

SANTONIAN–CAMPANIAN BOUNDARY INTERVAL IN
THE KYUNETSA SECTION, WESTERN SREDNOGORIE
ZONE, BULGARIA

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Abstract

The Kyunetsa section, 2.5 km west of Kosharevo, exposes mainly pelagic Upper Cretaceous marly limestones and marls of the Srednogorie Zone, part of the intermediate Balkanides in Bulgaria. The Melove Formation of Coniacian to early Campanian age involves a prominent Santonian–Campanian boundary interval of grey and reddish sediments, including CORBs (Cretaceous Oceanic Red Beds). The base of the Campanian can be discerned in bed 7c by the first rare (single) occurrence of the nannofossil *Broinsonia* (*Aspidolithus*) *parca parca*. A positive carbon isotope peak below, and a field magnetic susceptibility peak above may enhance correlation to other Tethyan sites such as the proposed GSSP at Bottaccione (Italy), the Postalm section (Austria) and the Mudurnu–Göynük Basin (Turkey).

Key words: Santonian, Campanian, calcareous nannofossils, isotope data, magnetic susceptibility

Introduction. The Upper Cretaceous volcano-sedimentary succession in the Western Srednogorie Zone, part of the intermediate Bulgarian Balkanides

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forms northwest-southeast-striking strips, spanning the Turonian–Maastrichtian interval, resting unconformably upon different Upper Jurassic–Lower Cretaceous carbonates. The Melove Tectonic Unit was recognized by [1,2] and considered by [3] as part of the Western Srednogorie Zone. It is a narrow NW-SE unit located close to the border area of the Western Srednogorie Zone and the Kraishte Tectonic Zone. The unit is best exposed along the Melove Hill (Western Bulgaria), west of the village of Kosharevo and between the villages of Gabrov Dol and Banishte [3]. The best and most continuous Upper Cretaceous sedimentary record in this unit is exposed in the Kyunetsa section, 2.5 km west of Kosharevo (Fig. 1). The sedimentary succession of the Kyunetsa section spans the Turonian–Campanian interval and four formations have been recognized by [4] as follows: the Paramun Formation (lower-middle Turonian), the Izvor Formation (middle Turonian–Coniacian), the Melove Formation (Coniacian–lowermost Campanian) and the Kosharevo Formation (lower Campanian).

Within the joint Bulgarian–Austrian correlation project and in order to define different Upper Cretaceous boundary events, the Kyunetsa section was described and sampled in detail. It was investigated in a multidisciplinary approach, using several methods, such as macrofossil sampling (inoceramid bivalves and ammonites), calcareous nannofossils, palynology (dinoflagellate cysts and pollen), stable isotope and field magnetic susceptibility data. The present paper reports the obtained new integrated results from the Upper Santonian–Campanian interval in the section with particular reference to the recognition and position of the Santonian–Campanian boundary. Integrated preliminary data include a refined nannofossil biostratigraphy, together with first stable isotope data and a record of the field magnetic susceptibility. These newly reported data increase the significance of this section for global correlations especially to western Tethys sections of Austria, Turkey and Italy.

Geological setting. The most complete and continuous Turonian–Campanian sedimentary sequence of the Melove Tectonic Unit is exposed in the Kyunetsa section situated 2.5 km northwest of the village of Kosharevo [3]. The scientific potential of these spectacular sedimentary strata has been evaluated for the first time by [5]. These authors provided first detailed lithological descriptions of the exposed succession and, based mainly on foraminiferal data, outlined the stratigraphic frame of the section. Later [4,6] proposed the first formal lithostratigraphical scheme for the volcano-sedimentary sequences in the Western Srednogorie Zone, including the sediments exposed in the Kyunetsa section and [4] outlined in general the age assessment of the main lithological units. The authors [4] reported the occurrence of *Broinsonia parca* in the uppermost parts of the Melove Formation and the presence of the eponymous zone in the Kosharevo Formation. Recently [7] have provided first integrated biostratigraphic data, based on inoceramid bivalves, calcareous nannofossils and palynomorphs and have assigned an early Campanian age for the lower part of the Kosharevo Formation, up to bed

11. These data included a well-preserved inoceramid assemblage represented by the lower Campanian *Cordiceramus pseudoregularis* inoceramid species and pollen from the Normapolles group, namely: *Vacuopollis percentus*, *Oculopollis orbicularis*, and *Subtrudopollis* spp. The authors suggested a distal shelf depositional environment and high continental input in the basin during the early Campanian.

