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PhD thesis

LOWER CRETACEOUS LIMESTONES IN PERŞANI MOUNTAINS: MICROFACIES, BIOSTRATIGRAPHY AND PALEOENVIRONMENTAL RECONSTRUCTION

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Extended Abstract

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1. Introduction

Perşani mountains are part of the Eastern Carpathians and presents a complicated nappes structure (Patrulius et al., 1966; Săndulescu, 1975). Lower cretaceous limestones belong to neoautohtonous cover of the Transylvanian Nappe (posttectonic sensu Săndulescu, 1975) or paleoautohtonous (cf. Patrulius et al., 1966).

The purpose of the present work is the study of the lower Cretaceous urgonian limestones in the central and southern area of the Perşani Mountains. The limestones have been analyzed in terms of microfaciesal and micropaleontologic content to determine their age and the paleoenvironment in which they were formed.

During the last decades, microfacies studies represent an important part in the investigation of carbonate rocks. The use and interpretation of microfacies criteria shows great potential for understanding depositional and diagenetic history of carbonate rocks (Flügel, 2004).

2. Localization

Located about 20 km east of the geographic center of the country, the Perşani Mountains are part of the Central Eastern Carpathian Group in the southern extremity (Fig. 1). The whole geomorphological assemblage corresponding to these mountains has an orientation NNE-SSW, with a length of about 96 km, with widths varying between 7 km and 17 km.

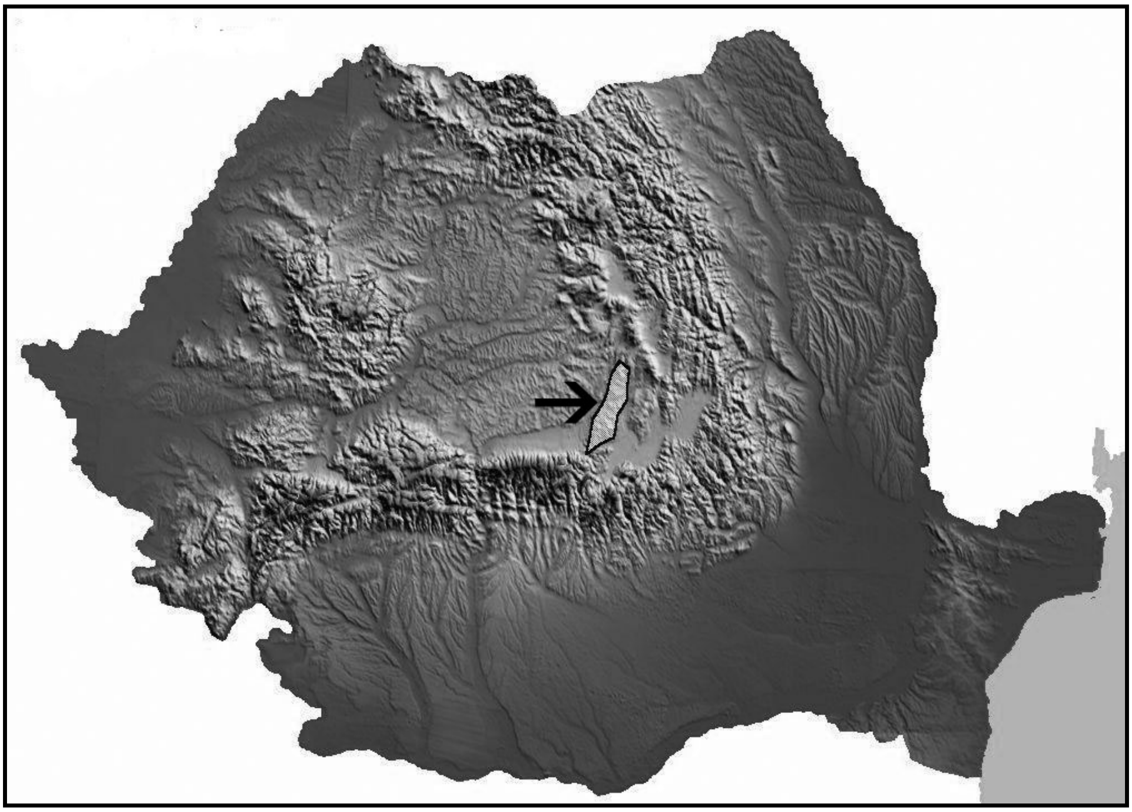

Fig. 1 Location of the Perşani Mountains within the Romanian territory
(thttp://commons. wikimedia.org/wiki/File:Muntii_Persani.jpg).

3. Geology

The Eastern Carpathians are organised in units with distinct structural and lithofacies features. These units comprise areas that are made up of sediments progressively younger towards the external area lying to the East. From a structural point of view in Perşani Mountains,there can be recognize two distinct series of sedimentary deposits (Fig. 2):

1. The Bucovinian Series, autohtonous;
2. The Transilvanian Series, allohtonous;

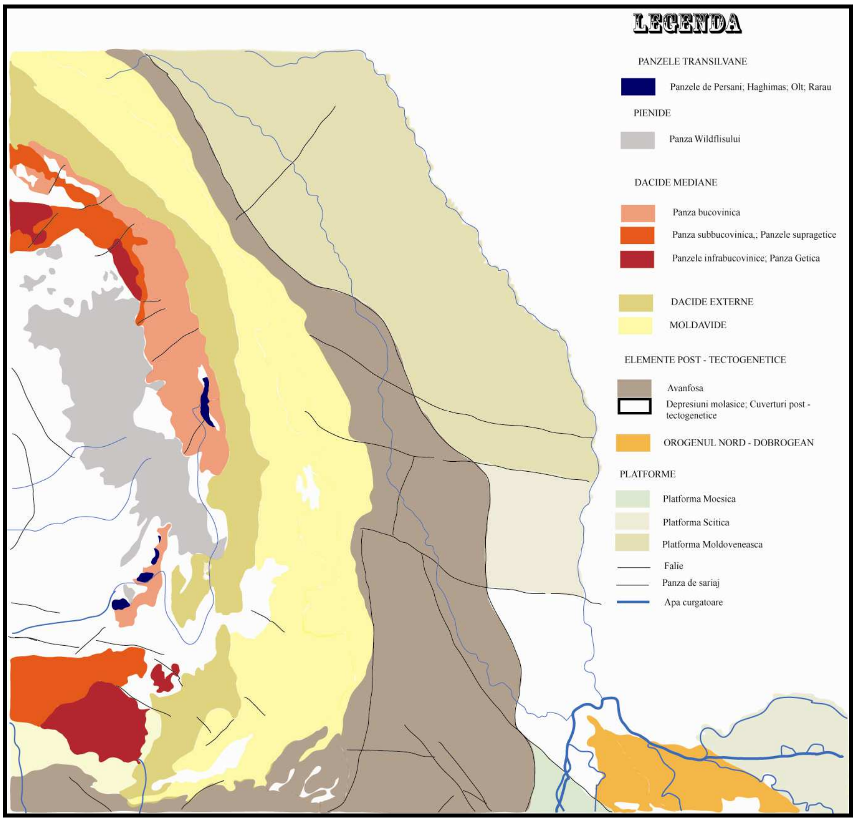

Fig. 2 Structural map of Romania 1:1000000 (after Săndulescu, 1984)

In Perşani Mountains the mesometamorphic crystalin sist group appears in restricted areas compared with central carpathian area (Rodnei Mountains, Rarau areas and Hăghimaş) outcroping in the Gârbova area (Dimitrescu, 1957).

With the upper Proterozoic an area of accumulation is installed, area in which were held all processes a tectonic-magmatic cycle (initially basic magmatism, subsidence and active sedimentation, orogeny, plutonic magmatism and metamorphism). Vulcano-sedimentary formations accumulated were were transformed by regional metamorfose in green sists facies during the baikalian orogeny. After Mutihac (1990) this whole group represents the crystalline epimetamorfic sist.

The Carboniferous formations have a restricted development and are represented by clay-coal sists and graphitous quartzite. Originally, these deposits were assigned to the Ciuta series (Manilici, 1956). Subsequently the metamorphic rocks of the Ciuta series have been recognized as belonging to the Făgăraş series (Dimitrescu, 1957).

