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The Lower Cretaceous deposits from the Hăghimaș Massif: microfacies, microfossils and sedimentary evolution

EXTENDED SUMMARY OF THE PHD THESIS

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Cluj Napoca
2019

CUPRINS

Key words: Lower Cretaceous, limestones, olistoliths, sedimentology, microfacies, microfossils, depositional environments, Hăghimaș Massif, Hăghimaș Nappe, Eastern Carpathians.

Introduction

The main purpose of this thesis is to study the Lower Cretaceous limestones. These deposits were studied by applying microfacies and micropaleontological analysis techniques in order to determine their age and their sedimentary evolution.

Carbonate rocks started to be studied in the 1950's when numerous oil bearing deposits were discovered in carbonate rocks. Towards the '60's and the '70's such microfacies analysis techniques became an integrating part of paleoenvironmental interpretations. The evergrowing importance of dolomites and limestones as reservoir rocks and the usage of thin section microfossils in order to define carbonate platforms have brought a great imbold for the progress of microfacies research (Flùgel, 2004).

1. Geographical location

The Hăghimaș Massif overlays entirely the homonymous Mesozoic syncline unit that stretches from north, from Bistricioara towards Frumoasa-Ciuc to the south. The eastern limit with the Ceahlău flysch structure corresponds with the Pintec Creek and Jidanului Valley. From there, it continues with Dămuc, Valea Rece and the Trotuș springs.

The Mesozoic sedimentary units from the western and northern part consist of erosion witnesses that contain Triassic dolomites (Vithavaș, Beneș, Piatra Arșiței, Piatra Comarnicului and Măgura Hangului). These structures are located in the Giurgeu and Bistriței Mountains in the Putna Întunecoasă and Valea Bistricioarei areas (Grasu et al., 2012) (Fig. 1).

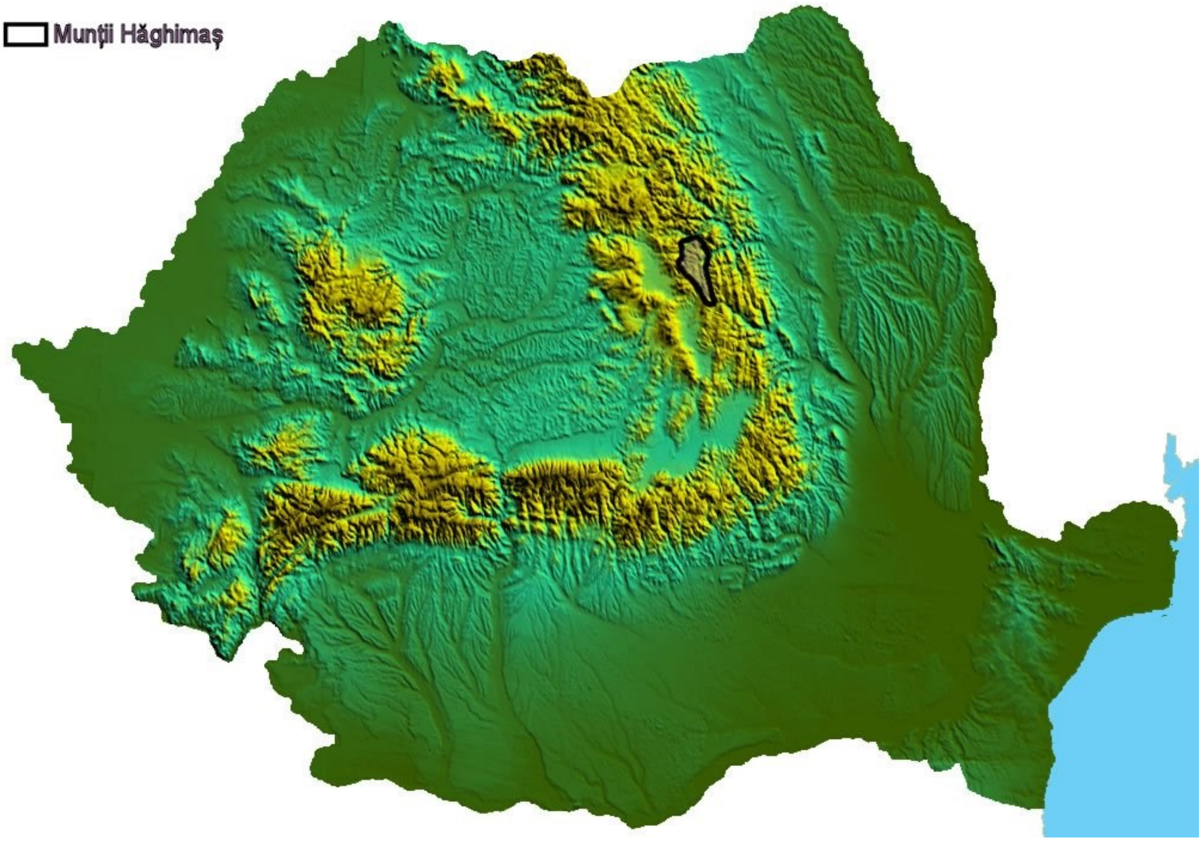

Fig. 1: Location of the Hăghimaș Massif within the Romanian Carpathians (source: https://en.wikipedia.org/wiki/Geography_of_Romania#/media/File:Romania-relief.png)

2. Geological research history

The earliest geological studies of the Hăghimaș Massif were performed by Herbich (1866, 1870, 1873, 1875). The same author prepared in 1878 a large synthesis that approached the „*Geology of the Szeklerland*„. In addition, Herbich discovered the fossiliferous locations from Ghilcoș and Ciofronca (*Acanthicum beds*) which form important reference points for the Malm deposits from this region of the Eastern Carpathians. In 1915, Vadasz published the last foreign geological contribution from the Hăghimaș Region. The author mentions the Adneth type Liassic deposits from Curmătura and brings important contributions for the knowledge of the Štramberk type limestones. The most important interwar studies were published by Atanasiu (1928) and Băncilă (1941) who studied in detail the geology of this region in order to produce the first modern geological maps. Săndulescu (1968, 1969), brought important contributions for the knowledge of the Mesozoic deposits from the Hăghimaș syncline by synthesising all this data in a PhD Thesis published in 1975.

In 1981, the author published a new paper concerning the geology of the region and in 1984 some of these results were presented in a book entitled *Geotectonics of Romania*. The first microfacies study of the malm-urgonian limestones belongs to Dragastan (1975) who describes in detail the carbonate deposits from the Bicazului Gorges area. Other micropaleontological contributions that deal with the transilvanian series were produced by Neagu and Neagu (1995) and Bucur (2006, 2011). Bucur (2006) mentions an association of dasycaldalean algae from the Urgonian Hăghimaș limestones. The author establishes their stratigraphic value and their importance for paleoenvironmental reconstructions. Other authors [Grasu et al., (2010, 2011, 2012) Grigore (1998, 2002), Grinea (1998), Mureșan (2006, 2008), Popescu (2001, 2003, 2008) and Hoeck et al. (2008, 2009)] published some recent papers that deal with various aspects concerning the crystalline-mesozoic area, with emphasis on the Hăghimaș syncline.

3. Geological framework

The crystalline schysts form the basement of the Hăghimaș Syncline, on both flanks. Their thickness gradually reduces towards south as they are covered by the Cretaceous deposits of the Ceahlău Flysch and the Pliocene Mihăileni-Frumoasa volcanosedimentary formation (Grasu et al., 2010) (Fig. 2). This basal unit is covered by the Mesozoic sedimentary units that contain either autochtonous deposits (**Bucovinian Nappe**) or allochtonous deposits (**Transilvanian Nappe**). The **Subbucovinian** unit is present only as a planing shred at the confluence between Dămuc and Bicaz Valley or at the Tomești tectonic window. This succession is incomplete, it contains numerous discontinuities corresponding with non-conformities which are marked by erosion and sedimentary gaps (Grasu et al., 2012).

Bucovinian Nappe

The Bucovinian Nappe represents the upper unit, within the central-eastern european nappe systems. It contains allochtonous sedimentary deposits belonging to the outer margina syncline. If compared with the other bucovinian series, the Mesozoic sedimentary succession is the most complete in this tectonic structure. However, frequent sedimentary gaps ar present at the end of Triassic, in the Lower Jurassic, after the Neocomian, after the Albian and probably after the Cenomanian. In the Hăghimaș area, the Bucovinian Nappe has one of the most complete stratigraphic successions. The best outcrop areas are located in the inner parts of the structure. (Grasu et al., 2012) (Fig. 2).

