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STUDY OF THE UPPER JURASSIC – LOWER CRETACEOUS CARBONATE DEPOSITS FROM THE NORTHERN PART OF PĂDUREA CRAIULUI MOUNTAINS (BETWEEN GĂLĂŞENI AND FÂŞCA SETTLEMENTS)

MICROFACIES, MICROFOSSILS AND PALEOENVIRONMENTAL RECONSTRUCTIONS

PhD Thesis
(Extended Summary)

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Keywords: Upper Jurassic deposits; lower Cretaceous, microfacies, microfossils; paleoenvironment reconstructions, Pădurea Craiului.

1. INTRODUCTION

The present Ph.D thesis **"STUDY OF THE UPPER JURASSIC – LOWER CRETACEOUS CARBONATE DEPOSITS FROM THE NORTHERN PART OF PĂDUREA CRAIULUI MOUNTAINS (BETWEEN GĂLĂȘENI AND FÂŞCA SETTLEMENTS) -MICROFACIES, MICROFOSSILS AND PALEOENVIRONMENTAL RECONSTRUCTIONS"** represents the research results performed during the period 2009-2012.

The aim was to obtain data related to the microfacies associations, age and successions of the studied deposits, in order to interpret the paleonevironmental conditions under which they were formed.

In order to achieve the intended purpose, the following *specific objectives* were set.

For more than 300 years, Padurea Craiului Mountains have been a point of the interest for geological research, mainly for its bauxite deposits. On the other hand its complex structure has yielded numerous scientific papers.

The present thesis brings additional information regarding the sedimentary facies, depositional environments, the microfossils content and some new interpretations concerning the evolution of the sedimentary area during the Upper Jurassic - Lower Cretaceous period.

2. GENERAL OVERVIEW

The Pădurea Craiului Mountains is located in the Northern part of the Apuseni Mountains between Borod Basin (north, north-west) and Beiuş Basin (south-west). Vlădeasa Mountains is bordering the Pădurea Craiului Mountains at south-est.

Fig.1. *Morfological division of the Apuseni Mountains (after Ianovici et al. 1976)*

3. RESEARCH METHODOLOGY

Various stages were completed during the PhD Thesis elaboration, one of the first steps being the delimitation of the scientific research area.

During field work (area mapping, data collection and sampling) a complete determination and separation of the deposits based on lithostratigraphic criteria was done.

The collected samples were processed in the laboratory and then analyzed using a Zeiss Axiolab Microscope and an optical binocular - magnifying glasses.

The microphotographs of the thin sections were taken using a Cannon Power Shot Camera mounted on the Zeiss Microscope. Beside thin sections, burnished samples were also obtained and afterwords scanned and stored on an optical drive.

The main types of microfacies and the identified micropaleonthological associations were illustrated in twenty plates, using photographs taken under the microscope.

Dunham Classification for carbonate sedimentary rocks (1962) was used for describing the facies associations.

<table>
<tr><td colspan="6">Allochthonous limestone
original components not organically
bound during deposition</td><td colspan="3">Autochthonous limestone
original components organically
bound during deposition</td></tr>
<tr><td colspan="4">Less than 10% >2 mm components</td><td colspan="2">Greater than
10% >2 mm
components</td><td colspan="3">Boundstone</td></tr>
<tr><td colspan="3">Contains lime mud (<0.02 mm)</td><td>No
lime
mud</td><td rowspan="3">Matrix
supported</td><td rowspan="3">>2 mm
component
supported</td><td rowspan="4">By
organisms
which
act as
barriers</td><td rowspan="4">By
organisms
which
encrust
and
bind</td><td rowspan="4">By
organisms
which
build
a rigid
framework</td></tr>
<tr><td colspan="2">Mud supported</td><td colspan="2" rowspan="2">Grain
supported</td></tr>
<tr><td>Less than
10% grains
(>0.02 mm
to <2 mm)</td><td>Greater
than
10%
grains</td></tr>
<tr><td>Mudstone</td><td>Wackestone</td><td>Packstone</td><td>Grainstone</td><td>Floatstone</td><td>Rudstone</td><td>Bafflestone</td><td>Bindstone</td><td>Framestone</td></tr>
</table>

Fig.2. *The Dunham (1962) classification of limestones according to depositional texture (modified by Embry and Klovan (1971).*

4. DATA INFORMATION (STUDIED PROFILES, LOCALISATION AND GEOLOGICAL DETAILS)

The studied area is located in the north-western part of the Padurea Craiului Mountains, between the settlements of Fâșca (in the west) and Gălășeni (in the east). The mapped area is situated between 2 important valleys: Mnerăie Valley, in the north and Poienii Valley, in the south, which also have a serious of other tributary valleys.

Seven main profiles were raised and 620 samples were collected.