Permian deposits are represented by breccias, polimictic conglomerates, consisting of crystalline sist fragments. The cement is silicious and has a redish color. In coarse deposits are interbedded with sandy red-purple or gray-green sist (Mutihac şi Ionesi, 1974).

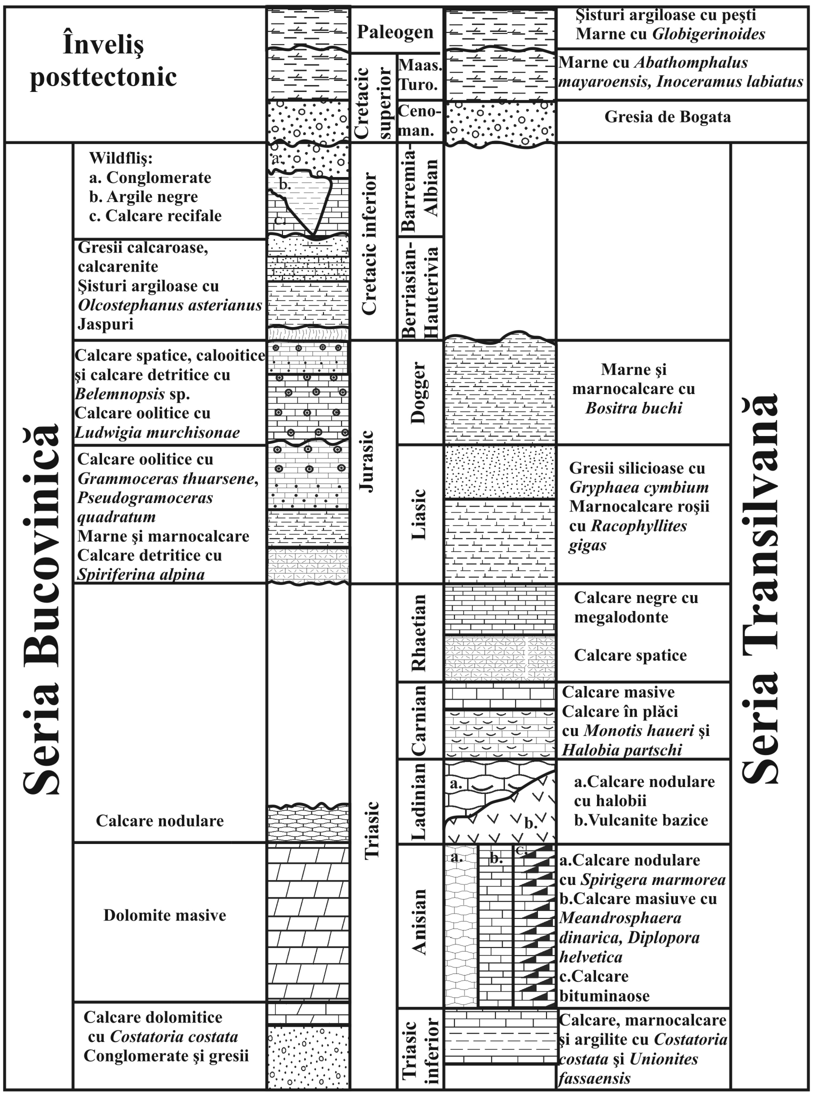

Fig. 3 The stratigraphy of Perşani Mountains (after Mutihac & Ionesi, 1974)

Mesozoic formations (Fig. 3) developed on the crystalline massif of Gârbova are represented by deposits of the Bucovinian Nappe, showing similar facies and of the same age with the Bucovinian Nappe in the Carpathians of Moldavia, and forms the autohtonous and parautohtonous of the Transylvanian Nappe. After Mutihac and Ionesi (1974) in Perşani Mountains mezozoic formations the of the Bucovinian series belong to the Triassic, late Jurassic (middle and lower) and Cretaceous (Berriasian-Hauterivian, Barremian, Apțian and Albian).

The mesozoic of alohtonous series of Perşani Mountains appears, as in the external marginal sinclinorium, either in the form of klippe or blocks, either as remnants of a nappe, constituting what Ilie (1954) named "Perşani Nappe", preserved mostly in the Comana region. The alohtonous sequence includes Triassic and Jurassic deposits until the middle Jurassic.

The post-tectonic (Cretaceous-Neogene) cover of the Perşani Mountains is the result of the accumulation of sediments after mesocretaceous (Austrian) tectogenesis. The big pieces of Transylvanian Nappe appear as klippes. In the conception of Patrulius (1996), urgonian limestones from the Perşani Mountains represent the first term of the Cretaceous-Neogene cover.

4. Materials and methods

This study is based on the investigation of over 1000 samples collected from 9 profiles over different areas. From these, thin and polished sections were produced that were studied under the microscope (Zeiss Axioskop and Zeiss Stemi DRC binocular) for their microfacies. The microphotos have been obtained by a digital Cannon PowerShot A640 camera. We have used the facies classification system proposed by Dunham (1962), extended by Embry and Klovan (1971) and revised by Wright (1992) (Fig. 4).

CLASIFICATION OF LIMESTONES (DUNHAM 1962)

DEPOSITION TEXTURE RECOGNIZABLE					DEPOSITIONAL TEXTURE NOT RECOGNIZABLE
Original components not bound togeder during				Original components were bound together during deposition as shown by intergrown or lamination contrary to gravity, sediment -floored cavities that are roofed over by organic matter and are too large to be	
Contains mud (particles of fine silt size)			Lacks mud and is grain supported		
Mud-supported		Grain- -Supported			CRISTALINE CARBONATE (Subdivide according classification designed to bear on phisical texture or diagenesis
Less than 10% grains	Morre than 10% grains				
MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BOUNDSTONE	

EXPANDED CLASFICATION (EMBRY and KLOVAN 1971)

ALLOCHTHONOUS LIMESTONE ORIGINAL COMPONENTS NOT ORGANICALLY ORIGINAL BOUND DURING DEPOSITION						AUTOCHTHONOUS LIMESTONE COMPONENTS ORGANICALLY BOUND DURING DEPOSITION		
Less than 10% > 2 mm components contains lime mud (<0.03 mm)			No lime mud	Grater than 10%>2mm components		By organism witch		
Mud-supported		Grain- supported		Matrix-supported	>2mm component supported	Build a rigid Framework	Encrust and bind	Act as bafflers
Less then 10% grains (>0.03 mm and <2 mm)	Grater than 10% grains					BOUNDSTONE		
MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	FLOATSTONE	RUDSTONE	FRAMESTONE	BINDSTONE	BAFFLESTONE

REVISED CLASFICATION (WRIGHT 1992)

DEPOSITIONAL				BIOLOGICAL			DIAGENETIC			
Mixed supported (clay and silt grains)		Grain- supported		In situ organisms			Non-obliterative			Obliterativ
<10% grains	>10% grains	With matrix	No matrix	Rigid organisms dominan	Encrusting Biding Organisms	Organisms Acted to baffler	Main component in cement	Main grain contacts micro-stylolites	Most grain contacts are micro-stylolites	Cristals >10μm
Calci- -Mudstone	WACKE- -STONE	PACK- -STONE	GRAIN- -STONE	FRAME- -STONE	BOUND- -STONE	BAFFLE- -STONE	CEMENT- -STONE	CONDENSED GRAINSTONE	FITTED GRAINSTONE	SPAR - -STONE
	FLOATSTONE	RUDSTONE								Cristals<10μm MICRO- SPARSTONE
	Grains >2 mm									

Fig. 4 Used classifications (after Flügel, 2004)

5. The significance of the term *Urgonian*

In 1850 d´Orbigny used the term urgonian to name a stage of lower Cretaceous (upper Neocomian) and considered rudist as an important element in its composition (Masse, 1976; Rat & Pascal, 1979). The name comes from the locality of Orgon in South-Eastern France. Many other facies, besides that of deposits with rudisti from Orgon, have been integrated later, because of their age, such as limestones and calcareous shales with cephalopods or shales with *ostrea* (Rat and Pascal 1979).