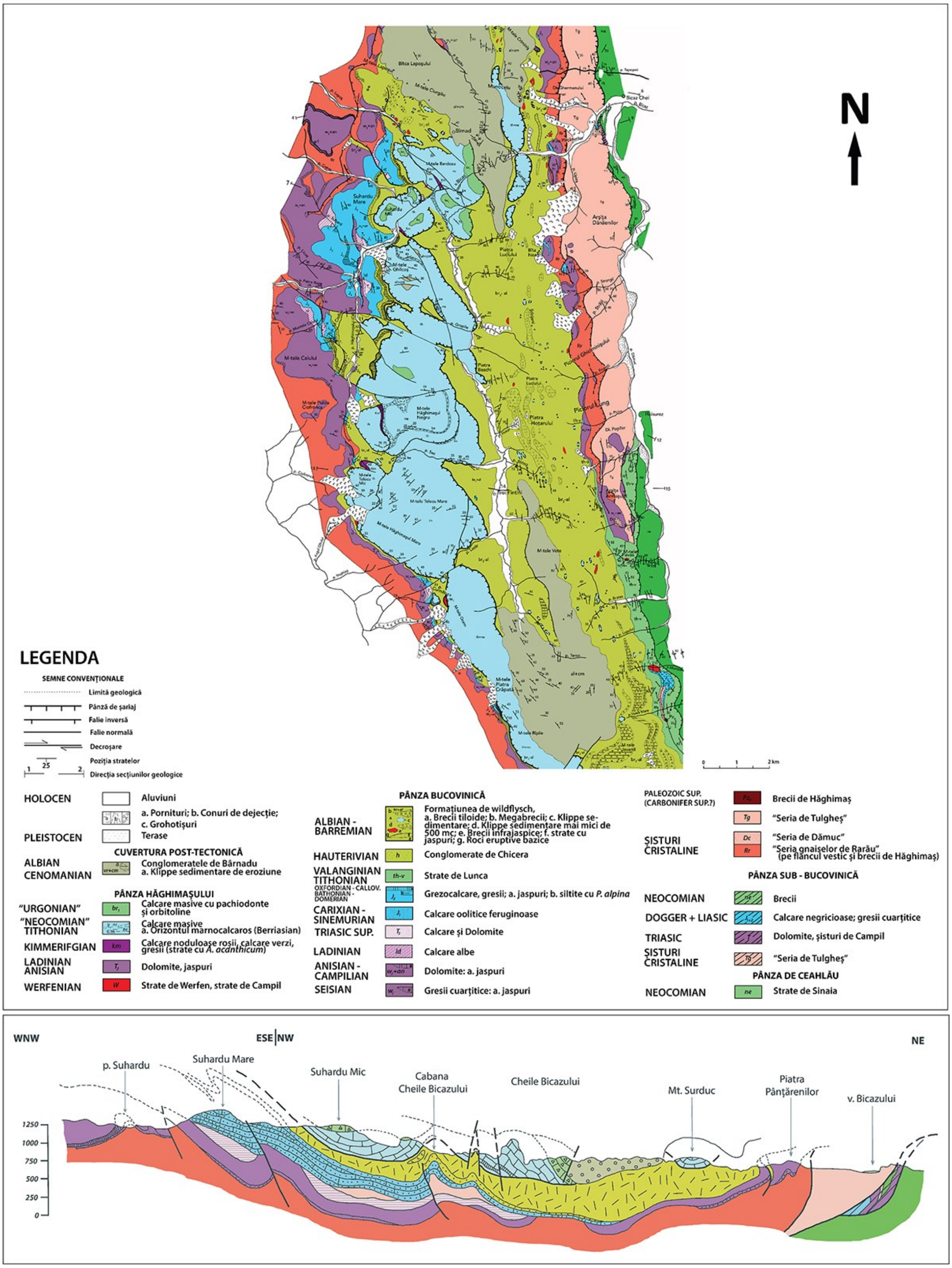

Fig. 2: Geological map/section of the Hăghimaș Syncline (redrawn from Săndulescu, 1975).

Hăghimaş Transylvanian Nappe

The allochtonous sedimentary formations of the Moldavian and Perșani Compartments belong to a a couple of transilvanian series that form individual nappe systems (Săndulescu, 1984). Each of them is defined by a specific stratigraphic suite with ophiolites of different ages. The accumulation of these deposits was controlled by the spreading of a Triassic-lower Cretaceous ocean. This process has influenced the heterochronous character of these sedimentary formations. As a consequence, there are no complete sedimentary successions within these nappes since the entire process was influenced by the synrift and post-rift stages (Grasu et al., 2012).

Săndulescu (1984) defines three distinct Transylvanian Nappes (Hăghimaș, Perșani and Olt) with the first one having the most internal position. Its internal position is indicated by the existence of more recent Kimmeridgian-Urgonian deposits. In addition, the presence of overthrusted Triassic deposits from the outer areas of the Transylvanian trough represent further arguments to sustain this idea (Fig. 2).

The Triassic formations belonging to the Hăghimaș transylvanian series are present as reworked blocks within the autochtonous bucovinian sedimentary formations (Grasu et al., 2012).

4. Materials and methods

Over ten fieldwork campaigns were performed in order to produce this study. Samples were taken from carbonate deposits belonging to the most important carbonate formations from the Bicaz Gorges area. A special attention was given to the Upper Jurassic-Lower Cretaceous deposits. 906 samples were collected and an equal number of thin sections were prepared. For sections were studied: Muntele Ghilcoș, Muntele Suhardu Mic, Valea Lapoșului, Valea Bicăjelului (Fig. 3, a, b, c, d).

The fieldwork campaigns were performed in two years with emphasis on outcrop description, outcrop photographs, sample collection and detailed logging activities. Other macroscopic features involved the description of the main components, bedding and sedimentary structures, faults and stratigraphic unconformities.

Thin sections were prepared in laboratory, from the collected samples in order to perform microscopic analysis. Matrix and granulometric analysis of the main components were performed in order to decipher the controlling factors of the sedimentary paleoenvironment. Carbonate rock description and classification folows Dunham (1962), Embry & Klovan (1971) and Wright (1992).

Microfossil analysis and their stratigraphic occurence were performed by consulting a series of published papers [Altiner (1991), Arnaud-Vanneau et al. (1988), Bassoullet (1997), Bruni et al. (2007), Bucur (1999), Bucur & Săsăran (2005, 2011), Bucur et al. (1995, 2013, 2014), Dragastan (1971, 1975), Farinacci & Radoicic (1991), Granier & Deloffre (1993), Masse (1993), Neagu (1994)].

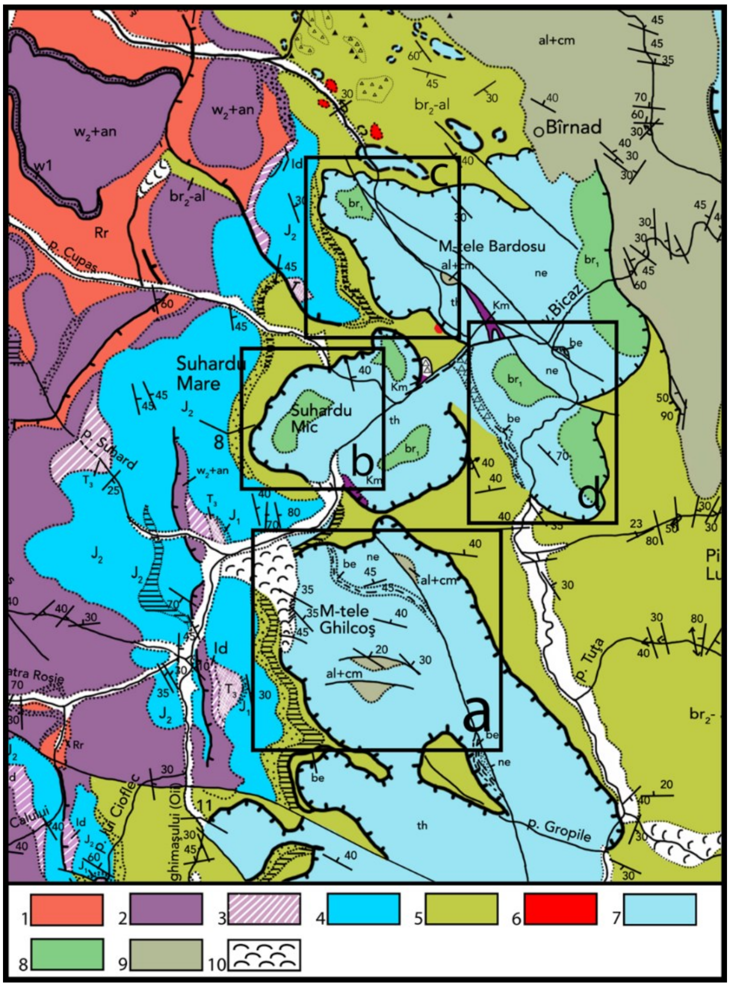

Fig. 3: Geological Map of the Hăghimaș Massif (from Săndulescu, 1975). **Bucovinian Nappe:** 1. Rarău gneiss series; 2. Dolomites (Campilian-Anisian); 3. White limestones (Ladinian); 4. Sandy limestones (Bathonian-Callovian-Oxfordian); 5. Wildflysch Formation (Barremian-Albian). **H[ghima; Nappe:** 6. Werfen Beds; 7. Massive limestones (Kimmeridgian-Thitonian-„*Neocomian*”); 8. Massive limestones (Barremian-lower Aptian in Urgonian facies); **Post-tectonic cover:** 9. Bârnadu Conglomerates (Albian-Cenomanian); 10. Dejection cones and rhegoliths (Holocene). Studied areas are indicated by letters **a, b, c, d**.

5. Ghilcoș Mountain limestones

The Ghilco; Mountain (Fig. 3a) represents one of the four interest points from this study. The Neocomian limestones (Berriasian-Valanginian-?Hauterivian) commonly occur as bedded structures, with red, yellowish to grey colour. They overlay a 200 m thick pile of Tithonian Štramberk type limestones.

246 samples were collected from this location, with numbers being allocated from 001 to 246. Sampling was performed at a resolution ranging from 0.5 to 2 m. Laboratory analysis allowed the identification of sedimentological and micropaleontological features. The following microfacies types are present: peloidal wackestone with lithoclasts and benthic foraminifera, bioclastic/lithoclastic wackestone with bivalves and foraminifera, bioclastic wackestone with dasycladalean algae, bioclastic wackestone with dasycladalean algae and benthic foraminifera, coarse bioclastic/lithoclastic wackestone with benthic foraminifera, wackestone with Bacinella type structures, fenestral wackestone, bioclastic/lithoclastic floatstone with bivalve fragments, bioclastic floatstone with algae and mollusks, lithoclastic floatsone with Rivularia type cyanobacteria, oncoidic floatstone, oncoidic lithoclastic bioclastic floatstone, lithoclastic bioclastic packstone with dasycladalean algae, bioclastic lithoclastic packstone with algae and bivalves, bioclastic grainstone-rudstone with green algae and oncoids (Fig. 4).

