„BABEŞ-BOLYAI" CLUJ-NAPOCA

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LAZAR DANIEL FLORIN

THE LOWER CRETACEOUS DEPOSITS IN THE NORTH-WEST OF THE PĂDUREA CRAIULUI MOUNTAINS (VÂRCIOROG-DOBREŞTI AREA)

ABSTRACT OF THE PhD THESIS

Scientific advisor:

Prof. Dr. BUCUR IOAN

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CONTENTS

Key words: Lower Cretaceous deposits, Pădurea Craiului, microfacies, microfossils, depositional environments;

1. INTRODUCTION

The PhD thesis concerns the study of the Lower Cretaceous deposits from the north-western part of Pădurea Craiului Mountains. The area under study is delimited by the localities Vârciorog in the north, and Dobreşti in the south. We have studied the micropaleontological content and the sedimentology of these formations in the view of establishing their age, the paleoenvironments of formation and the tectonic framework during their evolution.

This study continues a long series of previous investigations in the Pădurea Craiului area. Many were oriented on the economically important resources but there were also scientific papers proper that dealt with the complicated structure of the Northern Apuseni Mountains. The new contributions of our work are represented by original data on the facies types, the micropaleontological content and the typical depositional environments; they support new interpretations on the evolution of this sedimentary basin during the Lower Cretaceous.

2. METHODS OF INVESTIGATION

While studying in the field, we have mapped the deposits and collected samples. These allowed us to separate subunits, based on lithostratigraphic criteria. The samples were processed in the laboratory and then investigated by the means of a Zeiss Axiolab microscope and an Optika stereomicroscope. Microphotographs on the thin sections were taken with a Canon PowerShot camera attached to the Zeiss microscope. From some of the carbonate rocks we have also prepared polished slides that have been scanned afterwards. Based on the microscopic investigation, we have described the typical microfacies types and microfossils for each sample; these aspects are illustrated in 17 plates of microphotographs.

For describing the facies types we have used the terminology in the classification of Dunham (1962).

3. LOCATION OF THE PROFILES AND THE OUTCROPS DESCRIPTION

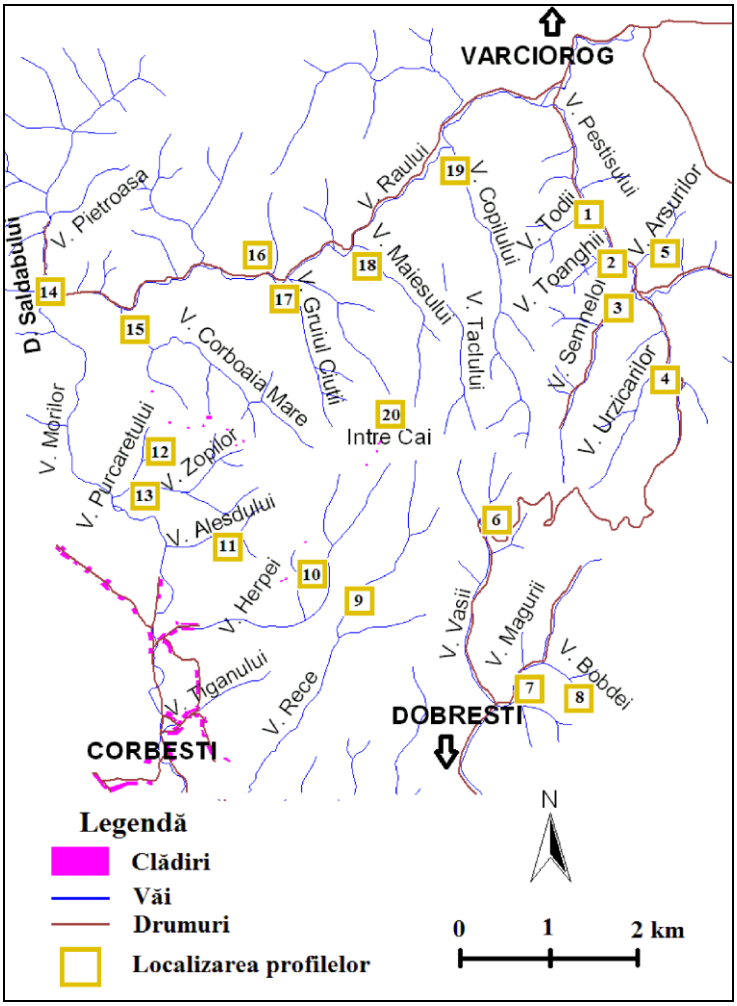

Fig. 1. Sketch showing the location of the studied profiles

The profiles are located in the valleys delimited by the localities Vârciorog in the north, and Dobrești in the south. The region is outlined by three main valleys: Valea Râului or Topa mark the north-western and western border of the studied area. They first flow from north-east to south-west, and then from north-west to south-east; Valea Peștișului and Valea Văsii (Valea lui Vasile) that mark the eastern border of the area under study.