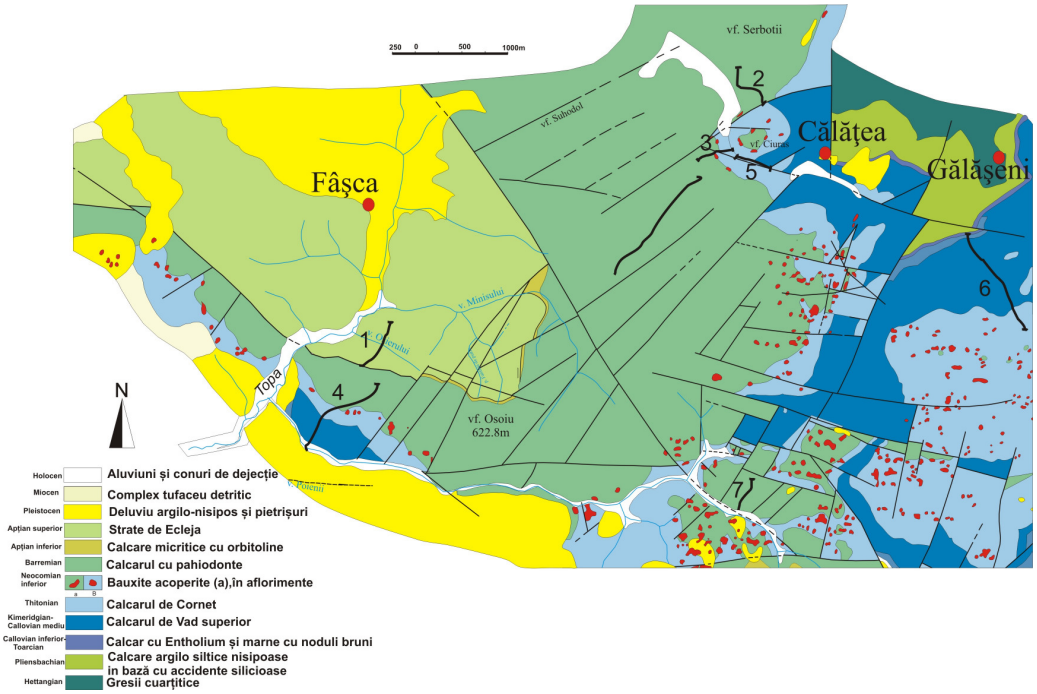


Fig. 3. *The geological map of the northern part of the Padurea Craiului Mountains 1:25000 (modified after Patrulius et al. 1981, raport)*

The northern part of the perimeter was studied on the Șerbota Hill (the Cretaceous deposits have a very good opening); and at the west of Ciuraș Hill, on the left bank of the Mnerăie valley, where the Jurassic – Cretaceous limit was intercepted; along the road between the settlements Aștileu and Călățea, intercept the Upper Jurassic deposits (where you can see the transition of the Vad Formation and Cornet formation)

Three more profiles were raised in the south-eastern part of the studied. One on the right (upper) side of Poienii Valley, downstream of the Osoiu Hill, at the junction between Strevinesului river and Poienii Valley. Other two profiles being raised on the Osierului river (Fâșca) on the right and left side of the valley.

Southern part of the perimeter was detailed by another profile raised in the Cornet settlement. The last profile was raised in the Vad Formation, in the sout-western part of the perimeter, near the Gălășeni settlement.

Profiles described above intercepted deposits belonging to the Vad Formation and the Cornet Formation (Upper Jurassic), the Blid Formation (with Dobresti Member and Coposeni Member) and Valea Măgurii Formation, Vârciorog Formation (including Subpiatră Limestone).

4.1. The Fâșca profile (Profile identification: section E-E' on geological map)

The Fâșca profile was raised in the southern part of the Fâșca settlement beginning from the left side (The northern slope of the Osoiu hill) to the Osierului river. From this profile 50 sample were collected, 26 of them being limestones and marly limestones from the lower side.

The weak marl limestones from the lower side were considered equivalent to the Subpiatra limestone, because they contained *Mesorbitolina texana*.

The Fasca profile is dominated by thick layers of grey marls, partly silty to silty marls. On the lower side there are several levels with weakly rolled limestone blocks caught up in marly material.

Most probably between the limestone banks and the glauconitic marly sandstones (nannoplancton material identified - especially samples 272-278,) there is sedimentary conformity.

In the marls which lay over the limestone, nannoplancton species have been identified for the first time by Dr. Mihaela Melinte (e.g. sample 272 ,located approximately 15m from the limit with the underneath limestone).

4.2. The Șerbota Hill profile (Profile identification: section A-A' on geological map)

This profile is situated north to Călățea settlement, on the southern slope of the Serbota Hill and intersect the road which binds the settlements Aștileu and Călățea. The profile has a length of proximately 80m.

In the upper third part of the profile, from the highway level upwards, massive limestones banks of grey colour appear, with a facies succession that denotes repeated sedimentary cycles, frequently terminated with subaerial exposure.

Usually, each cycle begins with marine facies (with dasycladales), a facies of very shallow depth, with ostracodes, and even rare charophyte), followed by a surface of subaerial exposure with drying factures and breccias surfaces. The succession presents itself in a shape of banks, which are decimeters up to metrics thick.

The deposits identified in this limestone have accumulated in a shallow depth environment, on a carbonatic platform, where peritidal deposits were predominant.

From these deposits, three depositional environments were identified: intertidal, subtidal and supratidal (with subaeral exposure at the top of the banks).

Based on the micropaleonthologic association analyses (*Paracosckinolina jourdanensis* identified), the limestones from Șerbota Hill area were established to be Lower Barremian.

These deposits belong to the Coposeni member of the Blid Formation.

4.3. The profile of the lower course of the Mneră ie Valley (Profile identification: near H-H' section on geological map)

This profile is situated on the left slope of the valley, immediately to the west of Glimeia Hill. From here, 62 samples were collected. In this profile the limit between Upper Jurassic Lower Cretaceous can be identified and established.

Based on the facies encountered in the lower part of the profile, the limestone deposits belong to the Upper Jurassic, respectively to the Cornet Formations. The intermediate part of the profile belongs to the Dobresti Member, from the Blid Formations, and the upper part of the profile belongs to the Coposeni Member based on the foraminiferous associations, especially *Paracosckinolina jourdanensis,* which indicates Lower Barremian.