The exposed sedimentary record of the Kyunetsa section includes these four formations: the Paramun Formation (middle Turonian), the Izvor Formation (Coniacian), the Melove Formation (Coniacian–lowermost Campanian) and the Kosharevo Formation (lower Campanian) (Fig. 1). The base of the section is represented by middle Turonian coarse terrigenous sediments, i.e. pebble-sized conglomerates and sandstones, unconformably overlying Valanginian–Albian gray marls. A distinguishable sandy limestone level with abundant specimens of *Exogyra columba* is clearly visible in the uppermost part of this clastic sedimentation interval within the range of the Paramun Formation (middle Turonian). Above the Paramun Formation, a 5 m thick red marlstone part of the Izvor Formation (Coniacian) is observed. Upwards, almost the entire section is represented by the thin-bedded, white (in the uppermost part red and pink) limestones with only rare thin-bedded, fine-grained sandstone and marlstone beds of the Melove Formation (Coniacian–lowermost Campanian). The succession is continued by the sediments of the Kosharevo Formation (lower Campanian), composed mainly of variegated marlstones and limestone/marlstone alternation with single coarse-grained sandstone beds.

In this study, detailed sampling has enabled the identification of the location of the Santonian–Campanian boundary (SCB) interval in the section at the uppermost part of the Melove Formation. A more detailed subdivision of this interval represented by bed 7 is proposed as follows (from base to top): 7a – alternation of pink to red, white limestones, sandy limestones and pink and white marlstones; 7b – alternation of pink to red thin-bedded limestones and marlstones; 7c – thin-bedded, white limestones; 7d – alternation of pink to red thin-bedded limestones and marlstones (Fig. 2). Within the Kyunetsa section, bed 7a marks also the start of CORB (Cretaceous Oceanic Red Beds, e.g. [8]) with their characteristic red-coloured pelagic deposits.

Results. Nannofossil data and age assessment. Calcareous nannofossils, although preserved only moderately to poorly, and not abundant in the sediments, provide a primary marker for the base of the Campanian in the section at sample 7.7, with the first occurrence of *Broinsonia parca parca* (*Aspidolithus parcus parcus*, see [9]). There are no other markers present that may indicate the Santonian–Campanian boundary interval, except curved morphotypes of *Lucianorhodus cayeuxii* and very rare *Arkhangelskiella cymbiformis* which indicate a late Santonian age [10,11]. Thus, beds 7a and 7b range into nannofossil standard zone UC13, and beds 7c and 7d into UC14a according to the zonation of [11]. Higher up in the section, at bed 10, *Broinsonia parca constricta* has its first