Both Valea Peștișului and Valea Văsii have their source in Cornilor Hill (544 m), from where they flow in opposite directions. Peștiș Valley flows toward north-west and joins Valea Râului, the junction being located at the southern limit of Vârciorog locality. Valea Văsii flows from north to south, and it joins Topa Valley in Dobrești locality.

The main valleys collect several western tributaries that are directly flowing into the Râului Valley, as well as some eastern ones that flow into Peștiș and Văsii Valleys. The main outcrops are located along these valleys.

3.1 Valea Todii profile

This profile is located in Todii Valley – a left tributary of Peştiş Valley, in the close neighbourhood of Vârciorog locality (fig. 1). We have identified two types of deposits: carbonatic and siliciclastic. They are represented by limestones – both bioaccumulated and bioconstructed, as well as marly limestones, marls, or glauconitic sandstones and conglomerates. A fault marks the transition between the carbonatic and the terrigenous deposits, which also separates the Valea Măgurii and Vârciorog formations.

3.2. ***Valea Toanghii profile***

Toanghii Valley is also a left tributary of Peștișului Valley, located south from Valea Todii (fig. 1). The lithologic succession consists of black limestones with orbitolinids and terrigenous deposits. The micropaleontological association, including *Mesorbitolina texana*, points to an Upper Aptian–Albian age for the Vârciorog Formation.

3.3. ***Valea Semnelor profile***

Semnelor Valley, the largest left tributary of Peștișului Valley, is delimited by Toanghii Valley in the north and Urzicarilor Valley in the south (fig. 1). We have recorded three calcareous levels in the profile in Valea Semnelor. The first level is 30 m-thick. It consists of black bioconstructed limestones. The bioconstructions contain corals, sponges and rudists, encrustations of calcimicrobes and red algae. The other two, much thinner, calcareous banks are interlayered between the clayey, marly and glauconitic sandstones deposits of the Vârciorog Formation.

3.4. Valea Urzicarilor profile

Valea Urzicarilor is the first important left tributary of Peştiş Valley (fig. 1). The carbonate deposits identified here in two levels consist of bioaccumulated limestones. In the base of the profile, the grey limestones rich in foraminifers and dasycladaleans an algae form stratified decimetre to metric layers. Packstones and bioclastic wackestone/packstone represent the main facies types. The darker limestones cropping out at the top of the profile are dominated by sparitic cement and they contain

foraminifers and algae, besides fragments of corals, echinoderms, crinoids. In the middle part of the profile and on the top of the uppermost calcareous level we have noticed siliciclastic deposits represented by sandstones and conglomerates interlayered with silty marls and silty marly clays.

3.5. *Valea Arsurilor profile*

Valea Arsurilor is a right tributary of Peștiș Valley (fig. 1). The main deposits in this profile are represented by calcareous rocks with thin sandstone and marls interlayers. The identified micropaleontological association points to differences between the two carbonate levels. The base level, with *Mesorbitolina texana* was included in the Vârciorog Formation, while the one at the top with *Palorbitolina lenticularis* was assigned to the Valea Măgurii Limestones.

3.6. *Văsii Valley profile (upstream)*

This profile is located on the side of DJ 767 local road between Dobrești-Vârciorog, toward the upper part of Valea Văsii (fig. 1). The succession starts with a thick level of marls that is interrupted by two faults. In the hairpin turn of the road along Valea Văsii, limestones crop out on the top of these marls; based on the micropaleontological association, these limestones were assigned to the Valea Măgurii Formation.

The marls in the base of these limestones, i.e., Ecleja Marls are laminated and include vegetal and coal fragments. We have also identified rare biseriate foraminifers and fragments of some rudist tests. In its middle part, the profile is dominated by both carbonate and terrigenous deposits, with *Mesorbitolina texana*; at the top we have recognized the Valea Măgurii Limestones, with *Palorbitolina lenticularis* and the marls with ammonites of the Vârciorog Formation.

3.7. *Outcrop in Valea Măgurii quarry*

This quarry is located along Valea Măgurii, 100 m upstream from its junction with Valea Văsii; the former is a left tributary of the second valley.

We have separated three lithostratigraphical units: Ecleja Marls, in the base of the profile; Valea Măgurii Limestones; and marls with ammonites from the base of

Vârciorog Formation. A paleokarst with hardground surfaces separates the Valea Măgurii Formation from the marls on their top.