Proceedings from the profile of the lower stream of the Mnerăie Valley, another profile was raised, (Profile identification: G-G' on geological map)on the plateau between Serbota Hill and the settlement of Fâșca. 19 samples were further collected. The first 8 samples belong to the Coposeni Member (Blid Formation) as indicated by the presence of the foraminiferous *Paracoskinolina jourdanensis*. In the remaining 11 samples, microfacies and microfossils were identified that are characteristic to the Subpiatra limestone (egs. *Triploporella steinamnni* BARATALLO, *Paracoskinolina jourdanensis* ROEMER.

4.4. Poienii Valley profile (Profile identification: near E-E' section on geological map)

This profile is situated on the right slope of Poienii Valley below the Osoiu Hilland at the junction between Strevinesului river and Poienii valley. From this profile, 42 samples were collected. As they were intensively covered by soil and vegetation, deposits succession could not be continuously followed.

The micropaleonthologic associations identified in the limestone present along the sampling succession line is mainly represented by foraminifera. Based on this, in the Lower part, the deposits probably belong to the Valea Măgurii Formation.

In the intermediate part of the profile, deposits belonging to the Upper Jurassic can be identified (the Cornet Formation) and in its Upper side we find deposits belonging to the Lower Cretaceous (Coposeni Member of the Blid Formation).

Carbonate deposits from this area are indicated to be Lower Barremian by *Paracoskinolina jourdanensis*. The limit between the Upper Jurassic deposits and the Lower Cretaceous is marked by a fault.

4.5. Ciuraș Hill profile (Profile identification: B-B' section on geological map)

This profile was raised along the highway which connects the settlements of Aștileu and Călățea, at the base of the Ciuraș Hill. From this profile, 34 samples were collected.

Based on the facies and the micropaleonthologic associations identified in the lower part of the profile, the deposits belong to the Upper Jurassic, respectively to the Vad Formation and the upper part belongs to the Cornet Formation.

4.6. Bradii Hill profile (Gălășeni settlement) (Profile identification: near C-C'section on geological map)

On this profile 108 samples were collected from deposits belonging to Upper Jurassic (Vad Formation and Cornet Formation).

Deposits identified at the base of this profile, along the road, belong to Middle Jurassic, based on several collected ammonites, which unfortunately could not be classified..

4.7. Cornet profile (Profile identification: near D-D' section on geological map)

Cornet profile is located in the Cornet area, 90 m to the right from the bridge which passes over Miersetilor Valley. From this area 24 samples were collected.

The micropaleonthological association identified in this limestone, especially *Paracoskinolina jourdanensis*, indicates the Barremian age. The limestone belong to the Coposeni Member of the Blid Formation.

5. THE MAIN FACIES ASSOCIATIONS

The Vad Formation - main microfacies associations identified:

a) bioclastic peloidal packstone with *Crescentiella.* The main components are peloids bioclasts, small oncoids, ooids and calcified sponge spiculs, *Saccocoma*, Radiolars, some echinoids fragments, bryozoars and hemipelagic foraminifera (*Lenticulina* sp.) and bivalves fragments.

This microfacies is characteristic to an external slope medium, open to the sea, with low energy and reduced hydrodinamics.

b) mudstone/wackestone and wackestone packstone bioclastics with spongeous spiculs.

This type of microfacies indicates the base of the shelf slope This type of facies often represent the transition from the Vad Formation to the Cornet Formation. Also present are: fragments of echinoids (plates radiols), small foraminifera (including miliolids) hemipelagic foraminifera (Lenticulina and other bioclasts with hemipelagic characteristics (ex. pieces of *Saccocoma*, ammonites.). Associated with this components, microbialites could formed, which formed crusts, oncoidic noduls or stromatolitic type structure. The presents of recifals clasts of ruditics to arenitics dimension, enclosed in a micritic matrix, which reflects conditions of open sea (ammonites, sponges), suggests the accumulation of deposits in an open sea environment with low hydrodinamics.

The Cornet Formation – facies types identified:

a) packstone/grainstone bioclastic coarse with echinoids, foraminifera, algae and intraclasts

This Facies corresponds to shelf edge system with bioconstructions and bioclastic bamcks (shoals), belonging to the Upoe Jurassic.

b) Wackestone/packstone peloidal-bioclastic fenestral. The main components are peloids, bryozoars as well as variations with intraclasts represented thru refial fragments (boundstone with corals and sponges) and also fragments of echinoids and foraminifera.

c) Packstone/grainstone ooidic bioclastic fenestral. The components are represented by ooids, peloids, dasycladals and cynobacteria of the type *Rivullaria*. The existence of ooids,

peloids, intraclasts and of the sparitic cements (concrete) indicate a subtidal environment with high energy. The diversity of skeletal components, of foraminifera and algae indicate normal marine environment.with good oxygenation conditions.

d) peloidal bioclastics, fine granular grainstone with *Crescentiella moronensis*, peloids and an abundance of echinoids fragments, bioconstructions formed by corals, microbiolites, sponges, green algae, bryzoars, foraminifera and cyanobacteria of the type *Rivullaria*.

e) grainstone ooidic bioclastic.This type of microfacies is characteristic to some deposits composed mainly of recifales fragments (fragments of corals, sponges and red algae of the *Solenopora* sp. Type). The depositional environment is probably of the shelf border and the upper part of the shelf slope. The microfacies, foraminiferal associations and calcareous algae indicate marine deposition environment of shallow depth, with unturbulence waters and normal marine salinity. The predominantly oolitic microfacies most probably represent oolitic barriers, and the peloidal ones were probably formed on the sides of these barriers.

