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DEPOSITIONAL ENVIRONMENTS, FACIES AND DIAGENESIS OF THE UPPER JURASSIC–LOWER CRETACEOUS CARBONATE DEPOSITS OF THE BUILA-VÂNTURARIȚA MASSIF, SOUTHERN CARPATHIANS (ROMANIA)

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Abstract: The Buila-Vânturarița Massif consists of massive Upper Jurassic reef limestones (Kimmeridgian–Tithonian) and Lower Cretaceous (Berriasian–Valanginian, and Barremian–?Lower Aptian) deposits. Besides corals and stromatoporoids, a wide range of micro-encrusters and microbialites has contributed to their development. In this study, the authors describe briefly and interpret the main facies associations and present the microfossil assemblages that are important for age determination. The distribution of facies associations, corroborated with the micropalaeontological content and early diagenetic features, indicate different depositional environments. The carbonate successions show the evolution of the Late Jurassic–Early Cretaceous depositional environments from slope and reef-front to internal-platform sedimentary settings, including peritidal environments in the lowermost Cretaceous. Early diagenesis, represented by synsedimentary cementation in the form of micritization (including cement crusts in the reef microframework), followed by dissolution, cementation and dolomitization in a meteoric regime, and void-filling late cementation during the burial stage.

Key words: Carbonate platforms, reefs, microfacies, micro-encrusters, carbonate diagenesis, Upper Jurassic, lowermost Cretaceous, Southern Carpathians, Romania.

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INTRODUCTION

The Buila-Vânturarița Massif, located in the central-northern part of Vâlcea County, Romania, is part of the Căpățânii Mountains, central Southern Carpathians (Fig. 1). Its lithology, geological history and geomorphology are unique by comparison with the features of the main mountain chain in the Capățânii Mountains. The Buila-Vânturarița Massif consists of a 12-km-long and 0.5- to 2-km-wide, linear, calcareous crest, mainly built of Jurassic limestones. It is a fragment of the carbonate sedimentary system, known as the Getic Carbonate Platform (Săndulescu, 1984), which covered the Getic-Supragetic domain during the Late Jurassic–Early Cretaceous. The outline and NNE–SSW orientation of the morphology of the main Buila-Vânturarița crest are similar to those of the Piatra Craiului Massif, another part of the Getic Carbonate Platform, located more to the east. The studied massif is dominated by Kimmeridgian–Tithonian reef limestones. Synchronous limestones of other areas in the Tethys realm are known as "Štramberk"-type limestones in the Carpathians (see Uță and Bucur, 2003; Şerban *et al.*, 2004; Bucur and Săsăran, 2005; Săsăran, 2006; Ivanova *et al.*, 2008; Pleş *et al.*, 2013; Săsăran *et al.*, 2014; Kołodziej, 2015a, b and literature therein), and as "Plassen"-type limestones in the Alps (e.g., Schlagintweit and Gawlick, 2008; Schlagintweit *et al.*, 2005). The term "Štramberk"-type limestones was even recently applied to limestones in Turkey (Masse *et al.*, 2015). In many occurrences, as is also the case with the Buila-Vânturarița Massif, the reef limestones are conformably overlain by lowermost Cretaceous (Berriasian–Valanginian) stratified limestones, followed by transgressive Urgonian limestones, Barremian–Lower Aptian in age (Dragastan, 2010; Pleş *et al.*, 2013; Mircescu *et al.*, 2014; Pleş and Schlagintweit, 2014). The aim of this paper is the identification and interpretation of the main microfacies types, micropalaeontological assemblages and diagenetic processes that affected these limestones, in order to reconstruct their depositional environments.

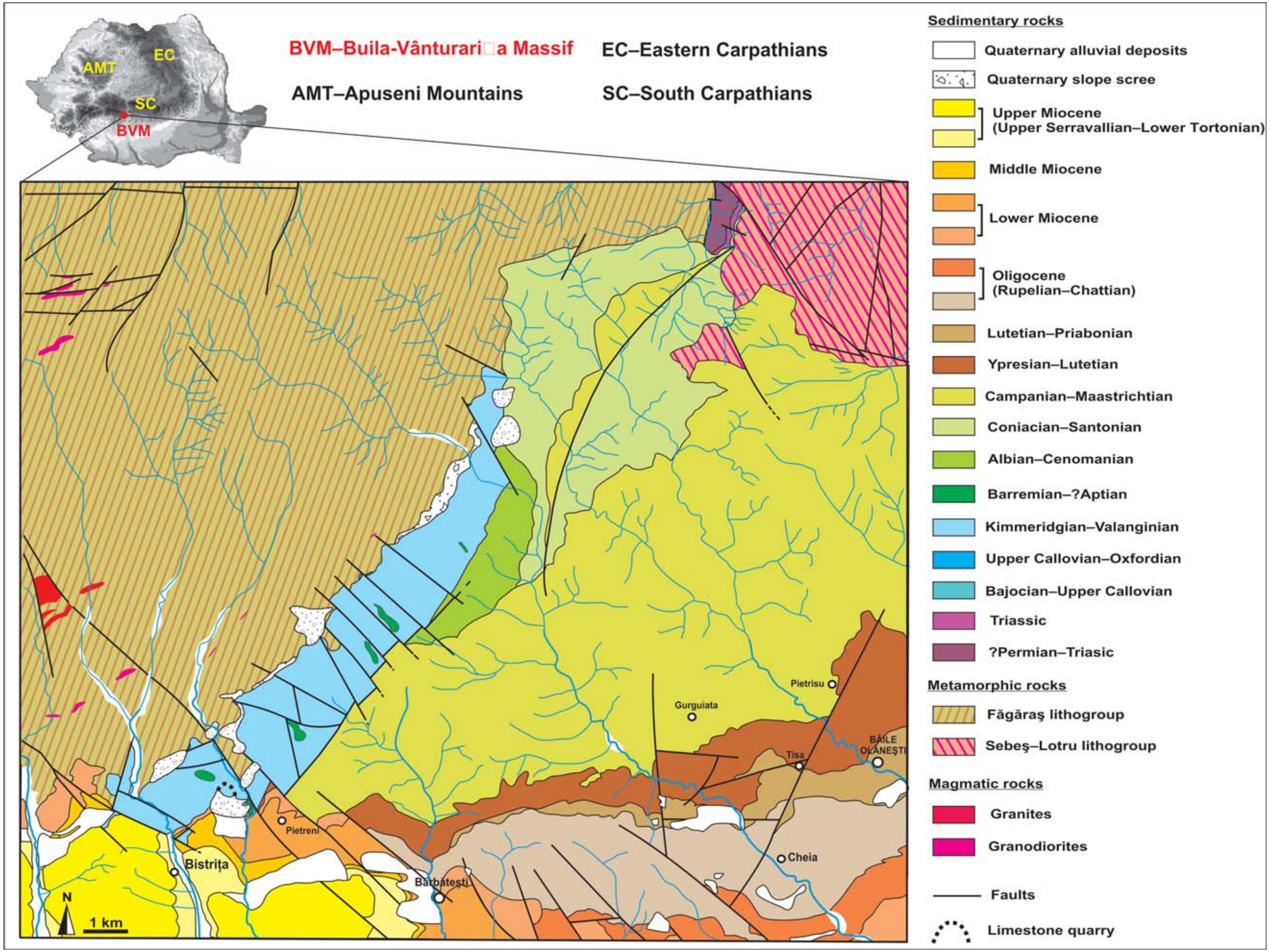


Fig. 1. Geological map of the Buila-Vânturariţa Massif (modified after Lupu *et al.*, 1978).