3.8. *Valea Bobdei profile*

Valea Bobdei is a left tributary of Măgurii Valley. Cociuba (2000) and Bucur & Cociuba (2001) considered that the calcareous rocks from Valea Bobdei represent a calcareous member within the marly Ecleja deposits. The marls in the base of the profile contain rare foraminifers. They are followed by marly limestones and by the Valea Bobdei Limestones with sponges, bryozoans, echinoids, foraminifers, green and red algae, or calcimicrobes. Among the algae, we have identified *Salpingoporella popgrigorei*, a species typical for Valea Bobdei Member.

3.9. Valea Rece profile

Valea Rece is a left tributary of Râului Valley, the junction being located in the area of Corbeşti (fig. 1).

Permian deposits crop out in the lower part of the valley; they consist of whitish and locally reddish sandstones and conglomerates. In the middle part, we have registered an unconformity represented by the overthrust of the Permian deposits on the top of the reddish marly deposits, while in the upper part of the valley marls and nodular limestones with orbitolinids, i.e., Vârciorog Formation, crop out.

3.10. Valea Herpei profile (upstream)

Valea Herpei is also a left tributary of Râului Valley. The two valleys converge right in the centre of Corbeşti locality (fig. 1).

Most of the valley exposes whitish Permian sandstone and conglomerates, components of the overthrust nappe. These deposits crop out from the river bed to about 380 m altitude. In the middle part of the profile we have identified dolomitic deposits, de-dolomitized limestones (dolomicrites, dolosparites with zoned dolomite crystals). The upper part of the profile is dominated by clayey-sandy deposits assigned to Vârciorog Formation.

3.11. Valea Aleșdului profile (upstream)

Valea Aleșdului is a left tributary of Râului Valley, the junction being located at the periphery of Corbești (fig. 1). In this profile we have identified whitish sandstones and conglomerates, reddish sandstones and conglomerates, finely stratified sandstones – all being Permian deposits included in the Arieșeni. In the middle part of the succession dolomites are present, very similar to those observed in the profile from Valea Herpei.

3.12. Valea Purcărețului profile

The western ramification of Purcăreț Valley, as well as the eastern one of Zopilor Valley, both are left tributaries of Râului Valley (fig. 1). On the top of the Permian terrigenous deposits of the overthrust nappe there is an interlayering of reddish marly and sandy deposits (150 m). In their base, the deposits are greyish-blackish in colour and they contain calcareous interlayers.

3.13. Valea Zopilor profile

The deposits cropping out along Zopilor Valley (fig. 1) have both terrigenous and carbonatic nature. The light-to dark greyish or grey-reddish terrigenous deposits consist of sandstones and sandy marls, some including carbonate fragments. The dark, blackish deposits are represented by siltites, marls, marly-limestones, glauconitic sandstones but also nodular limestones (coral-algal bioconstructions) with orbitolinids – all typical for the Vârciorog Formation. The black limestones and the marly limestones with glauconite are significant rocks at three levels within the succession: two in the middle part, and one in the top of the profile.

3.14. Outcrop in the old quarry (Piciorul Saldâbului Hill)

The outcrop is located at the junction between Pietroasa and Râului Valley (fig. 1) in an old limestone quarry at the foot of Saldâbului Hill, close to Bucuroaia locality. The succession here starts with carbonate deposits represented by bioaccumulated and bioconstructed limestones (packstone, bioclastic packstone/grainstone with orbitolinids, red algae, gastropods, microproblematic organisms, boundstone with rudists and corals). Above these, we have identified siliciclastic rocks dominated by marls and sandstones with rare conglomerate interlayers. In the top of the profile from Saldâbului Hill there is

another calcareous level main represented by bioconstructions with rudists and corals, but also by bioclastic grainstone/packstone.

3.15. Valea Corboaia profile

Valea Corboaia is a left tributary of Râului Valley (fig. 1). Our investigation of the outcrops along the valley and on the valley slopes has evidenced the presence of terrigenous (sandstones, marls) and calcareous (bioconstructed and bioaccumulated limestones) deposits.

The lower and middle part of the profile is represented by an interlayering of terrigenous and carbonatic deposits. The sandstones contain glauconite, while the marls locally contain small foraminifers. The marly limestones and the limestones are dark grey to black in colour, nodular, and they contain orbitolinids. The bioconstructions were built by corals, rudists and sponges, besides which green and red algae and foraminifers are also present. The internal sediment is a wackestone/packstone or a bioclastic packstone. In the top of the profile, terrigenous deposits from the "red formation" were identified. They show a significant extension, from Corbeşti Hill to Filipi Hill.