The Blid Formation

The Dobresti Member - a single type of microfacies was identified: wackestone fenestral with characee, ostracods, gasteropods. This type of deposit is specific to environments with variations from fresh waters to brackish ones.

The Coposeni Member - types of microfacies identified:

1) bindstone with bainnelids structure and other microbial structure. This type of microfacies is characteristic to a shallow water platform environment. Well oxygenated and relatively poor in nutrients (olygotrophic environment). Cyanobacteria of the *Rivullaria* type are present, as well as foraminifera, gasteropods, hollows and fenester filled with geopetals sediment.

2) microbial bindstone ,where the microbial crusts are similar to stromatolitic structure of the type LLH (laterally linked hemispheroids) which appear in a marine restrictive supratidal environment (FZ8 and FZ9, cf. Flugel 2004)

These structures were encountered in the medium part of the Șerbota Hill profile, in sample 99.

3) fenestral mudstone, identified in the first part of the succession. Fenestral of the type stromatactis “birds eyes”, cyanobacteria of the *Rivullaria* type, rare foraminifera (milliolids), rare fragments of gasteropods, fragments of rudists, other lamellibranchiate and ostracods were encountered. Also, intraclasts with flattened and elongated shapes or with subangular and rounded shapes were encountered. The fenestral structures are characteristic to the intertidal superior supratidal environments.

4) packstone /grainstone intraclastic peloidal fenestral oncoidic. Peloidal intraclasts and fenestral structures are predominant. The oncoids generally present a nucleous of large dimensions, intraclastic (unfossiliferous mudstone) or bioclastic (fragments of gasteropods, “nodules” of cyanobacteria -Rivullaria type, green algae). These deposits indicate an intertidal environment.

5) wackestone /packstone bioclastic. Contains green algae, alongside rudists, corals, foraminifera, gasteropods, sometimes even ooids. This type of facies indicates a subtidal, normal marine environment with low hydrodinamics.

6)wackestone bioclastic fenestral, strongly diaclaset . One of the main characteristics is the presents of fenestral structure. The bioclast are relatively rare, represented by foraminifera (milliolids, *Sabaudia minuta* (HOFKER), *Vercorsella* sp.), recristalised gasteropods, algae or cyanobacteria of the *Rivullaria* type. Predominance of peloids and intraclsts associated with fenestrated structure and the relatively poor flora and fauna are characteristic to a intertidal, normal marine environment.

7)wackestone fenestral with milliolids textularia irregular fenestrae, fragments of rudistsand other lamelibranchiates. This deposits correspond most probably to a intertidal, lower subtidal environment. Sometimes in this type of facies bindstone and *Bacinella* intercalated.

8)grainstone/packstone intraclastic with weakly rolled clasts, belonging to a subtidal environment with relatively low hydrodinamics.

9)carbonated breccia and microbreccia predominantly composed by intraclasts, encountered in the lower part of the sucession.

10)boundstone/floatstone coraligen bioclastic where corals fragments of rudists, other lamelibranchiats, echinoderms, foraminifera, gasteropods, ostracodes and dasycladales appeard. This type of facies indicate a subtidal environment with reduced hydrodinamics.

The Vârciorog Formation

In the Varciorog Formation the following microfacies have been identified:

a)wackestone/packstone intraclastic peloidal with microbial structure, fragments of echinoids, fragments of ostracods, *Crescentiella* sp. And rare incrustants foraminifera which indicates an environments with relatively low hydrodinamics

b)bioclastic wackestone, reach in terrigenous sediments, spicule of sponges and plates of echinoids.

c)wackestone/packstone bioclastic extraclastic, wackestone bioclastic which suffered an intensive bioturbation processs and wackestone packstone intraclstic. This facies appeared intercalated in the upper part of the sucession of the Varciorog Formation. Generally this deposits are finely laminated (micrits/marls) and some levels are reach in glauconite. The bioclasts are represented by sponges spicules, rare bentonic foraminifera (milliolids) and fragments of echinoids. These deposits have accumulated in a slope area of the shelf.

d) packstone/grainstone intraclastic bioclastic. This facies is present in lower and upper part of the sucession,intercalated with fine granular deposits. The palaeontological associations is represented by fragments of echinoids, bryozoars, gasteropods, bentonic foraminifera (milliolids, orbitolinids), fragments of rudists, green algae and corals. The microfacies indicate the fact that this limestone was accumulated in a shelf margine environment.

Subpiatra Limestone

In this lithotratigraphic unity two types of microfacies have been identified.

a)wackestone/packstone bioclastic with foraminifera, gasteropods, microproblematics of the type *Lithocodium*, microbial structure of the type *Bacinella*, cyanobacteria of the type *Rivullaria*, fragments of rudists and dasycladale algae.

b)grainstone peloidal bioclastic fenestrae, with intraclasts, milliolids, cyanobacteria of the *Rivullaria* type, microbial structure of the type *Bacinella*, fragments of rudists, ostracodes, and fragments of echinoids.

6. DEPOSITIONAL SYSTEMS - GENERAL SEQUENCE AND THE AGE OF THE STUDIED DEPOSITS

Based on the geological sections and studied profiles, a synthetic general column of the Jurassic and Cretaceous deposits of the studied area was created.