GEOLOGICAL SETTING

The Buila-Vânturarița Massif is part of the former Getic Nappe, a structural unit within the Median Dacides, in the Southern Carpathians (Săndulescu, 1984). In this massif, post-Triassic sedimentary deposits are mainly represented by Middle Jurassic–Oxfordian detrital and siliciclastic rocks, overlain by Kimmeridgian–lowermost Cretaceous reef limestones (Fig. 1). Boldur *et al.* (1968) identified Bajocian deposits in the south-eastern area. The Bajocian age is supported by the assemblages of ostreids, Phylloceratidae ammonites, and bivalve species of *Entolium* Meek, 1865 and *Camptochlamys* Arkell, 1930 (Dragastan, 2010). Bathonian deposits are present in smaller areas in the Buila-Vânturarița Massif and are often associated with Lower Callovian ones. Boldur *et al.* (1968) identified specimens of *Oecotraustes* sp. in a horizon of calcareous sandstones in the Bistrița Valley, indicating the presence of Bathonian–Callovian rocks within the succession. Boldur *et al.* (1968, 1970) identified Callovian deposits in the central-western part of the massif, in the Bistrița and Costești valleys, as well as south of Stogu Peak. These authors have described the following lithological succession for the Bathonian–Callovian: micaceous calcareous sandstones with *Oecotraustes* (Upper Bathonian–Lower Callovian); reddish and yellowish micaceous calcareous sandstones with *Grossouvria curvicosta* (Oppel, 1857) and *G. subtilis* (Neumayr, 1871), and sandy limestones with *Bositra buchi* (Roemer, 1836) and *Phylloceras* sp. (Middle–Upper Callovian). Sediments assigned to the Oxfordian occur across relatively larger areas compared to the Middle Jurassic equivalents. They were grouped into the Buila and Bistrița members (Dragastan, 2010), two lithological units that are difficult to discriminate in outcrop. From the first studies concerning the Jurassic deposits in this massif, it was assumed that Oxfordian deposits were present at the base of the reef limestones, as limestones with siliceous nodules. Boldur *et al.* (1968) assigned the succession of red, marly limestones and pink limestones with layers of reddish jasper to the Oxfordian. Nevertheless, the associations described in these deposits by Dragastan (2010) show a wider stratigraphic distribution, including the Kimmeridgian–Tithonian interval. As a consequence, the presence of the Oxfordian in the white limestones succession is still unconfirmed. The Kimmeridgian–Tithonian deposits, consisting of massive reef limestones with thicknesses sometimes exceeding 300 m, dominate the calcareous succession of the Buila-Vânturarița Massif, making up the main crest. They contain a rich micropalaeontological fossil suite. Pleş *et al.* (2013) identified the following main species of micro-organisms in microbial crusts and encrusting microbial organisms: *Crescentiella morronensis* Crescenti, 1969, *Radiomura cautica* Senowbari-Daryan et Schäfer, 1979, *Koskinobullina socialis* Cherchi et Schroeder, 1979, *Iberopora bodeuri* Granier et Berthou, 2002, *Bacinella*-type structures and/or *Lithocodium aggregatum* Elliott, 1956. The microbial structures and the encrusting organisms were essential for the development of these bioconstructions. Pleş *et al.* (2013) defined the latter as “coral-microbial-microencruster boundstones”. They are similar to the Upper Jurassic–lowermost Cretaceous carbonate deposits of other regions in the intra-Tethys domain. In this region, lowermost Cretaceous (Berriasian–Valanginian) sediments cover small areas; they are overlain transgressively by Urgonian limestones (Dragastan, 1980; Uță and Bucur, 2003). Dragastan (1980, 2010) identified the following micro-organisms as characterizing the Berriasian–Valanginian interval: foraminifera [*Mohlerina basiliensis* (Mohler, 1938), *Andersenolina elongata* (Leupold, 1935), *A. alpina* (Leupold, 1935), *A. delphinensis* (Arnaud-Vanneau, Boisseau et Darsac, 1988), *Mayncina bulgarica* ng1033 Laug, Peybernes et Rey, 1980, and *Kaminskia acuta* Neagu, 1999], calcareous algae [*Salpingoporella annulata* Carozzi, 1953, *Rajkaella iailensis* (Maslov, 1965), *Macroporella praturloni* Dragastan, 1978, *Actinoporella podolica* (Alth, 1878), *Felixporidium atanasiui* Dragastan, 1999, *Fagetiella angulata* Dragastan, 1988] and micro-encrusting organisms. Dragastan (2010) considered that Hauterivian deposits also should be present within the Lower Cretaceous deposits of the Buila-Vânturarița Massif. In the opinion of the present authors, the foraminiferal assemblage including *Haplophragmoides joukowskyi* Charollais, Bronnimann et Zaninetti, 1966, *Neotrocholina* sp., *Patellina turriculata* Dieni et Massari, 1966, *Andersenolina histeri* Neagu, 1994 and *Kaminskia exigua* Neagu, 1999 cannot be considered to be typical for the Hauterivian thus, its presence in the succession leaves questions about the correctness of the stratigraphy. Uță and Bucur (2003) confirmed the presence of Barremian–?Lower Aptian in the area, based on the occurrence of the species *Vercorsella hensoni* (Dalbiez, 1958), *Vercorsella camposaurii* (Sartoni et Crescenti, 1962), *Charentia* sp., *Everticycla- mmina* sp. and *Falsolikanella danilovae* Radoičić, 1969. In the north-

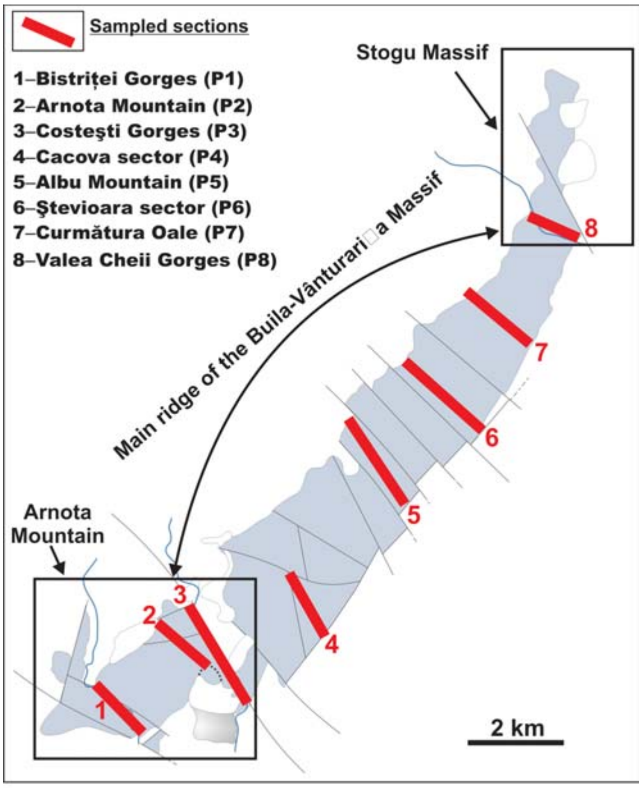


Fig. 2. Location of the sections studied.

eastern part of the massif, Upper Cretaceous deposits lie transgressively and unconformably on top of the Upper Jurassic–Lower Cretaceous limestones (Todiriță- Mihăilescu, 1973). Within these deposits, Boldur *et al.* (1970) recognized three individual sedimentary complexes: Vraconian–Cenomanian–Turonian, Coniacian–Santonian, and Campanian–Maastrichtian. Mesozoic deposits are covered by transgressive Eocene sedimentary rocks (Popescu, 1954).

MATERIAL AND METHODS

The authors collected 1,250 samples from profiles in eight different areas in the Buila-Vânturarița Massif: P1 – Bistrița Gorges; P2 – Arnota Mountain; P3 – Costeşti Gorges; P4 – Cacova sector; P5 – Albu Mountain; P6 – Ştevioara sector; P7 – Curmătura Oale, and P8 – Cheii Gorges (Fig. 2). The sampling procedure was established on the basis of local features in each of the profiles/transects. In most cases, the profiles run along valley bottoms, where the carbonate deposits are well-exposed. From these samples, the authors prepared 1,270 thin sections for petrographic analysis and the study of microfacies and diagenetic processes.

AGE CONSTRAINTS

Reef-type deposits were found in all eight profiles, making up the most significant calcareous succession in the Buila-Vânturarița Massif. The most important microfossils for biostratigraphy (Table 1) led the authors to assign a Kimmeridgian–Tithonian age to the sequence, on the basis of the association of foraminifera and calcareous algae [*Salpingoporella pygmaea* (Gümbel, 1891)*, Clypeina sulcata* (Alth, 1881)*, Nipponophycus ramosus* Yabe et Toyama, 1928, *Coscinoconus alpinus* Leupold, 1935, *Mohlerina basiliensis*] that are typical for Upper Jurassic carbonate-platform facies in many European regions (Dragastan, 1975; Bucur, 1978; Kołodziej and Decrouez, 1997; Carras and Georgala, 1998; Krajewski, 2000; Uță and Bucur, 2003; Olivier *et al.*, 2004; Bucur and Săsăran, 2005; Săsăran, 2006; Catincuț *et al.*, 2010; Ivanova and Kołodziej, 2010; Rusciadelli *et al.*, 2011; Turi *et al.*, 2011; Pleş *et al.*, 2013; Pleş and Schlagintweit, 2014).

The carbonate deposits overlying the reef limestones include a micropalaeontological association composed of *Coscinoconus delphinensis* (Arnaud-Vanneau, Boisseau et Darsac, 1988), *Montsalevia salevensis* (Charrolais, Brönnimann et Zaninetti, 1987), *Protopeneroplis ultragranulata* (Gorbatchik, 1971), *Charentia evoluta* (Gorbatchik, 1968) and *Bacinella*-type structures. To these, Dragastan (1980) added *Salpingoporella annulata, Rajkaella iailensis, Macroporella praturloni*, and *Actinoporella podolica*. The entire micropalaeontological association is typical for lowermost Cretaceous (Berriasian–Valanginian) rocks, as it also has been recognised in other areas within the facies types assigned to this stratigraphic interval, for example, in the Romanian Carpathians, the Hațeg-Pui and Braşov-Dâmbovicioara-Piatra Craiului areas, and in other areas of the Tethyan domain by Bucur (1993), Chiocchini *et al.* (1994), Bucur *et al.* (1995), Bulot *et al.* (1997), Kołodziej and Decrouez (1997); Ivanova (1999), Moshammer and Schlagintweit (1999), Schlagintweit and Ebli (1999), Schroeder *et al.* (2000), Pop and Bucur (2001), Radoičić (2005), Dragastan (2010), Bucur *et al.* (2014a, b, c) and Mircescu *et al.* (2014).

In some areas within the Buila-Vânturarița Massif (Arnota Mountain, Costesti Gorges, Cacova Mountain, Albu Mountain, Ştevioara sector and Curmătura Oale) the authors identified limestones that transgressively overlie the Upper Jurassic–lowermost Cretaceous. In such deposits the authors have identified specimens of *Paracoskinolina*? *jourdanensis* Foury et Moullade, 1966 and *Vercorsella camposaurii*. Dragastan (1980), and Uță and Bucur (2003) also found *Vercorsella hensoni*, *Paracoskinolina* sp., *Everticyclammina* sp., *Salpingoporella muehlbergii* (Lorenz, 1902), *Falsolikanella danilovae*, as well as rudist fragments. On the basis of this association, the deposits on top of the Upper Jurassic–lowermost Cretaceous succession were assigned by Dragastan (1980), and Uță and Bucur (2003) to the Barremian–?Lower Aptian interval. Similar associations were described elsewhere (Bucur *et al.*, 1993; Bodrogi *et al.*, 1994; Turi *et al.*, 2011; Lazăr *et al.*, 2012; Michetiuc *et al.*, 2012; or Bruchental *et al.*, 2014).

FACIES AND MICROFACIES ANALYSIS

The authors identified five major microfacies associations (MFA), three in the Upper Jurassic (MFA1, MFA2, MFA3) and two in the Lower Cretaceous (MFA4 and MFA5) deposits, respectively (Figs 3, 4).

