

THE UPPERMOST RHAETIAN-LOWER LIASSIC CONTINENTAL TERRIGENOUS SENOKOS FORMATION IN THE YUGOSLAVIAN CARPATHO-BALKANIDES (STARA PLANINA Mts)

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With 2 figures and 1 plate

Abstract: The Senokos Formation, composed of terrigenous sediments deposited in the late Rhaetian and early Liassic, is located in the Visok and Vidlic belts of the Stara Planina Mts in Yugoslavian and Bulgarian Carpatho-Balkanides. The formation is underlain by various Triassic sediments: Lower Rhaetian, Norian, Carnian, Ladinian, Anisian or even Scythian, and overlain by Middle Liassic carbonates: conglomeratic limestones with Lower Pliensbachian brachiopods and bivalves.

Zusammenfassung: Die Senokos-Formation (terrigenes Sedimente des höheren Rhät und tiefen Lias) ist in den Visok- und Vidlic-Ketten des Stara-Planina-Gebirges der jugoslawischen und bulgarischen Carpatho-Balkaniden verbreitet. Die Formation wird von verschiedenen triassischen Sedimenten (Unterrhät, Nor, Karn, Ladin, Anis oder Skyth) unterlagert und durch Mitteltrias-Karbonate (konglomeratische Kalke mit Brachiopoden und Lamellibranchiaten des Unter-Pliensbachien) überlagert.

1. Introduction

A continental terrigenous series in the Yugoslavian and Bulgarian Carpatho-Balkanides (Fig. 1; NACHEV, 1976, Fig. 4), known by various names, is presently described and introduced as Senokos Formation. On the territory of Yugoslavia, it is cropping out in two belts of Stara Planina Mts: Visok belt, 36 km long, and Vidlič belt, about 8 km in length.

The region of Stara Planina Mts is part of the Stara Planina-Poreč unit in the "Balkanikum", according to the geotectonic interpretation by ANDJELKOVIĆ & NIKOLIĆ (1974), or of the Stara Planina-Poreč structural zone of the Carpatho-Balkanides, according to MAKSIMOVIĆ (1974).

2. Previous works

The earliest information about sediments of the Senokos Formation in the Yugoslavian part of Stara Planina Mts is found in ŽUJOVIĆ (1983). He wrote that "sandstone with plant imprints" from Velika Lukanja and "conglomerate and sandstone from Pokrovnik can be taken for Lower Liassic".

In the Senokos locality M. ANDJELKOVIĆ (1957) recognized "Red series which is including marly and sandy shales and bright red marl, lying between Upper Triassic dolomitic limestone and Lower Liassic quartzose sandstone". The same author (1958, 1962, 1978) states that Het-

tangian and Sinemurian rocks of Stara Planina Mts are transgressively overlying the Lower, Middle or Upper Triassic. He divides these Liassic sediments into three parts. The lower part consists of conglomerates with quartz pebbles, gradually changing into quartzose sandstone. The intermediate level consists of fine-grained sandstones, intercalated with shales, coal clay, and marl with coal interbeds. The upper part is built up of red quartzites.

UROŠEVIĆ & J. ANDJELKOVIĆ (1970) divide the Rhaetian of the Stara Planina Mts into the lower part, represented by carbonates with Lower Rhaetian bivalves (*Cardita*, *Myophoria*, *Modiola*, etc.), foraminifers and algae, and the upper part, named by us as the "Red Series" (subdivided into two levels: the lower one composed of marly red limestone, conglomerate, loose argillaceous sediments, interbedded with sandstone including sphaerosiderite concretions; and the upper one of breccia, marly limestones, and siltstones).

In the village Rosomač, UROŠEVIĆ (1969) found ostracodes (*Darwinula* cf. *major* LONES) and plant detritus in siltstone, and at Vrelo locality, plant detritus and fish teeth in marls. Freshwater gastropods and ostracodes, similar to those from Rosomac, are found in bituminous limestones alternating with shales. Transgressively over the "Red Series" lie Liassic sediments.