Six formations were identified:

- The Vad Formation, the Cornet Formation
- The Blid Formation (with Dobresti member and Coposeni Member)
- The Ecleja Formation,
- The Valea Magurii Formation and
- The Varciorog Formation (including Subpiatra Limestone)

In some of the studied deposits micropaleonthologic associations were identified, especially calcareous algae and benthonic foraminifera, which are important for establishing the age of these deposits. Thus, in the Cornet Formation were identified:

- calcareous algae: *Salpingoporella annulata* (CAROZI), *Neuteotloporella* sp., *Cylindroporella sp., Salpingoporella* sp., *Clypeina sulcata* (ALTH), *Salpingoporella pygmaea* (GÜMBEL).
- foraminifera: *Andersenolina alpina* (LEUPOLD), *Trocholina* sp.

From this *Clypeina sulcata, Salpingoporella pygmaea* and *Andersenolina alpina* are characteristic for the Upper Jurassic.

A more abundant Lower Cretaceous association was identified in the limestone, more precisely at the Barremian -Aptian level:

- Calcareous algae: *Salpingoporella muehlberghi* (LORENZ), *Salpingoporella melitae* (RADOIČIĆ), *Similiclypeina conradi (*BUCUR), *Pseudocatinoporella silvaeregis* (BUCUR)*, Juraella bifurcata (*BERNIER)*, Salpingoporella genevensis* (CONRAD)*, Actinoporella* sp.*, Falsolikanella* sp.*, Similiclypeina* sp.*, Actinoporella podolica (*ALTH)*, Falsolikanella danilovae* (RADOIČIĆ), *Suppiluliumaella* sp.*, Neomeris* sp., *Clypeina* sp., *Clypeina solkani* (CONRAD & RADOIČIĆ), *Cylindroporella eliptica* (BAKALOVA), *Milanovicella pejovicae (*RADOIČIĆ)

- Foraminifera: *Paracoskinolina*? *jourdanensis (*FOURY & MOULLADE), *Trocholina* sp., *Sabaudia auruncensis* (CHIOCCHINI & DI NAPOLI ALIATA), *Meandrospira* sp., *Vercorsella* sp., *Lenticulina* sp., *Vercorsella scarsellai* (DE CASTRO), *Debarina hahounerensis*

(FOURCADE, RAOULT & VILA), *Glomospira urgoniana,* (ARNAUD-VANNEAU), *Nautiloculina broennimanni (*ARNAUD-VANNEAU & PEYBERNES), *Pfenderina globosa (*FOURY), *Mesorbitolina texana (*ROEMER), *Mesorbitolina subconcava (*LEYMERIE), *Sabaudia minuta* (HOFKER), *Glomospira* sp., *Lenticulina* sp., *Nezzazatinella* sp., *Gaudryna* sp., *Herbergella*sp., *Textularia* sp., *Meandrospira* sp., *Protopeneroplis ultragranulata (*GORBATCHIK), *Charentia evoluta* (GORBATCHIK).

From this association, the *Orbitolinid* has a special significance. Thus, *Paracoskinolina jourdanensis* is characteristic for Lower Barremian and dates the Lower part of the Coposeni Member. On the other hand, *Mesorbitolina texana* is not present before the Gargasian (Upper Aptian) and therefore the presence of this species in the limestone of the Varciorog Formation represent an important biostratigraphic marker.

The calcareous algae are more abundant in the deposits of the Lower Creataceous from the studied area. Some species (*Salpingoporella genevensis, Falsolikanella danilovae, Pseudoactinoporella silvaeregis*) are characteristic for the Barremian and also represent next to foraminifera an important biostratigraphic marker.

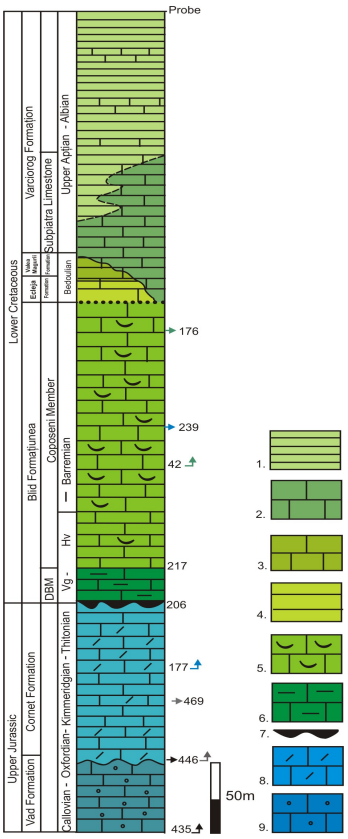


Fig. 4. *The general sucessions of the deposits from the study area 1. Vârciorog Formation; 2. Subpiatra Limestone; 3. Valea Măgurii Formation; 4. Formaţiunea de Ecleja; 5. Coposeni Member; 6. Dobreşti Member; 7. Bauxite; 8. Cornet Formation; 9. Vad Formation, DBM –Dobreşti Member, VG-HV-Valanginian-Hauterivian*

7. SEDIMENTARY EVOLUTION AND RECONSTRUCTION OF PALEOMEDIUM

In Pădurea Craiului Mountains the carbonate platform sedimentation lays on top of the Dogger reduced thickness sediments and with many sedimentary gaps. The carbonate shelf sedimentation starts from the Upper Callovian with slope and external plate facies. The sediments present hemipelagic characteristics, being represented mainly by slope deposits (The Vad Formation limestone). This facies is specific to the central- northern area, where they are probably continous (Kimmeridgian). Over the Vad Formation limestone recifal/perirecifal limestone can be found (The Cornet Formation limestone).

