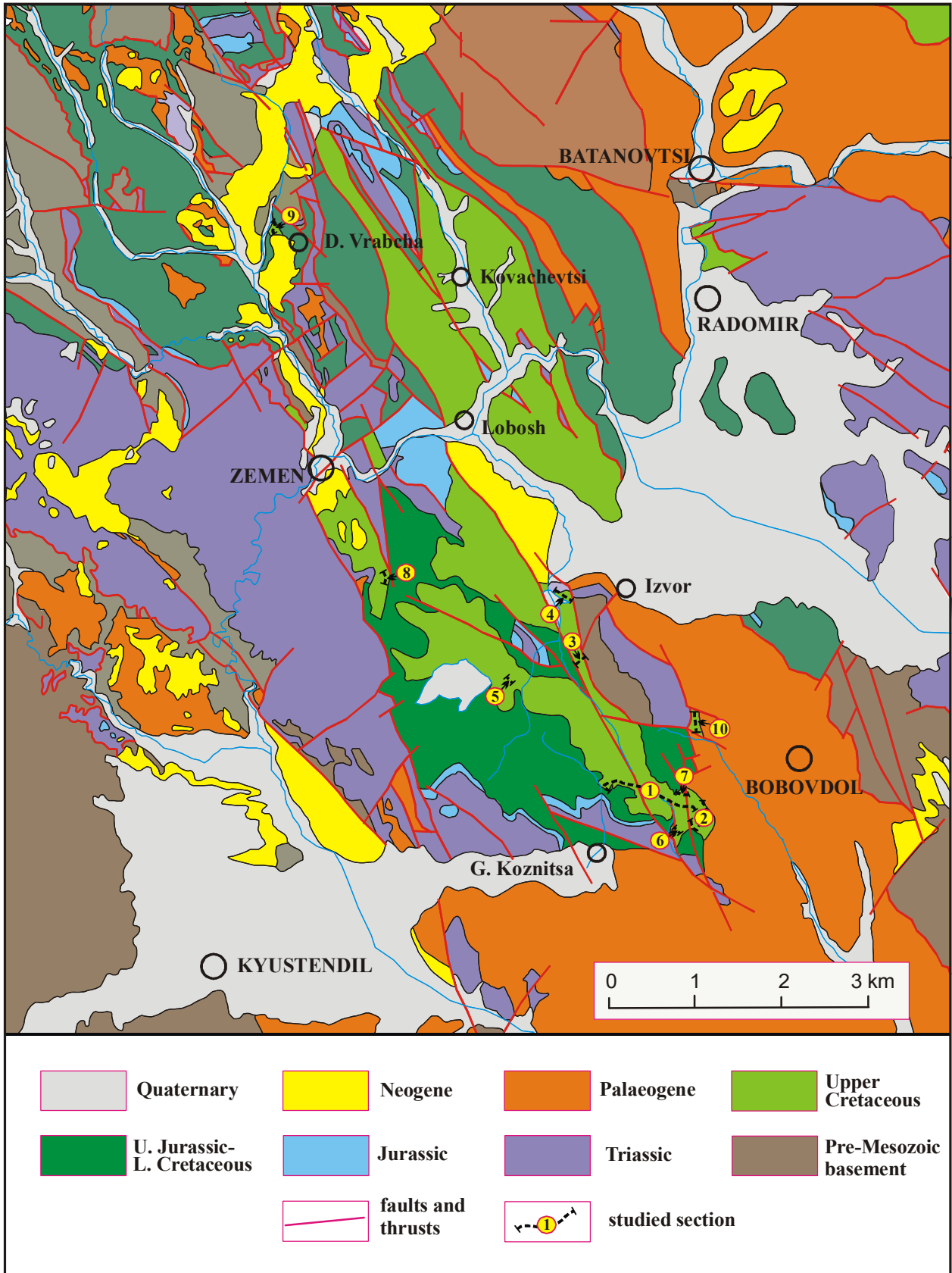


Fig. 1. Geological map of the area and location of the studied sections
 1 – Shabanitsa; 2 – Gorno Gabreshevo; 3 – Uglyartsy; 4 – Izvor; 5 – Dragomirovo; 6 – SW of Gorno Gabreshevo; 7 – Mala Fucha;
 8 – Blateshnitsa; 9 – Dolna Vrabcha



debrites and sandstones from the Upper Jurassic – Lower Cretaceous sediments. In the basal parts of the section huge boulders and blocks (up to a few meters) of Upper Jurassic–Lower Cretaceous coarse conglomerates and breccia are redeposited into the Gorna Koznitsa Formation.

Type section. The holostratotype is the section exposed to North of Gorna Koznitsa and along the ridge Shabanitsa, packet 3 to 6 (Fig. 2). Packet 2 probably belongs as well to the same formation.

Description of the formation in the type area. The formation covers with unconformity (sharp lithological boundary) the Bobovo Member of the Kostel Formation (Upper Jurassic – Lower Cretaceous). At the base, chaotically disposed clasts of rhythmic sediments (packet 2, from the Bobovo Member) have been probably gravity-driven into the forming basin. The next packet 3 of breccia-conglomerate clearly belongs to the Upper Cretaceous succession. It consists of clasts of various size and rock composition. The clasts at the base obviously underwent a very short transport. They come from Triassic (Radomir and Tran Formation) and Jurassic (Yavorets and Gintsi Formation) limestones or Jurassic carbonate debrites (Bobovo Member). The middle and upper parts of the formation are built of alternating packets of reddish to rusty-brown coarse grained sandstones, breccia-conglomerate and unsaturated pebble conglomerates with sandy matrix (Pl. I, 2). The topmost part of the formation consists of beige, predominantly coarse-grained sandstones with lenses of gravels. The upper boundary of the formation is a fast lithological transition to the rocks of the Gorno Gabreshevo Formation.

Regional aspects. The formation is traced as a strip (with small gaps) from Gorna Koznitsa to Blateshnitsa. It is widespread NW of Gorna Koznitsa, North and NE of Dragomirovo, and between the villages of Baykalsko and Blateshnitsa. Small outcrops at the base of the Upper Cretaceous section are observed NE of Uglyartsi, SW of Izvor, and West of Dolna Vrabcha.

The lithological features of the formation are relatively constant. Lateral changes concern the clasts composition (in function of the local basement), and the presence of relative amount of sandstones. In the sections where the formation is relatively thin, it is built mostly or exclusively of conglomerates.

The lower boundary is transgressive unconformity. The formation overlies the rocks of different age:

Paleozoic, Triassic and Late Jurassic–Early Cretaceous. The upper boundary is a fast lithological transition towards the Gorno Gabreshevo Formation or the Uglyartsi Formation. Lateral transitions are not directly observed. We suggest that it is laterally replaced in the topmost parts by the flyschoid sediments of the Gorno Gabreshevo Formation.

The thickness varies from 10–30 m in the westernmost (Dolna Vrabcha) and northern (Izvor) parts to about 100–120 m in the southerly outcrops (Gorna Koznitsa, Dragomirovo, Baykalsko and Blateshnitsa).