The micropaleontological association consists of: green algae [*Actinoporella podolica* (Alth), *Clypeina* cf. *loferensis* Schlagintweit, Dieni & Radoičić, *C. parasolkani* Farinacci & Radoičić, *C. radici* (Sokač), *Deloffrella quercifoliipora* (Granier & Michaud), *Permocalculus dragastani* Bucur, *Pseudotrinocladus piae* (Dragastan), *Rajkaella bartheli* (Bernier), *R. iailensis* (Maslov), *R. minima* (Jaffrezo), *R. subtilis* (Dragastan), *Salpingoporella anulata* Carozzi, *S. circassa* (Farinacci &Radoičić), *S.* cf. *katzeri* (Conrad &. Radoičić), *S. praturloni* (Dragastan), *Thaumatoporella parvovesiculifera* (Raineri), *Zergabriella embergeri* (Bouroullec & Deloffre)], benthic foraminifera [*Bramkampella arabica* (Redmond), *Charentia cuvilieri* Neumann, *Coscinoconus alpinus* (Leupold), *C. Campanellus* (Arnaud-Vanneau, Boisseau & Darsac), *C. Cherchiae* (Arnaud-Vanneau, Boissau & Darsac), *C. chiocchinii* (Mancinelli & Coccia), *C. delphinensis* (Arnaud-Vanneau, Boissau & Darsac), *C. schuberti* Leupold, *Everticyclammina* cf. *kelleri* (Henson), *E. virguliana* (Koechlin), *Freixialina planispiralis* Ramalho, *Haplophragmoides joukowskyi* Charollais, Brönnimann & Zaninetti, *Mohlerina basiliensis* (Mohler), *Montsalevia salevensis* (Charollais et al.), *Nautiloculina broennimanni* Arnaud-Vanneau & Peybernes, *Protopeneroplis ultragranulata* (Gorbachik), *Pseudocyclammina lituus* (Yokoyama), *Torinosuela peneropliformis* (Yabe & Hanzawa)].

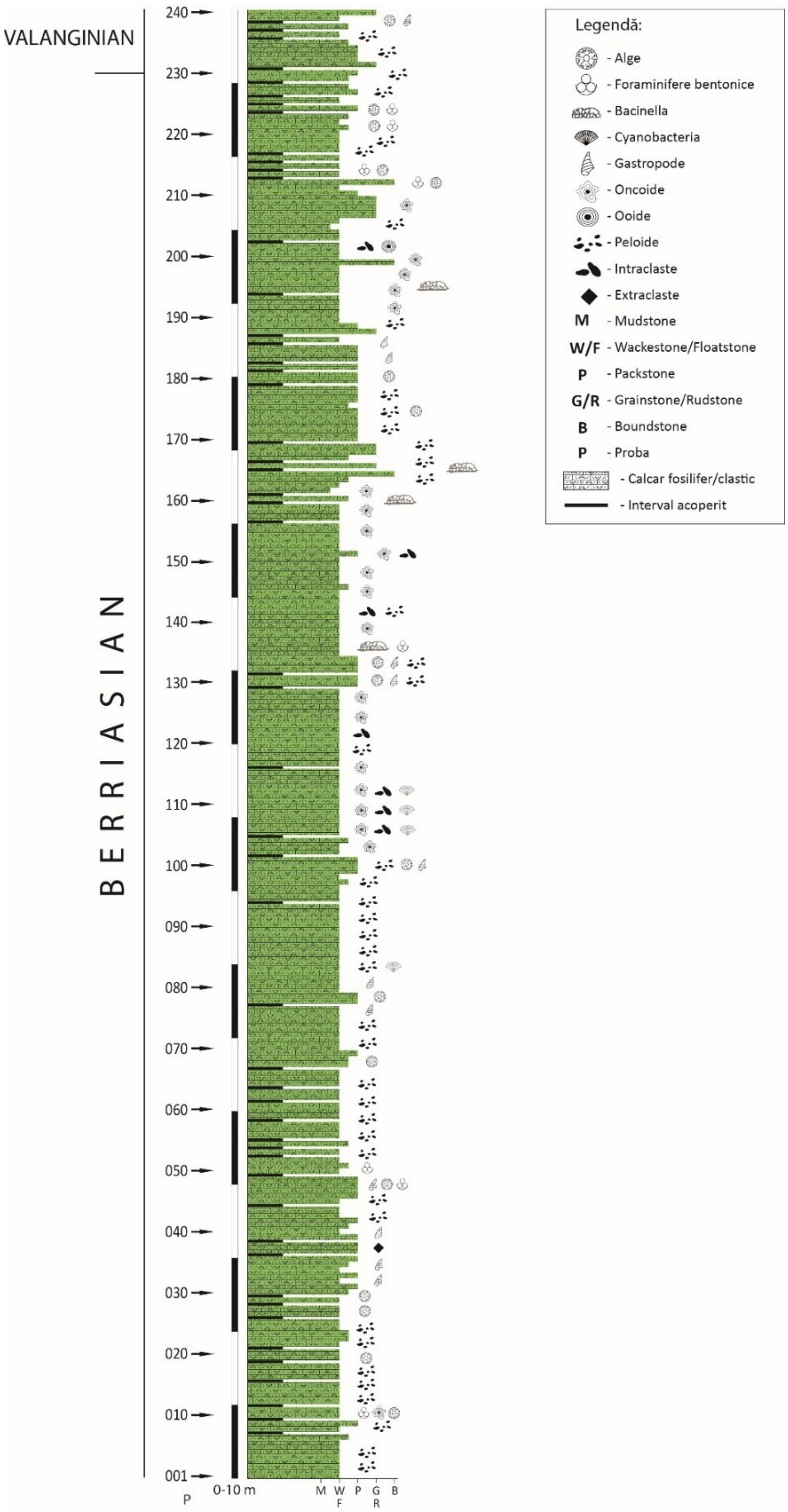

Fig. 4: General stratigraphic column of the limestones from the Ghilco; Mountain

5.1. Facies associations identified in the Ghilcoș Mountain

MFG 1 Peloidal bioclastic lithoclastic wackestone

This type of facies is the most important within this section and it forms the bulk of this profile being present in alternance with packstone, grainstone and floatstone facies types. Its main feature is indicated by the abundance of peloids which form almost 70 % of the total grains. Their shape ranges from angular to very well rounded, being dispersed in a general micritic mass. The bioclast association contains mollusk fragments (gastropods and bivalves), benthic foraminifera, green calcareous algae and echinoderm fragments; biogeneous encrustings are present sometimes. *Rivularia* type cyanobacteria are disseminated swithin the micritic mass of the rock. In some cases, the matrix is heterogeneous and it contains micritie in association with vadous silt or microspar. Fenestral structures form an important component of these limestones; the heterogeneous matrix contains bioturbated structures.

Interpretation

Microfacies association MFG 1 from the Ghilcoș area indicates an inner platform depositional setting, with a restricted character. Some open marine shallow water low energy influences can be present.

MFG 2 Bioclastic/lithoclastic packstone

This microfacies occurs both in the lower and middle part of the succession and with higher frequencies in its upper part. The main feature of these microfacies types is indicated by the presence of abundant peloids and bioclasts. The micropaleontological association contains encrusting organisms, algae, and benthic foraminifera; other microfossils include gastropods, bivalve fragments and rare echinoderm fragments. Bioclasts have a micritic rim and they are well rounded. Peloids are well rounded or subrounded with average dimensions of 0.4 mm. In terms of frequency, they form approximately 70 % from the total percentage of grains. Thay are commonly disseminated in the micritic mass being associated with banthic foraminifera, algae and subordinated ooids. Fenestral structures form an important component of this facies association. They have irregular shapes and they contain geopetal sediment. Angular to subangular terrigenous quartz particles are present.

Interpretation

These sedimentary features point to an inner platform, open marine depositional environment, with good sedimentary influx and constant water circulation (Flügel, 2004). The moderate terrigenous siliciclastic facies suggest the proximity of ocntinental source areas.

MFG 3 Oncoidal microbial floatstone with encrusting organisms

MFG 3 occurs in the same manner as MFG 2 in the first two thirds of the succession and in the final part of the section. Its main feature is indicated by the presence of abundant porostromatic oncoids and macrooncoids. Subordinated facies types contain gastropod fragments and rudists. The micropaleontological association contains rare foraminifera and dasycladalean algae. Encrusting organisms and Rivularia type cyanobacteria are frequent. The oncoid dimension ranges between 1 and 6 cm. Mollusk fragments are numerous and they form the oncoid nucleus. The sediment between oncoids has a micritic composition. It contains gastropods, rudsits, intraclasts and agglutinated foraminifera.

Interpretation

The porostromatic oncoids or non-skeletal oncoids represent a common component of the intertidal and supratidal shallow water areas (Flügel, 2004). The abundance of skeletal components and the laminitic structure of some oncoids indicates open lagoon normal marine environments with fluctuating water energy (Flügel, 2010).

MFG 4 Coarse peloidal grainstone with peloids, bioclasts and microbial structures

The grainstone facies types form the most important component of this succession especially in its upper part. Peloids, cortoids and well sorted grains define this facies type. Gastropods dominate the grain spectrum. Foraminifera and algae are subordinated. Echinoderm fragments are also present. Bioclast frequency has a value of 70 %. Peloids are well sorted and their dimension ranges between 0.2 and 0.4 mm. Encrusting organisms are present and they form either nodules or crusts. Intergranular spaces are filled with granular, drusy or blocky type cement, especially in the coarse facies varieties

Interpretation

Cortoids, peloids and other coated grains indicate well lit, well oxygenated, shallow water environments (Flügel, 2010). Well rounded bioclasts characterise areas with constant wave activity, at the base or over the wave base. Such features point to an open inner platform area (Flügel, 2010).