MFA1 – Fine bioclastic grainstone/packstone

This facies was identified on Albu Mountain (P5), in the Ştevioara sector (P6) and in the Curmătura Oale profile (P7). In the Albu Mountain area (P5), MFA1 is represented mostly by fine bioclastic grainstones and packstones with small fragments of echinoids, calcified sponges, foraminifera and *Crescentiella morronensis*. In the Ştevioara sector (P6), such deposits dominate the lower half of the carbonate succession and they are represented by fine-grained, bioclastic limestones with peloids, foraminifera and *Crescentiella morronensis*. In the well-sorted deposits, the authors identified the following microfacies types: fine, bioclastic-peloidal grainstone; bioclastic packstone/grainstone with thin microbial crusts; and bioclastic packstone with small fragments of bioconstructing organisms (sclerosponges or encrusting micro-organisms). The abundance of microbial laminated crusts in these limestones is noteworthy. In the Curmatura Oale profile (P7), the fine-grained microfacies types (MFA1) also occurs in the lower part of the succession, as interlayers within coarser deposits. These limestones have similar characteristics to the ones previously described: well sorted, microbial content, fragments of corals and encrusting micro-organisms. The main MFA1 microfacies types in this profile are represented by fine, bioclastic grainstone with foraminifera, peloids or *Crescentiella*-type structures and bioclastic packstone with fragments of sclerosponges and echinoids.

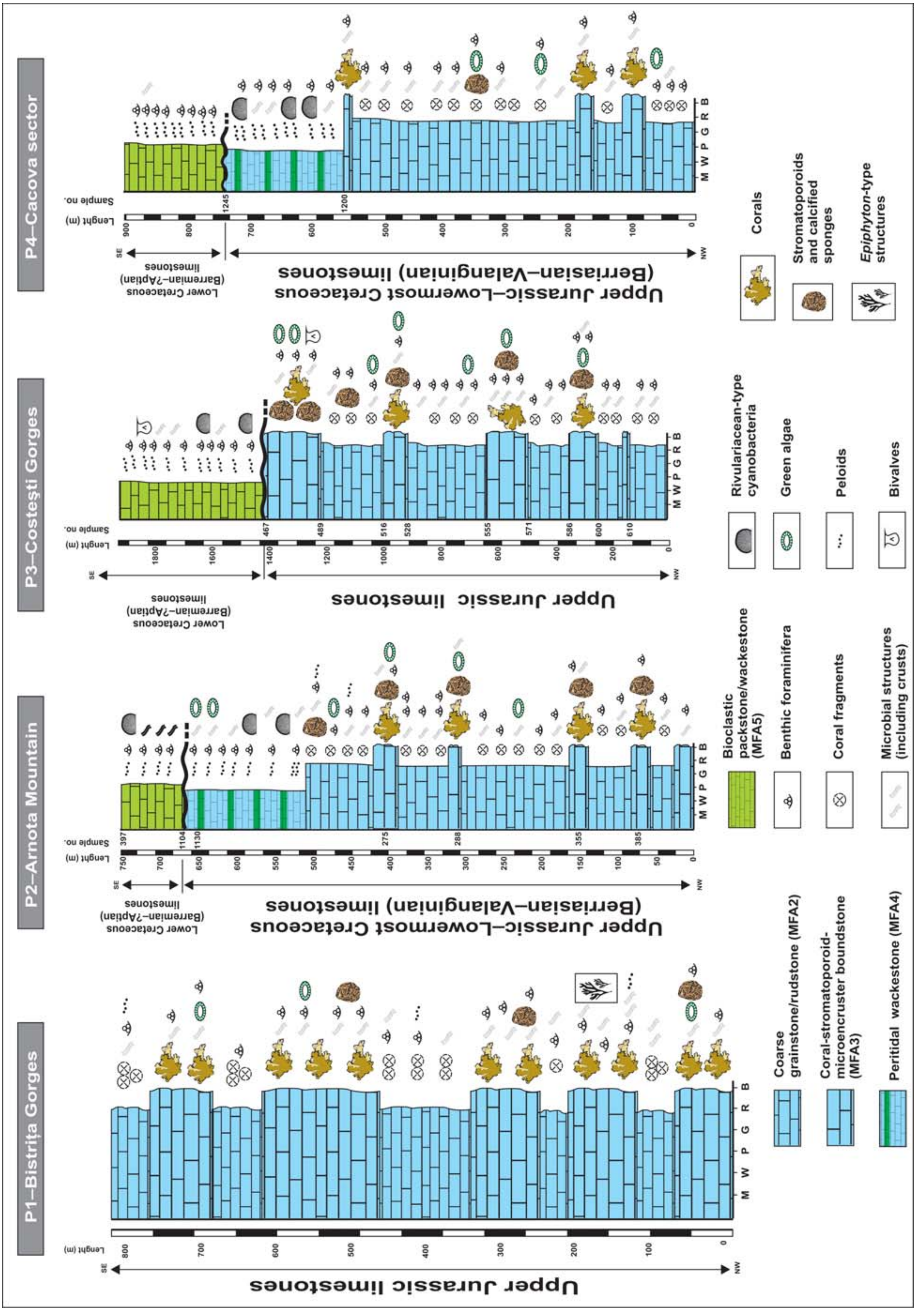


Fig. 3. General succession of the limestone deposits of the Buila-Vânturarița Massif (sections P1 to P4).

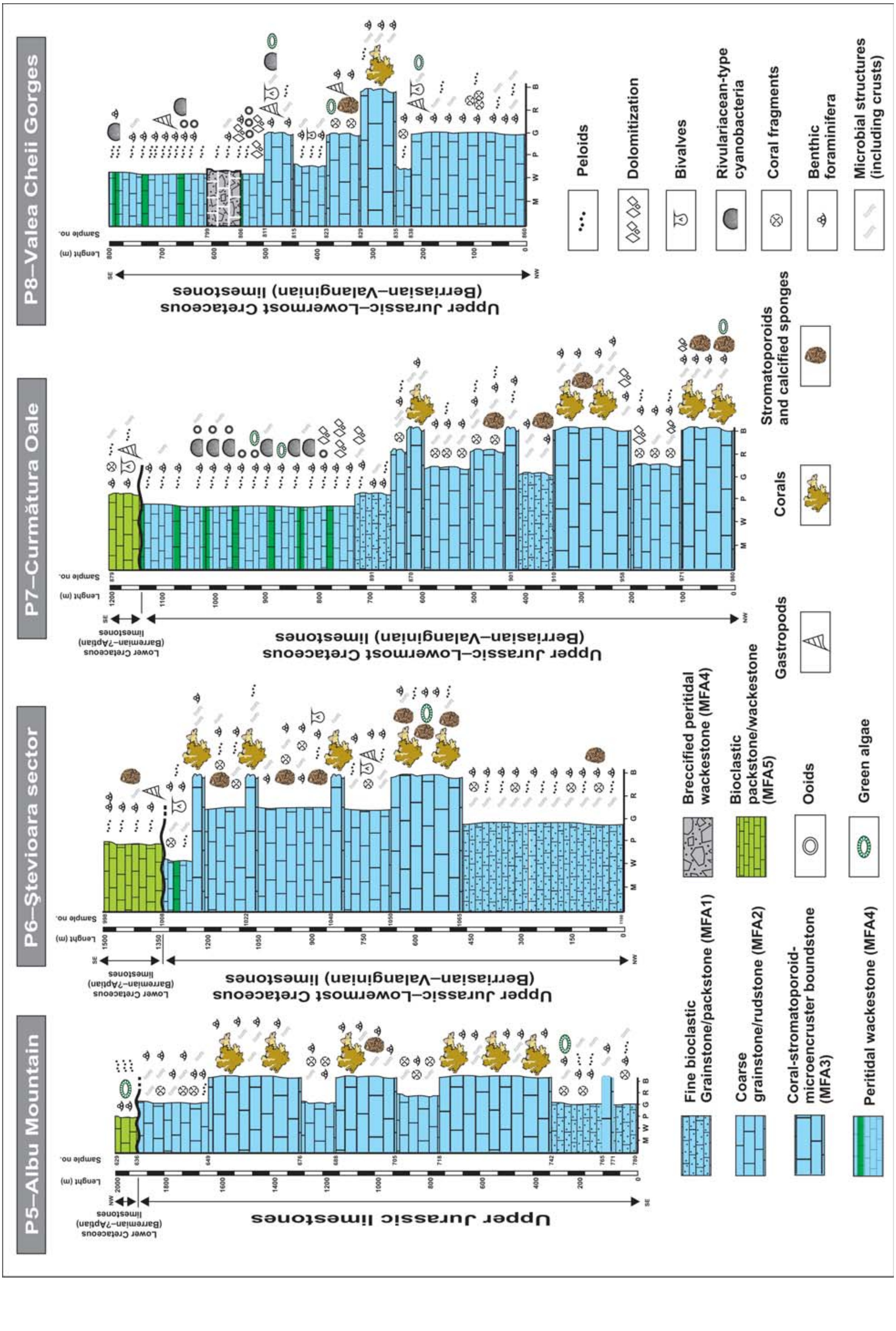
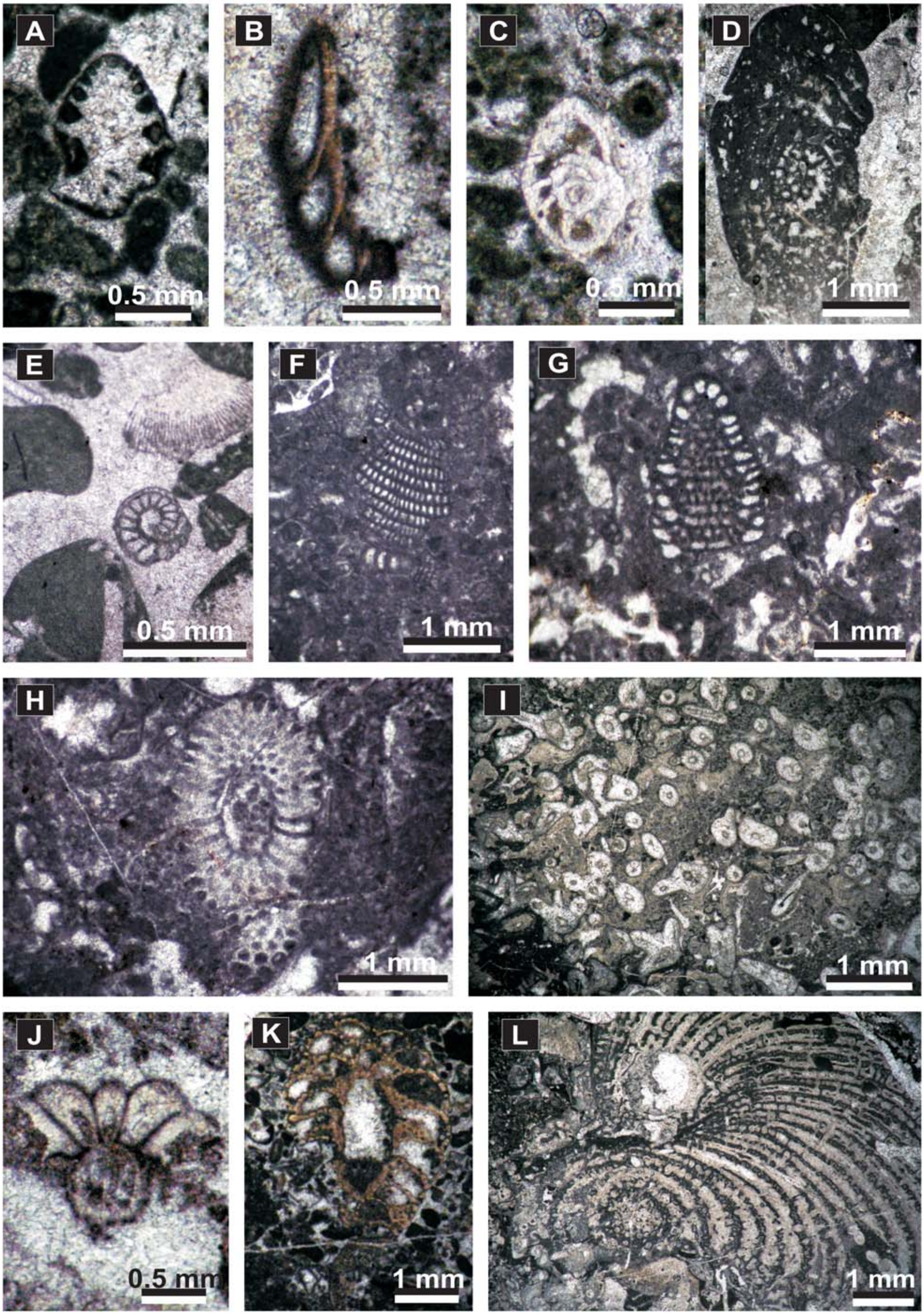