Fossil content. No fossils have been found. The samples from the matrix of the conglomerate (second conglomerate packet of the holostratotype) and sandstones (upper sandstone packet, same section) analyzed for calcareous nannoplankton are barren.

Chronostratigraphic range. The formation is tentatively referred to the Lower Campanian due to its stratigraphic position under the Lower Campanian Gorno Gabreshevo Formation.

Gorno Gabreshevo Formation

(new formation; Горногабрешевска свита, нова свита)(Fig. 2, 3; Pl. I, 3–4)

Previous uses and synonyms. The rocks of this formation have been previously assigned to a “shale-sandstone formation” and “sandstone formation” of supposed Priabonian-Oligocene age (Загорчев, 1993) or to the Kostel Formation (Upper Jurassic–Lower Cretaceous). As a “flyschoid formation” or “flyschoid (to flysch) formation” with Late Cretaceous (Campanian) age they have been described by Stoykova et al. (2003) and Zagorchev et al. (2006).

Name. The formation is named after the village of Gorno Gabreshevo (now – hamlet, part of the village of Korkina), Kyustendil District.

Defining features. The formation consists of thin- to medium bedded rhythmic flyschoid alternation or by rhythmic alternation of packets of sandstones with marls and packets with rhythmic interbedding (Pl. I, 3–4). The flyschoid rhythms consist of sandstones or siltstones and silty (less frequently, clayey) marls. Typical flysch textures are absent. Channel and amalgamated sandstones and slump sediments with different thicknesses are present within the rhythmic sequences.

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PLATE I

1. Outcrop of the Gorna Koznitsa Fm. (conglomerates), along the road-cut between Baikalsko and Blateshnitsa
2. Conglomerates and gravels within the uppermost part of the Gorna Koznitsa Fm. in its holostratotype section Shabanitsa
3. Thin and medium-bedded rhythmicity in the middle part of the Gorno Gabreshevo Fm. in its holostratotype section Shabanitsa
4. Rhythmic flyschoid sediments of the Gorno Gabreshevo Fm., cropping out near the road SW of Gorno Gabreshevo
5. Exposure of the base of the Shabanitsa Fm. (conglomerates, marls and limestones) in its type section between Gorno Gabreshevo and Mala Foucha
6. Oncoid limestones (overturned beds) in the lower part of the Shabanitsa Fm. in its type section
7. Thin- and fine layered marls of the Uglyartsi Fm. in the section near Dolna Vrabcha
8. Detail of the same sediments – fine laminated marls – in the same section as in photo 7

Type section. The holostratotype is the section North of Gorna Koznitsa and along the Shabanitsa Ridge, packets 7 to 15 (Fig. 2). The auxiliary section for the upper part of the Formation, here designated, is the interval of packets 1–10 in the section Gorno Gabreshevo.

Description of the formation in the type area. The lower boundary is a fast transition from the sandstones of the Gorna Koznitsa Formation. Fine rhythmic sediments (rhythms less than 8–10 cm) dominate the lowest parts of the section represented by sandstones and sizable amount of claystones. A packet of shallow channel sandstones is also present. In the middle and upper parts of the section the rhythmicity is of medium thickness. The sandstones occur in 20–30 cm thick beds, intercalated by silty marls. The marly packets consist of thin-layered clayey marls and very thin (less than 2–3 cm) sandstone or siltstone beds. (Pl. I, 3).

The uppermost parts of the formation exhibit macro rhythmicity. Packets (4–5 to 12 m) of thick-bedded poorly cemented sandstones with thin marls intercalations alternate with packets of marls or rhythmic sediments. Beds of variable thickness and slump origin are common. The marly interbeds in the sandstones contain clasts of sandstones and white limestones. The described alternation differs considerably from the rhythmic sequence, typical of the formation. Having a limited occurrence, it is here included into the Gorno Gabreshevo Formation but potentially could be individualized as a separate unit (member).

Regional aspects. The formation is widespread to the North of Gorna Koznitsa and North and West of Gorno Gabreshevo, where it builds the thickest part of the Upper Cretaceous section. Westerly it is exposed between Gorno Gabreshevo and Uglyartsi (East and West of the latter). Small outcrops appear above the conglomerates of the Gorna Koznitsa Formation at the lake of Izvor and in the southern end of Dragomirovo. Outside the type area the formation is represented by sandstones and marls with domination of the latter. Rhythmicity is not always well expressed.

The formation always overlies the Gorna Koznitsa Formation. In the type area it is covered by the Shabanitsa Formation. In the area of Uglyartsi, Izvor and Dragomirovo, the Gorno Gabreshevo Formation is overlaid by the Uglyartsi Formation, probably also through the lateral replacement and interfingering.

The formation thickness in the type area is greater (more than 450 m). It decreases to the North up to 40–50 m, and to the West possibly thins out, being absent at Dolna Vrabcha.

Fossil content. Both in the type section and in the outcrops near the villages of Uglyartsi, Izvor and Dragomirovo, Lower and Upper Campanian calcareous nannoplankton has been recorded. Small-sized gastropods are noticed in the upper parts of the formation.

Chronostratigraphic range. Based on typical calcareous nannofossil taxa the range of the formation is constrained as Lower (upper part) – Upper (lower part) Campanian Substage.

Shabanitsa Formation (new formation; Шабанишка свита, нова свита)(Fig. 3; Pl. I, 5–6)

Previous uses and synonyms. The rocks now referred to the formation have been previously included into a “sandstone formation” with supposed Priabonian-Oligocene age (Загорчев, 1993). It corresponds to the “limestone-marl formation” and the “sandstone-marl formation” described by Stoykova et al. (2003) and Zagorchev et al. (2006).

Name. The name of the formation comes from the hill Shabanitsa, situated to the West of the hamlet Gorno Gabreshevo of the village Korkina, Kyustendil District.

Defining features. The formation is built up of mixed siliciclastic (terrigenous) rocks: beige to brownish, poorly cemented, clayey sandstones with rare beds of silty marls, and alternation of sandstones and silty marls. In the lowermost part conglomerates and algal and oncoidal limestones occur.