5.2. Age of Mount Ghilcoș limestones

Some species define only the "*Neocomian*" (Berriasian-Valanginian-?Hauterivian) interval. They are represented by: *Clypeina radici, Rajkaella minima, Salpingoporella circassa, S.* cf. *katzeri, S. praturloni, Coscinoconus cherchiae, Montsalevia salevensis, Haplophragmoides joukowski.*

Montsalevia salevensis is a foraminifera with a very important biostratigraphic significance since it characterises the lower Valanginian. It is frequent in the upper part of the succession.

6. Limestones from the Suhardu Mic Mountain

The Suhardu Mic Mountain (Fig. 3b) is another point of major interest in this study. The existing research indicates that this carbonate succession has a total thickness of aprox. 600 m. It includes Tithonian Štramberk type limestones which are followed in a sedimentary continuity by "*Neocomian*" (Berriasian-Valanginian-?Hauterivian) and "*Urgonian*" (Barremian-Apțian inferior) massive, white and reddish limestones (Grasu et al., 2012). Sampling resolution is between 0.5 and 2 m. 188 samples were collected with numbers ranging from 250 to 437. Laboratory analysis produced important micropaleontological and sedimentological data. The following microfacies types are present: peloidal wackestone, peloidal/bioclastic wackestone, peloidal fenestral wackestone, wackestone with *Anchispirocyclina lusitanica*, peloidal intraclastic wackestone, oncoidal wackestone/floatstone, bioclastic floatstone with encrusting organisms, oncoidal floatstone with lithoclasts and peloids, peloidal bioclastic wackestone/packstone with lithoclasts, peloidal bioclastic lithoclastic packstone, packstone with microbial organisms, packstone with dasycladalean algae, oncoidal lithoclastic peloidal packstone, fenestral packstone, peloidal bioclastic lithoclastic packstone grainstone, peloidal bioclastic packstone/grainstone, peloidal lithoclastic grainstone, fenestral grainstone with peloids, peloidal grainstone litoclastic/peloidal, grainstone fenestral cu peloide, bioclastic lithoclastic grainstone/pakcstone, peloidal/bioclastic/litoclastic grainstone, fenestral grainstone/packstone with peloids and bioclasts, grainstone/packstone with dasycladalean algae, bioclastic rudstone with encrusting organisms, oncoidal peloidal rudstone, rudstone with reefal fragments, fenestral rudstone, peloidal fenestral bindstone, bindstone with *Bacinella* sp. (Fig. 5).

The micropaleontological association contains: green algae [*Actinoporella podolica* (Alth), *Clypeina* cf. *loferensis* -Schlagintweit, Dieni & Radoičić, *C. parasolkani* Farinacci & Radoičić, *C.* gr. *solkani* Conrad & Radoičić, *C. sulcata* (Alth), *Griphoporella jurassica* (Endo), *Neoteutloporella socialis* (Praturlon), *Petrascula bursiformis* (Etallon), *Rajkaella bartheli* (Bernier), *R. iailensis* (Maslov), *Salpingoporella anulata* Carozzi, *S. pygmaea* (Gümbel), *S. steinhauseri* Conrad, Praturlon & Radoičić, *Terquemella* sp., *Triploporella remesi* (Steinmann)], benthic foraminifera [*Ammobaculites* sp., *Anchispirocyclina lusitanica* (Egger), *Bramkampella* sp., *Bulbobaculites felixi* Pleș, Bucur & Săsăran, *Belorussiella* sp., *Charentia evoluta* (Gorbachik), *Coscinoconus campanellus* (Arnaud-Vanneau, Boisseau & Darsac), *C. cherchiae* (Arnaud-Vanneau, Boisseau & Darsac), *C. delphinensis* (Arnaud-Vanneau, Boisseau & Darsac), *C. elongatus* Leupold, *C. sagittarius* (Arnaud-Vanneau, Boisseau & Drasac), *Everticyclammina* sp., *Freixialina* sp., *Frentzenella* sp., *Mohlerina basiliensis* (Mohler), *Nautiloculina broennimanni* Arnaud-Vanneau & Peybernes, *Protopeneroplis ultragranulata* (Gorbatchick), *Pseudocyclammina* sp., *Redmondoides* sp., *Siphovalvulina variabilis* Septfontaine, *Spiraloconulus suprajurassicus* Schlagintweit], encrusting organisms [*Bacinella iregularis* Radoičić, *Koskinobulina* sp., *Lithocodium aggregatum* Elliott, *Troglotella incrustans* Wernli & Fookes], calpionellids [*Calpionella alpina* Lorenz, *Calpionellopsis oblonga* (Cadish), *Tintinopsella* sp.].

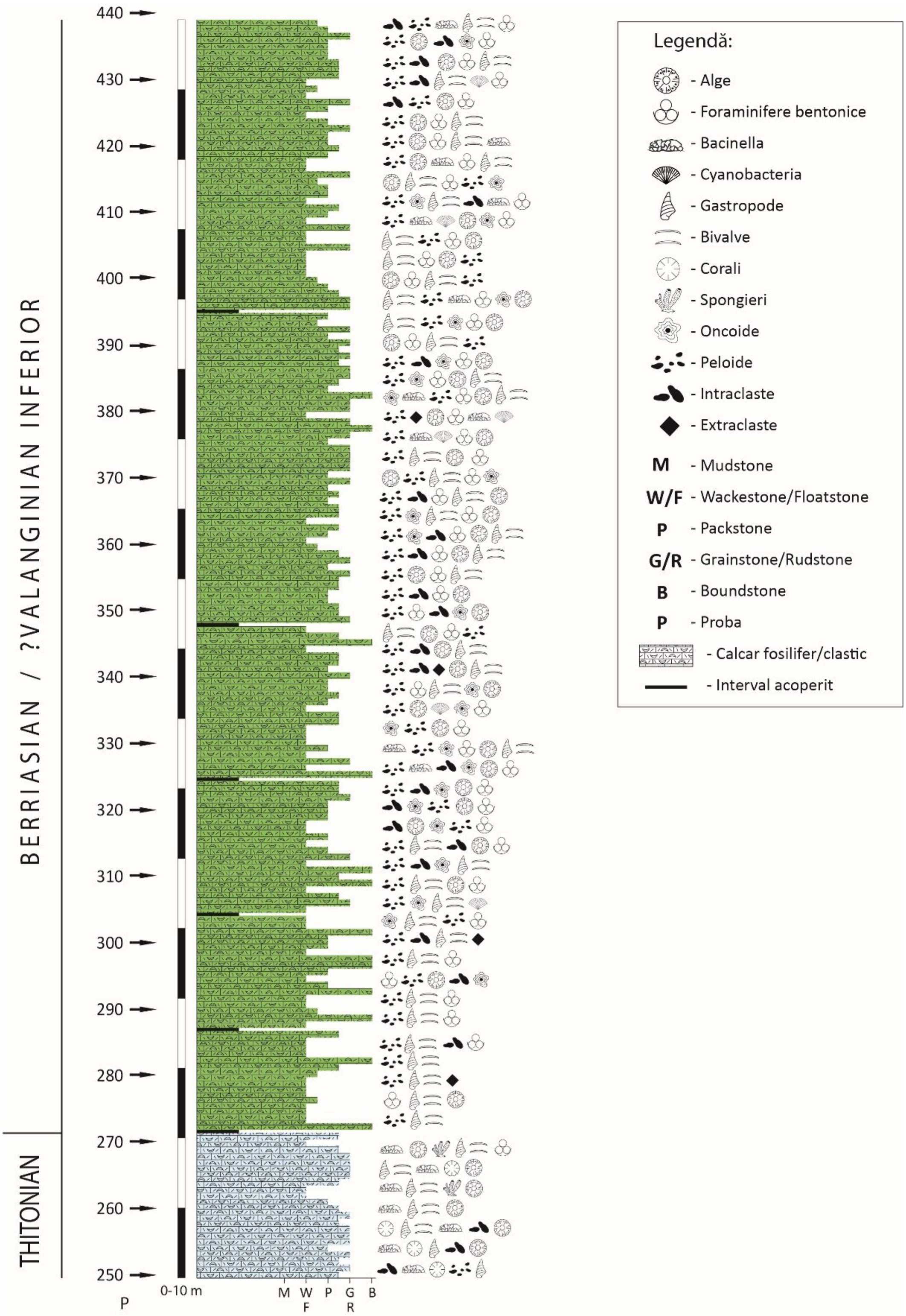

Fig. 5: General stratigraphic column of the Suhardu Mic limestones.

6.1. Facies associations from the Suhardu Mic limestones

MFS 1 Peloidal/bioclastic wackestone

The wackestone facies type is completely absent in the first part of the profile and it is frequently encountered in the middle and upper part of the section.

Bioclastele from MFS 1 are represented by gastropod and bivalve fragments, calcareous algae, benthic foraminifera, encrusting organisms, calpionellids and Ricularia type cyanobacteria. Non-skeletal components are represented by submilimeter sized peloids. Sferical to irregular intraclasts are less common than peloids. Surficial micritic rims are common for some grains; they can be partially or totally micritised. Components range between 10 % and 30 %. They are encased in a micritic matrix with rare spar, microspar or silt. The rock is fractured. Frequent fenestral structures. Voids are filled with sparitic cement or geopetal sediment. Isolated ferruginous pigments.

Interpretation

This microfacies association indicates an inner platform environment with some restricted features, with oscillating tendencies towards shallow open marine, low energy settings. Moderate to low terrigenous input indicates the proximity of a continental source area.