Fig. 4. General succession of the limestone deposits of the Buila-Vânturariţa Massif (sections P5 to P8).

Table 1

Main Upper Jurassic–Lower Cretaceous microfossils of the Buila-Vânturarița Massif and their stratigraphic range

		Biostratigraphical range			
		KIMMERIDGIAN	TITHONIAN	BERRIASIAN	VALANGINIAN
Foraminifera	*Charentia evoluta* (GORBATCHIK)		▬	▬	
	Protopeneroplis ultragranulata (GORBATCHIK)		▬	▬	▬
	Coscinoconus alpinus LEUPOLD	▬	▬	▬	▬
	Bullopora aff. *laevis* SOLLAS	▬	▬	▬	▬
	Lituola? baculiformis SCHLAGINTWEIT & GAWLICK	▬	▬	▬	▬
	Mohlerina basiliensis (MOHLER)	▬	▬		
	Troglotella incrustans WERNLI & FOOKES	▬	▬	▬	▬
	Montsalevia salevensis CHAROLLAIS, BRÖNNIMANN & ZANNINETI			▬	▬
Calcareous algae	*Thaumatoporella parvovesiculifera* RANIERI	▬	▬	▬	▬
	Salpingoporella pymaea (GUEMBEL)	▬	▬	▬	▬
	Clypeina sulcata (ALTH)	▬	▬	▬	
	Nipponophycus ramosus YABE & TOYAMA	▬	▬	▬	▪ ▪ ▪
	"Solenopora" sp.	▬	▬	▪ ▪ ▪	▪ ▪ ▪
Sclerosponges	*Calcistella jachenhausenensis* REITNER		▬		
	Neuropora lusitanica TERMIER & TERMIER	▬	▬		
	Perturbatacrusta leini SCHLAGINTWEIT & GAWLICK	▬	▬	▬	
	Thalamopora lusitanica TERMIER & TERMIER	▬	▬		
Microencrusters	*Crescentiella morronensis* (CRESCENTI)	▬	▬	▬	▬
	Radiomura cautica SENOWBARI-DARYAN & SCHAEFER	▬	▬	▬	▬
	Koskinobullina socialis CHERCHI & SCHROEDER	▬	▬	▬	▬
	Iberopora bodeuri GRANIER & BERTHOU	▬	▬		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Interpretation

Most probably, the fine-grained facies types (MFA1), identified in the three sections, are the results of moderate and concentrated density flows (turbiditic deposits). The clasts originated in the reef area and were probably deposited in the lower part of the reef slope. In some cases, they are associated with deposits showing MFA2 and MFA3 facies types. On the basis of their association with reef-slope rudstones (MFA2), these deposits can be assigned to the "slope carbonate apron" model defined by Mullins and Cook (1986). Comparable microfacies types were documented by Bucur *et al.* (2010a) in the Upper Jurassic carbonate deposits of the Mateiaş area, indicating similar depositional environments.

MFA2 – Coarse bioclastic-intraclastic grainstone/rudstone

This microfacies type is commonly recognized throughout the entire carbonate succession in the Buila-Vânturarița Massif, in all eight sections studied. In the Bistrița Gorges (P1) it consists mainly of reef debris levels ubiquitous throughout the entire succession, showing tabular and layer-like geometries (Pleş *et al.*, 2013). The microfacies are intra-bioclastic rudstone and coarse, intra-bioclastic grainstone. These limestones are mainly composed of coral fragments, sclerosponges and large intraclasts of coral-microbial boundstone, stromatolitic-thrombolitic microbial crusts and bioclastic packstone with *Crescentiella morronensis*. Clasts are angular to subangular and variable in size (up to 1.5 cm in diameter). The deposits are poorly sorted, with a chaotic orientation of clasts. These limestones contain a micropalaeontological association of foraminifera [*Charentia evoluta*, *Lituola*? *baculiformis* Schlagintweit et Gawlick, 2009, *Mohlerina basiliensis* (Fig. 5B), *Coscinoconus alpinus*, *C. delphinensis* (Fig. 5A), *Troglotella incrustans* Wernli et Fookes, 1992, *Bullopora laevis* Sollas, 1877, *Lenticulina* sp. (Fig. 5C), *Coscinophragma*ain sp. (Fig. 5D), *Ammobaculites* sp.)], calcareous algae [*Clypeina sulcata* (Fig. 5J), *Salpingoporella pygmaea* (Fig. 5H), *Thaumatoporella parvovesiculifera* (Ranieri, 1927), *Nipponophycus ramosus* (Fig. 5I), "*Solenopora*" sp.), sclerosponges (*Perturbatacrusta leini* Schlagintweit et Gawlick, 2011, *Murania reitneri* Schlagintweit, 2004, *Neuropora lusitanica* Termier et Termier, 1985, *Thalamopora lusitanica* Termier et Termier, 1985 (Fig. 5K), *Calcistella jachenhausenensis* Reitner, 1992), gastropods, bivalves and worm tubes (*Mercierella dacica* Dragastan, 1967 and *Terebella* sp.). In the Arnota Mountain profile (P2), the authors identified the following microfacies types: intra-bioclastic floatstone, bio-intraclastic rudstone, and less frequently, bioclastic grainstone. In the Costeşti Gorges (P3), rudstone levels (MFA2) are very thick; they were mainly observed in the lower and middle part of the profile. Facies assigned to the MFA2 type dominate the upper half of the Cacova sector succession (P4) and Albu Mountain (P5), consisting of coarse grainstone and bioclastic rudstone with fragments of reef macro-organisms. In the Ştevioara (P6) and Curmătura Oale (P7) sectors, the coarse deposits (MFA2) are found in the middle part of the succession. The main biota present in these microfacies types consist of organisms related to the reef, represented by fragments of corals and sclerosponges, microproblematic organisms (*Crescentiella morronensis, Lithocodium aggregatum* or *Bacinella*-type micro-organisms), benthic foraminifera, as well as some molluscs (gastropods or fragments of bivalves). In the lower and middle part of the Cheia Valley succession (P8), coarse deposits of MFA2 dominate.

Interpretation

The MFA2-type deposits are significantly thick and they consist of poorly-sorted angular clasts represented by intraclasts and bioclastic fragments. Constant wave action and currents caused erosion during reef growth, so many fragments were redeposited and incorporated within these rudstones (Turnšek *et al.*, 1981). Resedimentation of the reef clasts can be linked to small debris flows in an upper slope environment (Morsilli and Bosellini, 1997). The encrusting nature of many of the micro-organisms, associated with syndepositional cement crusts, have stabilized and reinforced these slope carbonates. The reef debris deposits (MFA2) in association with coral-stromatoporoid-microencruster boundstones (MFA3) are interpreted as an equivalent of the fore-reef/upper-slope "Plassen"-type limestones, described by Schlagintweit and Gawlick (2008) from the Northern Calcareous Alps. They also resemble the platform-margin *Ellipsactinia* facies of the Central Apennines (Rusciadelli *et al.*, 2011), characterized by similar sedimentary settings. Other close facies associations have been described from several areas of the Romanian Carpathians (Bucur, 1978; Bucur and Săsăran, 2005; Bucur *et al.*, 2010a, b; Bucur and Săsăran, 2012).

