FACIES ANALYSIS OF THE LATE CRETACEOUS DEPOSITS FROM CORNI QUARRY (NORTH-EASTERN BORDER OF GILĂU MOUNTAINS)

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ABSTRACT. The Late Cretaceous deposits outcropping along the northeastern border of Gilău Mountains form a NW-SE-oriented crest. The crest is delimited westwards by the crystalline formations of Baia de Arieș Nappe. Within these deposits, two distinctive sedimentary complexes could be separated: a) The Gosau-type facies formation, that can be correlated to the "Lower Gosau Subgroup" (Wagreich & Faupl, 1994), represented by alluvial/fluvial fans and shallow marine deposits; b) The flysch-type formation, that is similar with the "Upper Gosau Subgroup" (Wagreich & Faupl, 1994) and includes deep sea deposits (hemipelagites/turbidites). The syndepositional and postdepositional tectonics controlled the sedimentation and facies distribution; the shallow carbonate deposits are embedded in distal shelf marine ones. Isolated blocks of various sizes represent the rudist-bearing limestones (from m² up to hundreds of m²). The present study focuses on the identification of facies and depositional environments of the limestones outcropping along Pleșcuța valley, in Corni Quarry (SW from Finișel village). Based on sedimentological features and faunal associations, the following facies associations have been identified: 1) Marls and limestone with terrigenous clasts; 2) Build-ups with tubular/massive corals and rudists; 3) pillarstone-type bioaccumulations with branching/platy corals; 4) bioclastic rudstone/grainstone; 5) bioclastic floatstone/packstone. All these facies associations indicate a coastal environment developed along a shelf margin influenced by both the terrigenous supply, and the relative sea level variations.

Keywords: limestone, microfacies, facies, depositional environments, Late Cretaceous, Apuseni Mountains, Romania.

INTRODUCTION

The Late Cretaceous deposits outcropping along the northeastern border of the Gilău Mountains form a NW-SE-oriented crest. The crest is delimited westwards by the crystalline formations of Baia de Arieș Nappe (Figure 1). Koch (1888) was the first to mention these deposits, when indicating several fossiliferous sites without any information on the age of the limestone. Loczy (1916) recognised the Santonian-Campanian age of the youngest Late Cretaceous deposits in the Northern Apuseni Mountains. This age was confirmed by further papers (Givulescu, 1954; Ianovici *et al.*, 1976; Lupu, 1960, 1976).

Two distinctive lithostratigraphic units could be separated within the Late Cretaceous deposits: the Gosau-type facies "Formation", and the Flysch "Formation" (Moisescu, 1960; Lupu, 1960; Vlaicu-Tătărâm, 1963; Mureșan, 1980; Bucur & Urian, 1986, 1989; Bucur *et al.*, 1991). These deposits are comparable with the Late Cretaceous deposits from Gosau (Austria), where Wagreich & Faupl (1994) have separated two distinctive sedimentary complexes: a). The Lower Gosau Subgroup, represented by alluvial/fluvial fans and shallow marine deposits; b) The Upper Gosau Subgroup including deep sea deposits (hemipelagites/turbidites).

Figure 1 – Location of the study area

The present study focuses on the identification of facies and depositional environments in the limestones outcropping along Pleşcuța valley, in Corni Quarry (SW from Finişel village) (Figure 1). The rudist-bearing limestones in this quarry have been previously mentioned by Moisescu (1960) and Tătărâm (1962, 1963), who identified some species of rudists of a Santonian-Campanian age.

Due to the syndepositional and postdepositional tectonics, which controlled the sedimentation and facies distribution, the shallow carbonate deposits are embedded in distal shelf marine lutites. The rudist-bearing limestones are represented by isolated blocks of various sizes (from m^2 up to hundreds of m^2) outcropping as patches in the whole area (Pl. I, fig. 2).

FACIES ANALYSIS OF LATE CRETACEOUS LIMESTONES FROM CORNI QUARRY

The Late Cretaceous deposits from Corni quarry outcrop on a relatively small area (tens of meters) and consist of both siliciclastic and carbonate sediments (Figure 2). The siliciclastic sediments are scarce, outcropping only in the base of the succession (Pl. I, fig. 1,3). The carbonate deposits consist of limestones rich in corals and rudists, which form either primary biogenic concentrations, or reworked skeletal levels. In both cases, the main sediment is represented by bioclastic rudstone and floatstone with bioclasts ranging from gravel to silt. In the primary biogenic concentrations, corals are most frequently found in situ and in growth position, sometimes giving birth to build-ups clearly differentiated from the neighbouring facies.