MFS 2 Packstone and peloidal bioclastic lithoclastic packstone/grainstone

MFS 2 is present within the netire section and it forms the most abundant facies association.

The micropaleontological association contains calcareous algae, benthic foraminifera and calpionellids. Other abundant bioclasts include encrusting organisms, mollusk fragments, sponges and rare corals, microbial nodules, cyanobacteria and echinoderms. Some large bioclasts are biogenically encrusted. Non-bioclastic components are represented by peloids and intraclasts.

Fabric is grain supported and is moderately compacted. It contains frequent fenestral-laminoid structures which are filled with sparitic cement or geopetal sediment. Ferruginous pigments are present. The matrix contains micrite, sparitic cement, microsparite and rare silt.

Interpretation

The presence of dasycladalean algae points to a subtidal environment, with depths of approximately 30 m, with a sandy-muddy bedrock and low to moderate hydrodynamics. The laminoid fenestral structures characterise the intertidal to supratidal areas which are influenced by subaerial exposure. All these features characterise an inner platform setting that fluctuates from open to restricted conditions (probably a lagoon) (Flügel, 2010).

MFS 3 Peloidal lithoclastic bioclastic grainstone to rudstone

Microfacies association 3 is characterised by the presence of abundant grains (both skeletal and non-skeletal). Bioclasts consist of dasycladalean algae, udoteacean algae, bnethic foraminifera. Other bioclasts include gastropods, bivalves, encrusting organisms, Rivularia type cyanobacteria, rudsits, sponges, coral fragments, red algae, echinoderms. Non-skeletal grains and skeletal grains share equal proportions. Peloids are dominant and they are followed by intraclasts, oncoids and rare extraclasts. The structure is grain supported and fenestral structures are common. They contain geopetal sediment.

Interpretation

Such large bioclasts characterise open marine environments, platform margin areas or even restricted (Flügel, 2010). Well rounded bioclasts normally form under the constant action of currents, over the normal wavebase (Flügel, 2010). All these features point to environments that range from restricted to platform margin depositional settings.

MFS 4 Bindstone

Bindstone microfacies types are less frequent. Bioclasts are represented by mollusks, benthic foraminifera and calcareous algae. Non-skeletal grains are represented by peloids. Associated intraclasts and peloids. In terms of proportions, the grain spectrum ranges between 40 and 60 %. Peloids form the vast majority of the grains. Grain supported fabric, with frequenbt laminoid fenestral structures (LF-A and LF-B types). They contain sparitic cement and geopetal sediment (sometimes with ferruginous pigments). The matrix is composed of micrite, sparite and rare microsparite.

Interpretation

All the existing features point to accumulation in a subtidal area, under the wavebase (Flügel, 2010)

6.2. Age of the Suhardu Mic limestones

Preda and Pelin (1962 - 1968), have cartographically separated the Upper Jurassic and the Lower Cretaceous by interpreting an Urgonian association with rudists.

Grasu (1969, 1970) separated the Tithonian from the Neocomian. However, Dragastan's synthesis (1975) offfers the most complete approach in terms of microfacies analysis methods, for the malm-urgonian succession of the entire area (Grasu et al, 2012).

The "*Neocomian*" (Berriasian-Valanginian) interval is defined by the followign species: *Coscinoconus campanellus, C. cherchiae, C. delphinensis, C. perconigi, Clypeina radici, Salpingoporella katzeri, S. praturloni, S. steinhauseri, Calpionella alpina, Calpionellopsis oblonga*.

Calpionella alpina and *Calpionellopsis oblonga* are very important species since they indicate precisely the Berriasian interval. *Anchispirocyclina lusitanica,* characterises the Upper Jurassic-Lower Cretaceous tranistion (Tithonian-Berriasian).

All this data suggests that the Suhardu Mic limestones belong to the Berriasian-Valanginian interval. The abundance of *Clypeina sulcata* would rather indicate the presence of Berriasian. The upper Valanginian-Hauterivian and the Barremian-Aptian are not indicated by any of the identified microfossils.

Two explanations can be suggested: (1) The entire Suhardu Mic section belongs to the upper Tithonian-Valanginian and the upper stages (Hauterivian-Barremian-Apţian) were erronously identified by previous authors or (2) profile 4, that correspond to the „*Urgonian*„ could actually belong to the Berriasian. In addition, the upper "*Neocomian*" (Valanginian superior-Hauterivian) could be marked by sedimentary gaps.

7. Lapoș Valley limestones

This chapter presents the microfacies analysis of the Lapoș Valley limestones (Fig. 3c). The last important research activities were performed in this area by Dragastan (2011), who presents a series of micropaleontological and microfaices data. The author presumes a continuity of sedimentation corresponding to the Tithonian-Hauterivian interval. It describes some Tithonian-Berriasian calpionellid zones. Dragastan (2011) identified two unconformity surfaces (lower Berriasian-upper Berriasian and lower Valaginian-Hauterivian).

340 samples were collected with numbers ranging from 438 to 783. 350 thin sections were prepared. Sampling was performed in the Cheile Lapoșului section at a resolution of aprox. 5 m. The starting point is represented by the confluence with the Biza valley. It continues on a distance of 2 km until Piatra Bardoșului. The entire section is divided in two parts: profile 1 and profile 2.

Thin sections were analysed at the binocular microscope; the following microfacies types were identified:

Profile 1 – bioclastic wackestone with dasycladalean algae, bioclastic peloidal wackestone with dasycladalean algae, bioclastic peloidal wackestone with *Bramkampella* sp., bioclastic peloidal wackestone with encrusting organisms, fractured bioclastic peloidal wackestone, peloidal bioclastic wackestone with foraminifera, peloidal bioclastic wackestone with calpionellids, peloidal wackestone, intraclastic wackestone, intraclastic peloidal wackestone with *Anchispirocyclina* sp., microbial wackestone, bioclastic wackestone-floatstone with *Mohlerina* sp., peloidal bioclastic wackestone-floatstone, microbial wackestone-floatstone with *Bacinella* sp., intraclastic wackestone-floatstone, bioclastic floatstone with rudists, bioclastic floatstone with microbial organisms, floatstone with *Rivularia* type cyabobacteria, peloidal bioclastic floatstone with cyanobacteria, oncoidal floatstone with encrusting organisms, peloidal packstone with oncoids and *Rivularia* sp., bioclastic packstone-grainstone with *Coscinoconus* sp., peloidal bioclastic packstone-grainstone, peloidal packstone-grainstone with *Bacinella* sp., peloidal packstone-grainstone, brecciated lithoclastic packstone-grainstone, peloidal grainstone, lithoclastic peloidal grainstone, brecciated lithoclastic grainstone, bioclastic grainstone with *Bacinella* sp., peloidal bioclastic grainstone-rudstone, bioclastic rudstone, framestone with *Bacinella* sp., bafflestone with *Rivularia* sp., microbial bindstone (Fig. 6);

Profile 2 – peloidal wackestone, peloidal bioclastic wackestone with dasycaldalean alage, bioclastic peloidal wackestone-floatstone, wackestone/floatstone with oncoids, microbial floatstone with *Rivularia* sp., microbial floatstone with oncoids, bioclastic floatstone with rudists, bioclastic floatstone with *Rivularia* sp. and oncoids, bioclastic floatstone with terrigenous material, oncoidal floatstone, peloidal packstone, peloidal packstone woith dasycladalean algae, peloidal packstone with foraminifera, peloidal packstone with oncoids, peloidal lithoclastic packstone, bioclastic packstone with foraminifera, bioclastic/peloidal packstone grainstone, lithoclastic bioclastic packstone/grainstone, brecciated lithoclastic grainstone, lithoclastic/bioclastic grainstone with *Crescentiella* sp., bioclastic/peloidal grainstone, peloidal grainstone, bioclastic/peloidal grainstone/packstone, brecciated grainstone/packstone, microbial grainstone/packstone, bioclastic/intraclastic grainstone/rudstone with *Crescentiella* sp., bioclastic rudstone, bioclastic/litoclastic rudstone, reefal rudstone, microbial rudstone, bioclastic rudstone with sponges, oncoidal rudstone, bindstone with *Bacinella* sp., boundstone with sponges, reefal boundstone, coral framestone, framestone with *Neoteutloporella* sp. (Fig. 6).