MFA3 – Coral-stromatoporoid-microencruster boundstone

In the Bistrița Gorges profile (P1), boundstone levels (MFA3) occur as interlayers in the lower and upper part of

Fig. 5. Main Upper Jurassic–Lower Cretaceous microfossils of the Buila-Vânturarița Massif. **A.** *Coscinoconus delphinensis* (sample 794 – Valea Cheii Gorges – P8). **B.** *Mohlerina basiliensis* (sample 1053 – Ştevioara sector – P6). **C.** *Lenticulina* sp. (sample 38 – Bistriței Gorges – P1). **D.** *Coscinophragma* sp. (sample 1040 – Ştevioara sector – P6). **E.** *Protopeneroplis ultragranulata* (sample 879 – Curmătura Oale – P7). **F.** *Vercorsella camposaurii* (sample 890 – Curmătura Oale – P7). **G.** *Paracoskinolina*? *jourdanensis* (sample 457 – Costeşti Gorges – P3). **H.** *Salpingoporella pygmaea* (sample 1054 – Valea Cheii Gorges – P8). **I.** *Nipponophycus ramosus* (sample 472 – Costeşti Gorges – P3). **J.** *Clypeina sulcata* (sample 1054 – Ştevioara sector – P6). **K.** *Thalamopora lusitanica* (sample 19b – Bistriței Gorges – P1). **L.** *Ellipsactinia* sp. (sample 114 – Bistriței Gorges – P1).

the succession, on top of the intraclastic-bioclastic rudstone/grainstone facies types (MFA2). The corals and sponges are intensely encrusted by problematic micro-organisms (*Crescentiella morronensis*, *Radiomura cautica*, *Koskinobullina socialis*, *Lithocodium aggregatum*, *Iberopora bodeuri*, or *Bacinella*-type structures). Additionally, the authors identified stromatolitic- and thrombolitic-type structures. Peloids, bioclasts and silt-sized carbonate intraclasts embedded in stromatolitic crusts were recognized. Other organisms are represented by stromatoporoids (*Ellipsactinia* sp., *Calcistella jachenhausenensis*), ?udoteacean algae (*Nipponophycus ramosus*), dasycladales (*Salpingoporella pygmaea*), benthic foraminifera (*Lituola*? *baculiformis, Mohlerina basiliensis*, *Coscinoconus alpinus*, *Troglotella incrustans*, *Lenticulina* sp., *Coscinophragma* sp.), molluscs, echinoid fragments and spines, or worm tubes (including *Terebella* sp.). An important feature of the bioconstructed limestones from Bistriţa Gorges is represented by the presence of *Epiphyton*-type micro-organisms. These were recently identified for the first time in the Upper Jurassic limestones (Kimmeridgian–Tithonian) in Romania (Săsăran *et al.*, 2014). In the Arnota Mountain profile (P2) MFA3 is less frequent. The main micro-encrusters involved in the development and consolidation of this deposit are *Lithocodium aggregatum* and *Crescentiella morronensis*. MFA3-type boundstones were mainly observed in the lower half of the Costeşti Gorges section (P3), interlayered with MFA2-type deposits. They consist of coral-microencruster boundstones with internal wackestone/packstone sediment and boundstones with stromatoporoids and encrusting organisms. In the Cacova sector (P4) the boundstone levels (MFA3) are thin and were observed only at the base and the top of the succession. The most representative facies types consist of coral-microbial boundstones with thrombolitic crusts and stromatoporoids and brecciated boundstones with problematic micro-organisms (*Crescentiella morronensis*). In the Şteviooara profile (P6), a horizon of coral-microbial boundstone with stromatoporoids (MFA3) conformably overlies the fine-grained deposits (MFA1). Here, the following microfacies types occur: coral-microbial boundstone and boundstone with stromatoporoids (*Ellipsactinia* sp., *Calcistella jachenhausenensis*, *Neuropora lusitanica* or *Actinostromaria* sp.) and micro-encrusters. MFA3 is present along the entire succession in the Curmătura Oale profile (P7), as interlayers within bio-intraclastic rudstones (MFA2) and micritic fenestral deposits (belonging to MFA4). Boundstones dominate the lower part of the profile as banks of various thicknesses. The dominant microfacies type is coral-microbial framestone and boundstone with stromatoporoids and microbial crusts. Only sporadically, leiolitic or stromatolitic structures were noticed. In the Cheii Valley profile (P8), the deposits that the authors assigned to MFA3 occur solely at the end of the lower part of the profile. They are represented by coral-microbial and pure, microbial boundstone. Microscopically, as opposed to most of the MFA2- and MFA3-type limestone samples investigated in the region, thin sections from Cheii Valley (P8) show lesser amounts of microbial crusts. Crustiform fabrics associated with various encrusting micro-organisms are rare, while boundstones with stromatoporoids are absent. The microbial structures are represented by leiolitic microstructures, as well as fine-laminated mesostructures.

Interpretation

The bioconstruction levels (MFA3) from the Buila-Vânturariţa Massif are generally characterized by crustose and encrusting fabrics, associated with widely developed cement crusts. The intrareef sediment of MFA3-type deposits is mud-dominated, represented by bioclastic wackestone with various reef organisms, such as fragments of corals and sclerosponges, foraminifera, calcareous algae (*Salpingoporella pygmaea* and/or *Nipponophycus ramosus*), as well as encrusting micro-organisms or clotted microbial structures. The micro- and macropalaeontological assemblages from the MFA3 deposits, represent a typical frontal reef or reef-crest association, as previously documented by Morsilli and Bosellini (1997), Schlagintweit and Gawlick (2008) or Pleş *et al*. (2013). The abundance of calcareous sponges [*Perturbatacrusta leini*, *Ellipsactinia* sp. (Fig. 5L), *Neuropora lusitanica, Thalamopora lusitanica* or *Cylicopsis verticalis* Turnšek, 1968], makes possible the correlation of the analysed boundstones (MFA3) with bioconstructions of the stromatoporoid zones from many Late Jurassic barrier-reef models of the intra-Tethys domain. Thus, the MFA3 microfacies association may correspond to the "Stromatopores Unit" of Rusciadelli *et al.*, (2011) from the external zone (upper slope-reef crest transition) of the Marsica area reef (Central Apennines), characterized by abundant stromatoporoids (Ellipsactinia Limestones). MFA3-type deposits also resemble facies associations 4 and 5 (boundstones and coarse grainstones with *Ellipsactinia* or *Sphaeractinia*) of Morsilli and Bosellini (1997), and with the *Actinostromaria* Zone described by Turnšek *et al.* (1981) from Slovenia.

MFA4 – Peritidal bioclastic-oncoidal-peloidal wackestone

This microfacies association was assigned to the lowermost Cretaceous. They have been identified only in the profiles in the Arnota Mountain (P2), Cacova (P4), Şteviooara (P6), Curmătura Oale (P7) sectors, and Cheia Valley (P8), where they are developed conformably on top of the Jurassic reef limestones. For example, in the profile at Arnota Mountain (P2), the peloidal-bioclastic wackestones and the fenestral-microbial bindstones represent the main microfacies (MFA4) the top of the profile. In the Cacova (P4) and Şteviooara (P6) sectors, MFA4 includes the following microfacies: peloidal wackestones with fenestrae, bioclastic-peloidal wackestones with micritized rivulariacean-type cyanobacteria (?*Cayeuxia* sp.), peloidal-intraclastic wackestones, fenestral wackestones, and bioclastic-peloidal packstones. Foraminifera [*Protopeneroplis ultragranulata* (Fig. 5E) or *Montsalevia salevensis*], cyanobacteria, crustacean coprolites (*Favreina* sp.) and *Bacinella*-type structures represent the main biotic components. In the upper part of the Curmătura Oale profile (P7) the authors identified microbial limestones with fenestrae, which we also assigned to the MFA4. These are associated with (or, towards the top gradually pass into) bioclastic fenestral wackestone, peloidal bioclastic wackestone/packstone and non-fossiliferous mud-