3.16. Valea Râului profile (right bank)

The profile is located on the right slope of Valea Râului, at about 200 m upstream from the junction with Gruiul Ciuții Valley (fig. 1). This outcrop evidences a succession of clays, marls, marly limestones and limestones. Their colour ranges from light grey to dark grey and even black - mainly in the case of the nodular limestones with orbitolinids. Most of the calcareous succession is dominated by bioclastic packstone with foraminifers, except for the upper part where bioconstructions with corals, rudists, red algae encrustations and calcimicrobes become paramount.

3.17. Valea Gruiul Ciuții profile

Gruiul Ciuții Valley is a left tributary of Râului Valley (fig. 1). In the base of the succession there are siliciclastic deposits (sandstones, conglomerates), followed by finer ones - silts, marls, and by carbonate deposits.

The carbonate deposits in the succession are present as four levels consisting of bioclastic wackestone/packstone, bioclastic packstone/grainstone and boundstone with corals.

3.18. Valea Măieșului profile

Valea Măieșului is a left tributary of Râului Valley (fig. 1). The deposits cropping out here are represented by limestones, marly limestones, marls, sandstones and marly clays. The base of the succession is represented by the limestones of the Valea Măgurii Formation.

The middle and upper part of the profile is dominated by terrigenous facies types consisting of marls and sandstones with rare calcareous and marly limestone interlayers. These deposits are typical for Vârciorog Formation.

3.19. Copilului and Țâclului Valley profile

Valea Copilului is located at the southern limit of Vârciorog locality and is a left tributary of Râului Valley (fig. 1). In the base of the profile, there are grey limestones represented by bioclastic packstone or bioclastic peloidal packstone, bioclastic packstone/grainstone and bioclastic wackestone/grainstone with numerous foraminifers but also with rare fragments of green algae. In the middle and upper part of the profile the terrigenous deposits dominate; they are represented by marly and sandy clays, sandstones with local glauconite content, and subordinated interlayers of black nodular limestones with numerous orbitolinids and rudists. We have identified three levels of bioconstructed limestones built by corals, sponges, calcimicrobes and rudists. These deposits are assigned to the Vârciorog Formation.

3.20. Profile on the top of „Între Căi" Hill

This outcrop is located at „Între Căi" site, along the forest route in the neighbourhood of the three isolated dwellings close to Corbeşti (fig. 1). There are only calcareous deposits cropping out here, represented by wackestone/packstone, packstone, packstone/grainstone and boundstone. The dark-grey limestones contain rudists, corals, bryozoans, echinoids, algae, foraminifers and calcimicrobes. Among other species, these

limestones contain *Mesorbitolia texana* and *Sabaudia minuta* which plead for an Aptian–Albian age and their assignment to Vârciorog Formation.

4. FACIES AND MICROFACIES

The profiles previously described bring to the surface deposits belonging to the Ecleja, Valea Măgurii and Vârciorog Formations.

The marls of the Ecleja Formation have been intercepted in the profiles from the "hairpin turn" (Valea Văsii upstream), along Măgurii and Bobdei Valleys. These laminated marls are greyish and contain large amounts of metamorphic clasts (micas, quartzite etc). The schistosity is parallel to the stratification and is often marked by microstylolites. Rarely, they contain fragments of foraminifers and vegetal rests. Valea Măgurii Formation was recognized in the profiles from Valea Todii, Valea Arsurilor, Valea Urzicarilor, Valea Văsii (in the "hairpin turn"), Valea Măgurii, Valea Măieșului, Valea Copilului, and Valea Țâclului. The carbonate microfacies types identified in the Valea Măgurii Formation are mainly represented by bioclastic wackestone, bioclastic peloidal wackestone/packstone and oncoidic peloidal packstone/wackestone. Subordinately we have also evidenced mudstones with bioclasts, fenestral mudstone with bioclasts, peloidal bioclastic packstone/grainstone and extraclastic grainstone/packstone with angular clasts. These deposits formed in diverse areas of a subtidal depositional environment: subtidal with low hydrodynamic regime, subtidal with high hydrodynamic regime, restrictive subtidal (of lagoon-type). Only locally we have identified intertidal-supratidal deposits (most probably formed in tidal channels). The facies types of the subtidal and normal marine environments are clearly dominating.

In the Vârciorog Formation we have registered the presence of siliciclastic deposits (conglomerates, bioclastic sandstones, glauconitic sandstones, bioclastic siltites and greyish-black clays/marls). We have also identified carbonatic (bioconstructed and bioaccumulated) deposits.