Facies considered as typical urgonian (characterized in essence by the presence of rudists) are associated with other facies types, which are part of the same overall sedimentary assemblages. As it was considered more appropriate to speak of urgonian systems, urgonian sedimentary system or rather biosedimentary urgonian systems, given the place occupied by live in the definition of this facies type.

6. Overview of microfacies associations from urgonian limestones of the Perşani Mountains

Our study led to the separation of six microfacies-associations types (labelled as MFA 1 to MFA 6) within the investigated limestones.

MFA 1 Boundstone with rudists, corals and sponges

The microfacies types grouped into this association are dominated by bioconstructors (rudists, corals, sponges etc.) frequently accompanied by red algae, microproblematic organisms and foraminifera. They build-up small patch reefs. The association includes boundstone with coral; boundstone with corals, rudists and sponges (Fig. 5, E-L); boundstone with bacinellid-type structures (Fig. 5, D, F); or bindstone with bacinellid-type structures and *Lithocodium aggregatum* (Fig. 5, A-C). As a rule, the rudists shells are well-preserved, showing minor or no borings. They are brocken in fragments and sometimes locally covered by bacinellid and *Lithocodium agregatuum* crusts. The internal sediment shows diverse compositions, from bioclastic intraclastic grainstone (Fig. 5, K) to packstone/wackestone . The bioclasts are represented by dasycladaleans (*Cylindroporella ivanovici*, *Griphoporella cretacea*, *Griphoporella* sp., *Neomeris cretacea*, crab fragments, orbitolinids (*Mesorbitolina texana*), miliolids, textulariids, encrusting foraminifera, microproblematic organisms (*Crescentiella moronensis*) and ostracods. In general, corals are superficially encrusted by *Crescentiella moronensis*, encrusting foraminifera (*Coscinophragma*), and to a lesser extent by bacinellid-type structures or red algae.

The type of internal sediment varies according to the hydrodynamic regime: intraclastic bioclastic wackestone formed under relatively low, while intraclastic bioclastic (peloidal) packstone under relatively high hydrodynamic conditions. In some cases, we noticed an abrupt transition between the two types of internal sediment. Also terrigenous grains (subangular quartz or rounded crystalline schists clasts) are present in various amounts, usually representing less than 10 % of the sediment.

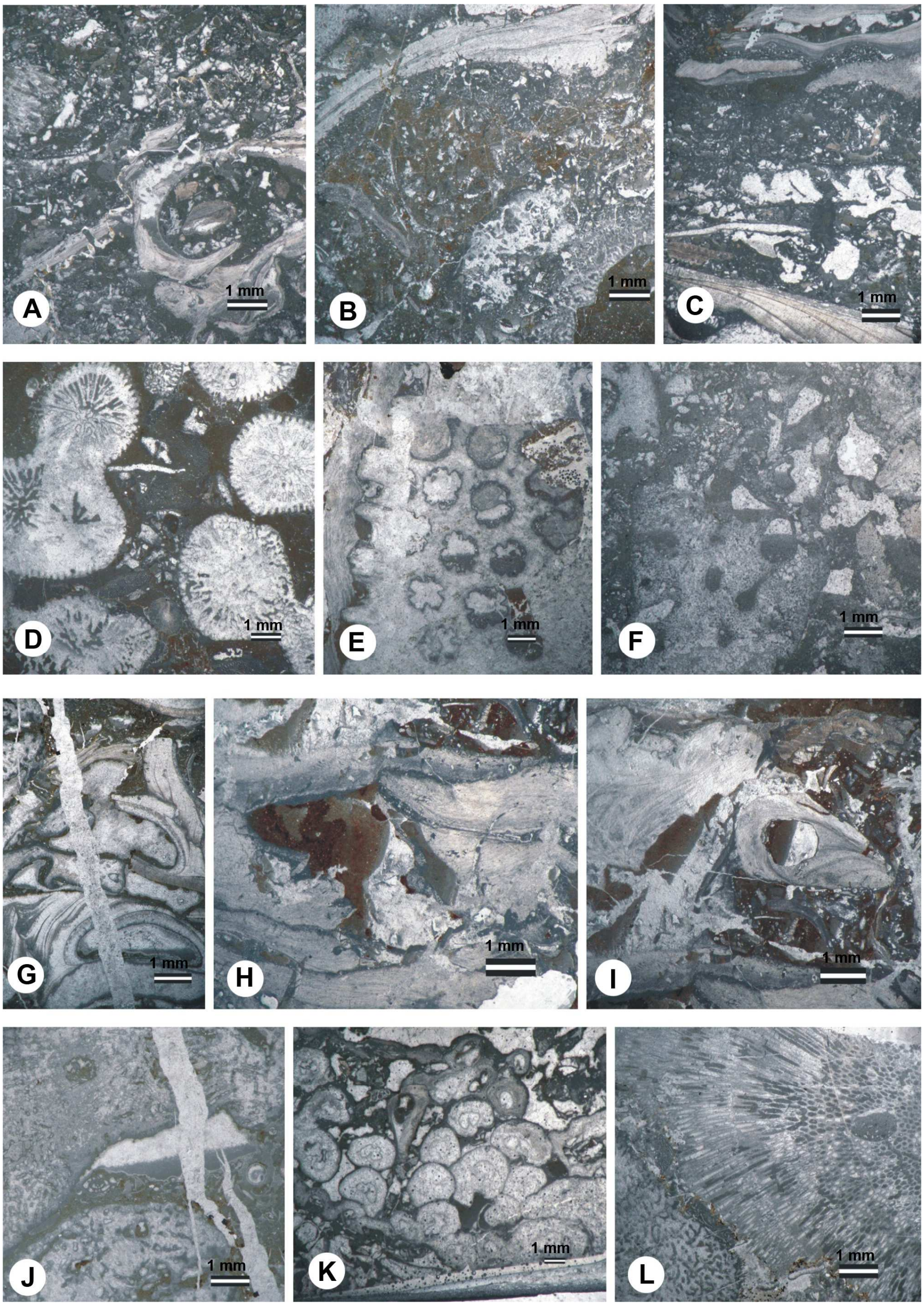

Figure 5 – Microfacies characteristric for MFA 1. A-C Bindstone with bacinellid structures and fragments of rudists, corals and sponges. D-F coral bounstone with ramified (D) or massive (E,

F) corals. Note the presence of geopetal sediment in the disolved coral structures (E, F). G-I Rudistid bounstone. J-L Coral (J, K) and sponge (L) bounstone .

The granular or fine granular cement filled the pores or replaced some dissolved fragments of rudist shells. In some cavities, dog-tooth-type cement lines the walls, while granular cement formed within the cavity.

Interpretation

The carbonate deposits grouped within this microfacies type are characteristic for a shallow, open marine environment with variable hydrodynamics. We assign this microfacies to the internal platform with medium to low sedimentation rate and frequent subaerial exposure stages, as indicated by the phreatic marine dog-tooth cement and the presence of Fe oxy-hydroxides (Fig. 5, B, E, H, I). In this area, there was only a minor sedimentary terrigenous input, represented by rare angular, submillimetre-long quartz grains and metamorphic schists clasts up to 2 mm in size. Bioconstructions are represented by small patch reefs, as opposed to those usually forming in the external platform.

MFA 2

Based on the presence of a grain-supported or mud-supported fabric, we have separated two subtypes within this microfacies (Figs. 6, 7):

MFA 2a **Bioclastic intraclastic packstone/grainstone/rudstone with fragments of rudists and corals,** and

MFA 2b Wackestone/floatstone with fragments of rudists and corals.