Other times, these in situ biogenic concentrations do not produce a bioconstruction proper that is sharply separated topographically from the neighbouring rocks, but outcrop as distinctive layers within the succession. These bioaccumulations may represent constratal constructions, *sensu* Gili et al. (1995) and Insalaco (1998). The coral biogenic concentrations have been classified according to the genetic growth fabric, as defined by Insalaco (1998).

Based on sedimentological features and faunal associations, the following **facies associations** have been identified:

- 1) – Marls and limestone with terrigenous clasts;
- 2) – Build-ups with tubular/massive corals and rudists;
- 3) – Pillarstone-type bioaccumulations with branching/platy corals;
- 4) – Bioclastic rudstone/grainstone;
- 5) – Bioclastic floatstone/packstone.

1) Marls and limestone with terrigenous clasts

This facies association, represented by decimetre-thick deposits, differs from all the other deposits outcropping in the Corni quarry (Pl. I, fig. 1,3). It occurs only in the base of the succession and it consists of marls, siltites and fine bioclastic sandstones gradually passing into bioclastic limestones rich in terrigenous material towards the top of this succession. This deposit was accumulated on the top of a coarse bioclastic packstone with red algae, Caprinidae (s. l.) and Hippuritidae, and it is laterally delimited by build-ups with tabular corals and rudists, and by coarse bioclastic floatstone with Hippuritidae and corals.

Benthic agglutinated (*Bothysiphon* sp. and *Ammodiscus* sp.) and calcareous (miliolids) foraminifera, as well as rare planktonic foraminifera (*Globotruncana ventricosa*?) have been identified in the marls. Besides, ostracods, internal moulds of gastropods and frequently vegetal debris occur. Bioclastic siltites and limestones rich in terrigenous material (up to 15 cm thick) are interlayered with the marls (Pl. I, fig. 3). The granular bodies show lens-shaped geometry and mainly consist of well-sorted quartz clasts and metamorphic lithoclasts, besides which bioclasts (rudist fragments, corals, red algae, and miliolids), and vegetal debris occur.

The tectonic limit between the crystalline basement and the sedimentary succession from Corni quarry makes the detailed interpretation of these siliciclastic deposits difficult. The lack of transitional facies between the alluvial/fluviol deposits and the marine facies in the area provides basis for theoretical arguments only. The faunal associations and the lithofacies include both shallow marine deposits (with calcareous and agglutinated benthic foraminifera, and gastropods?) and open shelf marine ones (planktonic foraminifera). The terrigenous clastic feature is clearly evidenced by the presence of vegetal debris and lithoclasts. Due to their remarkable adaptation to various depositional environments, the ostracods are not suitable for such interpretations. We assume that the lens-shaped siltite and limestone rich in terrigenous material bodies that are interlayered with the marls belong to some distal submerse fans, which formed near a river mouth. It is obvious that these siliciclastic deposits have been reworked and mixed with marine fauna prior to their accumulation, probably due to low siliciclastic input or to a remote source-area. Based on the faunal associations, the siliciclastic sequences are interpreted as representing a brackish marine environment.

Figure 2 – Sedimentary profile through the investigated succession from Corni quarry;
 1 - Bioclastic rudstone/grainstone; 2 – Marls and limestone with terrigenous clasts;
 3 – Pillarstone-type bioaccumulations;
 4 – Platestone-type bioaccumulations.

2) Build-ups with tubular/ massive corals and rudists

These “bioconstructions” outline a distinctive topography, clearly individualised from the neighbouring facies (Pl. I, fig. 1). The deposits are decimetre to meter-thick and consist mainly of coral colonies with a tabular growth fabric (Pl. II, fig. 2,3); less frequently, massive colonies were noticed (Pl. II, fig. 1). The rudists are always associated, being concentrated at certain levels but always in subordinate amounts (Pl. III, fig. 1,2). These “bioconstructions” constrain the extension of siliciclastic facies in the base of the succession. The internal sediment and the lateral sides of the “bioconstruction” are represented by coarse bioclastic floatstone/packestone with large fragments of corals, rudists and red algae.

Along the succession, some other levels that are rich in corals occur, showing a dominant tabular growth fabric (Pl. II, fig.4; Pl. III, fig. 1,2). This growth feature represents more than 60 % of the total coral skeletal volume. The sediment consists of coarse bioclastic floatstone/packestone with large fragments of corals, rudists and red algae. The biogenic accumulations are decimetre-thick; they outcrop along the whole extension of the quarry, without producing a clearly individualised topographic landscape as compared to the neighbouring facies. These bioaccumulations may be interpreted as constratal constructions (Gili et al., 1995; Insalaco, 1998). According to the genetic growth fabric type, the coral accumulations may be considered as platestone-type (Insalaco, 1998).