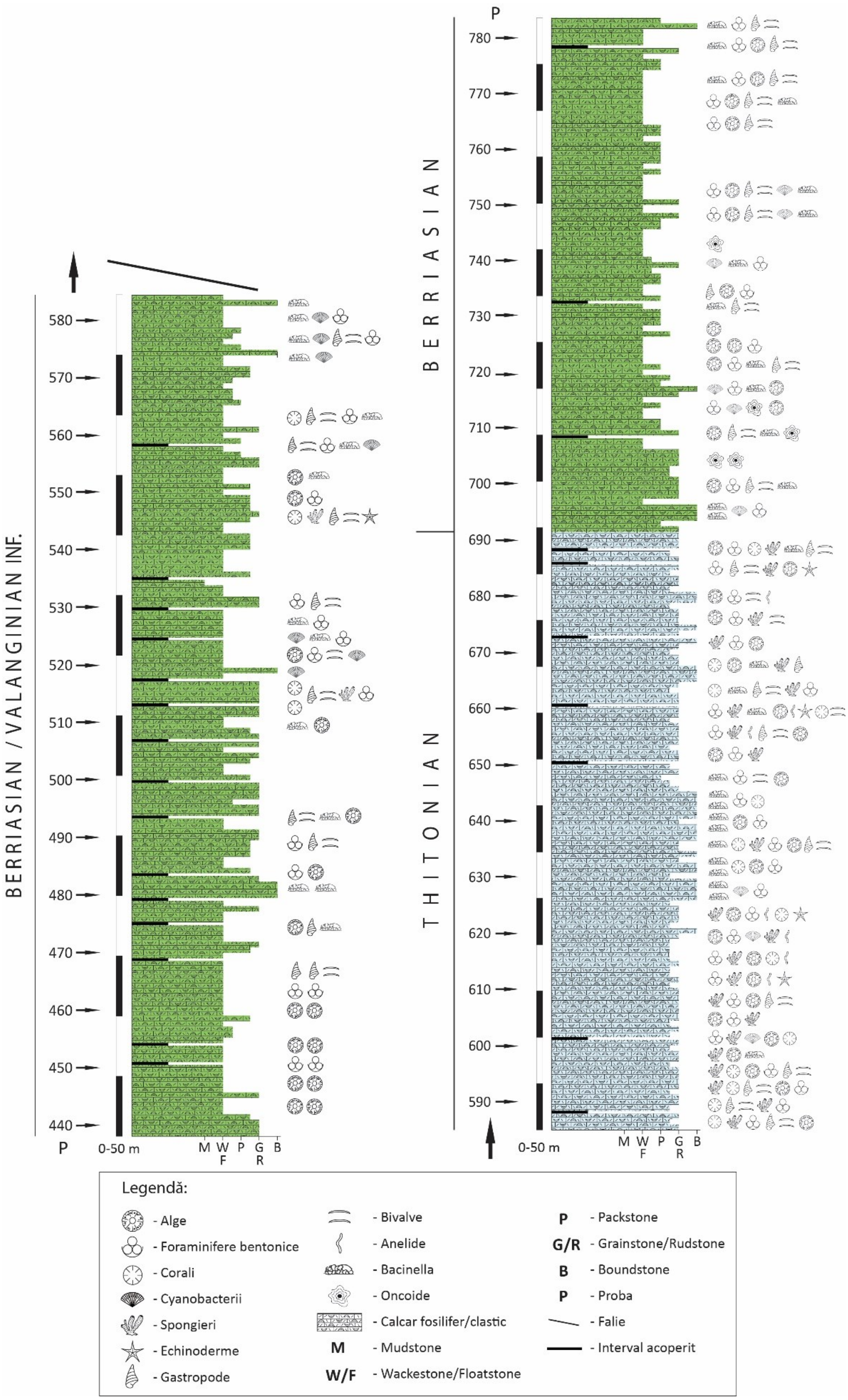

Fig. 6: General stratigraphic column of the Lapoș Valley limestones

7.1. Facies associations from the Lapoș Valley

MFL 1 –Peloidal-bioclastic wackestone

This facies contains abundant peloids. It contains dasycladalean algae, benthic foraminifera and poorly preserved calpionellids. Heterogeneous bioturbated matrix. . Rare laminar fenestral structures. They are filled with sparitic cement or vadous silt, common geopetal structures.

MFL 2 – Bioclastic-oncoidic floatstone

Angular to subrounded centimeter sized bioclasts. They include rudist fragments, gastropods, bivalves, coral fragments or echinoderms. Such bioclasts are encrusted by microbes or other microorganisms. Oncoids are abundant. Peloids, intraclasts and extraclasts (terrigenous quartz) form other components.

MFL 3 –Peloidal-bioclastic-lithoclastic packstone/wackestone

Peloids are dominant, they are disseminated through the micritic mass. They have small sizes (sub 0,5 mm) being associated with benthic foraminifera and calcareous algae. Moderately to well sorted peloids. Angular to subrounded intraclasts, their size rarely exceeds 1 mm. Quartz type extraclasts (siltic-arenitic dimensions) are angular to subangular, they are smaller than 0.5 mm. Porostromatic oncoids have ovoidal shapes and an average dimension of 1 mm. Bioclastic cores. Moderately fractured fabric, fractures are filled with sparitic cement.

MFL 4 – Bioclastic-peloidal-lithoclastic packstone-grainstone

Peloid size ranges between 0.1 and 1 mm. They are disseminated through the rock mass being associated with bioclasts. Microorganism are represented by benthic foraminifera, dasycladalean algae, bivalves and gastropods. These bioclasts are almost completely micritised or present a surficial micritic rim. Angular to subrounded lithoclasts are smaller than 1 mm in dimension.

MFL 5 – Lithoclastic-bioclastic rudstone

Bioclasts are represented by sponges, encrusting organism, dasycladalean algae and benthic foraminifera. Rare intraclasts and extraclasts (subangular quartzitic fragments). Intergranular pores contain sparitic cement or vadous silt.

MFL 6 – Microbial binstone

Dominated by Bacinella type structures. They are associated with cyanobacteria and they form a solid framework sustaining the clasts. Fragments of dasycladalean algae, corals, rudists and other mollusks. Intergranular pores are filled with micrite and sparitic cement.

MFL 7 – Coral framestone

Corals are dominant and they are associated with *Crescentiella morronensis.* Non-biotic component conmsists of very small peloids, less than 0.2 mm in size. Intergranular pores are filled with micrite and sparitic cement.

MFL 8 Framestone with *Neoteutloporella socialis*

It includes only one species of dasycladalean algae. It occupies the entire rock mass, it is present in its original growth position.

7.2. Age of Lapoș Valley limestones and facies distribution

Some of the stratigraphic and micropaleontological data was already presented by Dragastan (2011). This information will be completed with data from the actual study.

Until the fault the succession belongs to the uper Berriasian -? Lower Valanginian; after the fault the succession contains upper Tithonian-Berriasian deposits. Microfacies and micropaleontological data will be presented in a stratigraphic order.

Upper Tithonian-Berriasian

This interval (samples 585 – 783) is dominated by platform margin depositional areas. The first part is dominated by boundstone facies types (rarely framestone), rudstone and grainstone with abundant reefal bioclasts (**MFL4, MFL5, MFL7, MFL8);** the upper part is marked by a passage towards packstone, wackestone or bindstone facies types

(**MFL1, MFL2, MFL3, MFL6**). In the first part, the facies types contain sponges, corals, red algae, dasycladalean algae, benthic foraminifera, dand large, abundant angular lithoclasts. The abundance of peloids and microbial structures characterises the second part. It contains dasycladalean algae, benthic foraminifera and coated grains.

The micropaleontological association contains: **algae** [*Campbelliella striata* (Carozzi), *Griphoporella cretacea* (Dragastan), *G. jurassica* (Endo), *Neoteutloporella socialis* (Praturlon), *Nipponophycus ramosus* Yabe & Toyama, *Solenopora jurassica* Brown, *Triploporella remesi* Steinmann, *Actinoporella podolica* (Alth), *Arabicodium* sp., *Clypeina isabellae* Masse, Bucur, Virgone & Delmasso, *C. loferensis* Schlagintweit, Dieni & Radoičić, *C. parasolkani* Farinacci & Radoičić, *C. sulcata* (Alth), *Deloffrella quercifoliipora* Granier & Michaud, *Linoporella* sp., *Neomeris* sp., *Permocalculus* sp., *Petrascula bursiformis* (Etallon), *Pseudotrinocladus piae* (Dragastan), *Rajkaella bartheli* (Bernier), *R. subtilis* (Dragastan), *Salpingoporella pygmaea* (Gümbel), *Thaumatoporella parvovesiculifera* (Raineri)], benthic **foraminifera** [*Ammodiscus* sp., *Charentia evoluta* (Gorbachik), *Coscinoconus alpinus* Leupold, *C. chiocchinii* Mancinelli. & Coccia, *C. delphinensis* (Arnaud-Vanneau, Boisseau & Darsac), *C. cherchiae* (Arnaud-Vanneau, Boisseau & Darsac), *C. elongatus* Leupold, *C. molestus* (Gorbatchik), *C. perconigi* (Neagu), *Coscinophragma cribrosa* (Reuss), *Lenticulina* sp., *Mohlerina basiliensis* (Mohler), *Neotrocholina infragranulata* (Noth), *Reophax* sp., *Troglotella incrustan*s Wernli & Fookes, *Ammobaculites* sp., *Everticyclammina virguliana* (Koechlin), *Freixialina planispiralis* Ramalho, *Haplophragmoides joukowskyi*Charollais, Brönnimann & Zaninetti, *Lenticulina* sp., *Mayncina* sp., *Nautiloculina broennimanni* Arnaud-Vanneau & Peybernès, *Protopeneroplis ultragranulata* (Gorbachik), *Pseudocyclammina lituus* (Yokoyama), *Siphovalvulina variabilis* Septfontaine], **microproblematica** [*Bacinella irregularis* Radoičić, *Crescentiella morronensis* (Crestenti), *Iberopora bodeuri* Granier & Berthou, *Koskinobulina socialis* Cherchi & Schroeder, *Labes atramentosa* Eliášova, *Lithocodium aggregatum* Elliott, *Perturbatacrusta leini* Schlagintweit & Gawlick, *Pseudorothpletzella* sp., *Radiomura cautica* Senowbari-Daryan & Schäfer], **sclerosponges** [*Calcistella jachenhausenensis* Reitner, *Neuropora lusitanica* Termier & Termier, *Thalamopora lusitanica* Termier & Termier, *Cladocoropsis mirabillis* Felix], anellids (*Terebella lapilloides* Münster), coral fragments, echinoderms, rudists and other mollusks.