The main feature of both these subtypes is represented by the prevalence of corals and rudists, followed by sponges, as compared to the other grains. Besides, we have identified bacinellid (Fig. 6, J, K) and *Lithocodium* (Fig. 6, F, L) crusts, peyssoneliacean red algae and encrusting foraminifera on the large fragments of corals and rudists (Fig. 6, F, G, J, K). The bioclasts association also includes gastropods, orbitolinids, miliolids, textulariids, *Vercorsella* sp., *Troglotella* sp., *Cosscinofragma cribrossa*, ostracods, fragments of echinoids and crabs (*Carpathocancer triangulatus*, *Carpathocancer*? *plassenensis*) (Fig. 7 K), microproblematic organisms (*Crescentiella morronensis*) as well as green

(*Triploporella* div. sp. (Fig. 6, H; Fig, 7, C, H), *Neomeris* sp. and *Salpingoporella pygmea*) and red (*Polystrata alba* and *Para*-

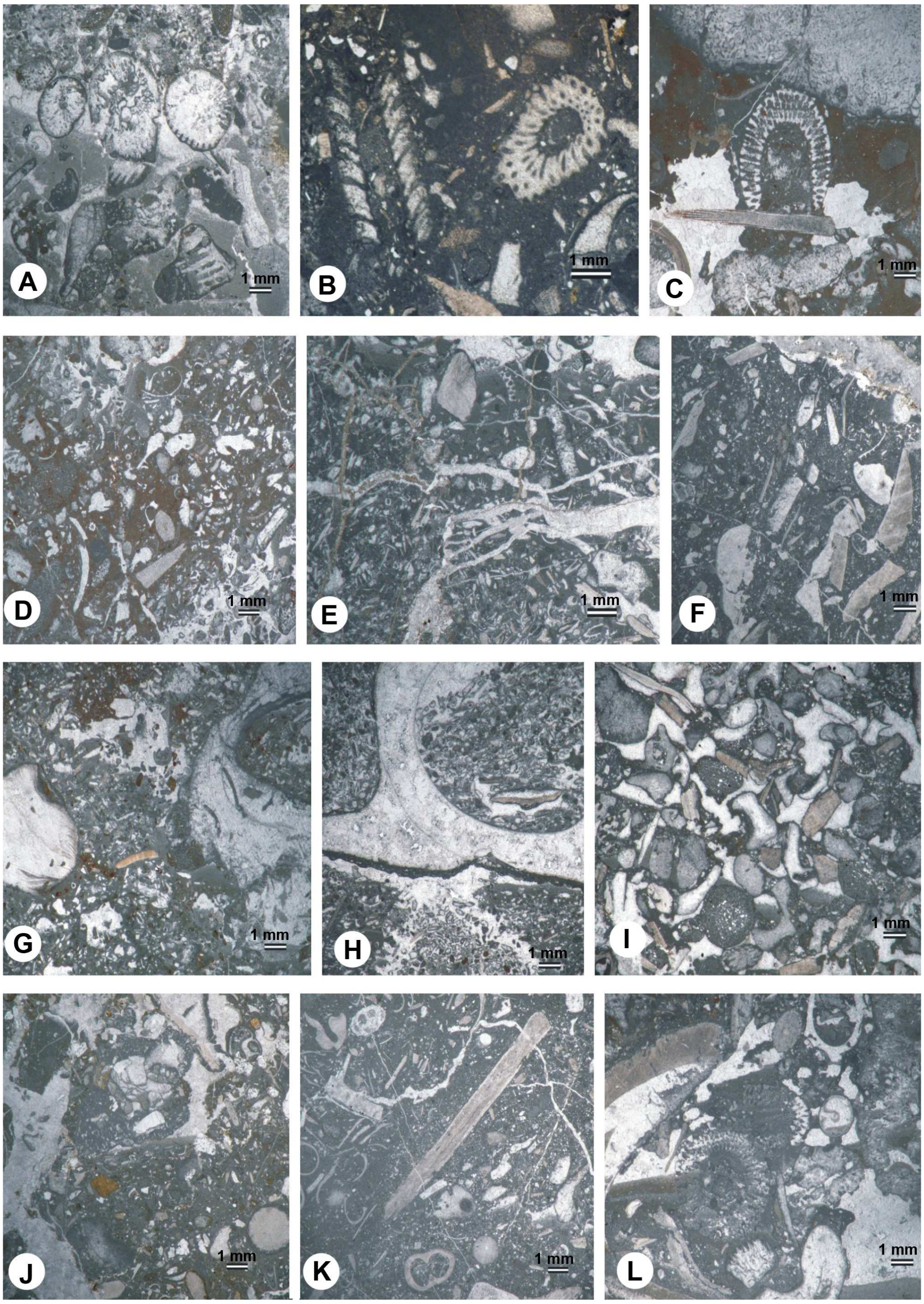

Figure 6 – Microfacies characteristric for MFA 2. A Bioclastic-peloidal packstone, B, C, L bioclastic grainstone, fine to medium grained (B), coarse grained with gastropods and corals (C), or with rudists, bacinellid structures and geopetal sediment (L). D, E, K bioclastic-intraclastic packstone/wackestone with fragments of dasycladalean algae (E) and fenestral structures (K). F

Bindstone with coral fragments encrusted by bacinellid structures. G-I Floatstone/rudstone with corals, rudist fragments and dasycladalean algae (*Triploporella* sp.)). J Fenestral bindstone with bacinellid structures and geopetal sediment.

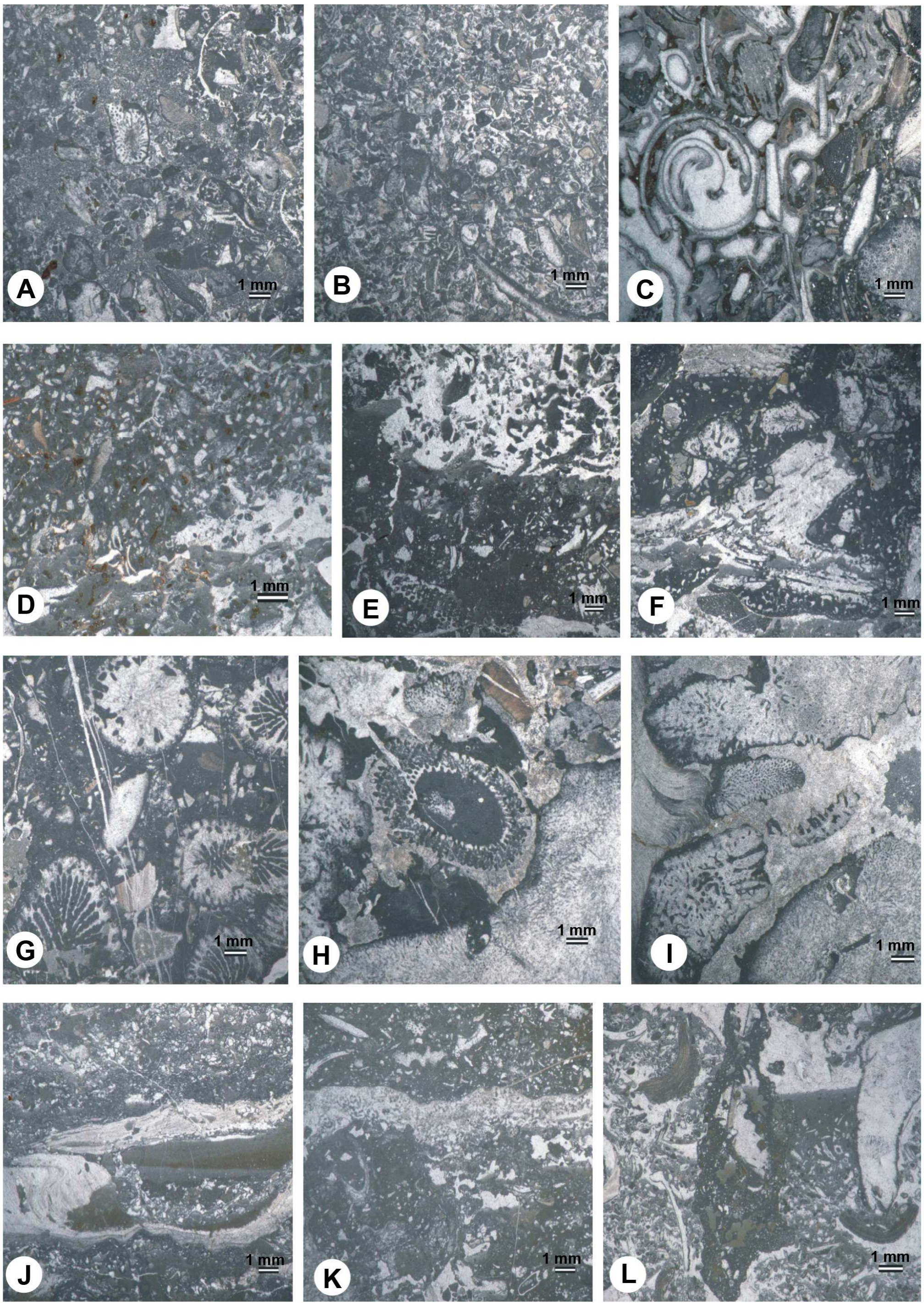

Figure 7 – Microfacies characteristric for MFA 2. A Bioclastic-peloidal grainstone with fragments of corals and calcareous algae. B, C, G, J, L Rudstone to floatstone with rudists, corals and dasycladalean fragments. H, I Bioclastic grainstone with frequent specimens of

Carpathoporella occidentalis (H), or with orbitolinids (I). K Bioclastic wackestone with fragments of moluscs and crabs (*Carpathocancer* sp.).

chaetetes sp.) calcareous algae. At certain levels, the fragments of rudists, crustaceans and gastropods form concentrations of shell debris.