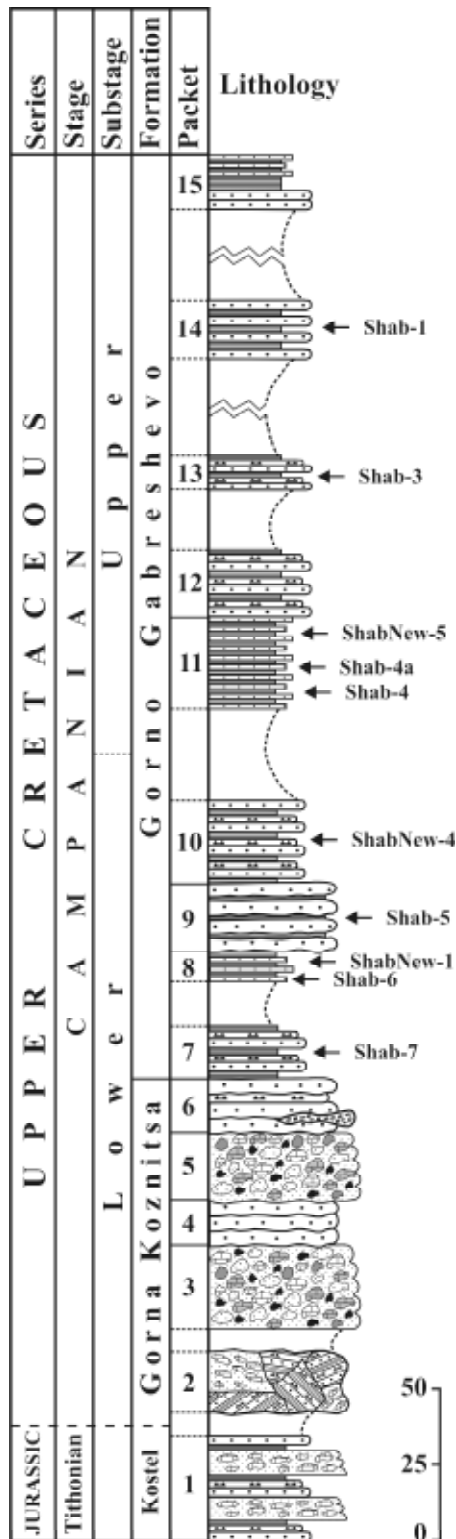
Type section. The holostratotype includes packets 11 to 21 of the section Gorno Gabreshevo (Fig. 3).

Description of the formation in the type area. The formation overlies with a sharp boundary the Gorno Gabreshevo Formation. It starts at the base with a thick conglomerate packet. The clasts are of varying size: pebble to cobble (5–30–50 cm) and composition: Triassic and Jurassic limestones, Jurassic and Cretaceous sandstones, and Cretaceous? limestones. Immediately above the conglomerates the succession consists of laterally pinching channel sandstones, silty and clayey marls, crystalline limestones and grainstones (Pl. I, 5), as well as loose sandstones interbedded by mixed silty-clayey rocks and thin layers of oncoidal limestones. The latter are a typical element for this part of the section. Oncoids are present as globules of different size (from several mm to 1–2 cm). Bigger forms (30–40 cm) of oncoids or stromatolites probably produced by Cyanophyta algae also occur (Pl. I, 6). As far as this part of the section is in overturned position, the direction of growing of the bigger colonies indicates the beds top. The middle parts of the section is built up of beige poorly cemented clayey sandstones, and the upper parts – by alternation of similar sandstones with silty marls with coalified plant debris and leaf prints.

Regional aspects. The formation has a limited occurrence. It is traced as a narrow discontinuous band from the type area (road East of Gorno Gabreshevo) through Mala Foucha to Golema Foucha.

Variations of the lithological composition are rather vertical than lateral. The presence of limestones and oncoidal limestones within the formation may have the potential of a marker level.

The lower and upper boundaries have not been observed directly. Supposedly, the formation could be partly laterally replaced by the Uglyartsi Formation being also overlaid by the latter; but no direct evidence has been found so far.



The thickness is deduced (composite sections) to be at least 180–200 m.

Fossil content. At the base of the type section (section Gorno Gabreshevo, packet 14) as well as in the uppermost parts of the formation (outcrops around Golema Foucha) calcareous nannoplankton has been recovered.

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Fig. 2. Section “Shabanitsa” – type-section of the Gorna Koznitsa and the Gorno Gabreshevo Formation (legend as on fig. 5)

Chronostratigraphic range. Based on calcareous nannoplankton finds, the range of the formation is constrained as Upper Campanian Substage.

Uglyartsi Formation (new formation; Углярска свита, нова свита) (Fig. 4; Pl. I, 7–8)

Previous uses and synonyms. The rocks of the formation (finely bedded and finely laminated marls rich in organic matter) have been formerly included in the “bitumolite formation” or in the “formation of variegated clays and sandstones” with probable Oligocene age.

Name. The name comes from the village of Uglyartsi where the type section is situated.

Defining features. The formation consists of gray to beige marls with indistinct or fine bedding, finely laminated, with very thin (3–4 to 8–10 cm) beds of clayey limestones. The marls often contain dark bitumen-rich layers representing coalified fine plant detritus that are concentrated in paper-thin lamina (“paper schists” of the old authors). Thin (1–2 cm) reddish-brownish layers and small carbonate concretions are also noted (Pl. I, 7–8).

Type section. The holostratotype consists of packets 2 to 6 of the section situated NE of the village Uglyartsi (Fig. 4).

Description of the formation in the type area. The lower boundary (with the Gorno Gabreshevo Formation) is not exposed. The succession consists mostly of beige to gray marls with variable carbonate content, and undistinct or fine bedding. Some intervals contain small (1–3 cm) carbonate concretions of irregular shape.

Regional aspects. The formation is widespread in the vicinities and to the West of Uglyartsi, South of Izvor, between Dragomirovo and Baykalsko, and West of Blateshnitsa, as well as near Dolna Vrabcha.

The lithological features of the formation are constant. At the base sometimes rare and thin sandstone beds are observed, and in the westerly outcrops, rare thin beds of light-gray clayey limestones occur.

The formation usually overlies (fast lithological transition) the Gorno Gabreshevo Formation, and rarely the sandstones of the Gorna Koznitsa Formation. The upper boundary is an unconformity (wash-out). It is covered by younger deposits, the sections being incomplete due to the erosion. To the South and East, the formation is probably replaced by the rhythmic and sandy sediments of the Gorno Gabreshevo or Shabanitsa Formation.

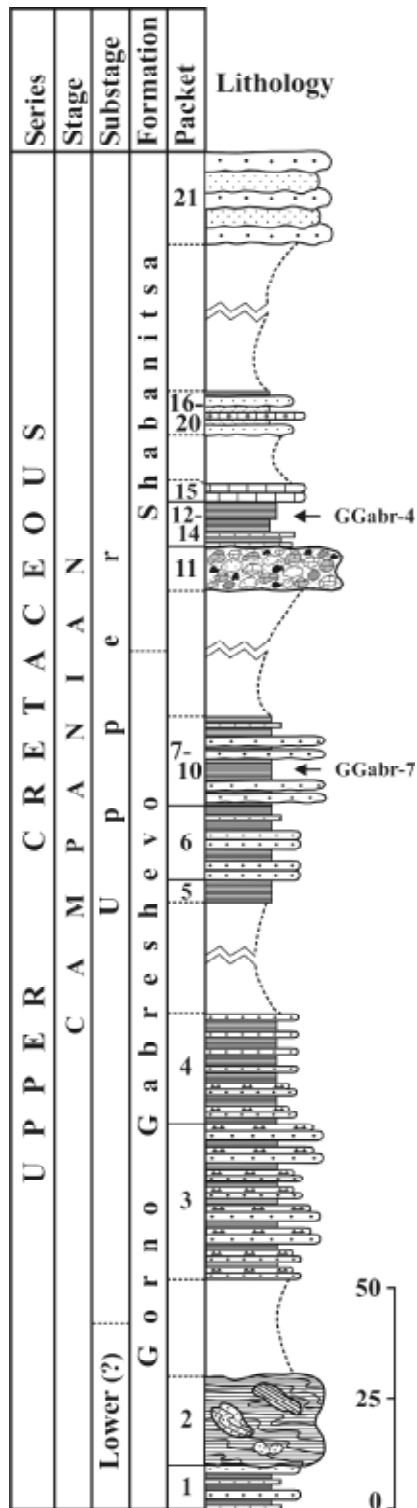


Fig. 3. Section at the hamlet Gorno Gabreshevo of the village of Korkina, Kyustendil District – auxiliary section of the Gorno Gabreshevo Formation and holostratotype section of the Shabanitsa Formation (legend as on fig. 5)

The thickness depends on the completeness of the sections and the erosion depth. It varies between 15–20 and 80–100 m.