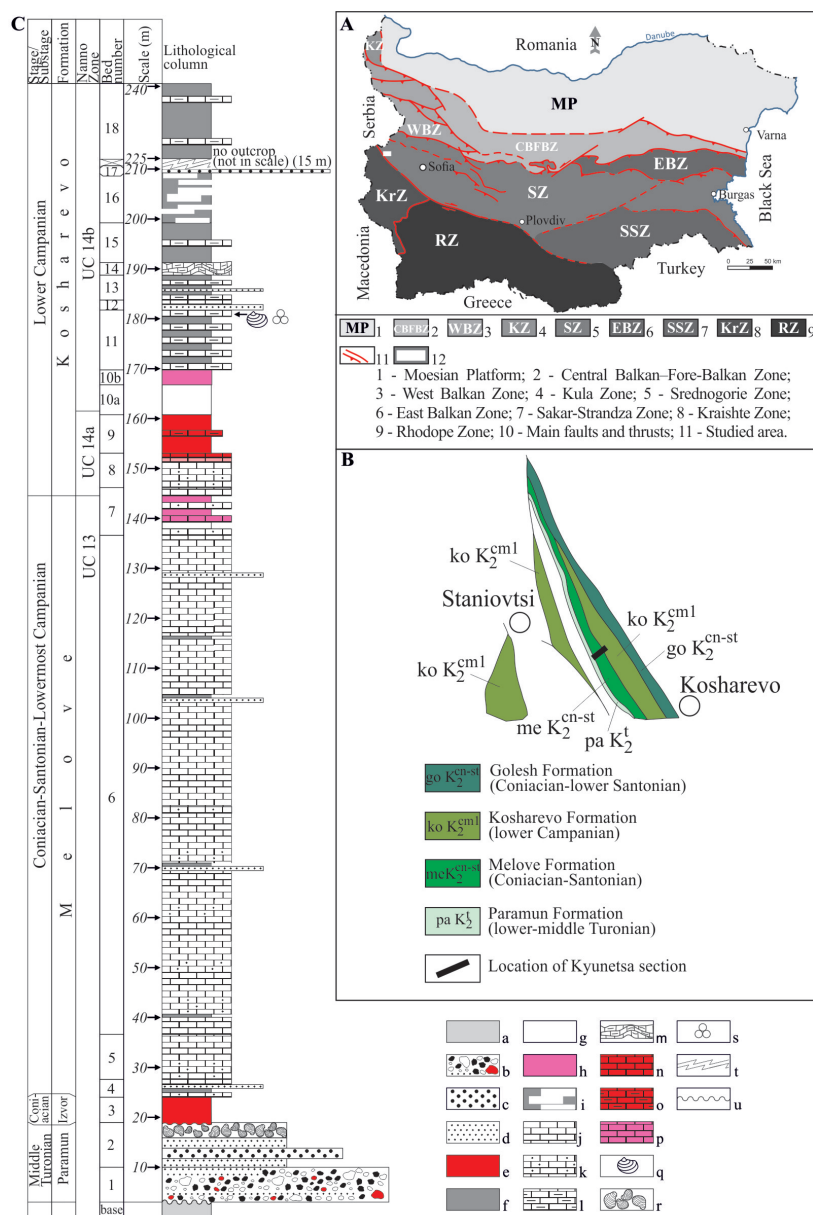


Fig. 1. Location map. A. Tectonic sketch map of Bulgaria [3] with position of the studied area; B. Melove Tectonic Unit – part of the Western Srednogorie Zone [4]; C. Lithological column of the Kyunetsa section. a – Valanginian grey marls (base); b – quartz-grained, gravel to pebble sized conglomerate, composed of white, black and red clasts. Medium bedded, coarse-grained sandstones are observed; c – gravel-size conglomerate; d – medium- to thin-bedded sandstones; e – red marls; f – grey marls; g – white marls; h – pink marls; i – slightly exposed marls; j – white thin-bedded limestones; k – sandy, thin-bedded limestones; l – clayey, thin-bedded limestones; m – deformed, thin-bedded, clayey limestones; n – red, thin-bedded limestones; o – red, thin-bedded clayey limestones; p – pink limestones; q – position of the collected inoceramid bivalves; r – layers of abundant *Exogyra* specimens; s – pollen; t – non scale interval; u – unconformity

(local) occurrence, marking nannofossil subzone UC14b of the Tethyan province.

The following *Broinsonia* species and subspecies (see [9] and [12]) have been recognized in the section: *Broinsonia enormis* (coccolith length usually 6.5–8 μm), *Broinsonia parca expansa*, with a length above 8 μm and a width of the central area around 3–4 μm), *Broinsonia parca parca*, (length above 9 μm , width of the central area around 2–3 μm , FO in sample Ku7.7), *Broinsonia parca constricta*, (length above 9 μm , width of the central area lower than width of the margin, FO in sample Ku10.1) (Fig. 2, 3).