The large rudists' fragments with bacinellid-type encrustations display fenestral structures that are sometimes filled with geopetal sediment and/or granular cement. The small rudists' fragments (2–3 mm) are intact or only slightly perforated, indicating stages with high sedimentary rates. The muddy sediment may contain subangular micritized intraclasts; among the small bioclasts, miliolids are dominant. The poor to moderate sorting resulted in fabrics with skeletal grains, intraclasts and peloids of various sizes. Occasionally, we have noticed bimodal sorting: the large fragments of rudists, corals, gastropods and crustaceans represent the coarse fraction, while the sub-millimetre bioclasts and intraclasts the fine one. Extraclasts are rare, being represented by subrounded or subangular fragments of crystalline rocks from the basement. They occur in amounts slightly higher as compared to the ones in the limestones assigned to MFA 1. Peloids and secondary dolomite crystals are relatively frequent, nevertheless in amounts not exceeding 15 % of the total clasts. The levels towards the top of the succession display fissures filled with calcite or occasionally with fine terrigenous sediment rich in iron oxy-hydroxides.

Interpretation

The shape of the bioconstructors (corals, sponges, or rudists) fragments varies from subangular to rounded, while the sorting is poor to moderate. These features plead for the alternation of stages with wave dynamics and calm stages. The fenestral structures (Fig. 6, J, L; Fig. 7, G, L) point to a shallow intertidal and/or subtidal environment, the latter being suggested by the presence of green algae (Fig. 6, H; Fig. 7, B, C, L).

The grains are mainly represented by fragments of rudists and corals associated with bioclasts and intraclasts from the internal platform. This suggests that bioclasts originate from areas with relatively high hydrodynamics, under the conditions of some storms episodes and/or intense bioerosion. The presence of dasycladalean calcareous algae and of large and small benthic foraminifera is an index for normal marine environments. The fragments of rudists, corals and other bioconstructors were transported along short distances within the median area of the platform (Fig. 11).

Two cement generations are present in the grain-supported limestone levels: the first generation is represented by the isopach cement that is common in marine/phreatic environments, while the second generation is represented by a fine echigranular pore filling cement that characterized subsurface and vadose meteoritic environments (Fig. 6, C, I, H; Fig. 7, I).

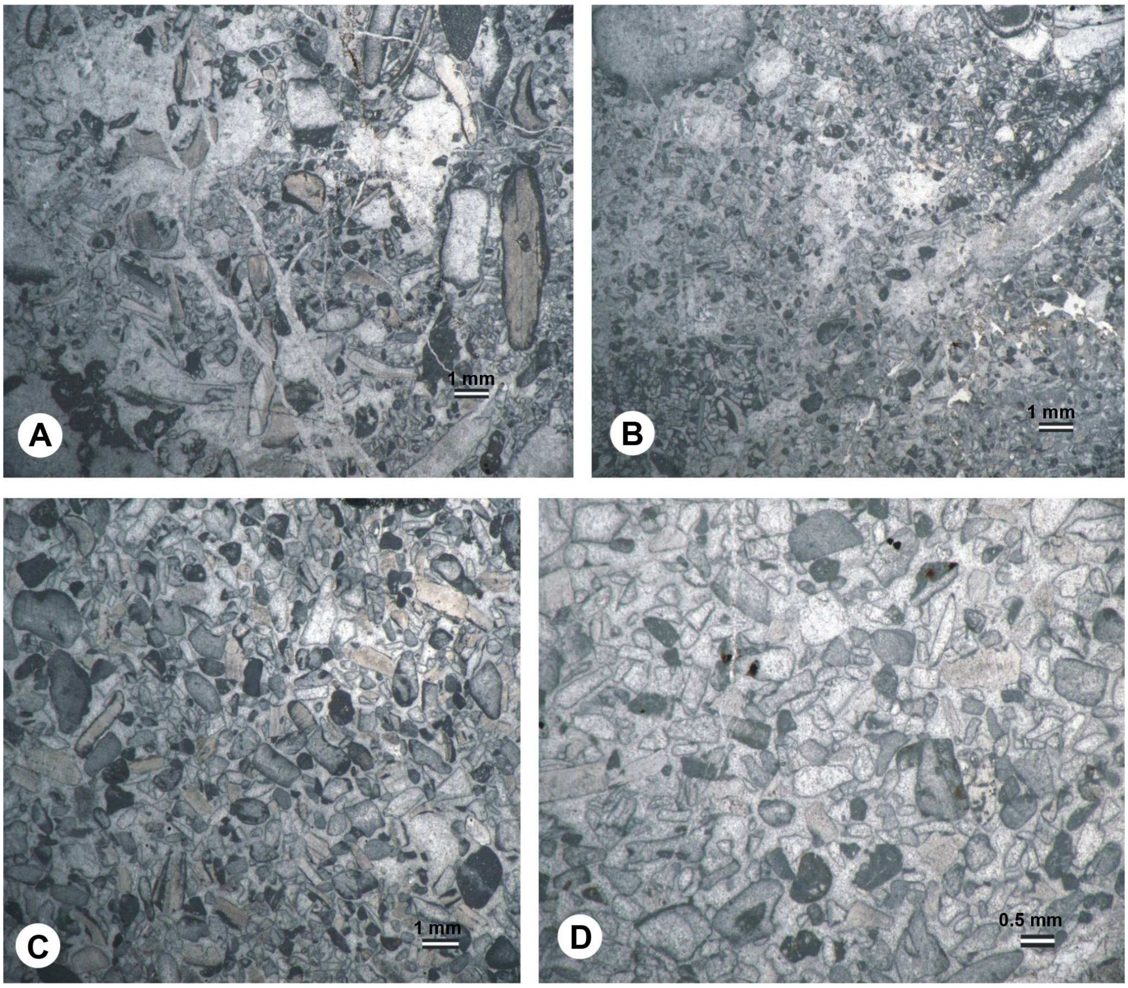

Figure 8 – Microfacies characteristric for MFA 3. A-D Intraclastic-bioclastic grainstone/rudstone with frequent mollusks, and rare echinoderm.

MFA 3 Intraclastic bioclastic grainstone/rudstone

The main characteristics of this microfacies association are the high degree of sorting and the subangular to subrounded grain morphology, besides the presence of the grain-supported fabric (Fig. 8, A-D). As a rule, the microfacies types grouped under this association represent either the base, or the top of the deposits assigned to the MFA 1 and MFA 2 associations. Among the grain types, the subangular intraclasts may represent up to 30-40%, while peloids, cortoids (including rare oncoids) can reach more than 25% (Fig. 8, B, D). Skeletal grains such as fragments of bivalves, gastropods, dasycladalean algae, foraminifers and echinoids occur in variable amounts (Fig. 7, A, C). Coral or other bioconstructors fragments represent only less than 10% of the total bioclasts. Orbitolinids (*Mesorbitolina texana*) and *Carpatoporella occidentalis* may locally become dominant among bioclasts; however, more commonly the micropaleontological association consists of miliolids, gastropods, dasycladaleans (*Griphoporella cretacea*, *Griphoporella* sp., and *Neomeris cretacea*), crab fragments (*Carpathocancer* sp.) and ostracods. Bioclasts do not exceed 25 % of the rock volume. Terrigenous extraclasts are relatively scarce (<5 %); they are represented by subangular, submillimetre quartz clasts frequently showing fissures filled with Fe oxy-hydroxides. Interpretation

The non-skeletal components, *i.e.*, intraclasts, peloids, cortoids and oncoids) and the sparitic cement plead for an agitated subtidal environment. The skeletal fragments of dasycladaleans and the orbitolinids characterize well-oxygenized normal marine environments. Based on the clasts shape and the grain-supported fabric, we can conclude that the shallow subtidal environment had high hydrodynamics, above the base of the fair-wather waves. These facies types accumulated in the area of platform margin with bioclastic shoals.