The siliciclastic deposits build-up a complex succession consisting of fine sediments (micrites/marls) interlayered with coarser levels of conglomerates/carbonatic or siliciclastic sandstones. The marls and marly clays are yellowish to black, and they

sometimes contain siltic nests and bioturbations, or vegetal remains. The marls are often laminated, but the schistosity is not identical with the stratification (Cociuba, 1999). These marls contain foraminifers, gastropods and locally fragments of corals and glauconite.

In the area under study, glauconite is a typical component of the sandstones and conglomerates. The bioclastic sandstones beds show tabular and layer-type geometries, while the conglomerate ones occur as lenses. The clasts composing the conglomerates and microconglomerates are mainly represented by rounded fragments of metamorphic rocks (quartzites, micaschists, chloritic schists and re-crystallized limestones). Besides these clasts, we have identified large rudists bioclasts, corals, gastropods and benthonic foraminifers (orbitolinids). In general, the conglomerates are poorly sorted, while the ruditic clasts show chaotic display within a bioclastic arenitic matrix.

Sedimentary bodies with unchannelled, tabular and layered geometries are typical in the case of the relatively "coarser" deposits interlayered within the finer ones in the whole succession. These bodies are centimetre-decimetre thick and they show limited lateral extensions, of tens of meters. They consist of fine carbonate or siliciclastic material, with grain sizes in the range of the fine sand to silt. The material consisting the infilling of the sandy granular bodies is represented by carbonatic intraclasts, bioclasts (numerous echinoid plates, bryozoans and benthonic foraminifers), extraclasts – especially of metamorphic nature (schists and re-crystallized limestones) and clay/marls clasts.

The carbonate deposits consist of bioaccumulated and bioconstructed limestones (coralgal bioconstructions, bioconstructions with rudists and corals). The bioconstructions occur on the top of the siliciclastic deposits. In the profiles form Valea Todii and Valea Urzicarilor this calcareous level is located towards the top of the succession. On the contrary, along Semnelor and Arsurilor Valleys, or on Piciorul Saldâbului Hill, the bioconstructions are located at the base of the profiles, while they occur in their middle parts along Gruiul Ciuții and Zopilor Valleys. They mainly consist of biogenic concentrations of corals colonies showing, as a rule, a branching growth pattern. Subordinately, we have noticed corals colonies with lamellar/layered growth fabrics.

The bioaccumulated limestones are represented by bioclastic packstone/grainstone, bioclastic grainstone/packstone, bioclastic wackestone/packstone and subordinately by bioclastic packstone and wackestone. The bioclasts consist of fragments of rudists, corals, sponges, echinoids, orbitolinids, gastropods, brachiopodes, worm tubes, dasycladaleans and red algae, as well as by nodules of calcimicrobes and cyanobacteria. We have identified such calcareous horizons in the profiles along Văsii, Urzicarilor, Arsurilor, Toanghii, Semnelor, and Todii Valleys. As a rule, the limestones are dark in colour and usually display nodular morphologies. They were generated by grain flows. The bioclasts' high degree of fragmentation and abrasions represent additional proofs for the platform's instability during the geological interval under discussion, in Vârciorog area.

5. GENERAL SUCCESSION, MICROFOSSILS AND THE LOWER CRETACEOUS AGE OF THE DEPOSITS

Based on the profiles built-up in the area under study, we have summarized a synthetic general lithological column for the Cretaceous deposits. We have recognized three distinct lithostratigraphic units: Ecleja, Valea Măgurii and Vârciorog Formations.

The marls of the Ecleja Formation have been intercepted in the profile from the "hairpin turn", in the upper part of Văsii Valley. These greyish marls are laminated and they contain high amounts of metamorphic clasts (mainly represented by micas and quartzite). The schistosity is parallel with the stratification and it is often outlined by microstylolites. They only rarely contain rests of foraminifers (*Lenticulina* sp., textularids) and vegetal remains. The lack of index fossils renders establishing the age of these marls difficult. They were assigned to the Lower Aptian (Lower Bedoulian) based on their location beneath the Valea Măgurii Limestones, of Upper Bedoulian age.

A typical association was identified in the profile along Bobdei Valley. Besides sponges, bryozoans, echinoids, foraminifers and algae are also present in large amounts. Among the foraminifers, we have recognized *Charentia cuvilieri* NEUMANN, *Vercorsella* sp., *Gaudryina* sp., *Textularia* sp., *Palorbitolina lenticularis* (BLUMENBACH), *Orbitolinopsis* sp., *Paracoskinolina* sp., while among the algae we noticed frequently *Salpingoporella popgrigorei* BUCUR, *Salpingoporella muehlbergi*

LORENZ, and *Sporolithon rude* (LEMOINE). In some cases, the bryozoans and the sponges display *Bacinella irregularis* RADOICIC encrustations. These limestones were assigned to the lower part of the Aptian.