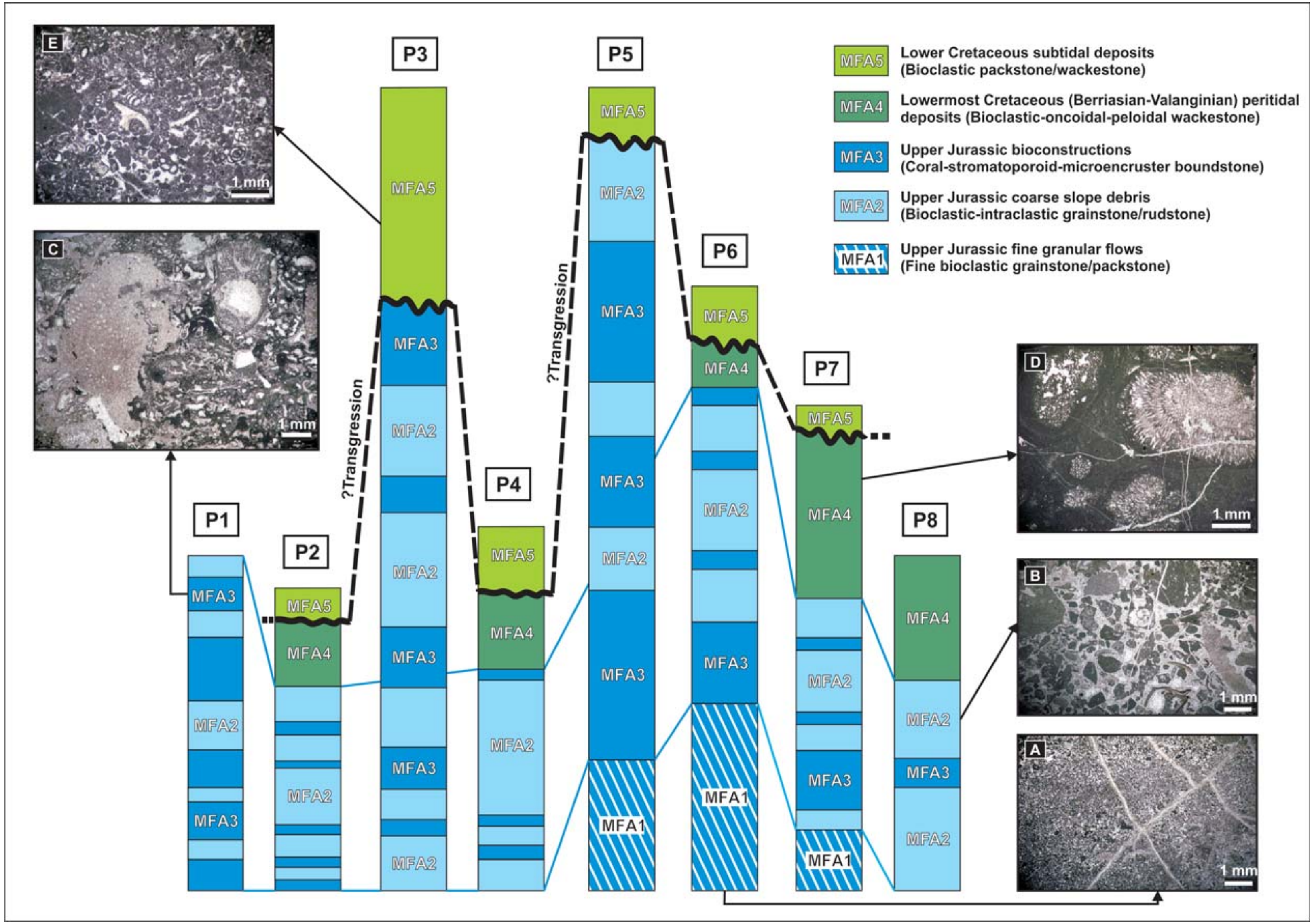
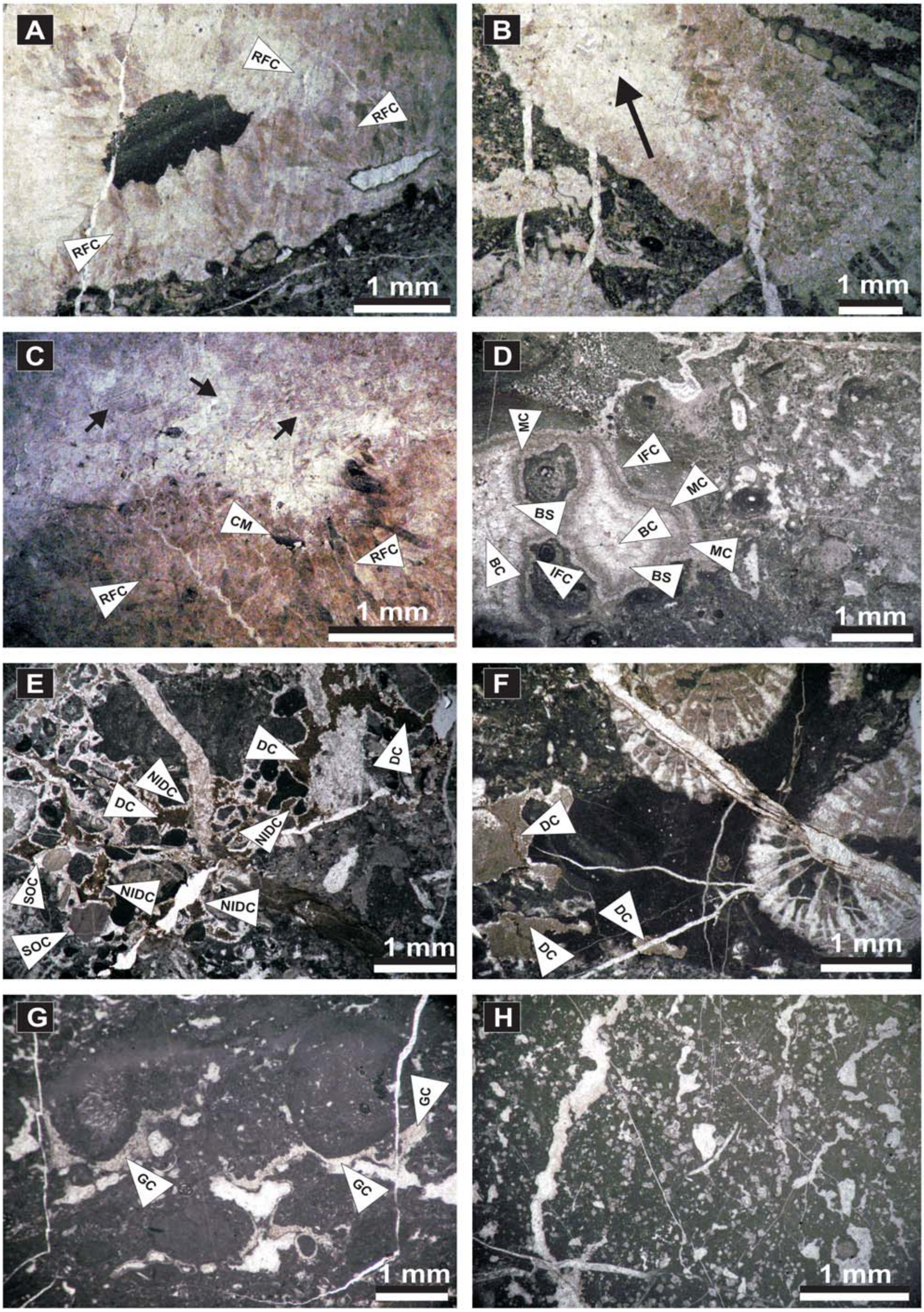


Fig. 6. Distribution of the main facies associations within the carbonate succession of the Buila-Vânturarița Massif. **A.** Fine bioclastic-peloidal grainstone with *Crescentiella morronensis* (MFA1) (sample 778 – Albu Mountain – P5). **B.** Coarse intraclastic-bioclastic rudstone with microbial structures and echinoid fragments (MFA2) (sample 657 – Albu Mountain – P5). **C.** Stromatoporoid-microencruster boundstone with *Neuropora lusitanica*, *Perturbatacrusta leini* and *Crescentiella*-type structures (MFA3) (sample 489 – Costești Gorges – P3). **D.** Bioclastic floatstone with rivulariacean-type cyanobacteria oncoids (MFA4); note the distinct micritic envelopes surrounding the cyanobacteria fragments (sample 548 – Costești Gorges – P3). **E.** Bioclastic packstone with foraminifera (MFA5) (sample 889 – Curmătura Oale – P7).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stone. In the carbonate succession from Cheii Valley, the following microfacies occur: peloidal-bioclastic wackestone with cyanobacteria and micritic envelopes; bioclastic wackestone with fractures and cement-filled cavities; fractured mudstone, and brecciated peloidal-intraclastic wackestone. Here, the biotic component is represented by foraminifera, microbialites, as well as species of green algae (*Clypeina sulcata*).

Interpretation

The facies types assigned to MFA4 are present in the upper part of the profiles studied, being deposited in peritidal environments with reduced hydrodynamics (Shinn, 1983; Hardie and Shinn, 1986). These limestones are frequently associated with the facies of intertidal ponds and in places with supratidal deposits. Overall, they most probably characterize lagoonal sedimentary settings (Morsilli and Bosellini, 1997). The abundant rivularia-type cyanobacteria (often with clear envelopes or fine micritic cortexes), microbial oncoids and fenestral structures indicate a transition with more protected depositional environments of these micrite-dominated limestones (Flügel, 2004).

MFA5 – Bioclastic packstone/wackestone

This microfacies type is found in six out of the eight profiles studied. They transgressively overlie Upper Jurassic–lowermost Cretaceous deposits (MFA1, MFA2, MFA3). In the Arnota Mountain (P2) and the Costeşti Gorges (P3), the Lower Cretaceous deposits (MFA5) are similar to those of MFA4-type, at the tops of the successions. Microfacies types are represented by bioclastic-peloidal wackestone with foraminifera [*Paracoskinolina*? *jourdanensis* (Fig. 5G) and *Vercorsella camposaurii* (Fig. 5F)], fractured, intraclastic wackestone, bioclastic-oncoidal wackestone with rivulariacean-type cyanobacteria and peloidal-fenestral wackestone. In the Cacova sector (P4), the authors have identified bioclastic-peloidal wackestone/packstone with foraminifera (*Paracoskinolina*? *jourdanensis*) and rudist fragments, peloidal fenestral wackestone and fractured wackestone. The deposits assigned to MFA5 crop out in small areas on top of the successions in Albu Mountain (P5), Ştevioara (P6) and Curmătura Oale (P7) sectors. Here, fossils are relatively scarce, the main bioclasts being represented by benthic foraminifera. Microfacies types are: bioclastic peloidal wackestone with foraminifera, bioclastic microbial wackestone and fractured bioclastic packstone.