MFA 4 Fenestral bindstone/wackestone/packstone

This microfacies association is characterized by the presence of fenestral and geopetal structures that are usually common in intertidal areas (Fig. 9, A-I). The fenestrae may consist of open cavities or of voids fully or partly filled with sediment or diagenetic products (silt with Fe oxides or cement).

The microfacies we grouped under the MFA 4 type are: bindstone with bacinellid structures, *Lithocodium*, fragments of corals and rudists, and poorly bioclastic fenestral wackestone/packstone. The fenestrae and geopetal structures display various morphologies: elliptical, with oval base and irregular top or irregular shape, while sizes vary from millimetres to submillimetres.

As a rule, fossils are scarce in these microfacies types. Occasionally, they may contain fragments of rudists or corals, besides fenestral structures filled with vadose silt or

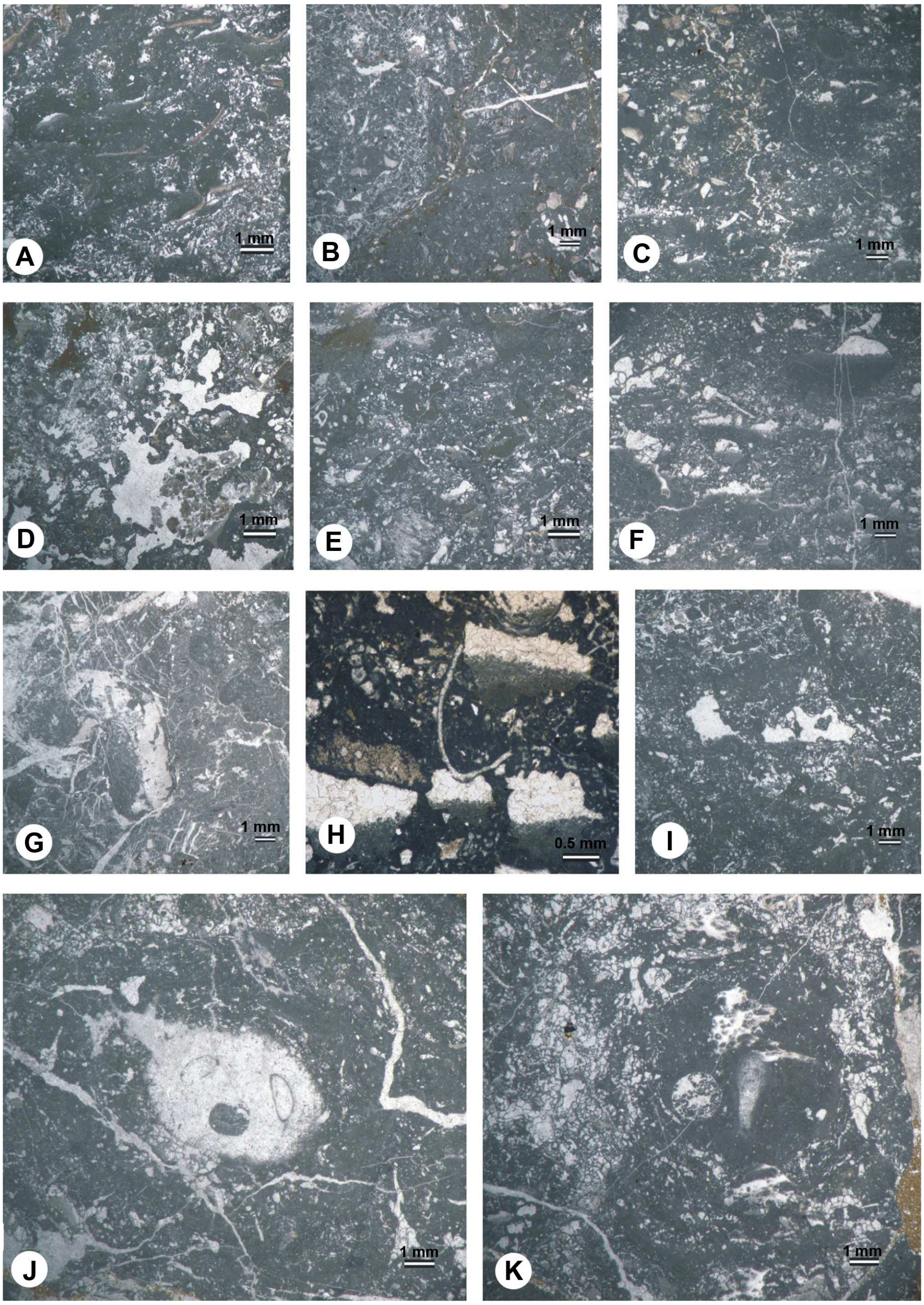

Figure 9 – Microfacies characteristric for MFA 4 and MFA 5. A-C, G Intraclastic-bioclastic wackestone/packstone with bacinellid oncoids, occasionally with rudist fragments -F, H Fenestrate bindstone with bacinellid structures and *Lihocodium*, with geopetal sediment I

Bidnstone with bacinellid structures passing to a bioclastic packstone (left upper part). J, K Bacinellid oncoids, with a complex core (J) made up of coral fragments, peloid and intraclasts, or with a core represented by a recystalised gastropod (K)

skeletal grains and peloids. The associated sediment is represented by wackestone/packstone with subordinate bioclastic-intraclastic content. The bioclasts include rare echinid plates, crab fragments, dasycladalean fragments, miliolids, gastropods, ostracods and microproblematic organisms (*Crescentiella morronensis*). Sometimes, the foraminifer *Coscinophragma* contributes significantly to the encrustations covering the rudists and corals fragments, while *Bacinella*-*Lithocodium*-type structures bound the whole assembly. We did not identify terrigenous extraclasts.

Interpretation

The fenestral structures, as well as early diagenetic features are indicate peritidal (subtidal, intertidal and supratidal) environments (Shinn, 1968; Tucker & Wright, 1990). The micropaleontological association suggests a subtidal to intertidal environment with moderate to low hydrodynamics. This suggests an open lagoon within the platform interior.

MFA 5 Grainstone /rudstone with "*Bacinella*"-*Lithocodium* macroids and non-laminar structure, with fissures filled with terrigenous sediment

The organisms that usually develop non-laminar oncoids include foraminifera, serpulids, bryozoans, sponges, chaetetids and the microproblematic organisms "*Bacinella*"-*Lithocodium* (Flugel 2004). We have identified oncoids in a single geological section (Hamaradia), and in a single level. These oncoids showing non-laminar structure and nodular texture, as well as fissures filled with fine sediment consist of "*Bacinella*"-*Lithocodium*-type structures (Fig. 9, J, K). They are 1 to 5 cm in size, and they can be assigned to the macroids class according to Peryt (1983). The oncoids' core incorporates bioclasts such as micritized fragments of gastropods (Fig. 9, J) or corals (Fig. 9, K), while the cortex shows reticulated "*Bacinella*"-*Lithocodium*-type structures. The sediment in-between oncoids consists of intraclastic bioclastic wackestone/packstone. The skeletal grains are occasionally bind by bacinellid structures. Besides intraclasts, foraminifera (miliolids and fragments of orbitolinids) and crab fragments (*Carpathocancer* *plassenensis*) occur frequently. The fissures are filled with siltic terrigenous sediment (Fig. 9, K).