Bulgarian authors also wrote about these series: GORANOV (1961) describes Rhaetian red calcareous clay and argillaceous marls from western Bulgaria (Balkan

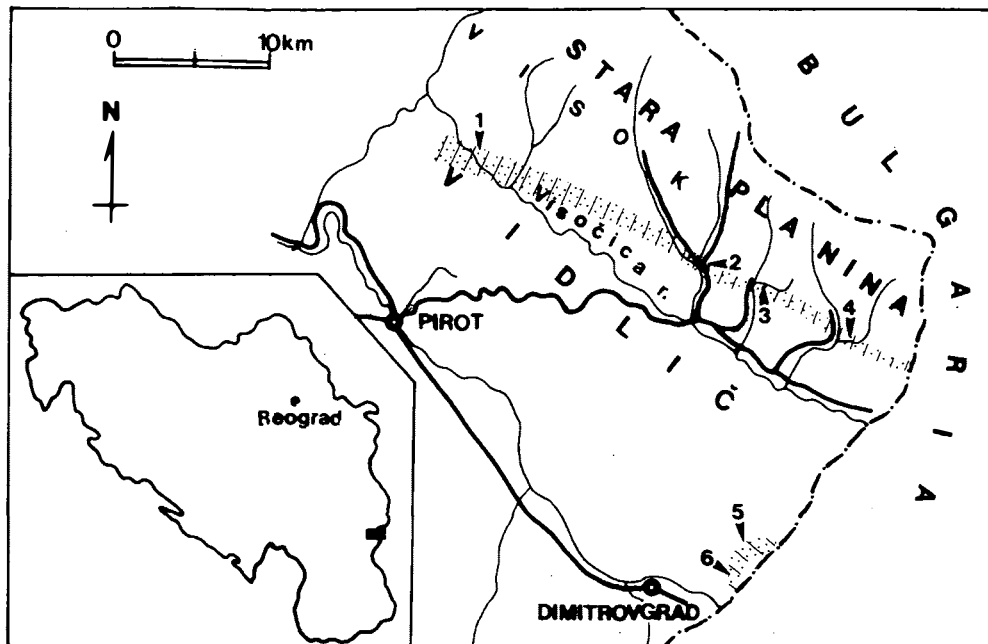


Fig. 1:

Distribution (hatched) and location of the investigated Senokos Formation sections of the Stara Planina Mts in Yugoslavian Carpatho-Balkanides.

Legend: (1) Mala Lukanja; (2) Vrelo; (3) Rosomac; (4) Senokos; (5) Mojinci; (6) Brebevnica.

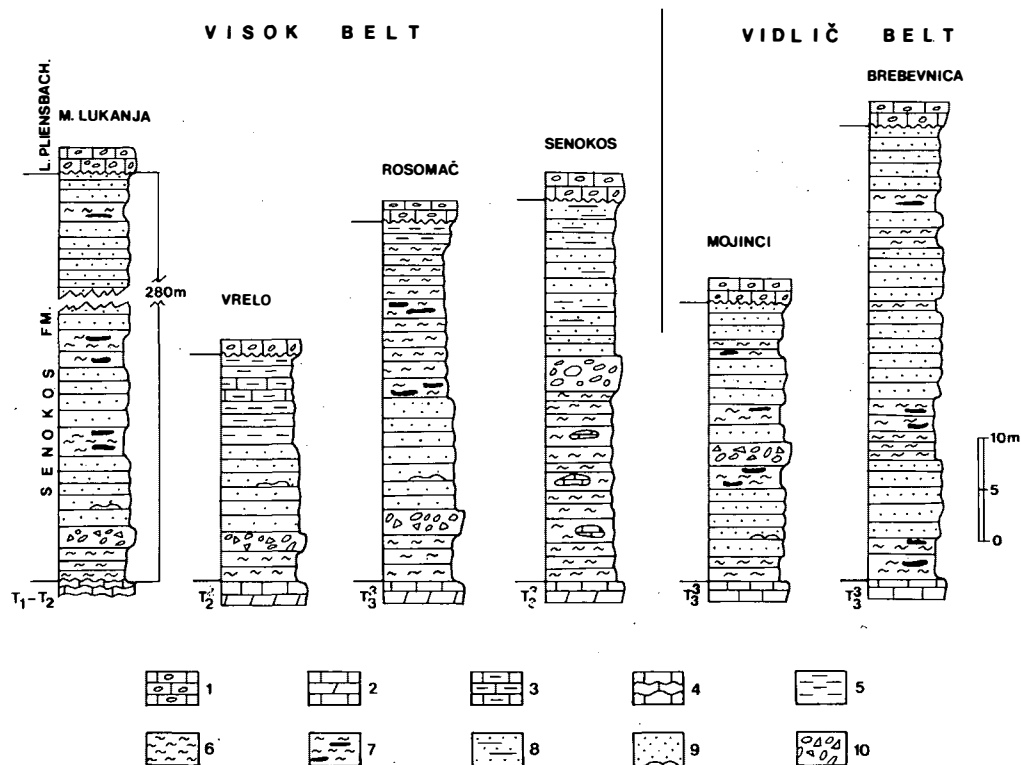


Fig. 2: Stratigraphic columns of the Senokos Formation in the Visok and Vidlic belts.