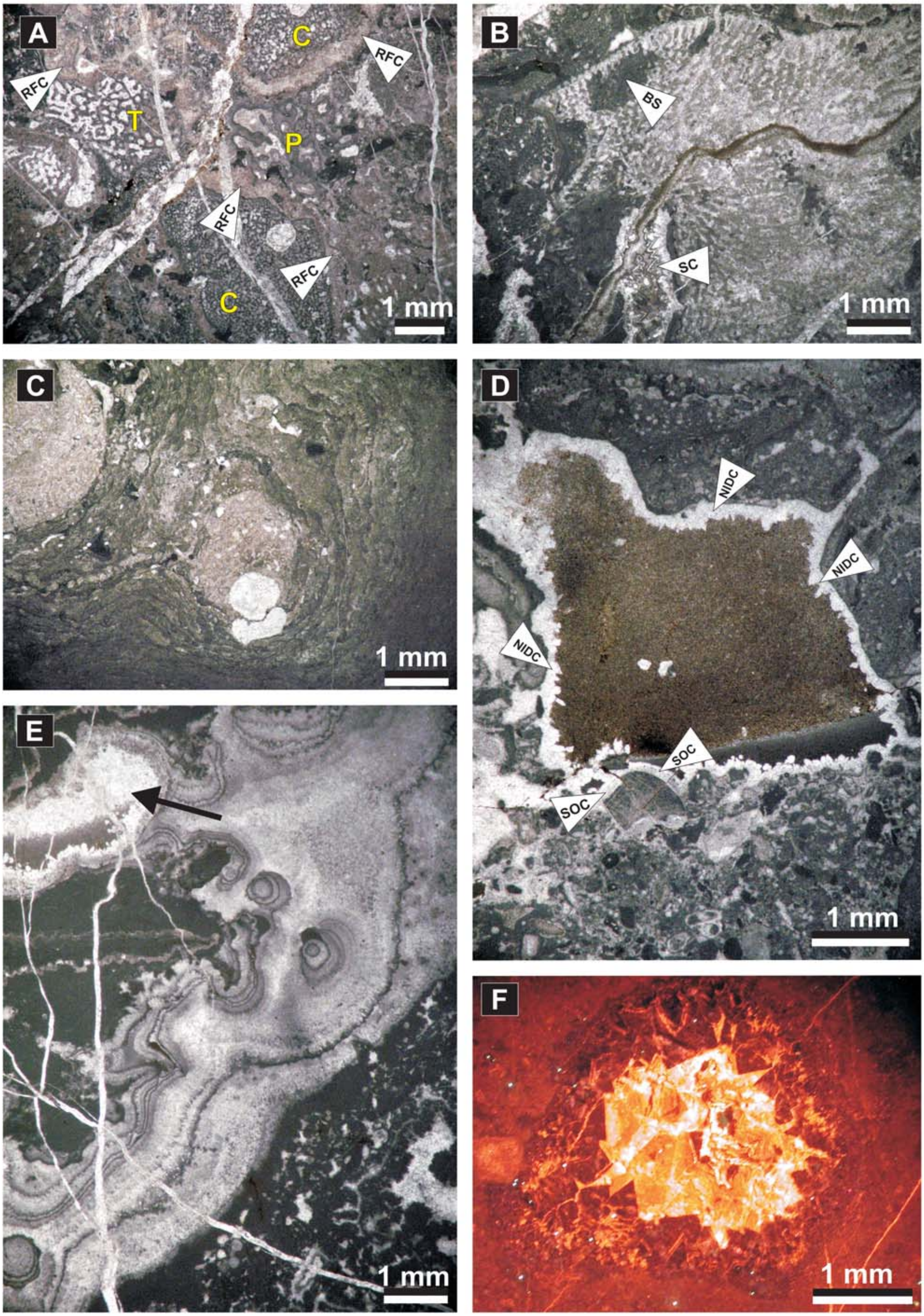
Interpretation

The carbonate deposits assigned to MFA5 formed in a shallow, subtidal environment of the platform shelf. Taxonomic diversity of microfossils is significantly reduced as compared to the previously described deposits (MFA1 to MFA4). Micrite-dominated facies types, characterized by micritization processes, were noticed towards the top of this microfacies association type.

FACIES DISTRIBUTION, SEDIMENTARY SETTINGS AND EVOLUTION OF STUDIED CARBONATE PLATFORM

Starting with the lower part of the carbonate succession of the Buila-Vânturariţa Massif, finer deposits of granular flows with turbiditic character (MFA1) occur. They were recognized in three of the sections analysed (Fig. 6). This feature points to an environment with relatively high energy, most probably located towards the base of the reef slope (Mullins and Cook, 1986; Bucur *et al.*, 2010a). On top of these deposits, thick levels of reef rudstones (MFA2), intelayered with coral-microencruster boundstones with stromatoporoids (MFA3), are present. Bioconstructions (MFA3) occur on top of MFA2-type facies that evidence the instability of the reefal slope. The associated distribution of reef facies types (MFA2 and MFA3), the thickness of the rudstone levels and the presence of typical microfossil associations are all arguments for a patch-reef development of most of the bioconstructions in Buila-Vânturariţa Massif. The genesis of these bioconstructions was strictly controlled

Fig. 7. Diagenetic features. **A.** Large cement crust formed as a result of radiaxial-fibrous cement recrystalization (RFC) in a reef-slope rudstone; note fine laminated peloidal sediment in the cavity formed by cement growth indicating synsedimentary cementation (sample 21 - Bistriţei Gorges – P1). **B.** Neomorphic features inside a coral fragment; after dissolution of the septa the interseptal spaces were subsequently filled with granular cement (arrow) (sample 1050 – Ştevioara sector – P6). **C.** Synsedimentary radiaxial-fibrous cement (RFC) succeeded by a recrystalization phase; notice the relic features of the primary radiaxial-fibrous cementation (arrows) followed by a granular spar cement coarsening towards the centre of the crust; CM – *Crescentiella morronensis* encrusting synsedimentary cement (sample 14b – Bistriţei Gorges – P1). **D.** Multiple cement generations in a reef-slope facies; the first generation of cement is represented by a fine rim of isopachous-fibrous cement (IFC) surrounding the oncoids, followed by a brownish microcrystaline cement (MC); the third generation of cement is composed of bladed isopachous spar crystals (BS) succeeded by a final stage of clear blocky calcite cementation (BC) (sample 696 – Albu Mountain – P5). **E.** Meteoric dissolution resulted in cavities (DC) bordered by rims of non-isopachous dog-tooth cement (NIDC), locally associated linewith syntaxial cement overgrowing echinoid fragments (SOC); the internal filling of the cavities is made up of fine, marl-silty sediment, probably of vadose origin (sample 151 – Bistriţei Gorges – P1). **F.** Mixed meteoric and shallow burial features in a coral-microbial boundstone; the meteoric diagenesis is represented by several dissolution cavities (DC); the corals were partially fractured during initial burial, followed by a last stage of cementation inside the fissures, represented by clear blocky crystals (sample 13a – Bistriţei Gorges – P1). **G.** Peritidal oncoidal wackestone with gravitational cements (GC) that hang from the bottoms of the grains; the remaining pores were filled with granular spar (sample 332 – Arnota Mountain – P2). **H.** Early dolomitization; some of the rhomboedrical dolomite crystals are partially filled with vadose calcite (dedolomitization), probably triggered by the change of meteoric regime into a normal-marine one (sample 943 – Curmătura Oale – P7).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by stabilization of the reef debris. Thus, the encrusting character or the sediment-binding function that most bioconstructing organisms play. The relatively reduced thickness of these bioconstructed levels (MFA3) may be also connected to the nature of the reef framework-forming organisms. In contrast to the Upper Jurassic microbialite-dominated reefs of the northern Tethyan realm (Leinfelder *et al.*, 1993), the cement-supported microencruster frameworks, which characterize the MFA2 and MFA3 facies associations, show many similarities with the Late Jurassic "Plassen"-type microencruster boundstones of the Northern Calcareous Alps (Schlagintweit and Gawlick, 2008; Pleş *et al.*, 2013). Therefore, laminated microbial structures are subordinate to encrusting micro-organisms associated with synsedimentary cement crusts in the development and consolidation of these deposits. On the basis of the composition and textural-structural features, the described facies associations (MFA2 and MFA3) were assigned to fore-reef slope environments, close to the proximal areas of the reef crest (Turnšek *et al.*, 1981; Schlagintweit and Gawlick, 2008; Rusciadelli *et al.*, 2011; Pleş *et al.*, 2013). The presence of stromatoporoids in these facies was supported by their location in shallow, high-energy environments. This also explains the resistance of most of these taxa to remobilization or fragmentation, which are typical phenomena in platform-marginal environments (Leinfelder *et al.*, 2005). In the upper part of the Upper Jurassic–lowermost Cretaceous succession, all the typical terms of peritidal environments (subtidal, intertidal and supratidal – MFA4) were recorded. The subtidal, marine environment is indicated by the type of carbonate components (bioclasts, peloids, oncoids), embedded in a micritic matrix associated sometimes with bioturbation structures. The intertidal environment includes beach deposits, formed in areas with high energy (peloidal packstones with "keystone vugs") and fine, laminated fenestral deposits, typical for a low-energy environment. The supratidal environment contains non-fossiliferous and fenestral, micritic limestones that might have been affected by dolomitization. These deposits are comparable to the peritidal cycles of the lagoonal facies association (F1A, F1D and F1E), documented by Morsilli and Bosellini (1997) in Upper Jurassic–Lower Cretaceous platform-margin limestones in Southern Italy. Peritidal limestones of the Buila-Vânturarița Massif show a decrease of accommodation space in the carbonate platform. The Lower Cretaceous deposits assigned to the MFA5 (Barremian) transgressively overlie the Jurassic–lowermost Cretaceous succession (Fig. 6). Towards the top of the Cretaceous succession the authors observed a more internal evolutionary trend of the depositional environment, as indicated by fracture fillings, bioclast micritization and oncoids.

The general distribution and features of the main facies associations, together with the associated biota, indicate a barrier-type development of the Buila-Vânturarița carbonate platform (Turnšek *et al.*, 1981; Schlagintweit and Gawlick, 2008; Rusciadelli *et al.*, 2011). Furthermore, the Buila-Vânturarița platform slope shows the classical geometry of many intra-Tethyan platform margins (Morsilli and Bosellini, 1997; Pleş *et al*., 2013). The gradual transition from deeper to shallower sedimentary settings can be strongly correlated with the prograding character of the carbonate platform during the Upper Jurassic.