A major exondation of the entire region was produced at the of Jurassic. The duration of this exondation is difficult to be established, but it can be said that it corresponds to the terminal part of the Tithonian and most part of the Berriasian. In this period, palaeocarst was formed with deposits of "terra rossa" type, which led bauxite deposits formation. The sedimentation resumed in the regions to fresh and brackish water deposits, with charophites, ostracodes and gasteropods (the carbonate deposits of the Dobrești Member of Valanginian Hauterivian age). Carbonate platform deposits (The Coposeni Member) with rudists, foraminifera and calcareous algae followed and were deposited during the Hauterivian- Upper Barremian.

Probably at the end of the Barrremian, the first manifestation of the Middle Cretaceous tectonism caused the carbonate platform breaking and the formation of blocks with different vertical movements. North to Pădurea Craiului Mountains, due to the oscillatory movements of these blocks, good conditions for accumulation of some slope breccias in continental systems system (the Gugu breccia member) and of some horsts and grabens (Patrulius et al.1982, Cociuba 1999).

Conditions were thus created for the deposition of some sediments with predominantly terrigenous character in deeper areas (Ecleja marls). On the higher blocks the carbonate platform sedimentation continued on certain time interval, leading to the formation of the limestone of Valea Bobdei and that of Valea Măgurii ("medium limestone with pchiodonte" in older literature) of Lower Aptian age.

Above the Valea Măgurii limestone an important discontinuity in sedimentation was recorded. The deposits of the Varciorog Formation, which follow in the succession are

predominantly terrigenous (clay, marls, sandstone and conglomerates often with glauconitic). There is some intercalation limestones in this succession that may contain corals and rudists, most often representing flows of carbonate material from a more shallow area, of the carbonate platform. This area was identified in the north of Pădurea Craiului Mouuntains being represented by the Subpiatră Limestone (Daoud et al. 2004), Bucur et al. 2010).

The Vârciorog Formation was deposited during the Upper Aptian-Albian, being followed by “reddish colour” deposits, assigned by Patrulius (in Ianovici et al 1976) to the Cenomanian.

8. GEOLOGICAL MAP – Scale 1: 10.000

The aim of this thesis imposed from the beginning the use of a well developed mapping background. The latest work in Pădurea Craiului (Cociuba, 1999; Bucur et al., 2010) demonstrated the need for a review of the extension and the age of the data represented in Pădurea Craiului Geological Map (1:25.000 scale) and 40b-Zece Hotare Geological Map (1:50.000 scale). This is the reason why the geological map of the region was done on a 1:10.000 scale. The resulted geological map and geological sections may be consulted in the appendix of the actual PhD Thesis.

Using the 1:25.000 map, three layers: Lower Jurassic, Middle Jurassic, Upper Jurassic (Vad Limestone, Cornet Limestone and Gălăşeni Limestone) have been identified on the investigated area.

The Cretaceous is represented by Neocomian limestone with C*harophytes*, Barremian limestone with *Pachiodonts* (Orbitolins on top of the layer). Above, the Ecleja layers (Upper Aptian) were identified, which contain a micrite part and at the base some Lower Aptian orbitolines were discovered. Gugu Breccia is also considered to be Lower Aptian, but it can be seen only south from our studied perimeter.

Some newer formations were also identified: detritic deposits with tuff intercalations, but also quaternary ones represented by gravel and clay and sandy deposits, along the valleys and dejection cones (alluvial cones). "Pietrişurile de Oarzăna" – Oarzăna gravels are considered to be Sarmatian and are characterized by gravel with large blocks of Permian conglomerates.

Jurassic, Cretaceous and Cenozoic deposits have been identified after building up the geological profiles and drawing the detailed mapping.

The Jurassic was mapped and separated into Lower, Middle and Upper Jurassic. Separating the Middle Jurassic and Upper Jurassic deposits was not the aim of this thesis and therefore were not covered here.

The Upper Jurassic is represented by:

- Vad Formation (Callovian-Oxfordian)
- Cornet Formation (Oxfordian- Middle Tithonian).

The Aştileu Formation has not been well identified and mapped, although oolitic intercalated facies specific for this layer has been encountered as intercalations into the Cornet Limestone. In practice, the Gălăşeni Limestone was impossible to be determined considering the almost identical facies as in Vad Formation.

Lower Cretaceous formations identified were:

- Blid Formation (with Dobreşti part belonging to Valanginian-Hauterivian and Coposeni part belonging to Hauterivian-Baremian);
- Valea Măgurii Formation (Lower Aptian);
- Ecleja Formation (Bedoulian age; as Patrulius 1964 understood it: the marl between Blid and Valea Magurii) ;
- Varciorog Formation (belonging to Gargasian-Albian; including the Subpiatra Limestone).

The Mesozoic deposits have been covered by Sarmatian and Quaternary ones.