Carbon isotope data. The pilot study using 5 test samples for whole rock carbonate carbon isotopes from bed 7 resulted in $\delta^{13}\text{C}$ values between 2.40 and 2.58‰, largely similar to values from other pelagic western Tethys sites like Bottaccione [13,14] and Postalm [12]. Although the number of samples was low, a single positive peak of 2.58‰ can be recognized slightly below the FO of *B. parca parca*, which is discussed further below (Fig. 2).

Field magnetic susceptibility. Test field measurements of magnetic susceptibility resulted in a rather wiggly curve that peaks in bed 7, slightly above the proposed base of the Campanian, the FO of *Broinsonia parca parca*. However, some uncertainties arise due to the nature of the outcrop with covered intervals of up to 100 cm, and the lithology, which provided not continuously flat sediment surfaces, thus giving rise to relatively large errors in measurements of magnetic susceptibilities (Fig. 2).

Discussion. The proposed GSSP candidate for the base of the Campanian, the Bottaccione section near Gubbio, Umbria, Italy, provides a similar pelagic limestone to marly limestone section compared to Kyunetsa. The proposed boundary relies on the primary marker using the base of the inverse magnetochron C33r above the Long Cretaceous Normal interval (C34n). In the pelagic realm, this primary marker is accompanied by secondary markers like the LO of *Dicarinella asymetrica* (planktonic foraminifera) and *Broinsonia parca parca* (calcareous nannofossil). At Bottaccione, the rare single first occurrence of *B. parca parca* occurs slightly below the base of C33r. The same is true for the Austrian alpine Postalm section where *B. parca parca* occurs rarely at a level slightly above the named reversal [9]. Higher up in both sections, *B. parca parca* becomes more frequent (first common occurrence) and some kind of *Broinsonia* acme can be recognized from bed 10 onwards at Kyunetsa.

The FO of rare *Broinsonia parca parca* allows also correlation to the 150 km distant Petrich section (Central Srednogorie), the northwestern Tethyan Postalm section (Austria) and the Mudurnu–Göynük Basin of northwestern Turkey. All those sections show a gradual increase in the sizes of *Broinsonia* with decreasing central areas, and a very rare FO of *B. parca parca* larger than 9 μm [12,15]. At Postalm, a comparable peak in field magnetic susceptibility is present, and may allow further means of correlations around the Santonian–Campanian boundary [12]. This interval also shows the presence of a minor positive peak in pelagic