Fossil content. Almost all sections (Uglyartsi, Izvor, Blateshnitsa, Dolna Vrabcha) contain abundant and diverse calcareous nannoplankton associations.

Chronostratigraphic range. Based on the nannoplankton taxa determined the formation is referred to the upper part of the Lower Campanian – lower part of Upper Campanian.

Description of selected sections

The holostratotype and auxiliary sections of the newly-introduced lithostratigraphic units are described only. The rest of the sections studied are briefly commented. The synthetic stratigraphic information is shown on the correlation scheme (Fig. 5).

Section “Shabanitsa”

The section begins at about 1.2 km North of Gorna Koznitsa, along the road towards Uglyartsi in the river valley. It is traced along the road NNW, and then along the western and northern slopes of the ridge Shabanitsa along the dirt road towards Gorno Gabreshevo. Sediments of Gorna Koznitsa and of Gorno Gabreshevo Formation are exposed, the chronostratigraphic range being Upper Lower Campanian (parts) – Lower Upper Campanian (parts) (Fig. 2, 5).

Cover: not exposed.

Gorno Gabreshevo Formation (holostratotype) (№ 15-7)

15. (more than 15 m)

Alternation of packets (several m thick) of beige, loose sandstones with packets of marls and/or of rhythmic sediments.

--- lack of outcrops – about 100–150 m (along the road) ---

14. (more than 20 m)

Medium-bedded alternation of sandstones, siltstones and marls. The rhythm's thickness varies between 30 to 50 cm. The sandstones are grey, medium-grained, whereas the marls are grey to beige, silty, containing calcareous nannofossils: *Watznaueria barnesae*, *Micula* sp. indet., *Eiffellithus eximius*.

--- lack of outcrops – about 200–250 m (along the road) ---

13. (more than 10 m)

Fine rhythmic alternation of sandstones, siltstones and marls. The sandstones are grey, fine-grained, alternating with thin-bedded silty or clayey marls. Upper Campanian nannofossil association is recovered from this packet: *Watznaueria biporata*, *Uniplanarius sissinghii*, *Nannoconus* spp.

----- lack of outcrops – about 18–20 -----

12. (22 m)

Medium- to thick-bedded alternation of sandstones, siltstones and marls (Pl. I, 3). The dominant rhythm's thickness is between 40 and 50 cm. The sandstones are fine- to medium-grained; the marls are grey, silty, indistinctly bedded.

11. (32 m)

Fine rhythmic alternation of marls and sandstones (Pl. I, 3). The rhythms are 10–12 cm thick. The marls are dominant – grey, thin to medium-bedded or fine laminated, clayey. The sandstones are thin-bedded (3–4 cm), fine-grained. Calcareous nannofossil association includes *Zeughrabdotus spiralis*, *Micula concava*, *Watznaueria barnesae*, *Chiastozygus litterarius*, *Glaukolithus compactus*, *Retecapsa crenulata*, *R. conicus*, *Eiff-*

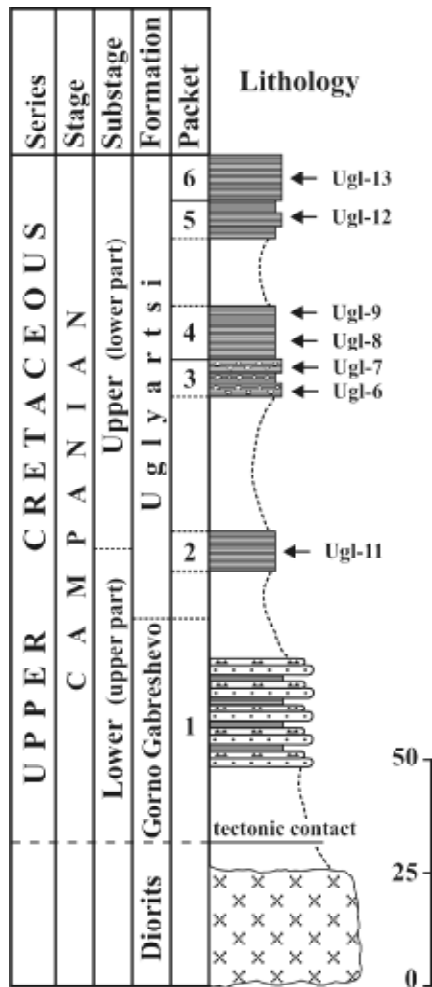


Fig. 4. Section East of the village Uglyartsy, Pernik District – type-section of the Uglyartsy Formation (legend as on fig. 5)

ellithus eximius, *Reinhardtites anthophorus*, *Quadrum gartneri*, *Gartnerago obliquum*, *Reinhardtites anthophorus*, *Lucianorhabdus maleformis*, *L. cayeuxii*, *Micula cubiformis*, *M. praemurus*, *Chiastozygus litterarius*, *Prediscosphaera cretacea*, *Cyclagelosphaera reinhardtii*, *Braarudosphaera* spp.

----- lack of outcrops – about 40 m -----

10. (27 m)
Medium-bedded (30 to 50 cm) alternation of sandstones, siltstones and marls. The sandstones are fine to medium-grained, beige to grey in color. The marls are grey, silty, indistinctly bedded, containing calcareous nannoplankton: *Arkhangelskiella cymbiformis*, *Octolithus multiplus*, *Uniplanarius gothicus*.

9. (23 m)
Sandstones, beige to brownish, massive, indistinctly bedded, poorly cemented, with thin interbeds of siltstone and strongly silty marls or mixed rocks. The sandstones built up a thick packet that is geomorphologically marked in the relief. They have irregular bedding surfaces and variable thickness, with the character of shallow channel formation. Siltstones and marls contain irregularly distributed or localized in thin layers fine coalified plant detritus. Nannofossils are rare and without characteristic taxa – only *Watznaueria barnesae* is observed.

8. (more than 10 m)

Fine rhythmic flysch-like alternation of beige or gray fine-grained sandstones with clayey or silty marls. Rhythms are up to 30 cm thick, with dominance of the marls. Calcareous nannoplankton association recorded includes: *Cyclagelosphaera margerelii*, *Watznaueria barnesae*, *Retecapsa crenulata*, *Lucianorhabdus cayeuxii*, *Prediscosphaera cretacea*, *Eiffellithus eximius* and reworked *Nannoconus steinmanni steinmanni*, *N. kamptneri minor*, *N. quadratus*.