Identifying and finding the accurate extension of Vârciorog Formation was rather difficult during field work, due to a different succession from the typical known and described model of the formation succession. The main deposits are represented by an alternation of marls and limestone (without glauconitic sandstone) as represented in the typical Vârciorog Formation. This is probably formed due to the proximity to source area of the carbonate flows which formed the carbonate platform of Subpiatră Limestone. In fact, we have concluded that the extensive area of limestone, prior considered to be Neocomian- Lower Aptian is actually formed by two different formations: Coposeni Limestone and Subpiatra Limestone. Few small occurrences Ecleja formation has been identified northern from the one already present on the existing 1:25.000 map of the area. In Fâşca area, most of the parts previously considered to be Ecleja formation on the old maps, are in fact the Varciorog formation with marl facies (due to the proximity of the carbonate platform, represented by the Subpiatra Limestone). One fact that needs to be mentioned here is that, in our area of interest, mapping has revealed that Subpiatra Limestone outcrops over 100m in the north side and continues under the Varciorog Formation on the south west with thicknesses between 30 and 40m, transgressively overlaying Coposeni Limestone and it can be seen from Osoiu pick. It is important to say that it has been mapped and recorded for the first time in the present thesis.

In the south part of our studied perimeter, Valea Măgurii Formation outcrops in the Valea Poienii Valley creek. On the old 1:25.000 geological map, this was previously mapped as Pleistocene (represented by alluvium flows and dejection cones.)

As showed by Popa et al (1998), the Oarzana gravels, located on the left side of Poienii Valley are to considered to be Sarmatian.

The stratigraphic and tectonic arrangements are completely different from the initial ones, previously mapped inside our area of interest. Based on information from the geological maps and eight geological cross sections (4 E-W: AA', BB', CC', DD' and 4 N-S: EE', FF', GG', HH'), a new geological situation has been created. The Fâşca Syncline, very well drown on old maps, was not highlighted on the present geological map (fact which also emerges from the BB' and CC' geological sections).

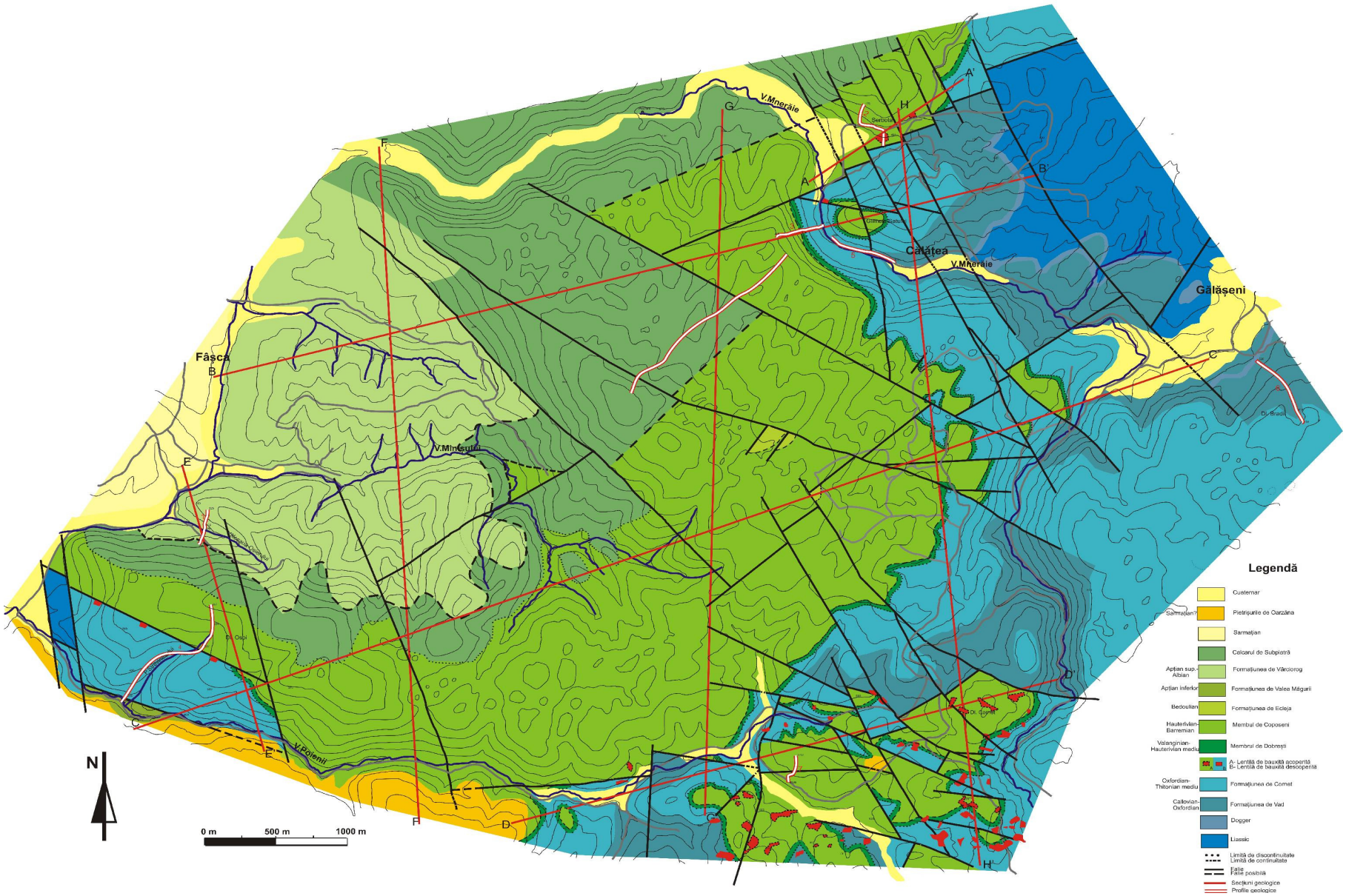
From the tectonics point of view, the mapped region revealed three generations of faults, which can be grouped after their direction and different relations between them in:

- first group: the newest ones (cross cutting all the others) orientated NNW-SSE
- the second group (cross cut by the first ones and moved horizontally) orientated NE-SW
- the third group (cross cut by the first two) orientated NW-SE.