Interpretation

The oncoids produced by microbial, algal or other encrusting organisms represent common elements in limestones formed on carbonate platforms. The type of skeletal fragments, as well as the size and non-laminar texture of the oncoids suggest a normal intertidal-subtidal marine environment of open lagoon.

MFA 6 Carbonate conglomerates/breccia with terrigenous material and calcareous sandstones

We have noticed such deposits in the base of most of the sections in the central (Gârbova crystalline zone) or southern part (Făgăraş crystalline zone) of the area under study. Their basic feature is a rich terrigenous supply within the carbonate sediments, with sparry cement.

Up to 40% of the total rock volume may be represented by terrigenous material. Small (<0.5 mm) quartz grains and larger (1–5 mm) subangular or rounded crystalline schists grains are embedded in a carbonate matrix or cement (Fig. 10, A-G). The carbonate clasts are reworked fragments of corals (broken, dissolved, with or without crusts), fragments of crustaceans (*Carpathocancer plassenensis*), fragments of bivalves and foraminifera: orbitolinids (complete or fragmented, with submilimeter quartz grains within their tests), rare textulariids, dasycladaleans (*Neomeris* sp., *Triploporella frassi*) and miliolids. The terrigenous clasts show subangular to rounded morphologies (Fig. 10, A-F, G), while their sizes are in the centimetre range, occasionally exceeding 20 cm. The sources of the terrigenous material are the crystalline Gârbova series in the central area, and the Cumpana-Holbav series in the south. Lens-shaped carbonate sandstones bodies (Fig. 10, H, I) are interlayered within the conglomerates or limestones with terrigenous material. These sandstones contain up to 80–90% silt-sized terrigenous material. The carbonate fragments are usually represented by bioclasts and less often by granular aggregates. As a rule, the sandstones are well- to very well-sorted, while the clasts are subangular to rounded.

Interpretation

The dominantly siliciclastic deposits point to significant terrigenous supply from the continent. Based on the textural, structural and compositional features of these facies types, we concluded that these successions represent extensions of some alluvial fans. The calm episodes have generated arenitic deposits, while the turbulent ones the conglomerates and breccias. This association can be related to a potential uplift stage in the platform evolution, as the angular carbonate fragments characterizing the MFA 2, MFA 4 and occasionally MFA 3 associations are embedded together with the terrigenous clasts (quartzites, schists) within a carbonate matrix. Most probably, the breccias, conglomerates and microconglomerates interlayered with calcareous sandstones were formed in a littoral environment.

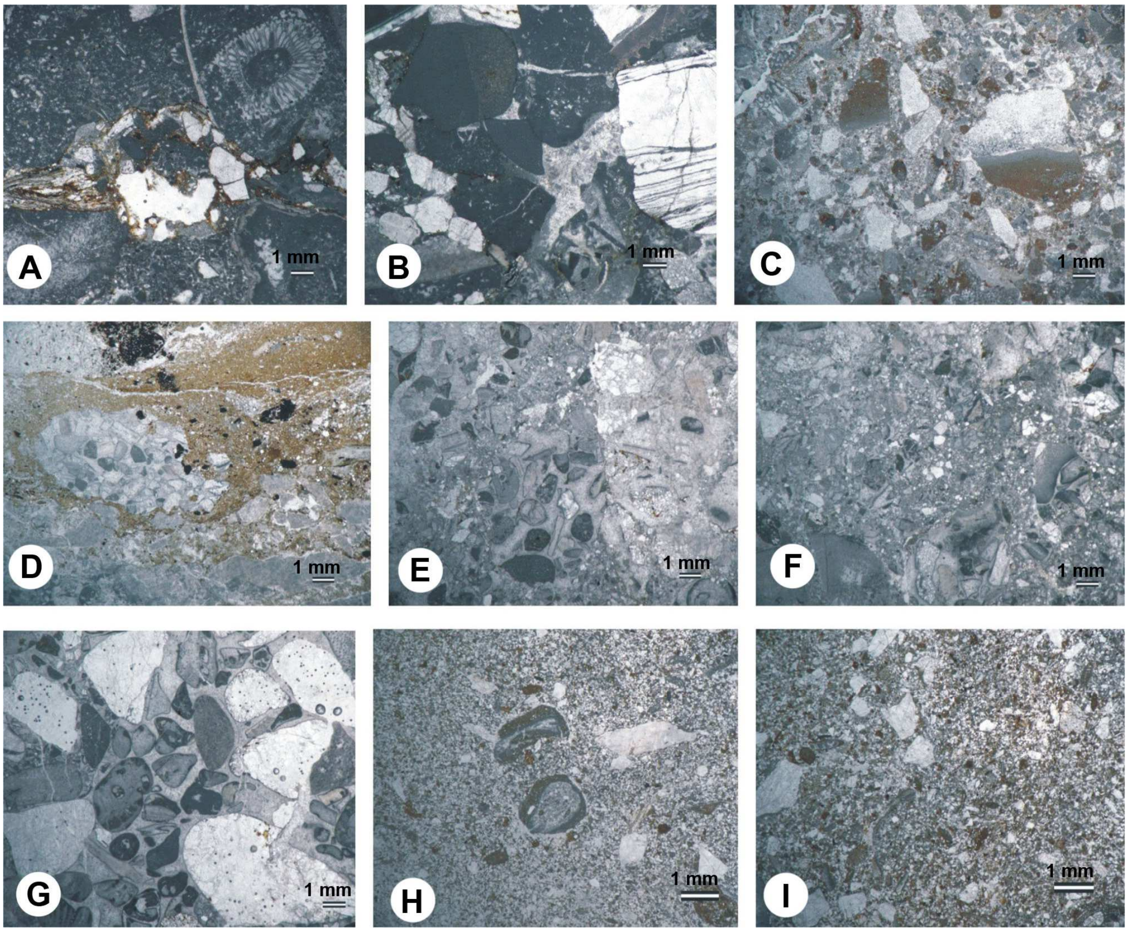

Figure 10 – Microfacies characteristic for MFA 6. A-C, E, F Microbreccia (with *Triploporella fraasi* in A) D, H, I Carbonate sandstone. G Conglomerate with quarzite fragments, and bioclasts represented mainly by mollusks and echinoderms).

7. Discussion

The microfacies analysis enables us to formulate some hypotheses on the depositional environments of formation for the Urgonian-type limestones in Perşani Mountains. The data interpretation support the identification of the following carbonate depositional systems:

a) open platform margin with intraclastic-bioclastic shoals;

b) open platform-interior with isolated bioconstructions and lagoons;

c) marginal-littoral system.

a) Open platform margin with intraclastic-bioclastic shoals

Two models were generally used in interpreting the sedimentation in the Urgonian systems: (1) one assumes the presence of a barrier between the more or less protected areas of the platform and the external, open basin, and (2) a second one that does not imply a barrier. In the studied area, we consider that the second model fits better (Fig. 11), while taking into account that the slope could not be documented here.

The early diagenesis and the types of components are arguments for the presence of some intraclastic-bioclastic shoals located at the platform margin (Fig. 11), characterized by the microfacies types grouped under the MFA 3 association. These shoals did not fully separate the internal and external platform. In general, the intraclastic-bioclastic shoals located at the platform margin are controlled by tidal currents or by fair-wather and storm waves, along the shore line (Davies, 1970; Enos, 1977). Specific components differentiate among the platform margin and the littoral/tidal shoals. Thus, in the carbonate platform margin clasts are mainly related to bio-constructed facies types. In such environments, the development and evolution of the granular bodies has been mainly influenced by the relative sea level changes, the actual topography, physical-mechanical factors (such as tidal currents, fair-wather or storm waves) and by diagenesis (Halley et al., 1983).

b) Open platform-interior with isolated bioconstructions and lagoons

In this case, the most typical environments are represented by the biotopes with rudists (Fig. 11). Often, they contain deposits from the MFA 1, MFA 2 and MFA 3 associations mixed in various concentrations. The shallow environments with rudists are dominated by intense dissolution, borings, encrustations (performed by foraminifera, red algae or microproblematic organisms), bioerosion and mechanical fragmenting. Episodes of low to medium energy and reduced sedimentary rates are documented by the presence of internal sediment consisting of bioclastic packstone. On the contrary, when the water energy was high, the internal sediment consisted of bioclastic intraclastic grainstone; also, the rudist fragments lack borings. The shells of rudists, corals or other bio-constructors were slightly fragmented and reworked, being transported along small distances. In the MFA 1 association, we noticed very little fragmentation of these shells that are involved in the formation of some isolated bioconstructions. In this depositional environment, the common facies types are characteristic for the shallow subtidal to intertidal marine domain.