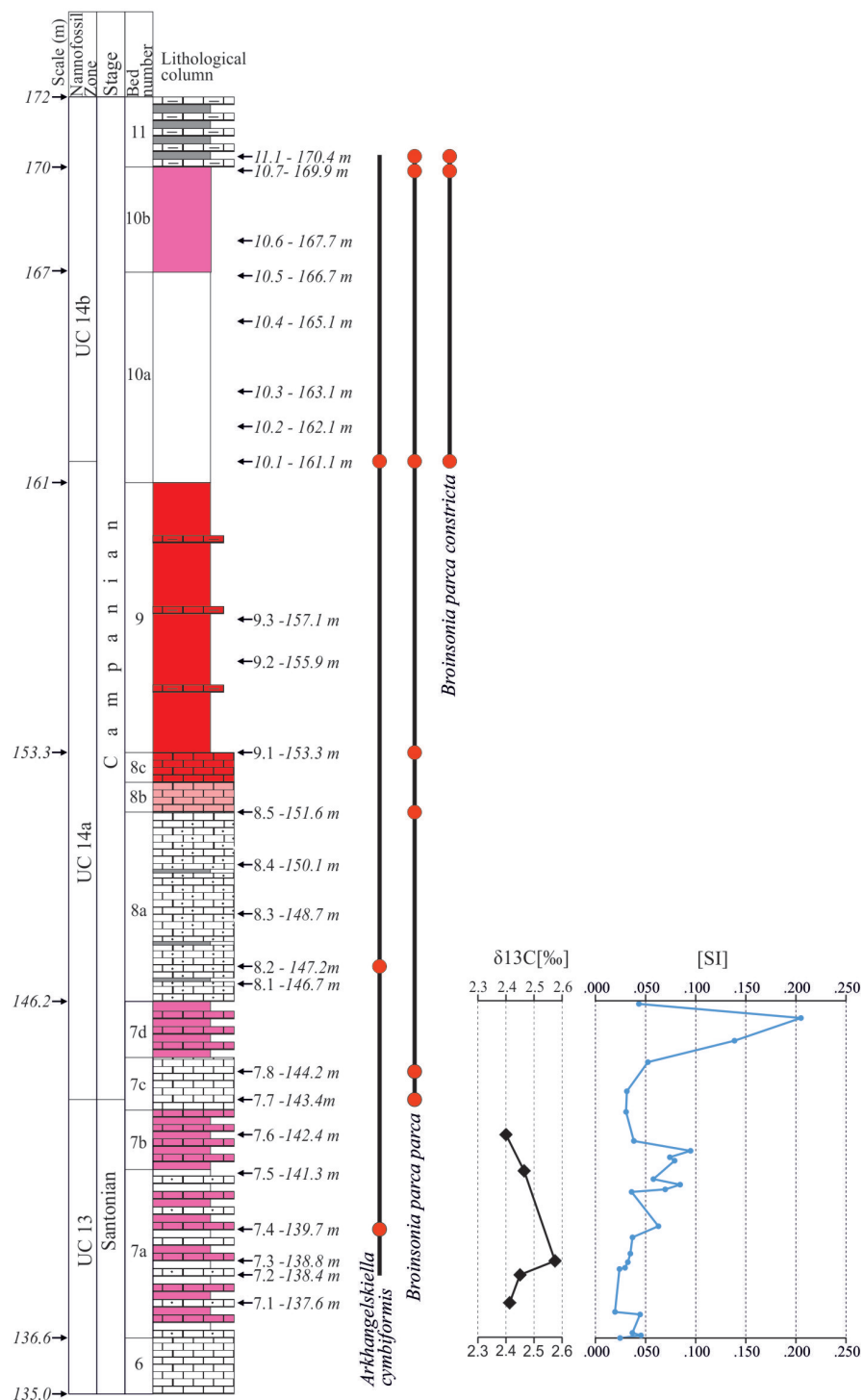


Fig. 2. Detailed lithological column (top of bed 6 to bed 11) with occurrence of main nanofossil marker species, $\delta^{13}\text{C}$ isotope data (‰) and field magnetic susceptibility (SI)