The most important species are some algae [*Campbelliella striata* (Tithonian cf. Granier & Deloffre, 1994; Tithonian superior-Berriasian inferior cf. Bucur et al., 2014), *Neoteutloporella socialis* (Kimmeridgian-Tithonian cf. Granier & Deloffre, 1994; Bassoulet, 1997; Bucur, 1999) *Petrascula bursiformis* (Kimmeridgian-Tithonian cf. Granier & Deloffre, 1994), *Clypeina sulcata* (Kimmeridgian-Berriasian cf. Bassoulet, 1997; Bucur, 1999), *Clypeina parasolkani* (Berriasian cf. Farinacci & Radoicic, 1991; Berriasian-Valanginian cf. Bucur & Săsăran, 2005; Bruni et al., 2007; Tithonian-Berriasian cf. Schlagintweit, 2011), *Otternstella lemmensis* (Kimmeridgian superior-Berriasian inferior cf. Granier and Deloffre, 1993), *Rajkaella bartheli* (Kimmeridgian-Berriasian cf. Bucur et al., 2013); spongierii *Neuropora lusitanica, Thalamopora lusitanica* și *Calcistella jachenhausenensis* (Tithonian cf. Reitner, 1992; Pleş et al., 2012; Kaya et al., 2015);] some foraminifera [*Charentia evoluta* (Kimmeridgian superior-Valanginian cf. Olszewska, 2010), different species of *Coscinoconus* (Tithonian superior-Valanginian inferior cf. Arnaud-Vanneau et al., 1988; Neagu, 1994, 1995; Bucur et al., 1995, Bucur & Săsăran, 2005), *Haplophragmoides joukowskyi* (Berriasian superior-Hauterivian cf. Altiner 1991; Bucur et al., 1995, Ivanova, 2000)], some microproblematica [*Iberopora bodeuri* (Berriasian cf. Uta & Bucur, 2003; Oxfordian-Berriasian cf. Schlagentweit, 2004)] or the anellid *Terebella lapilloides* (Kimmeridgian-Berriasian inferior cf. Kaya & Altiner, 2014) (Fig. 145).

This association characterises the upper Tithonian-Berriasian.

Upper Berriasian-?lower Valanginian

Inner platform facies types with transitions towards the peritidal domain (**MFL1, MFL2,MFL3, MFL4)**. Bioclasts are dominant (mollusks, dasycladalean algae, microbial organisms, benthic foraminifera), folowed by peloids and lithoclasts (intraclasts and extraclasts).

The micropaleontological association contains: **algae** [*Actinoporella podolica* (Alth), *Arabicodium* sp., *Clypeina* cf. *loferensis* Schlagintweit, Dieni & Radoičić, *C. maslovi* Praturlon, *C. parasolkani* Farinacci & Radoičić, *C. solkani* Conrad & Radoičić, *C. sulcata* (Alth), *Cylindroporella* sp., *Deloffrella quercifoliipora* Granier & Michaud, *Felixporidium* sp., *Holosporella* sp., *Otternstella lemmensis* (Bernier), *Permocalculus* sp., *Petrascula bursiformis* (Etallon), *Rajkaella bartheli* (Bernier), *R. iailensis* (Maslov), *R. subtilis* (Dragastan), *Russoella* sp., *Salpingoporella anulata* (Carozzi), *S. pygmaea* (Gümbel), *Suppiluliumella* sp., *Solenopora jurassica* Brown, *Thaumatoporella parvovesiculifera* (Raineri)], **benthic foraminifera** [*Ammobaculites* sp., *Anchispirocyclina lusitanica* (Egger), *Bramkampella arabica* Redmond, *Charentia cuvilieri* Neumann, *C.evoluta* (Gorbatchik), *Coscinoconus alpinus* Leupold, *C. campanellus* (Arnaud-Vanneau, Boisseau & Darsac), *C.cherchiae* (Arnaud-Vanneau, Boisseau & Darsac), *C. delphinensis* (Arnaud-Vanneau, Boisseau & Drasac), *C. elongatus* Leupold, *C. molestus* (Gorbatchik), *C.* cf. *perconigi*

(Neagu), *C. sagittarius* (Arnaud-Vanneau Boisseau & Darsac), *Everticyclamina* gr. *hedbergi* Maync, *E. virguliana* (Koechlin), *Freixialina planispiralis* Ramalho, *Lenticulina* sp., *Mayncina* sp., *Mohlerina basiliensis* (Mohler), *Nautiloculina broennimanni* Arnaud-Vanneau & Peybernès, *Protopeneroplis ultragranulata* (Gorbatchik), *Pseudocyclamminalituus* (Yokoyama), *Spiroloconulus suprajurassicus* Schlagintweit, *Troglotella incrustans* Wernli & Fookes], encrusting organisms [*Bacinella irregularis* Radoičić, *Lithocodium aggregatum* Elliott, *Rivularia* sp., sponges [*Cladocoropsis* sp.], calpionellids [*Calpionellopsis simplex* (Colom), *Calpionella minuta* Houša, *Precalpionellites filipescui* Pop, *Sturiella oblonga* Borza, *Tintinnopsella carpathica* (Murgeanu & Filipescu)], rare calcispheres [*Cadosina minuta* Borza] and mollusk fragments.

From the entire association, the following species have a biostratigraphic importance: algae [*Clypeina maslovi* (Valanginian cf. Schindler & Conrad, 1994), *C. solkani* (Berriasian superior cf. Masse, 1993)] and benthic foraminifera [*Anchispirocyclina lusitanica* (Tithonian-Berriasian cf. Dragastan, 1975; Sotak, 1989; Schlagintweit et al., 2005), *Bramkampella arabica* (Kimmeridgian-?Valanginian inferior cf. Pleș et al., 2015) și *Charentia evoluta* (Kimmeridgian superior-Valanginian cf. Olszewska, 2010)].

The calpionellid association characterises the upper Berriasian (Calpionnellopsis Zone, Simplex Subzone). The entire association characterises the upper Berriasian -? Lower Valanginian.

Discussions

The upper part of the section, located above the fault has an upper Tithonian-Berriasian age. By contrast, the lower part of the section, below the fault corresponds to the upper Berriasian-? Lower Valanginian interval.

The identified microfacies and micropaleontological assocations are simillar with elements from other parts of the Median Dacides (Bucur, 1997; Ples et al., 2012, Mircescu et al, 2014 etc., Ungureanu et al., 2015, Gradinaru et al., 2016). They represent good corrrelation tools for future studies. They can be used to define the depositional events at the Jurassic-Cretaceous transition in the Tethyan Real.

8. Bicăjel Valley limestones

Bicăjel Valley (Fig. 3d) is the fourth point of interest from this study. 100 samples were collected and 105 thin sections were prepared. Sampling was performed in the northern sector of the valley, more precisely in the Bicăjel Gorges, at a sampling resolution of 5 m. The studied area begins at the confluence between the Bicăjel and Bicaz Valleys. It continues towards S-SE on a distance of aprox. 0.7 km, until the confluence with the Cighenilor Creek. The following microfacies types are present: wackestone with calăionellids, bioclastic floatstone with algae, sponge floatstone, peloidal, packstone, peloidal packstone with calpionellids, peloidal packstone with dasycladalean algae, coarse peloidal packstone with oncoids, coarse peloidal lithoclastic packstone, lithoclastic packstone with microbial organisms, grainstone/packsotne with Bacinella, peloidal grainstone, lithoclastic peloidal grainstone with terrigenous input, bioclastic l.ithoclastic peloidal rudstone, oncoidal rudstone, reefal rudstone (Fig. 7).

The micropaleontological associations consists of : **algae** [*Clypeina* gr. *isabellae* Masse, Bucur, Virgogne & Delmasso, *C. sulcata* (Alth), *Griphoporella* sp., *Holosporella* sp., *Petrascula bursiformis* (Etallon), *Rajkaella iailensis* (Maslov), *Salpingoporella anulata* Carozzi, *Solenopora* sp., *Thaumatoporella parvovesiculifera* (Raineri), Udoteacee], **benthic foraminifera** [*Bramkampella* sp., *Bulbobaculites felixi* Pleş, Bucur& Săsăran, *Coscinoconus. delphinensis* Arnaud-Vanneau, Boisseu & Darsac, *C.* cf. *perconigi* Neagu, *C. cherchiae* (Arnaud-Vanneau, Boisseu & Darsac), *Everticyclammina* sp., *Freixialina planispiralis* Ramalho, *Meandrospira* sp., *Mohlerina basiliensis* (Mohler), *Nautiloculina broennimanni* Arnaud-Vanneau & Peybernes, *Protopeneroplis ultragranulata* (Gorbatchik), *Pseudocyclammina lituus* (Yokoyama), *Rectocyclammina* sp., *Siphovalvulina variabilis* Septofontaine, *Spiraloconulus suprajurassicus* Schlagintweit, *Troglotella incrustans* Wernli & Fookes], **calpionellids** [*Calpionella alpina* Lorenz, *Crassicollaria intermedia* (Durand-Delga), *C. massutiniana* (Colom), *C. parvula* Remane], organisme microbiale/incrustante [*Bacinella irregularis* Radoičić, *Crescentiella morronensis* (Crescenti), *Koskinobulina socialis* Cherchi & Schroeder, *Lithocodium aggregatum* Elliott, *Rivularia* sp.], gastropods, bivalves, corals and rudists.