----- lack of outcrops – about 20–30 m -----

7. (16 m)
Rhythmic flysch-like alternation of gray sandstones, siltstones and marls. The rhythms are relatively thin (less than 20-30 cm) with dominant turbiditic parts. The calcareous nannoplankton determined: *Watznaueria barnesae*, *W. biporta*, *Quadrum gartneri*, *Cyclagelosphaera margerelii*, *Creiarhabdus conicus*, *Eiffellithus eximius*, reworked: *Nannoconus steinmanni steinmanni*, *N. kamptneri*.

Gorna Koznitsa Formation (holostratotype) (№ 6-3, ?2) (?Lower Campanian Substage)

6. (18 m)
Beige, mostly coarse-grained sandstones interbedded with siltstones, with thin beds or lenses of gravels and fine- to medium-sized pebble conglomerates. The conglomerates are gray to beige in color, less often reddish, with sandy matrix and pebble content similar to that of packets 3 and 5.

5. (24 m)
Alternation of breccia, conglomerate, and gravel to pebble saturated matrix-supported conglomerate. They are usually reddish, the clasts composition is similar to that of packet 3, but the pebbles are much more rounded. The large clastic, pebble to boulder size clasts, occur rarely.

4. (15 m)
Sandstones – reddish to rusty-brown, mostly coarse-grained, locally grading to gravels.

3. (more than 30 m)
Breccia-conglomerate, reddish to brownish, cobble- to boulder-sized clasts. The clasts are usually angular, of different shape and size. The matrix is sandy and reddish. The clasts come from various rocks: high-grade metamorphites, granitoids, quartz, Palaeozoic schists, quartzite and limestone, red sandstones (probably Permian and/or Lower Triassic), Triassic and Jurassic limestones, Upper Jurassic and Lower Cretaceous debrites and sandstones. The clasts of Triassic limestones (Radomir and Trun Formation), Jurassic limestones (Yavorets and Gintsi Formation) or Jurassic carbonate debrites (Bobovo Member of the Kostel Formation) predominate.

----- lack of outcrops – about 10 m -----

2. (около 20 m)
Strongly deformed interval built up of packets (huge blocks?) of rhythmic alternation (sometimes whole redeposited blocks of coarse conglomerate from the Kostel Formation), with different orientation of the bedding, rarely some debrites packets.

----- lack of outcrops – about 15 m -----

Base: Kostel Formation (Bobovo Member) (№ 1) (Upper Jurassic – ?Tithonian Stage)

1. (more than 30 m)
Alternation of flysch and debrite packets. The debrites are composed of limestone clasts with sandy matrix. The flysch alternations are medium-bedded with presence of thicker turbiditic beds. The rhythms are built up of sandstones, siltstones, shales or marls.

Section at the hamlet Gorno Gabreshevo of the village Korkina, Kyustendil District (Fig. 3)

The section starts approximately 500 m SW from the village and is traced to the center; afterwards continues NE along the road towards Mala Foucha. The Gorno Gabreshevo and Shabanitsa Formation are exposed. The sedimentary succession is normal in the lower part of the section; the beds are sub-vertical in the middle part and overturned in the upper part. The chronostratigraphic range of the succession is Lower to Upper Campanian.

Shabanitsa Formation (holostratotype)(№ 21–11)

21. (more than 20 m)

Sandstone – beige, brownish and rusty-brownish, medium to coarse-grained, poorly cemented, clayey. Rare interbeds of siltstones, silty marls or mixed clayey-sandy hypo-rocks occur.

----- lack of outcrops – about 60–70 m -----

20. (more than 1m)

Marls – beige, thin-bedded or indistinctly bedded, silty.

19. (1.8 m)

Sandstone – beige to pale-grey, clayey, loose, indistinctly bedded.

18. (4.2 m)

Alternation of sandstones, marls and mixed hypo-rocks with clayey limestones containing oncoids and stromatolites. The limestones beds are of variable thickness, thinning and thickening, with biomorphic shape. They are built up of oncoids with variable shape and size: from small globules (2–3 to 5–6 mm) up to large oncoids or stromatolites (30–40 cm – Pl. I, 6). They possess flatten base at the bottom of the bed and hemispherical shape at the top, clearly showing vertical direction of growth. The growth direction of the colony exactly witnessed the overturned bedding in this packet. Some isolated colonies are inserted into the marls too. The oncoid limestones pass gradually to the marls with oncoids nodules, besides the size of the oncoids decreases.

The oncoids limestones and marls are restricted in 3–4 m thick interval, representing remarkable sedimentary marker in the section, inserted within the clayey-sandy succession.

17. (2.5 m)

Sandstones – beige, loose, with clayey-sandy cement.

16. (more than 4.5m)

Alternation of beige poorly cemented sandstones and silty undistinctly bedded marls and mixed rocks.

----- lack of exposures – about 10–12 m -----

15. (4–5m)

Limestones – pale beige to whitish, their structure is grain-supported /grainstones. The packet is well expressed geomorphologically in the relief (Pl. I, 5).

14. (2.2 m)

Marls – grey, clayey, thin-bedded.

13. (4 m)

Marls – beige, silty, indistinctly bedded, with rare thin interbeds of loose sandstones.

12. (2.5 m)

Alternation of sandstones, marls and/or mixed hypo-rocks. The sandstones are poorly cemented, clayey, with variable thickness and oblique bedding plane on the conglomerates. The marls are beige, silty, passing to hypo-rocks.

11. (over 10 m)

Conglomerates – unsaturated, sandstone matrix, large clastic, pebble to small boulder size clasts (30–40 cm). The clasts con-

sist mainly of Triassic and Jurassic limestones; sandstones and granite clasts occur too. Some of the clasts are incrustated with fine carbonate coating – possibly produced by fresh-water algae.

----- lack of exposures – about 150 m along the road -----

Gorno Gabreshevo Formation (auxiliary section)

(№ 10–1)

10. (over 3 m)

Marls – beige, silty with thin sandstone interbeds.

9. (6 m)

Sandstones – beige to brownish, massive, firmly or weakly cemented. At the bottom and the top of the packet thin intercalation (3–5 cm) of siltstones occur.

8. (4.5 m)

Marls – grey to beige, silty, fine laminated. In the upper part there are two beds of fine-grained sandstones (8–10 cm thick).

7. (5.5 m)

Alternation of thick-bedded to massive sandstones with silty marls or mixed silty-clayey rocks. The sandstones are beige, medium to coarse-grained, with specific weathering, undulating lower bed surface and amalgamation signs. In the upper part sandstones are medium to thick-bedded, whereas the mixed rocks in between contained limestone's clasts (similar to "Melovete" – type Upper Cretaceous limestones) and sandstone's clasts.

6. (15.5 m)

Alternation of sandstones' and marls' packets (1 to 3 m thick). The sandstones are beige, massive, indistinctly bedded, poorly to well cemented. The marls grey to beige, silty, indistinctly bedded or thin-bedded, passing to mixed rocks. The presence of mini-slumps is indicated by sin-sedimentary deformations.