The deposits of the Valea Măgurii Formation represented by compact greyish limestones show the greatest micropaleontological diversity in the area under study. We have intercepted this calcareous horizon in the profiles along Valea Todii, Valea Arsurilor, Valea Urzicarilor, Valea Văsii - upstream, the quarry in Valea Măgurii, Valea Măieșului, Valea Copilului, Valea Țâclului and on the slopes of Râului Valley in the proximity of Vârciorog locality.

In the Valea Todii profile, the micropaleontological association includes algae representing *Salpingoporella* genus, and the foraminifers *Nezzazatinella* sp., *Arenobulimina* sp., *Meandrospira* sp., *Textularia* sp., *Vercorsella* sp. The limestones from Valea Urzicarilor, Valea Arsurilor and Valea Măgurii contain the following association: *Nezzazatinella* sp., *Novalesia producta* (MAGNIEZ), *Glomospira urgoniana* ARNAUD-VANNEAU, *Charentia cuvillieri* NEUMANN, *Ammobaculites* sp., *Vercorsella* sp., *Gaudryina* sp., *Bolivinopsis* sp., *Paracoskinolina* sp., *Paleodictyoconus cuvillieri* FOURY, *Sabaudia capitata* ARNAUD-VANNEAU, *Sabaudia auruncensis* CHIOCCHINI & DI NAPOLI ALIATA, *Derventina filipescui* NEAGU, *Bacinella irregularis* RADOICIC and numerous miliolids. Besides, we have identified forms of *Orbitolinopsis kiliani* SILVESTRI, *Paracoskinolina arcuata* ARNAUD-VANNEAU, *Debarina hahouenerensis* FOURCADE, ROUL & VILA, *Lenticulina* sp., *Textularia* sp., *Belorusiella* sp., ?*Archaealveolona* sp., *Salpingoporella muehlbergi* LORENZ, *Salpingoporella melitae* RADOICIC (on Valea Văsii, Valea Măgurii and Valea Copilului), *Neomeris* sp. and *Palorbitolina lenticularis* (BLUMENBACH) (in the profile on Văsii Valley). *Palorbitolina lenticularis* has a distribution restricted to the Terminal Barremian–Lower Aptian; accordingly, we assigned a Lower Aptian age to the Valea Măgurii Limestone (the Upper Barremian being most probably included in the lower level of the Ecleja Marls).

Within the terrigenous deposits of the Vârciorog Formation, we have identified much more microfossils as compared to the Ecleja Marls. These deposits were identified in most of the studied profiles, especially towards their top. The most common types of

bioclasts are represented by rudists, gastropods, fragments of echinoids, bryozoans, fragments of algae and foraminifers. Less frequent, we have noticed coral fragments and worm tubes. In the base of the Vârciorog Formation, marls with ammonites and belemnites crop out. These marls were recognized in the profiles displaying a normal succession, where not faults were present.

We have identified ammonites-containing deposits in the quarry on Măgurii Valley (left slope of Văsii Valley) and on Cornilor Hill (profile from Valea Văsii, upstream). Emil Avram have studied the ammonite fauna at the base of the Vârciorog Formation in the Valea Măgurii profile; he has identified the following genera and species: *Colombiceras* (Egoianiceras) gr. *multicostatum* AVRAM, *Colombiceras* gr. *subpeltoceratoides* (SINZOW), *Tonohamites* cf. *limbatus* CASEY, *Acanthohoplites* cf. *aschiltaensis* ANTHULA, *Deshayesites*? cf. *planus pyritosus* CASEY and fragments of *Helicancylus* sp. This association pleads for an Upper Aptian (Gargasian) age (cf. Avram et al., 2001). Among foraminifers, *Mesorbitolina texana* represents an index species for relative age assignment. Additionally, *Textularia* sp. and *Lenticulina* sp. are also present.

The limestones of the Vârciorog Formation can be separated into two groups: bioconstructed, and bioaccumulated. The paleontological association described from the bioconstructed limestones includes fragments of sponges, corals, rudists, gastropods, bryozoans, calcimicrobes, green and red algae and foraminifers. Among the corals, we have identified species of *Microsolena* sp., *Callamophylliopsis* sp. and *Cyatophora* sp. (Kolodziej et al. 2011); sometimes, they are encrusted by *Bacinella-Lithocodium* sp. The most representative coralgal levels were noticed along in the Valea Gruiul Ciuții profile (in the middle part of the succession), Valea Todii (towards the top), and Valea Semnelor (in the base of the profile). We can also add the levels in the upstream sector of Văsii Valley and in the Piciorul Saldâbului Hill.