3) Pillarstone-type bioaccumulations with branching/ platy corals

Biogenic accumulations consisting of coral colonies with a dominant branching growth fabric (Pl. III, fig. 3,4; Pl. IV, fig. 2,3) occur within the succession. Sub-

ordinately, sheet-like and lamellar colonies (Pl. IV, fig. 1) were identified. In most of the cases, corals are intensely encrusted by red algae, sometimes generating nodular or dendritic (Pl. III, fig. 4,5; Pl. V, fig. 2) concentrations. Less commonly, Caprinidae (s. l.) and Hippuritidae are also present (Pl. IV, fig. 2,3). The internal sediment is constituted of bioclastic mudstone/wackestone with fragments of corals, rudists, and red algae. These bioaccumulations do not outline a positive landscape, but give birth to distinctive levels (decimetre thick) interlayered in the succession.

Based on the dominant branching growth fabric, representing more than 60 % of the total coral skeletal volume, we attribute this facies to the pillarstone-type (Insalaco, 1998).

4) Bioclastic rudstone/grainstone

The granular deposits are interlayered in both the middle, and the upper part of the succession. They consist of centimetre to decimetre-thick, well to moderate sorted bodies of bioclastic rudstone/grainstone with sheet-like geometry, interlayered with bioclastic packstone laminae (Pl. V, fig. 1). The reworked skeletal fragments are of gravel to silt size, and show angular to subrounded morphologies. They mainly consist of coral fragments, rudists and red algae. Isolated coral colonies with a tabular growth fabric are associated to the granular bodies.

The associations of granular bodies show gradual transitions, in the base as well as in the top (Pl. VI), as a consequence of the gradual variations of the energy/dynamics of the environment. We consider these deposits as granular shoals, formed along a shelf margin.

5) Coarse floatstone/packstone

The primary biogenic concentrations are usually associated with coarse, poorly sorted skeletal debris, with the bioclast fragments in the gravel to silt size range. The bioclasts are represented by a large amount of coral and rudist fragments, accompanied by red algae, benthic foraminifera and echinids embedded into bioclastic wackestone/mudstone (Pl. V, fig. 3). These deposits are associated with coral colonies with a tabular growth fabric, rudists, and red algae.

The internal sediment and the lateral sides of the biostrom-type "bioconstruction" in the base of the quarry are represented by coarse bioclastic floatstone/packstone with large fragments of corals, rudists and red algae (Pl. V, fig. 4).

CONCLUSIONS

The restrained area of occurrence of the Late Cretaceous deposits in Corni quarry renders the interpretation of their evolution difficult. Thus only a discussion on the carbonate facies and depositional environment could be supported by evidence.

The identified faunal associations indicate a depositional environment developed along a shelf margin. In such an environment, corals and rudists may form either primary biogenic accumulations, or reworked skeletal levels. In both cases, the main sediment consists of bioclastic rudstone and floatstone with bioclasts in the gravel to silt grain size range. In general, within the primary biogenic accumulations, corals occur in situ and in growth position, sometimes

leading to the formation of build-ups clearly individualised from the neighbouring facies. Other times the in situ biogenic accumulations do not outline a specific topographic body, but they constitute distinctive levels in the succession. These bioaccumulations may be interpreted as constratal constructions *sensu* Gili et al., (1995), and Insalaco (1998). According to the genetic growth fabric type, the coral accumulations may be attributed to platestone- and pillarstone-type (Insalaco, 1998). Both the siliciclastic terrigenous supply and the relative sea level variations influenced this depositional environment.

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REFERENCES

- Bucur, I.I., Urian, R., 1986, *Une nouvelle occurrence du microfacies a Pithonella dans les Monts Apuseni*. "Crisia", **XVI**, p. 563-568.
- Bucur, I.I., Urian, R., 1989, *Algues calcaires (Rhodophyceae) dans les depots du Cretace superieur de la bordure nord-est des Monts Gilau*. Studia Univ. Babeş-Bolyai, Geologia-Geographia, **XXXIV**, 2, p. 33-38.
- Bucur, I.I., Urian, R., Tompa, V., 1991, *Note on a wildflysch sequence in the upper cretaceous deposits from Hasdate (eastern border of the Gilau Mountains)*. Studia Univ. Babeş-Bolyai, Geol., **XXXVI**, 2, p. 15-20.
- Gili, E., Masse, J.-P., Skelton, P.W., 1995, *Rudist as gregarious sediment-dwellers, not reef-builders, on Cretaceous carbonate platforms*. Palaeogeography, Palaeoclimatology, Palaeoecology, **118**, p. 245-267.
- Givulescu, R., 1956, *Contribuţiuni la studiul Cretacicului superior din Bazinul Borodului*. Stud. şi Cerc. St., Acad. Filiala Cluj, an. **V**, nr. 1-2.
- Ianovici, V., Borcoş, M., Bleahu, M., Patruşiu, D., Lupu, M., Dimitrescu, R., Savu, H., 1976, *Geologia Munţilor Apuseni*. Editura Acad., 631 p.
- Insalaco, E., 1998, *The descriptive nomenclature and classification of growth fabrics in fossil scleractinian reefs*. Sedimentary Geology, **118**, p. 159-186.
- Koch, A., 1888, *Bericht über die in dem südlich von Klausenburg gelegenen Gebiete im Sommer des Jahres 1886 durchgeführte geologische Detailaufnahme*. Jahresb. K. ungar. Geol. Anst 1886, Budapesta.
- Loczy, J., 1916, *Beiträge zur Kenntnis der Gosau und Flyschbildungen des Aranyostales*. Jahresb. K. ungar. Geol. Reichsanst., Budapesta.