5. (more than 3 m)

Marls – gray, thin bedded, silty.

----- lack of outcrops – about 70–80 m -----

4. (more than 25 m)

Thin-bedded alternation of sandstones or siltstones with marls. Towards the top of the section the marls become dominant whereas the sandstone's amount decreases. The sandstones are mostly beige, fine-grained, and the marls are beige, silty.

3. (35 m)

Thin- to medium-bedded sandstones, siltstones and marls rhythmic alternation. Sandstones are beige, fine-grained. The marls are beige, silty, thinly to indistinctly bedded. Locally limestones and sandstones clasts (0.1 to 0.3 m in size) are included in the rhythms. Laterally they pass into micro-conglomerate.

----- lack of outcrops – about 25–30 m -----

2. (20 m)

Slumpy interval represented by marl matrix with clasts or packets of sandstones that are strongly sin-sedimentary deformed (bended). In the upper parts randomly oriented mudclasts and sandstone clasts are included into sandy to gravel matrix.

1. (more than 10 m)

Thin- to medium-bedded flyschoid alternation. Some intervals are dominated by thin-bedded to fine-laminated marls and shales. The marls are dark-gray to almost black, and contain significant amount of coalified fine-grained plant debris. Small gastropods are recovered, too.

Section East of the village of Uglyartsi, Pernik District (Fig. 4)

We faced up to serious difficulty when trying to select the type section of the Uglyartsi Formation. There are many different isolated outcrops around and in

the village of Uglyartsi, but no one continuous exposure is available due to the specific soft lithology – marls.

Therefore the section in the gully NE of the village, along the black road is selected and described here. It starts at 1.2 km from the village centre and is followed along the western slope of the hill. The Gorno Gabreshevo and Uglyartsi Formation are exposed, ranging chronostratigraphically within the Campanian Stage.

Uglyartsi Formation (holostratotype) (№ 6–2) [Campanian Stage (partly)]

6. (more than 10 m)

Marls – beige, indistinctly bedded, clayey. Nannofossil recovery from this interval comprises: *Watznaueria barnesae*, *Retecapsa crenulata*, *Eiffellithus turriseifellii*, *E. gorkae*, *Prediscosphaera grandis*, *Nannoconus* sp. indet.

5. (more than 8 m)

Marls – grey, fine-laminated, thin-bedded, alternating with indistinctly bedded marls. The recovery of the calcareous nannofossils *Reinhardites levis* together with *Eiffellithus eximius*, *E.*

turriseifellii, *Lucianorhabdus maleformis*, *Watznaueria barnesae*, *W. biporta* proved the Campanian age of the sediments. ----- lack of outcrops – about 10–15 m -----

4. (over 11 m)

Marls – beige, thin-bedded, clayey, fine-laminated (1 to 3 mm laminae). There is a peak in nannofossil abundance in this packet – a rich and diverse association is documented: *Broinsonia parca parca*, *Eiffellithus eximius*, *E. turriseifellii*, *E. gorkae*, *Lithastrinus grillii*, *Ahmuelerella regularis*, *helicolithus trabeculatus*, *Prediscosphaera grandis*, *P. stoveri*, *P. cretacea*, *P. microrhabdulina*, *Eprolithus rarus*, *Rhagodiscus reniformis*, *Gartnerago segmentatum*, *Micula staurophora*, *Chiastozygus amphipons*, *Manivitella pemmatoidea*, *Retecapsa crenulata*, *Lucianorhabdus cayeuxii*, *L. maleformis*, *Reinhardites anthophorus*, *Microrhabdulus decoratus*, *Watznaueria barnesae*, *W. biporta*.

3. (more than 8 m)

Alternation of grey and beige beds of indistinctly and thin-bedded marls. Small-sized (up to 3 cm) carbonate concretions and nodules occurred within the marls. Abundant nannofossil association is recovered, comprising: *Reinhardites levis*, *Lithastrinus grillii*, *Chiastozygus litterarius*, *Eiffellithus eximius*, *E. turriseifellii*, *E. gorkae*, *Prediscosphaera ponticula*, *P. cretacea*, *Retecapsa crenulata*, *Micula staurophora*, *Lucianorhab-*