In both the bioconstructed and bioaccumulated limestones we have identified a micropaleontological association consisting of the following genera and species of foraminifers, algae and microproblematic organisms: *Mesorbitolina texana* (ROEMER), *Sabaudia minuta* (HOFKER), *Charentia cuvillieri* NEUMANN, *Charentia nana* ARNAUD –VANNEAU, *Meandrospira* sp., *Vercorsella* sp., *Everticyclammina* sp., *Rectocyclamina* sp., *Nezzazatinella* sp., *Debarina* sp., *Textularia* sp., *Quinqueloculina*

sp., *Bolivinopsis* sp. *Novalesia* sp., *Gaudryina* sp., *Glomospira urgoniana* ARNAUD-VANNEAU, *Griphoporella cretacea* (DRAGASTAN), *Triploporella* sp., *Sporolithon rude* (LEMOINE), *Permocalculus* sp., *Neomeris cretacea* STEINMANN, *Marinella lugeoni* PFENDER, *Polystrata alba* (PFENDER), *Solenopora* sp., *Bacinella irregularis* RADOICIC, *Lithocodium aggregatum* ELLIOTT, *Carpathoporella occidentalis* DRAGASTAN, *Carpathocancer* sp. and Rivulariacean-type cyanobacteria. Less frequent forms are *Mayncina bulgarica* PEYBERNES, *Spiroplectamina* sp., or *Diversocalis* sp. In the upper part of the Valea Todii profile, in the Valea Zopilor and Valea Copilului (upstream) profiles we have also identified *Triploporella* sp. specimens.

The stratigraphical distribution of the benthonic foraminifer *Mesorbitolina texana* concerns the Upper Aptian–Albian interval. Given the fact that it was identified in all the deposits attributed to the Vârciorog Formation, we can undoubtedly assign it this stratigraphical age.

The "red formation" was not investigated from micropaleontological point of view. In the profiles from Gruiul Ciuții Valley, Corboaia, Saldâbului Hill, Purcăreţ Valley or Filipi Hill, they are located on the top of the deposits of the Vârciorog Formation. On the other hand, they are topped by overthrust nappes. Based on reference data (Istocescu, 1970; Istocescu et al., 1970; Bleahu et al., 1971), these deposits can be assigned to the Cenomanian–Turonian interval.

6. DEPOSITIONAL ENVIRONMENTS

Most probably, the Ecleja Marls have sedimented in a shallow basin formed under the influence of incipient tectonic activity in the region, at the end of the Barremian. These events have led to the uplift of some surrounding areas and the reactivation of the landscape energy, thus to an increased terrigenous supply. The study of this formation – of complex significance in the regional context, is in progress.

The typical microfacies features and the micropaleontological associations plead for the genesis of the calcareous deposits of the Valea Măgurii Formation in a normal marine environment, covering the shallow subtidal to the intertidal areas – the latter signalled by the presence of fenestral fabrics. The upper part of the formation displays a

karstic paleolandscape, with ferruginous-bauxitic deposits developed as films, nests or lenses in the small cavities at the surface of the limestones, or along fissures. These features suggest subaerial exposure of the limestones and a subsequent transgressive and unconformable deposition of the marls in the base of the Vârciorog Formation.

The two types of deposits characterizing the whole succession within the Vârciorog Formation, i.e., the siliciclastic and carbonate ones, proof the alternation of distinct depositional environments within the sedimentary basin.

The siliciclastic deposits represent submerse fan deltas accumulated in the marginal areas of the basin. The bioclasts included point to a normal marine environment. Nevertheless, the various potential sources, the heterogeneity of shapes and sizes of the clasts within the conglomerates suggest the origin in an alluvial-fluviatile environment, with accumulation in the proximal areas of the marine shelf. This can explain the mixture of typical marine bioclasts with the clasts originating from alluvial-fluviatile fans discharging at the shelf margin.

The siliciclastic bodies led to the construction of positive topography at the basin margin, providing favourable conditions for the subsequent accumulation of the carbonate deposits. On the top of these highlands, formed the carbonate bioconstructions and open shelf carbonate deposits (bioclastic packstone-grainstone). Limited-in-size bioconstructions, initiated by corals and solitary or small groups of rudists could evolve in this shallow normal marine environment with low hydrodynamics and favourable bioclastic substrate. The internal sediment (bioclastic wackestone/packstone) and the encrustations caused by various organisms on the corals and rudists fragments point to low sedimentary rates that supported the installation and development of the bioconstructions. Most probably, the sporadic fresh water supply from the continent has inhibited their rate of growth.