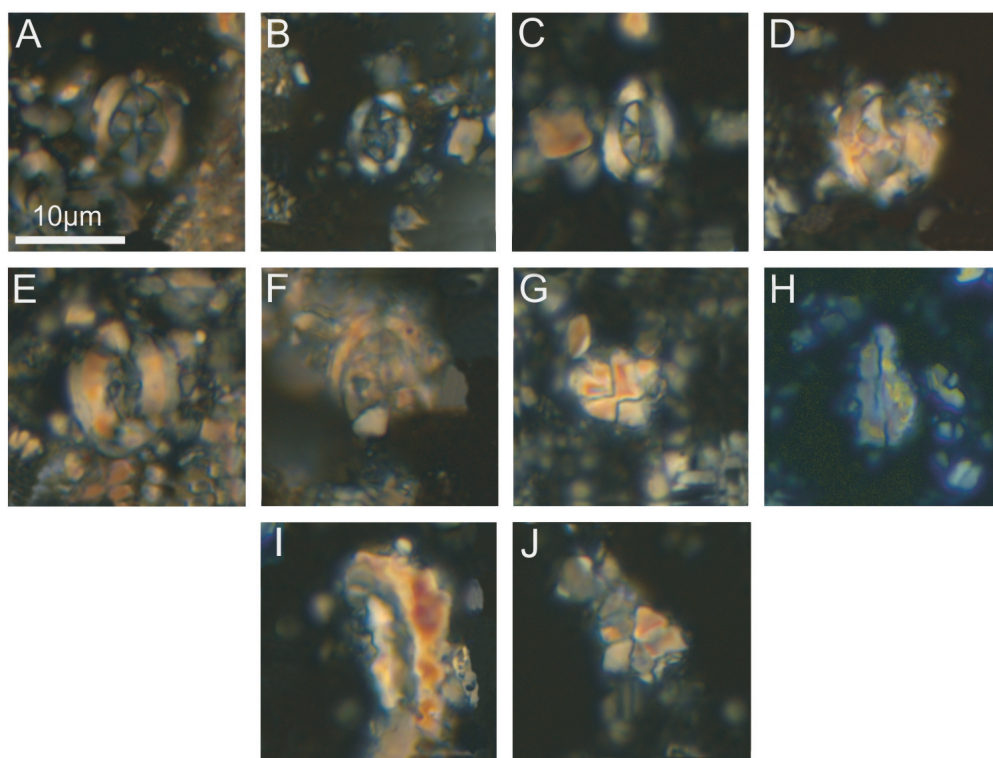


Fig. 3. Nannofossil polarization microscope photographs from the Santonian–Campanian interval of the Kyunetsa section, with *Broinsonia* (*Aspidolithus*) species and subspecies (A–E) and other biostratigraphically distinct taxa (F–J). Nannofossils are poorly preserved, with fragmentation and overgrowth; all with oil immersion, crossed nicols and same scale (scale bar in A is 10 μ m): A – *Broinsonia parca* subsp. *expansa* Wise & Watkins in Wise, 1983, sample KU7.21.8; B – *Broinsonia enormis* (Shumenko, 1968) Manivit, 1971, 7 μ m, sample KU7.4; C – transitional morphotype from *Broinsonia enormis* (Shumenko, 1968) Manivit, 1971, to *Broinsonia parca* subsp. *parca* (Stradner, 1963) Bukry, 1969, 8.8 μ m, sample KU7.8; D – *Broinsonia parca* cf. subsp. *parca* (Stradner, 1963) Bukry, 1969, 10.5 μ m (strongly overgrown, single occurrence as FO), sample KU7.7; E – *Broinsonia parca* subsp. *constricta* Hattner et al., 1980 11.5 μ m, sample KU10.7; F – *Arkhangelskiella cymbiformis* Vekshina, 1959, broken specimen, sample KU7.4; G – *Calculites obscurus* (Deflandre, 1959) Prins & Sissingh in Sissingh, 1977, sample KU7.4; H – *Lucianorhabdus cayeuxii* Deflandre, 1959, sample KU8.5; I – *Lucianorhabdus cayeuxii* Deflandre, 1959, curved morphotype, sample KU7.4; J – *Lithastrinus grillii* Stradner, 1962, sample KU7.8

carbonate carbon isotopes, which may indicate the uppermost Santonian peak below the FO of *B. parca parca*, probably related to the Santonian–Campanian Boundary Event of [16].

Interestingly, the sections from Bulgaria, Austria and Turkey show a sedimentological change from whitish-grey pelagic sediments (marly limestones) to more reddish and/or cyclic red pelagic sediments during the late Santonian, giving way

to a significant interval of CORB sediments in this part of the Tethys, established by oxic to suboxic bottom-water conditions in this part of the ocean [8].

Conclusions. This preliminary study has identified the Santonian–Campanian boundary in the Melove Formation at the pelagic Kyunetsa section in the Western Srednogorie Zone of the Bulgarian intermediate Balkanides by means of calcareous nannofossils, i.e. the first rare occurrence of *Broinsonia parca parca* as a proposed secondary marker for the base of the Campanian. Preliminary carbon isotope data and a significant field magnetic susceptibility peak may allow further correlations around the boundary interval within the Tethyan realm, e.g. Italy, Austria and Turkey. Inoceramids and dinoflagellates occur upwards in the lower Campanian part of the section. Further high-resolution stratigraphic and geochemical data along the section may allow a more precise correlation to the proposed GSSP of the base of the Campanian.

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