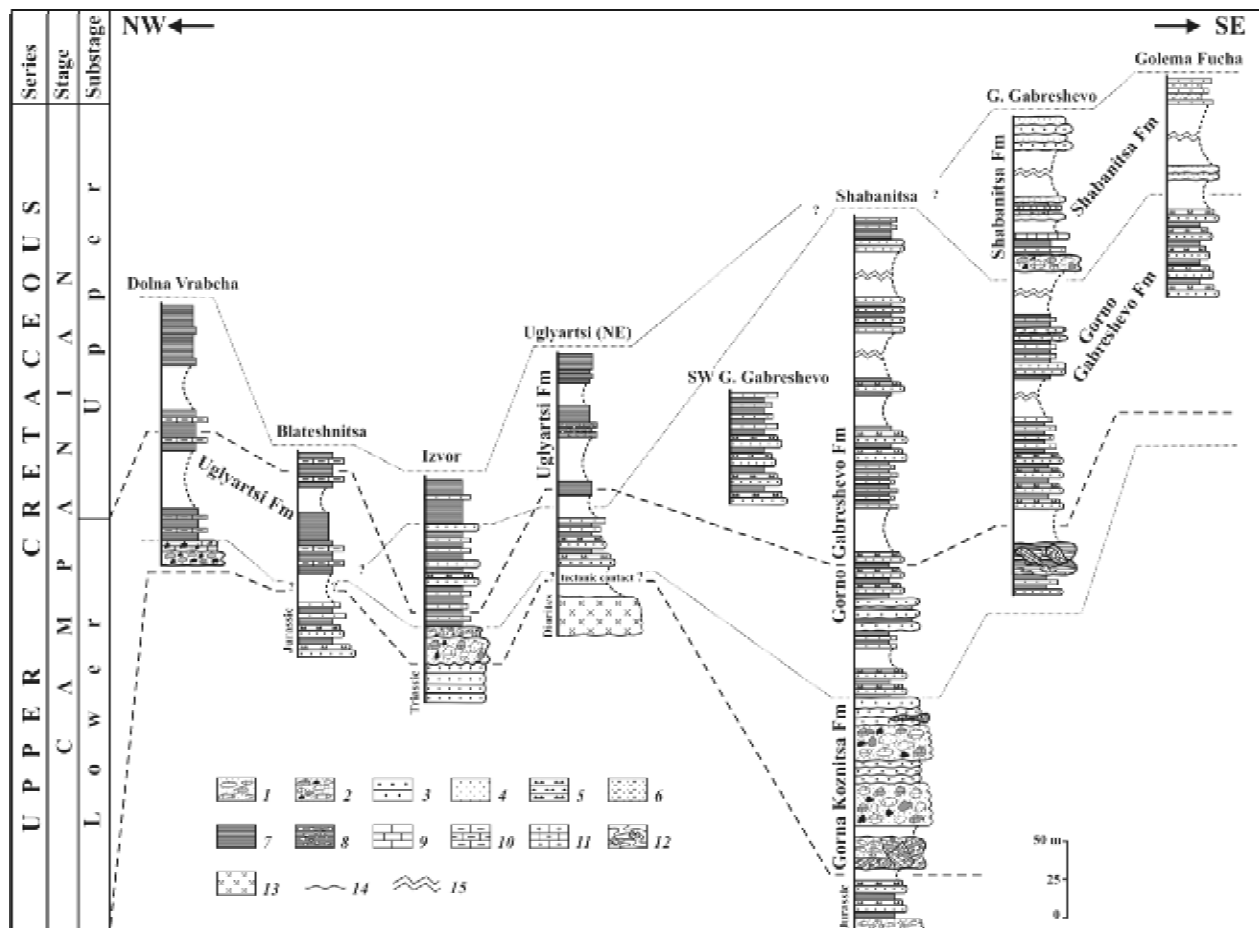


Fig. 5. Stratigraphic correlation between the studied sections

1 – debrites and limestone clasts; 2 – conglomerates and breccia-conglomerates; 3 – sandstones; 4 – loose sandstones; 5 – siltstones; 6 – mixed silty-clayey rocks; 7 – marls; мергели; 8 – marls with carbonate concretions; 9 – limestones; варовици; 10 – clayey limestones; 11 – oncoid limestones; 12 – slump; 13 – diorites; 14 – undulating or wash-out boundary; 15 – drawing of the interval is interrupted

dus cayeuxii, *Cribrosphaera ehrenbergii*, *Watznaueria barnesae*, *Cyclagelosphaera reinhardtii*.

2. (over 7 m)

Marls – light-grey, clayey, thin-bedded. They yield the following nanoflora: *Eiffellithus eximius*, *E. turriseifellii*, *M. staurophora*, *Gartnerago segmentatum*, *Watznaueria barnesae*.

----- lack of outcrops – about 15–20 m -----

Gorno Gabreshevo Formation (№ 1) (Campanian Stage, partly)

1. (more than 20 m)

The rocks are poorly outcropped – clasts of thin- and medium-bedded sandstones are observed. We presume that the interval is represented by rhythmic turbidite sediments.

----- tectonic contact -----

Diorites

Seven additional sections and few isolated outcrops have been investigated except of the described above type-sections. The sedimentary sequences of all different formations yield 40 productive samples, containing calcareous nanoflora, thus evidencing the Late Cretaceous – Campanian age.

In the section SW of the village of Izvor, along the beach of the lake, the Upper Cretaceous sediments overlaid transgressively Lower Triassic limestones. The Gorna Koznitsa, Gorno Gabreshevo and Uglyartsi Formations are cropping out in this section. The Late Campanian age of this succession is witnessed by the simultaneous occurrence of calcareous nanofossil taxa *Eiffellithus parallelus*, *E. eximius* and *Lithraphidites praequadratus*. It is worth to mention the relatively reduced thickness of the formations here.

The section SW of Dragomirovo (at the road fork to Baykalsko) demonstrates the boundary between the Gorna Koznitsa and Gorno Gabreshevo Fm. The Latest Campanian age is categorically proved for the latter due to the co-occurrence of the nanofossil species *Uniplanarius trifidus* and *Uniplanarius sissinghi*.

The section SW of Gorno Gabreshevo exhibits the typical rhythmic succession of Gorno Gabreshevo Fm. which is proved to be Campanian in age (Pl. I, 4).

The section at Mala Fucha village illustrates the uppermost part of the Gorno Gabreshevo Fm. We suppose that part of the flyschoid succession, assigned so far to the Kostel Fm., can also be referred to the Gorno Gabreshevo Fm., but no palaeontological arguments available so far.

The section at the hamlet Vlasinska mahala of Blateshnitsa village represents the sediments of the Uglyartsi Fm. with proved Campanian age only.

The Upper Cretaceous succession shows specific features in the westernmost section studied near Dolna Vrabcha village. In this location the conglomerates of the Gorna Koznitsa Fm. are overlaid by the limestones with clasts of Paleozoic phyllites. These limestones are covered by the marls of the Uglyartsi Fm. (Pl. I, 7–8), which are interbedded in the lower part with clayey limestones.

The uppermost part of the Upper Cretaceous sedimentary succession in the area is documented near the village of Golema Fucha. It consists of alternation of loose clayey sands with silty marls and mixed hyporocks. These sediments yield well preserved leaf-casts and abundant coalified plant debris. They are included into the uppermost part of the Shabanitsa Fm.

Characteristics of the Late Cretaceous basin in the area

According to our previous work, the existing Late Cretaceous marine basin in Krayshte area shows specific features (Stoykova et al., 2003; Zagorchev et al., 2006). It was formed comparatively late, at the beginning of the Campanian. There is no sign of volcanic activity and volcanic components in the sedimentary succession. The basin extends to the WNW on Serbian territory, named as Babushnitsa-Fucha basin (Zagorchev et al., 2006). In the westernmost parts (E Serbia) it is dominated by relatively shallow-water carbonates and glauconite-bearing sediments.

In Krayshte area the Babushnitsa-Fucha basin is narrow and asymmetric, its southern board being

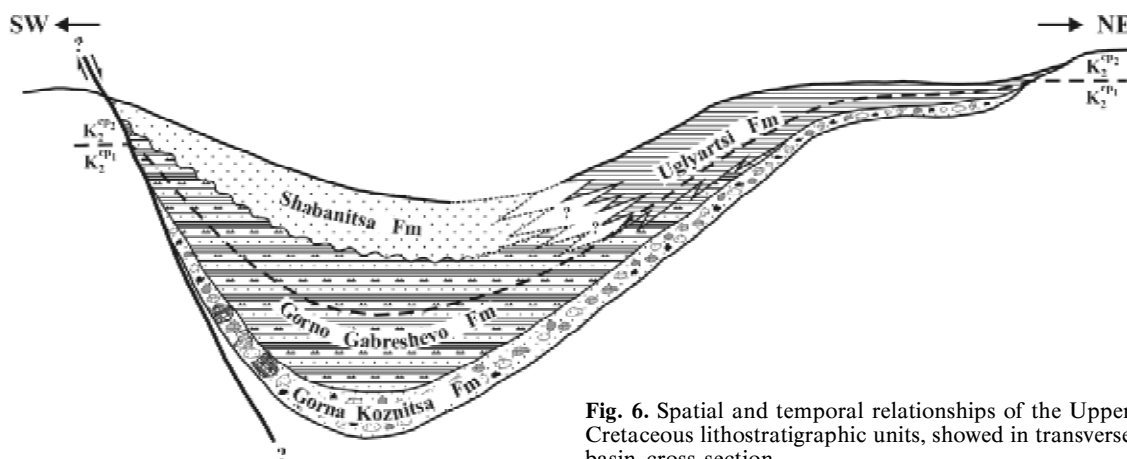


Fig. 6. Spatial and temporal relationships of the Upper Cretaceous lithostratigraphic units, showed in transverse basin cross-section

steep and most likely formed by faulting (Fig. 6). On this southern board, poorly sorted chaotic siliciclastic sediments are deposited during the Campanian. The maximal thicknesses of the basal breccia-conglomerates (Gorna Koznitsa Fm.) and the deep-water flysch and flyschoid sediments (Gorno Gabreshevo Fm.) are documented in the axial part of the basin (Fig. 6). The northern board is relatively oblique. The onset of the marine transgression on this board is later (with some delay). It is marked by the deposition of coarse clastic and non-rhythmic siliciclastic sediments with small thickness.