Legend: (1) Bioturbated Lower-Middle Triassic limestone; (2) Triassic limestone and/or dolomitic limestone; (3) Clay, clay-shale, clay sandstone; (4) Black clay and clay-shale with coal; (5) Quartzose sandstone, laminated sandstone and siltstone (a), and quartzose conglomerate (b); (6) Quartzose sandstone with sphaerosiderite, and limonitecrusts; (7) Marl; (8) Marly limestone; (9) Breccia; (10) Pliensbachian conglomeratic limestone.

Range), which he takes to overlies the slightly eroded Norian sediments. Rhaetian sediments are transgressively overlain by Lower or Middle Liassic.

Using ammonites, bivalves, and brachiopods, SAPUNOV, TCHOUMTCHENCO & SHOPOV (1967) give the biostratigraphy of the Lower Jurassic of western Bulgaria. Due to the non-availability of biostratigraphic data, these authors "make the lower boundary of the Hettangian coincident with the lithologic boundary between the Kostina Formation above and the nameless formation of the likely Rhaetian age under it". The same authors state that sandstones, siltstones, and conglomerates of the Kostina Formation lie transgressively over various Triassic sediments. NACHEV (1976) described in detail "The Continental Coal-Bearing Terrigenous Association (CCTA)" which "overlies a diverse basement of Early Palaeozoic to Rhaetian with angular or parallel unconformity. Its age is assumed to be Hettangian". The same sediments are mentioned by NACHEV & YANEV (1980) as "limnic clay-sand geocomplex".

3. Senokos Formation

Name: After the village of Senokos in Yugoslavian part of Stara Planina Mts.

Synonyms: "Sandstone with plant imprints" and "conglomerate and sandstone" - ŽUJOVIĆ (1983).

"Red Series and quartzose sandstone of the Lower Liassic" - M. ANDJELKOVIĆ (1957).

"Hettangian and Sinemurian rocks" - M. ANDJELKOVIĆ (1958, 1962, 1978).

"Red calcareous clay and argillaceous marls" (correspond to the lower part of the Senokos Formation) - GORANOV (1961).

? "Nameless Formation" and "Kostina Formation" - SAPUNOV, TCHOUMATCHENKO & SHOPOV (1967).

"The Continental Coal-Bearing Terrigenous Association" - NACHEV (1976).

"The limnic clay-sand geocomplex" - NACHEV & YANEV (1980).

Type section: A section near the village of Senokos, from the Karibanjska Reka to the village itself.

Boundaries: Triassic rocks of different age underlie the Senokos Formation (in Bulgaria, the Paleozoic also) with angular or parallel unconformity: (1) Campilian bioturbated sediments with *Costatoria costata* Zenker (Mala Likanja), (2) anisian limestones with *Lopha decemcostata* (GOLDFUSS) (Velika Likanja), (3) Ladinian rocks with *Diplopora annulatissima* PIA (Vrelo), (4) Canian sediments with *Paragondolella polygnathiformis* (BUDUROV & STEFANOV) and *Chlamys obliqua* (MÜNSTER) (Brebevnica), (5) Norian limestone with *Aulotor-*

tus pokorny SALAJ and *Coenothyris radulovici* (UROŠEVIĆ) and (6) Lower Rhaetian dolomitic limestone with *Cardita austriaca* HAUER, *Cardita cloacina* (QUENSTEDT), *Modiola minuta* GOLDFUSS, and *Involutina* (Senokos and Rosomač).

Senokos Formation is transgressively overlain by limestones including quartz grains and pebbles and Lower Pliensbachian fauna: *Pseudopecten* (*Ps.*) *equivalvi* J. SOWERBY, *Lobothyris subpunctata* (DAVIDSON), *Callospiriferina tumida* (v. BUCH), etc.

In Bulgaria are "The Transgressive Terrigenous Carbonate Association" of NACHEV (1976) is an equivalent of these sediments, with the lowermost *angulata*-zone sediments, suggesting a diachronous marine transgression (Hettangian in the Bulgarian, Pliensbachian in the Yugoslavian part of the belt, that means the age of the transgression in the central area is Hettangian, while on the periphery it is Pliensbachian).

Lithology and genesis: Dominant rocks in the Senokos Formation are white, yellow to reddish quartzose sandstones, varying in grain size from fine to conglomeratic. Other constituents are clay, fire proof kaolin clays, clay-shales, clay sandstone (mainly in the lower part), marls and marly limestones with ostracodes, freshwater gastropods, plant detritus, fish teeth and scales. Banks of breccia are present in some sections. Limonite crusts and large nodules (concretions) of sphaerosiderite occur almost throughout the formation. The formation includes coal and black shale coloured by coaly matter.