DIAGENETIC HISTORY

Early marine diagenesis in subtidal environments

The features identified in the eight profiles studied that are related to early marine diagenesis consist of: (i) successive generations of cements with fibrous fabrics, (ii) recrystallization, and (iii) micritization. Fibrous-radiaxial, microcrystalline and scalenohedral cements were frequently noticed in reef deposits (MFA2 and MFA3). Fibrous radiaxial cements may form crusts inside interparticle spaces or vugs, in most cases being associated with biogenic encrustations. Sometimes these cements can be seen as replacements for fast, early cementation products. This mechanism is supported by the presence of relic, prismatic crystals (possibly of aragonitic nature) within the crusts (Fig. 7A, C; Reitner, 1986). Morphological traits of the relic crystals are preserved (Kendall and Tucker, 1973; Henrich and Zankl, 1986; Koch and Schorr, 1986), or alternatively the replacement process may be traced by the presence of obvious discontinuities within the cements crusts formed in the cavities of the reef deposits (MFA2 and MFA3). The synsedimentary nature of these cement crusts is reflected in the encrustation by micro-encrusters (Fig. 8A; Schlagintweit and Gawlick, 2008; Kołodziej, 2015b). The scalenohedral cements are mainly composed of denticulated, prismatic cements, developed as infilling crusts within intra-reef cavi-

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Fig. 8. Microfacies and diagenetic features. **A.** Crusts of radiaxial-fibrous cement (RFC) strengthening a stromatoporid-microencruster framework with *Cylicopsis verticalis* (C), *Tubuliella fluegeli* Turnšek (T) and *Perturbatacrusta leini* (P) (sample 737 – Albu Mountain – P5). **B.** Scalenohedral cement (SC) formed in a reef cavity; note the presence of a boring structure (BS) inside the zoantharian fragment (sample 1109 – Arnota Mountain – P2). **C.** Stromatolitic-clotted meso-structure supporting the stromatoporid boundstone (sample 554 – Costești Gorges – P3). **D.** Dissolution cavity (DC) filled with fine silty or marly sediment; the external margins are bordered by a clear layer of non-isopachous dog-tooth crystals (NIDC) associated with syntaxial-overgrowth cement (SOC) (sample 1118 – Arnota Mountain – P2). **E.** Successive microcrystalline crusts probably induced by cyanobacterial growth; note the radial displacement of crystals associated with fine, micritic lens; in the upper pat of the picture, there is a small cavity filled with geopetal sediment (arrow); in the lower part of the cavity a second generation of non-isopachous dog-tooth cement developed on a early generation of isopachous marine cement (sample 1130 – Arnota Mountain – P2). ain **F.** Multiple generations of cements in a closed pore; the chronological order of cementation is evidenced by cathodoluminescence; the first cementation stage is represented by non-luminescent, zoned crystal rims, followed by dull-luminescent much larger crystals; the final filling of the pore is marked by bright orange, blocky cementation probably formed during shallow burial (sample 5 – Bistriței Gorges – P1).

ties (Fig. 8B). In the peritidal facies types (MFA4), some crusts of microcrystalline cements are represented by very fine, micritic laminae intercalated with radial, microsparitic cements (Fig. 8E). The relatively small size of crystals in the microcrystalline filaments indicates relatively rapid cementation processes, probably induced by changes in the chemistry of the environments, where cyanobacteria were present. Heinrich and Zankl (1986) have described association of cyanobacteria with sparitic, microcrystalline cements as organic-diagenetic-type cements. Microbial micritization occurs in sponge-coral bioconstructions (MFA3) and particularly in peritidal facies (MFA4). This characteristic may be used as a proxy for incipient diagenetic processes (Qureshi *et al.*, 2008; Lazăr *et al.*, 2013). These processes consist of the formation of micritic microcrystalline cortices around some bioclasts (partial micritization); *in extremis*, the bioclasts can be completely replaced by micrite (complete micritization; Flügel, 2004). In the Jurassic reef deposits studied (MFA2 and MFA3), the authors have identified neomorphic processes represented by selective (partial or total) dissolution of the coral structure, or of some stromatoporoid skeletons. This was followed by low-Mg calcite recrystallization (precipitation) within the newly-created inter-skeletal space (Fig. 7B).

Diagenesis in meteoric environments

Selective dissolution, gravitational isopachous and syntaxial cements and microkarst associated with marly-fine siliciclastic fillings, are all proof of meteoric diagenesis in the limestones in the Buila-Vânturarița Massif. In the reef environments (MFA2 and MFA3), as well as in the intertidal facies (MFA4), gravitational cementation is represented by microstalactitic cements, formed on bioclasts or intraclasts (Fig. 7G; Scholle and Ulmer-Scholle, 2003). The most common cements that the authors have associated with processes in the phreatic zone are the bladed and dog-tooth types. They consist of crystalline bands, bordering cavities in reef deposits (Figs 7E, 8B). The crystals are oriented sub-perpendicular to their substrate. Another meteoric diagenesis-related product is the overgrowth of syntaxial cement formed on the echinoderm radioles and/or plates (Figs 7E, 8D), identified in reef detrital deposits (Pomoni-Papaioannou *et al.*, 1989; Flügel and Koch, 1995; Qureshi *et al.*, 2008). In the case of the samples in the present study, the syntaxial cements are often associated with the bladed or dog-tooth cements along the borders of cavities formed as a result of meteoric dissolution. Koch and Schorr (1986) considered the association of these cements as possible evidence for subaerial episodes. According to Buddemeier and Oberdorfer (1986), dolomitization is favoured by a certain degree of mixing between marine and meteoric fluids. The present authors consider that this may explain the fact that dolomitization was observed in their samples only in the peritidal facies (MFA4), on the top of the Jurassic succession. The results are rhombohedral crystals dispersed in the microcrystalline matrix, associated with late-generation cements (Fig. 7H). In the same peritidal facies the authors also have observed partial dissolution of dolomite crystals (de-dolomitization). De-dolomitization may point to a migration of the mixing zone towards the basin, in connection with falls in sea level (Frykman, 1986).

Shallow burial diagenesis

In their material, the authors noticed a low compaction of sediments, given the fact that early cementation took place during marine diagenesis. The fragmentation of some macrofossils (corals, bivalves or gastropods), and the presence of fissures and cavities filled with sparitic calcite are the most typical features of burial diagenesis in the limestones of the Buila-Vânturarița Massif. In the reef deposits (MFA1, MFA2 and MFA3), the burial diagenesis-related cements show typical morphological features for burial environments. The crystals are mainly equigranular (mosaic), but in some places there is an increase in size towards the centre of the pores (druse-type cement) (Fig. 8F). Such late stages may be followed by a final, blocky-type cementation. In the peritidal facies (MFA4), the final cavity-filling products are represented by mosaic-type granular cements.

Porosity

The intense microbial activity and the encrusting character of most of the biota identified in the reef limestones of the Buila-Vânturarița Massif (MFA3) resulted in a significant decrease of primary porosity and in the development of morphologies, typical for bioconstructions. In the reef-slope deposits (MFA1 and MFA2) showing coarser fabric as a result of reef detrital flows, the primary porosity is relatively higher. Secondary porosity was clearly noticed in some samples, in spite of the fact that most of the cavities had been rapidly filled with early marine cements. The authors assume that, following the early burial, selective dissolution by meteoric waters led to increased porosity in the form of fissures and cavities (Heinrich and Zankl, 1986). These voids were subsequently filled in part by sparitic microcrystalline crusts or bands of inequigranular crystals (Fig. 7E). Kerans *et al.* (1986) stated that porosity shows particular features on the basis of the depositional environments. The highest values are registered in areas with constant synsedimentary activity, such as reef-slope deposits (MFA1 and MFA2), or peritidal facies (MFA4) at the top of the carbonate succession.

CONCLUSIONS

1. Carbonate deposits of the Buila-Vânturarița Massif, studied here in eight profiles, mainly consist of massive, white carbonates, assigned to the Upper Jurassic–Lower Cretaceous interval. The lower and middle part of the succession is characterized by thick levels of reef debris interlayered with coral-microbial bioconstructions with encrusting micro-organisms and stromatoporoids. Towards the top of the succession, peritidal limestones are assigned to the lowermost Cretaceous. The Barremian–?Lower Aptian deposits, which cover relatively small areas, spread over the massif, transgressively overlie the white limestones of Kimmeridgian-Valanginian age.

2. The assemblages of calcareous algae and benthic foraminifera allowed the authors to specify the age of the deposits studied. Reef limestones were assigned to the Kimmeridgian–Tithonian; peritidal facies to the Berriasian–Valanginian (*Montsalevia salevensis* and *Protopeneroplis ultragranulata* being the main supporting evidence), while limestones at the top of the succession, which transgressively overlie the Upper Jurassic–lowermost Cretaceous deposits, are referable to the Barremian–?Lower Aptian (with *Paracoskinolina*? *jourdanensis*).

3. The facies analysis allowed us to discriminate five major facies associations: MFA1 – fine bioclastic grainstone/packstone, MFA2 – coarse bioclastic-intraclastic grainstone/rudstone, MFA3 – coral-stromatoporoid-microencruster boundstone, MFA4 – peritidal bioclastic-oncoidal-fenestral wackestone, and MFA5 – bioclastic packstone/wackestone. The first three associations are typical for the Upper Jurassic, the latter being more frequent at the top of the Jurassic, or in the Lower Cretaceous part of the sections.

4. The distribution of the facies associations within the carbonate successions studied shows the evolution of the Late Jurassic–Early Cretaceous depositional environments: from slope and reef -front to internal-platform sedimentary settings , including peritidal environments in the lowermost Cretaceous (Berriasian–Valanginian) deposits. This succession is typical for platform progradation, as recently was documented in other areas of development for Upper Jurassic–Lower Cretaceous limestones in the Getic domain (e.g., Piatra Craiului-Dâmbovicioara area).

5. Investigation of diagenetic features of the Buila-Vânturarița Massif reveals three stages. The first stage is represented by syndepositional, marine cementation that strongly influenced the features of the reef deposits, either during their formation or during early burial. Successive laminae of radiaxial and microcrystalline fibrous cements have consolidated the reef framework and have strengthened the reef-slope and peritidal deposits. The second diagenetic stage is represented by dissolution, recrystallization and precipitation of specific cement types, as a result of the infiltration of meteoric waters. Processes of dolomitization and de-dolomitization took place sporadically, triggered by the mixing of marine and meteoric waters, probably connected with transgression episodes. Given the frequent marine and meteoric cementation stages, the deposits are poorly compacted. The third stage was the formation of fractures and late-generation cements, which took place in the burial environments.

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