In these deposits, some of the sequences evidenced a slightly diversified micropaleontological association dominated by "*Bacinella*"-*Lithocodium*-type structures. Their irregular growth resulted in fenestral structures. The bioclastic intraclastic wackestone with fenestral structures and the fenestral bindstone with bacinellid structures plead for a subtidal-intertidal environment with relatively low hydrodynamics.

c) Marginal-littoral system

The facies included within this system can be assigned to the infra-, medio- and supratidal zones (Fig. 11). In this case, the internal platform margin is characterized by a significant terrigenous supply resulting in the formation of beach sand deposits and expanded terrigenous fans. Such deposits have been described from Urgonian successions of Santander region, Spain (Rat, 1959; Pascal, 1976; Garcia-Mondejar, 1979). In the case under study, we can argue for a littoral platform margin characterized by important terrigenous supply consisting of mixed, carbonate-terrigenous sedimentation (MFA 6), or carbonate sedimentation only (MFA 4 associated with MFA 5, and rarely with MFA 3).

Besides the carbonate components, the calcareous conglomerates and sandstones also include fragments of crystalline schists originating from the Gârbova series, or from other units within the Perşani sedimentary succession.

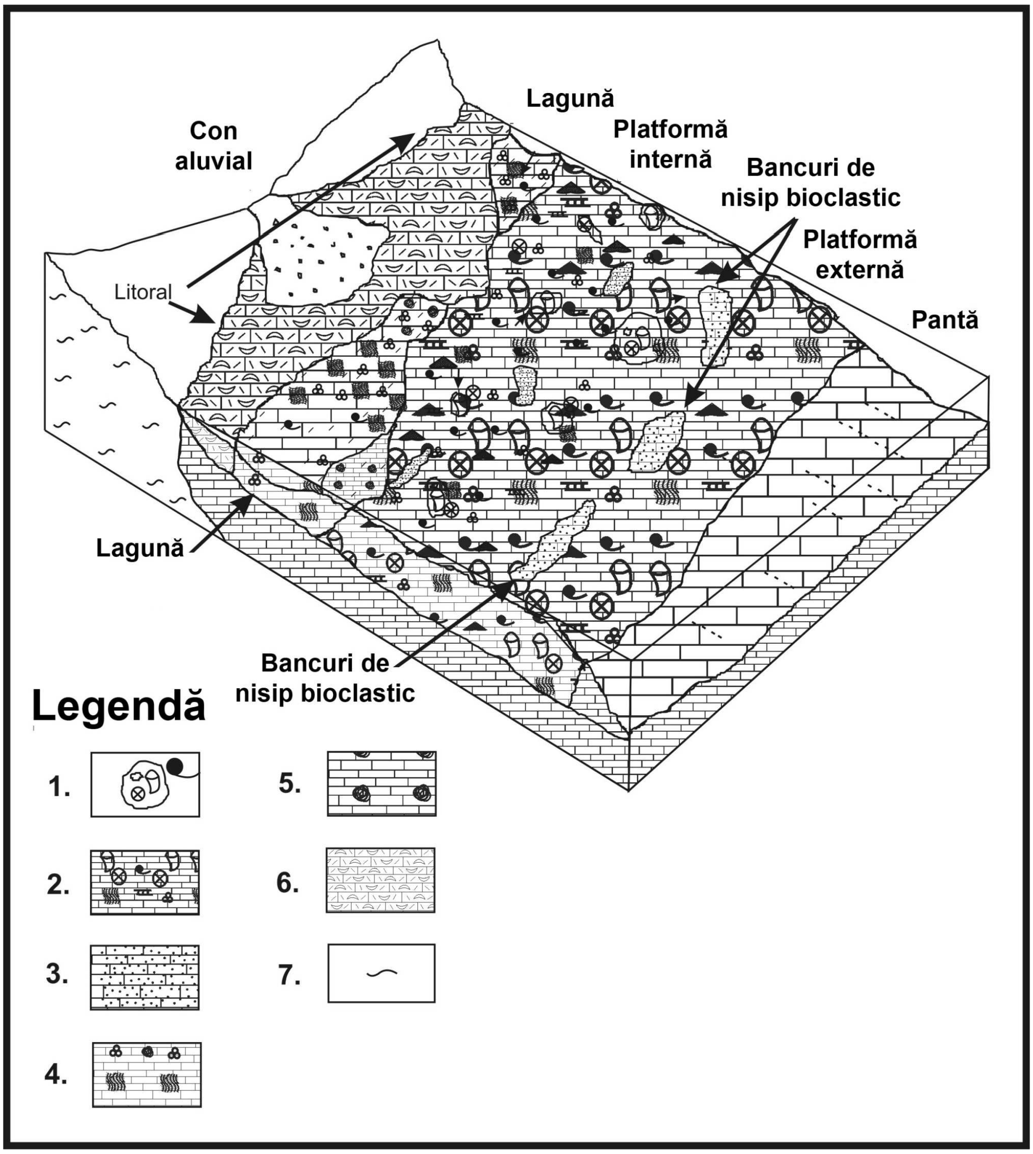

Figure 11 – Tentative reconstruction of the different paleoenvironments characterisctic for the Urgonian limestones of Perşani Mountains. 1, MFA 1: boundstone with rudists, corals and sponges; 2, MFA 2: Floatstone/rudstone with corals, rudist fragments and dasycladalean algae, fenestral bindstone with bacinellid structures and corals, bioclastic-intraclastic grainstone/packstone/wackestone; 3, MFA 3: intraclastic-bioclastic grainstone/rudstone; 4, MFA4: fenestral bindstone/wackestone/packstone; 5, MFA 5: grainstone/rudstone with bacinellid oncoids; 6, MFA 6: conglomerate/breccia and calcareous sandstone; 7, crystalline basement.

8. Conclusions

Our study tried to bring new data that contributes to the knowledge of the Urgonian-type limestone from the central and southern sector of the Perşani Mountains. 9 sedimentological sections were made, for which we have collected 1110 samples and at least a thin section from each sample was made.

This paper represents the first attempt to characterise the microfacies of limestones developed in Urgonian facies of central and southern areas of Perşani Mountains illustrated in 42 Figures.

We have separated six types of associations of microfacies, based on analysis of the grains, texture-structure and diagenet phenomena that have affected these deposits.

The interpretation of microfacies associations allowed the classification of the studied deposits in depositional systems characteristic of carbonate platforms: open platform edge with intraclastic-bioclastic shoals; internal open platform, with isolated bioconstruction and lagoons; littoral-margin ensemble.

Rudists, which are next to the corals and, more rarely, sponges the main source of bioclastic didn't have a essential builder role, tis being a feature of the urgonian biosystems (Masse, 1976; Pascal, 1976; Pascal et Rat, 1979). Fragments from the crystalline basement (Gârbova series and Cumpăna -Holbav series) and other structural units that make up the Perşani Mountains, along with elements of the carbonate platform, compose the source material of the calcareous sandstones and conglomerates of the studied area.

The urgonian limestones of Perşani Mountains contain a wide variety of microfossils, and the main organisms were illustrated in 24 pages. 4 species of *Triploporella* and a fossiliferous point in the region of Fântâna have been identified.

The limestones from Harham Hill, Cuibului Hill, the Mâmăstire Valley, Hămărădia Valley and Cerboaia Valley have a age contained within the upper Barremian-lower Aptian interval indicated by Palorbitolina lenticularis (Blumenbach) and Montsecialla arabica (Henson).

Upper Apțian age deposits in the area Fântâna, Trestia Valley and Hill Gârbova is confirmed by the presence of the orbitolinid foraminifera *Mesorbitolina texana* (Roemer).

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