The Senokos Formation has a thickness ranging from 30 to 350 m. The lithology of the Formation varies largely from section to section, it changes laterally according to the paleogeographic position of the Formation. Clayey sediments dominate in the central part of the area of deposition.

NACHEV (1976: 24-31) gave a detailed presentation of petrological, sedimentological, and in respect of the economic importance of the series, especially geochemical characteristics of the Formation. He wrote that it included alluvial, lacustrine, and marsh facies "originated in a continental flat with rivers, lakes and marshes in humid climate". Alluvial sediments are dominantly coarse-grained and poorly sorted, cross-laminated; cycles up to 15 metres occur in some outcrops.

The main early Kimmerian events (block faulting) in the Stara Planina Mts belt occurred after the Lower Rhaetian. Erosional processes in the uplifted blocks reached various Triassic levels (in Bulgaria even the Paleozoic). A new sedimentation cycle probably began in the late Upper Rhaetian: fluvio-lacustrine sediments were deposited in the Upper Hettangian or Sinemurian.

Age: In the Yugoslavian territory the Senokos Formation lies over Lower Rhaetian marine sediments and under Lower Pliensbachian marine conglomeratic limestones, suggesting deposition during the uppermost Rhaetian, Hettangian and Sinemurian. With respect to the general area of the belt, the boundaries of the formation are diachronous.

4. Senokos Section

Rocks underlying the Senokos Formation are sandy and dolomitic limestones with *Cardita austriaca* (HAUER), *C. cloacina* (Quenstedt), *C. cf. munita* STOPPANI, *Myophoria inflata* EMMRICHE, *Modiola minuta* GOLDFUSS, and *Parallelodon azzorale* (STOPPANI) (Pl. 1, figs. 1-7).

The formation begins with clay, clay-shale, clayey sandstone including three layers of quartzose sandstone. In the middle part occur medium to coarse-grained quartzose sandstone beds including sphaerosiderite concretions. The uppermost part of the formation consists of white laminated quartzose sandstone.

Over the formation lie Lower Pliensbachian sediments with: *Entolium (E.) corneolum* (YOUNG & BIRD), *Pseudopecten (Ps.) equivalvis* (J. SOWERBY), *Pectenidae* (n. gen. ?), *Modiolus thiollerei* (DUMORTIER), *Pholadomya cf. ventricosa* (AGASSIZ), *Pleuromya striatula* AGASSIZ, *Lobothyris subpunctata* (DAVIDSON), *Mediterranirhynchia dubia* Sučić-Protić, *Keratothyris moorei* (DAVIDSON), and *Callospiriferina tumida* (v. BUCH) (Pl. 1, Figs. 8-18). The succession continues upwards with sandy limestones and marly sandstones abounding with brachiopods (SUČIĆ-PROTIĆ, 1969, 1971, 1985) and bivalves (RADULOVIĆ, 1982) of the *armatus*- and *jamesoni*-zone.

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Explanation of plate

Plate 1

Figs 1–7: Lower Rhaetian

Fig. 1: *Cardita austriaca* (HAUER), x 1.5.

Fig. 2: *Cardita cf. munita* STOPPANI, x 1.5.

Figs 3–4: *Cardita cloacina* (QUENSTEDT), x 1.

Fig. 5: *Myophoria inflata* (EMMRICHE), x 1.5.

Figs 6–7: *Paralledon azzorale* (STOPPANI), x 1.

Figs 8–18: Lower Pliensbachian

Fig. 8: *Pectenidae* (n. gen. ?), x 1.

Fig. 9: *ntolium* (E.) *corneolum* (YOUNG & BIRD), x 1.

Figs 10–11: *Modiolus thiollerei* (DUMORTIER), x 1.

Fig. 12: *Pseudopecten* (Ps.) *equivalvis* (J.SOWERBY), x 1.

Fig. 13: *Pleuromya straitula* AGASSIZ, x 1.

Figs 14–15: *Lobothyris subpunctata* (DAVIDSON), x 1.

Fig. 16: *Keratothyris moorei* (DAVIDSON), x 1.

Fig. 17: *Callospiriferina tumida* (v. BUCH), x 1.5.

Fig. 18: *Mediterranirhynchia dubia* SUČIĆ-PROTIĆ, x 1.5.

All specimens are from Senokos locality, Stara Planina Mts, Yugoslavian Carpatho-Balkanides, and coated with ammonium chloride.

(Photos by V. Radulović)

Plate 1