First category is Sarmatian because slightly to the NW it affects some Sarmatian deposits by putting them into contact with some Lower Cretaceous ones. The age of the other two is difficult to be established, but is very likely to be post Lower Aptian due to the fact that they are putting in contact Lower Aptian deposits with Jurassic ones (see EE' geological section from V. Poienii).

It has been noticed noticed that the Upper Jurassic and Lower Cretaceous formations (at least Barremian ones and SW of Bedoulian area), even without any unconformities, have been sedimented on a stabile and very unitary carbonate shelf. The self ended towards the open sea, on the north side being affected only by vertical movements and oscillations. The situation changes drastically after Gargasian, when the northern part of the studied area and the carbonate shelf functioned as a marginal carbonate platform; south –western area was considered to be an open see area. This is the result made by the start of the collision between Bihor Unit the the rest of the units from its north and south. The entire post-Gargasian cycle has progressively started to be more terrigenous, its upper part being called by older geologists ***"fliş"***.

Harta geologică a zonei cuprinsă între localitățile Fâșca și Gălășeni 1:10.000



CONCLUSIONS

The aim of this thesis was a detailed study of the Upper Jurassic-Lower Cretaceous deposits from the Fâşca - Gălăşeni region (north of Pădurea Craiului Mountains), in order to establish the sedimentary evolution, facies associations and depositional systems.

In order to achieve this goal, seven profiles were accomplished, from which 620 samples were collected. Out of these samples 654 thin sections and 48 polished surfaces were obtained.

Thin sections and polished sections along with direct observations made during fieldwork periods led to separating carbonate microfacies and depositional environments of the six geological formations encountered : The Vad Formation, The Cornet formation (Upper Jurassic), The Blid Formation (with the Dobresti Member and the Coposeni Member), The Valea Magurii Formation, The Varciorog Formation and the Subpiatră Limestone (Lower Cretaceous) were described.

The Vad Formation limestone is characterized by shelf slope microfacies, with packstone deposits and small peloidal bioclastic grainstones, with microfilaments and rare *Saccocoma,* sponges spicules and sections thru ammonites. Above the condensed deposits of the Middle Jurassic, the Vad limestone makes the transition to the carbonate platform deposits of the Upper Jurassic (the Cornet Formation). Here, various microfacies were identified, starting with bioclastic-ooidic grainstones characteristic to the platform marginal environments and the external platform ones, until the packstone/wackstone bioclastics, which characterize the internal platform environments.

In the Upper Jurassic, platform exondation led to paleocarst deposits and the depositional of residual sediment which will eventually lead to the formation of bauxite deposits.

The sedimentation continued in Valanginian, with freshwater limestone with charophyte and brackish water limestones with gastropodes and ostracodes (The Dobresti Member).

The normal-marine sedimentation most probably resumes to Upper Hauterivian, when the formation of the carbonate deposits of the Coposeni Member begins. The microfacies identified in this lithostratigraphic unit are various from external platform deposits (bioclastic grainstone) to wackstone with dasycladales and foraminifera (characteristic to the internal platform environment) and up to micritic fenestral which characterized the intertidal environments of the marginal-marine environment.

Most of the studied area presents terrigenous and carbonate deposits of the Varciorog Formation. The limestones of this formation are characterized by shelf margins and slope microfacies and show the allodapic characteristics of the component material.

The source for carbonate material is represented by carbonate platform deposits of the Subpiatra Limestone, identified in the northern part of the studied area.

An important contribution to the study of this area is made by the identified microfossils associations , which allowed lithostratigraphic units dating from the seven profiles.

In the deposits of the Upper Jurassic (the Vad Formation and the Cornet Formation as many as 10 microfossils were identified. From this, several limestone algae and foraminifera are important for establishing the Kimmeridgian-Thitonian limit (*Clypeina sulcata, Salpingoporella pygmea, Andersenolina alpine)*. The micropaleonthologic associations from the Lower Cretaceous deposits (The Blid Formation and the Varciorog Formation are richer and more diverse, 40 microfossils were identified, among this, the dasycladales *Salpingoporella genevensis, Falsolikanella danilovae* and *Pseudoactinoporella silvaeregis*, alongside orbitolinids *Paracoskinolina? Jouradanensis* and which are characteristic for the Baremian (the Coposeni member), while *Griphoporella creatcea Triploporella steinmani, Neomeris Cretacea*, as well as the orbitolinids *Mesorbitolina Texana* and *Mesorbitolina subconcava* characterized Aptian Albian interval (The Subpiatra Limestone and the Varciorog Formation). The main types of microfacies and identified micropaleonthologic associations have been illustrated on twenty plates with photographs taken under the microscope.

One of the most important contribution to the geological knowledge of the studied area is the drawing of the 1:10000 scale geological map.

In the mapping activity, field observations were put beside laboratory results, based on thins sections analyses .

According to the new generated map, a large part of what was considered on old maps to be Ecleja Layers on the Fâșca area, actually represents the Varciorog Formation, with more marly facies then those in the type area, because of the proximity to the carbonate platform area (represented by the Subpiatra Limestone). The large area where this type of limestone can be found, previously considered Neocomian (Lower Aptian) is in fact composed from two different formations: The Coposeni Limestone and the Subpiatra Limestone situated in a transgressive and discordant relation.

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