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- Lupu, D., 1960, *Contribution à la connaissance des rudistes du sénonien des Monts Apuseni*. Studii și Cerc. Geol. Geofiz. Geogr., Geologie, t. 5, p. 627-653.
- Lupu, D., 1976, *Contributions a l'étude des rudistes senoniens des Monts Apuseni*. Memoires l'Institut de Geologie et de Geophysique, vol. XXIV, p. 83-152.
- Moiescu, V., 1960, *Contribuții la studiul hipuriților senonieni din regiunea Hășdate-Stolna (Bazinul Iarei-Munții Apuseni)*. Studii și Cerc. Geol., VI/1, p. 101-119.
- Mureșan, I., 1980, *Geologia și petrografia bordurii de Nord-Est a Munților Gilăului*. Edit. Acad., p. 125.
- Vlaicu-Tătăram, N., 1962, *Câteva specii de corali din Santonianul de la vest de Feneșel (Sud-Vest de Cluj)*. Analele Univ. București, Științele Naturii Geol.-Geogr., XI, 32, p. 89-97.
- Vlaicu-Tătăram, N., 1963, *Stratigrafia Eocenului din regiunea de la sud-vest de Cluj*. Edit. Acad., 181 p.
- Wagreich, M., Faupl, P., 1994, *Paleogeography and geodynamic evolution of the Gosau Group of the Northern Calcareous Alps (Late Cretaceous, Eastern Alps, Austria)*. Palaeogeography, Palaeoclimatology, Palaeoecology, 110, p. 235-254.

PLATES

Plate I

- Fig. 1 – The lower part of the Late Cretaceous succession in Corni quarry. In the base, marls and limestone with terrigenous clasts outcrop, right-hand laterally delimited by build-ups with tabular corals and rudists. Arrows show the limit of the granular bodies.
- Fig. 2 – Blocks of limestone with rudists (m² in size) embedded in distal shelf lutite deposits.
- Fig. 3 – Detail of figure 1. Arrows mark the limits of the granular bodies interlayered within the marls.

Plate II

- Fig. 1 – Build-ups with tabular/massive corals and rudists.
- Fig. 2 – Coral colonies with a tabular growth fabric.
- Fig. 3 – Tabular corals in thin section.
- Fig. 4 – Coral accumulations with a dominant tabular growth fabric.

Plate III

- Fig. 1 – Rudists associated with levels of coral accumulations showing a tabular growth fabric.
- Fig. 2 – Tabular coral colony overgrown on a rudist level.
- Fig. 3 – Pillarstone-type accumulations with branching corals.
- Fig. 4 – Coral colonies with a branching growth fabric encrusted by red algae.
- Fig. 5 – Red algae in this section.

Plate IV

- Fig. 1 – Sheet-like and lamellar colonies associated with biogenic accumulations of coral colonies showing a branching growth fabric.
Fig. 2 – Hippuritidae within biogenic accumulations of coral colonies showing a branching growth fabric.
Fig. 3 – Caprinidae (s.l.) and Hippuritidae associated with pillarstone-type accumulations with branching/platy corals.

Plate V

- Fig. 1 – The upper part of the succession in Corni quarry, mainly consisting of granular shoals and coral accumulations with a dominant tabular growth fabric.
Fig. 2 – Red algae consisting nodular accumulations
Fig. 3 – Coarse bioclastic floatstone/packstone with fragments of rudists and corals.
Fig. 4 – Bioclastic floatstone with fragments of hippuritidae and corals.

Plate VI

- Fig. 1 – The gradational limit between the granular shoals and the coral accumulations.

PLATE I

PLATE II

PLATE III

PLATE IV

PLATE V

PLATE VI