Based on the facies types identified in the siliciclastic deposits, we can state that more "coarsening upward" cycles existed. These cycles record a transition from the prodelta clays in the base, to delta front turbiditic sands/gravels, as a sign of alluvial fans' progradation towards the basin. The subsequent accumulation of the carbonate deposits took place as a consequence of an increase of the relative sea level and of the basin margin stability, leading to a retrograde trend of the alluvial fans. The delta fans from

Vârciorog Formation have evolved in a specific tectonic framework (the meso-Cretaceous tectogenesis) that determined an intensification, or reactivation of the landscape energy in the areas bordering the basin. In the active stages of the basin border, siliciclastic deposits formed; they became progressively thicker towards the top of the succession, and dominated by the coarser fractions (i.e., "coarsening upward" sequences).

7. SEDIMENTARY EVOLUTION

When considering the overall evolution of the area under study, we can state that at the end of the Barremian, the tectonic movements got more intense, leading to the platform fragmentation and to the formation of distinctive tectonic blocks with very diverse vertical lifting rates. These oscillatory movements of the blocks created premises for the accumulation of continental slope breccias (Gugu Breccia Member), as well to the establishment of a series of horsts and grabens in the northern Pădurea Craiului Mountains (Patruius et al., 1982, Cociuba, 1999).

Towards the end of the Bedoulian, such a tectonic event lead to the installation on extended areas of internal restrictive depositional environments, similar to those recorded during the Barremian. This lead to the accumulation of the limestones of the Valea Măgurii Formation; these deposits also document a short emersed stage, at the top of the succession (Cociuba, 1999).

Starting with the Gargasian, the terrigenous detrital sedimentation becomes more intense, as a result of the reactivation of the landscape energy in the neighbouring emerse areas. The terrigenous supply is dominating as source of material, while the calcareous interlayers – consisting of nodular limestones get thinner. Thus, the Vârciorog Formation as a whole achieves „flyschoid" features. After the Albian, this process is once more intensified, with the formation of the deposits of „the red formation". The red clays point to an increased continental influence, as a result of the emplacement of the overthrust nappes. In the Northern Apuseni Mountains, the overthrust trend lasted until the Middle Turonian.

CONCLUSIONS

1. The main aim of this PhD thesis was to perform a detailed investigation of the Cretaceous deposits cropping out in the Vârciorog-Dobreşti area (northwest Pădurea Craiului Mountains) for establishing the stratigraphical succession, the age of the geological formations and the depositional environment of formation. In order to achieve this objective, we have performed a detailed mapping of the region, we have elaborated 20 geological profiles, and we have collected 920 samples that were used for preparing 930 thin sections and 74 polished sections.

2. The field observations during the mapping activities, together with the results of the thin sections investigation in the laboratory resulted in the elaboration of a geological map (see Appendices). This original map brings several additions and interpretations as compared to the previous one by (1999); it may be considered as a basic regional geology reference.

3. The detailed study of the 20 geological profiles elaborated for the Vârciorog-Dobreşti area evidenced the presence of four stratigraphical units, i.e. Formations: Ecleja Marls (including the Valea Bobdei Member), Valea Măgurii Limestones, Vârciorog (with mixed, carbonatic-siliciclastic features) and the "red formation".

4. The deposits assigned to the four units were investigated for their lithology, microfacies, diagenetic features (in the case of the carbonate deposits) and micropaleontological content (the latter also mainly in the case of the carbonate ones). The main microfacies types were illustrated in 10 plates of microphotographs. Based on the lithological, micropaleontological and microfacies data we reconstructed the general depositional environment of formation for the studied deposits.

5. For most of the stratigraphical units, we have studied the micropaleontological associations. The identified microfossils, some mentioned for the first time from this region, are presented in 7 plates of microphotographs. Based on the index species, we have assigned the age of these deposits; this concerns the interval

from the Lower Aptian (in the case of Ecleja Marls and Valea Măgurii Limestones, as mainly indicated by *Palorbitolina lenticularis*) to the Upper Aptian–Albian (Vârciorog Formation, with the Gargasian ammonite fauna in the base, and contains *Mesorbitolina texana*). The foraminifers identified by Istocescu (1970) in the "red formation" plead for the Cenomanian–Turonian interval.

6. Vârciorog Formation, which is the most extended unit in the studied area, mainly formed via gravitational reworking of both carbonate and siliciclastic deposits. The transport was oriented from the shallow marginal areas to the deeper, internal parts of the basin. Some higher areas on the bottom of the basin were the place where occasionally small coralgal reefs developed. For the first time, we described the detailed succession of the deposits assigned to Vârciorog Formation. Thus, we could provide significant new data on its characteristic paleontological and micropaleontological associations.

7. Finally, the present thesis provides original data on the stratigraphical succession and the relationships between the lithological units identified. Understanding the complex geological framework of the studied region requires even more data, thus research is still in progress.

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