The amount of coarse clastics clearly decreases to the North-NorthEast and to the West-NorthWest direction, being replaced by the domination of marls (Uglyartsi Fm.). The marls are clayey, finely laminated, interbedded by thin-bedded clayey limestones. The finely laminated marls, including organic-rich layers are typical element of the successions in this part of the basin. These sediments make the facial transition from the eastern (with dominant siliciclastic sedimentation) to the western (with dominant carbonate sedimentation) parts of the basin.

Due to the depositional filling of the basin or event at the end of the Campanian, the loose siliciclastics and mixed hypo-rocks are deposited in the south-eastern part of the basin (Shabanitsa Fm.). These sequences started with non-marine sediments, represented by specific limestones with oncoids and small stromatolites. They gradually passed to the marine, shallow-water siliciclastics and mixed rocks, containing abundant plant remains.

Our previously reported data about the presence of the Lower Maastrichtian sediments (Stoykova et al., 2003; Zagorchev et al., 2006) are revised here – there is no clear evidence about it. This problem is still open and needs further elucidation.

Conclusion

Our new studies found a considerably wider occurrence of the Upper Cretaceous in Kraishte area. Different parts of the Campanian Stage are evidenced in more than 10 sections, using calcareous nannofossils as a main biostratigraphic tool.

The field studies resulted in nomination and characteristics of 4 new formal lithostratigraphic units. The Gorna Koznitsa Fm. (breccia-conglomerates and coarse siliciclastics) is possibly of Early Campanian age. The Gorno Gabreshevo Fm. (flysch and flyschoid rhythmic sediments) is of late Early to early Late Campanian age. The same age interval is proved for the Uglyartsi Fm. (marls dominated, fine-laminated clayey marls interbedded by thin-bedded clayey limestones). These three formations are of wide distribution in the area. The Shabanitsa Fm. locally occurs in the eastern parts, consisting of loose terrigenous and mixed rocks and non-marine sediments – oncoidal limestones. Its age is restricted to the Late Campanian only, thus revising our previous statement.

The Upper Cretaceous formations were deposited most probably in a tectonically controlled (extensional onset and evolution in a most unstable area situated northwest of the thickened crust of the Rhodope massif) asymmetric basin (Babushnitsa-Fucha basin – Zagorchev et al., 2006). The sediments in the eastern parts of the basin exhibit the greatest variety. The coarse clastic sequences cover transgressively over the northern board of the basin, and are covered by predominantly marly deposits. Westwards, they are gradually replaced by marly and carbonate sediments that probably pass to the north into the limestone sequences typical for the western parts of the basin on the territory of Serbia.

The Babushnitsa-Fucha basin suffered considerable post-Cretaceous deformations in Palaeogene and earliest Miocene times. Its relics are now spread as a belt (Fig. 7) west of the Lyubash-Golo bardo high (cordillera?) and the Srednogorie zone. The real extent and geodynamics of the basin are not yet fully understood. Further studies should elucidate the extent and relations of the basin with the Late Cretaceous basins of the Srednogorie, Balkan and South Carpathian zones thus allowing for a better understanding of the Late Cretaceous plate motions.

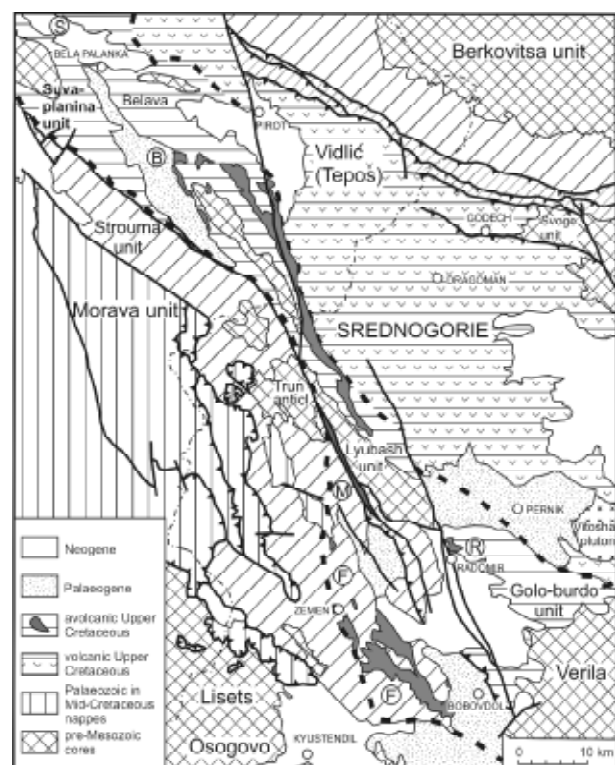


Fig. 7. Sketch map (Zagorchev et al., 2006, fig. 1; after different Serbian and Bulgarian sources and own research) for the tectonic structure and the distribution of Upper Cretaceous sediments in parts of East Serbia and West Bulgaria. The main areas of Upper Cretaceous occurrences are: S – Sichevo; B – Babushnitsa; M – Melovete; R – Radomir; F – Fucha

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М. Иванов, К. Стойкова, И. Загорчев, Е. Горанов – Литостратиграфия на горнокредната серия в част от Краището (Югозападна България). В резултат на нови изследвания е установено значително по-широко разпространение на горнокредни седименти в Краището. Те са датирани с варовити нанофосили, като в повече от 10 разреза е доказано присъствието на различни части на кампанския етаж. Наблюденията върху седиментните последователности позволи да се номинират и характеризират 4 нови официални литостратиграфски единици. Горнокознишката свита е представена от бречкоконгломерати и грубозърнести теригенни скали и е вероятно с раннокампанска възраст. Горногабрешевската свита се състои от флишки и флишоидни ритмични, по-рядко неритмични седименти. Тя е с ранно- до къснокампанска възраст. В Углярската свита доминират мергели, включително глинести и финоламинирани, прослоени от тънкопластови глинести варовици е също с ранно- до къснокампанска възраст. Тези три свити имат широко разпространение в областта. Шабанишката свита е локално развита в източните части и се изгражда от предимно слабоспоени силицикластити и смесени скали с присъствие на неморски седименти – вкл. онкоидни варовици и строматолити. За тази свита е доказана само къснокампанска възраст, като ревизираме наше предходно мнение.

Горнокредните скали в областта са се отложили в асиметричен, вероятно тектонски формиран басейн. Най-разнообразни фациално са седиментите в източните части на басейна. Грубокластичните последователности тук трансгредират върху северния борд на басейна и се покриват от финокластични мергелни и глинести скали. На северозапад те постепенно се заместват от мергелно-карбонатни седименти, които реализират прехода към варовиковите последователности в западните части на басейна, които се намират на територията на Република Сърбия.