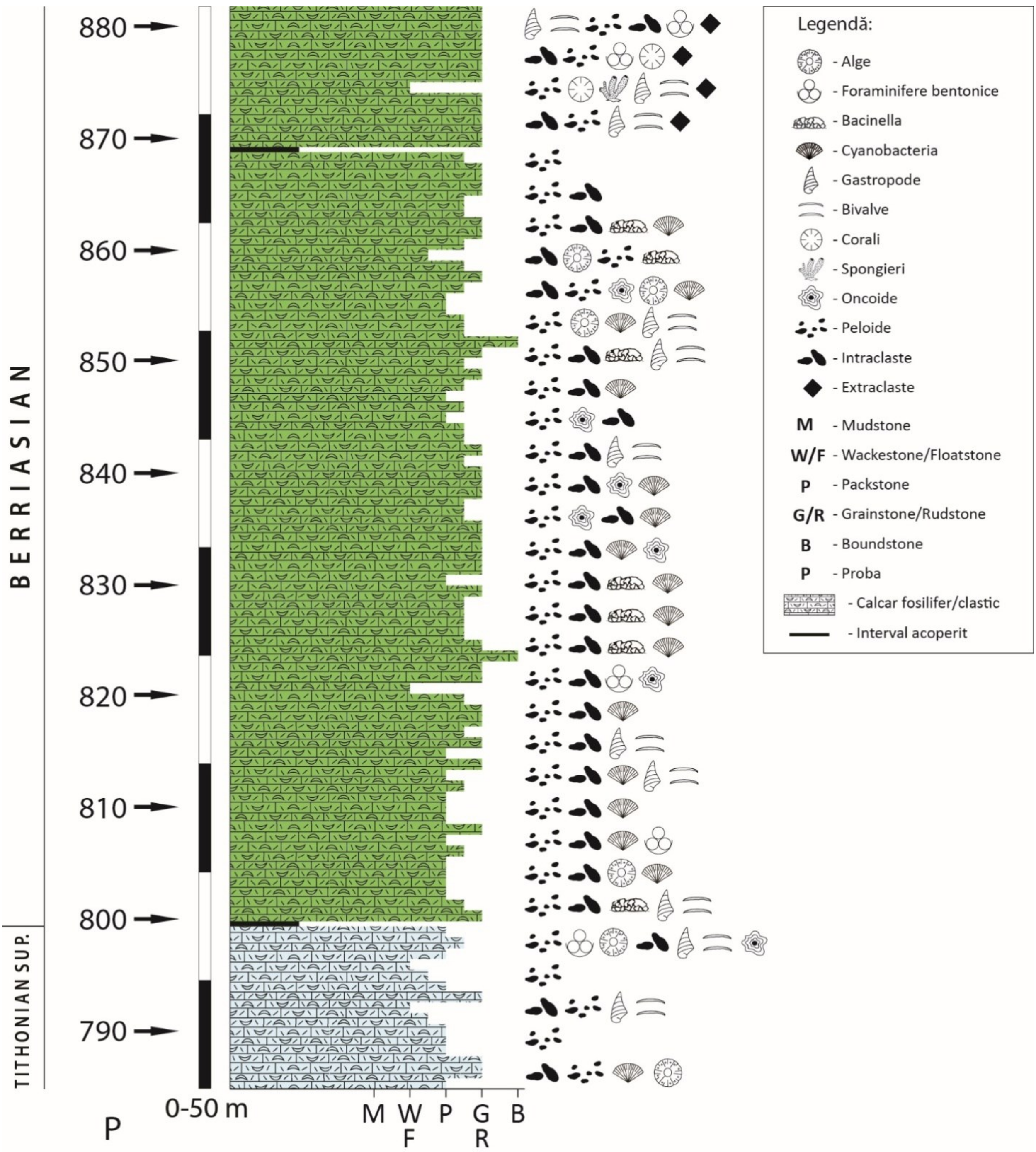

Fig. 7: Carbonate deposits from the Bicăjel Valley.

8.1. Facies associations from the Bicăjel Valley

MFB 1 –Peloidal/lithoclastic packstone

Abundantr peloids nad lithoclasts; associated with cyanobacteria, calpionellids, daycladalean algae and foraminifera; surficial micritic rim is coating the grains.

- Moderate to well sorted peloids; Some fo the peloids have a biotic origin since micritisation processes are very strong.

Fractures are filled with sparite while the intergranular pores contain micrite, microsparite and sparite. Rare geopetal structures.

MFB 3 – Peloidal/lithoclastic grainstone

Peloidal lithoclastic facies types with cyanobacteria are dominant. Rare benthic foraminifera, dasycladalean algae and mollusks.

Abundant fenestral structures are filled with sparitic cement or geopetal sediment. Fractured fabric

MFB 4 – Rudstone bioclastic/litoclastic/peloidal

Microbial organisms are less common in this case. Rare peloids, lithoclasts, oncoids and large bioclasts. Coated grains and micritic rims or surficial micritic coatings are common.

8.2. Age and facies distribution of the Bicăjel Valley Limestones

This alignment (samples 784 – 882) contain inner platform facies types with transitions towards peritidal settings. The first part contains packstone-grianstone to rudstone facies types ((**MFB1, MFB3, MFB4**); abundant peloids (Fig. 158) and intraclasts associated with cyanobacteria, calcareous algae, and benthic foraminifera with rare calpionellids at the base. The second part contains packstone-grainstone and coarse grainstone facies types (**MFB2, MFB3**) with rare packstone and rudstone varieties (**MFB1, MFB4**); peloids are dominant. The upper part contains more bioclasts (Fig. 158). Such as algae, benthic foraminifera, corals, sponges, rudsits, cyanobacteria.

Biostratigraphic respresentative species are some algae [*Petrascula bursiformis* (Kimmeridgian-Tithonian cf. Granier & Deloffre, 1994), *Clypeina sulcata* (Kimmeridgian-Berriasian cf. Bassoulet, 1997; Bucur, 1999), *Clypeina isabellae* (Berriasian cf. Masse et al., 1999), *Clypeina parasolkani* (Berriasian cf. Farinacci & Radoicic, 1991; Berriasian-

Valanginian cf. Bucur & Săsăran, 2005; Bruni et al., 2007; Tithonian-Berriasian cf. Schlagintweit, 2011), *Rajkaella iailensis* (Tithonian-lowerBerriasian cf. Dragastan & Bucur, 1988);] some foraminifera [*Charentia evoluta* (upper Kimmeridgian -Valanginian cf. Olszewska, 2010), different species of *Coscinoconus* (upper Tithonian –lower Valanginian cf. Arnaud-Vanneau et al., 1988; Neagu, 1994, 1995; Bucur et al., 1995, Bucur & Săsăran, 2005) *Spiraloconulus suprajurassicus* (upper Tithonian-lower Valanginian cf. Schlagintweit & Ebli, 1999 & Dragastan 2011)]; some calpionellidels [*Calpionella alpina* (upper Tithonian –lower Valanginian cf. Lorenz, 1902), biozone with Crassicollaria, intermedia subzone (upper Tithonian Remane et al., 1986), some microproblematica [*Iberopora bodeuri* (Berriasian cf. Uţă & Bucur, 2003; Oxfordian-Berriasian cf. Schlagentweit, 2004)] or the anellid *Terebella lapilloides* (Kimmeridgian-Berriasian inferior cf. Kaya & Altiner, 2014) (Fig. 160).

The entire association indicates the upper Tithonian-Berriasian.

9. The sedimentary evolution of the limestones from the studied area

The upper Tithonian limestones were studied in the following sections: Suhardu Mic Mlountain (section I, S1), Lapo; Canyon-Lapo; Gorges (profile 2 ,S3) and the Bic[jel valley limestones. It is difficult to separate the exact boundary between the Tithonian and Berriasian since there is a continuity of sedimentation. The Berriasian limestones are well bedded and they contain coarse facies types. In the Suhardu Mic Mountain the upper Tithonian limestones contain packstone-grainstone, bioclastic rudstone and bioclastic floatstone facies types. These limestones were accumulating in shallow subtidal resticted settings. Profile 2 (S3) from the Lapoș Gorges contains platform margin facies types. The first part contains boundstone facies, rudstone and grainstone. The upper part of the Tithonian succession contains floatstone, packstone, wackestone and bindstone facies types. The Bicăjel Valley succession is upper Tithonian-Berriasian in age. The identified facies types point to inner platform depositional settings with transitions tiowards coastal/littoral areas. The first part of the succession contains packstone-grainstone facies types with peloids, intraclasts, cyanobacteria, benthic foraminifera and rare calpionellids.

The upper Jurassic-lower Berriasian limestones were accumulating in a low angle ramp type setting. Bioconstructions did not form a strong reefal barrier, they could only colonise the substrate. This paleotopography has influenced the subsequent Lower Cretaceous deposition of carbonates. Carbonate sediments were accumulating in shallow water areas, ranging from subtidal lagoons to intertidal/littoral areas. The lower Cretaceous depositional systems are dominated by restricted subtidal and subtidal facies types. Some of the Lower Cretaceous sediments were suberailly exposed for short periods of time. The presence of abundant extraclasts indicates a terrigenous input from the continent. This transition from more restricted conditions to normal marine and then again to restricted conditions is typical for the Berriasian-? Lower Valanginian part of the succession (Strasser, 1991). These evolutions were influenced by the topography and the morphology of the carbonate shelf itself.

10. Conclusions

The present work tries to bring new data concerning the geological structure of the Hăghimaș Nappe in terms of microfacies analysis and micropaleontological content. Together with the studies performed by Dragastan (2011), this work represents a detailed study of the Lapoș Valley and other three adjacent areas (Ghilcoș Mountain, Suhardu Mic Mountain și and Bicăjel Valley).

906 samples were collected from these four areas and thin sections were prepared. Microfacies and micropaleontological studies were performed on these samples. For a better understanding, the studied profiles were separated into sections [Ghilcoș Mountain – S1→S5; Suhardu Mic Mountain – S1→S4; Lapoș Valley – Profile 1 (S1→S2); Profile 2 (S3→S4); Bicăjel Valley – S1]. Thus, 5 profiles were constructed and they were prepresented in 14 sections. The identified microfacies types were illustrated in 61 figures and the microfossils in 45 figures.

All these applied microfacies, micropaleontological and biostratigraphical concepts have brought new insights towards a better knowledge of the geological framework of the Hăghimaș Nappe and the Transylvanian Nappes as a whole.

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