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STRATIGRAPHIC EVOLUTION AND DEPOSITIONAL ENVIRONMENT OF THE CARBONATE SEQUENCES OF THE TRIPOLIS ZONE IN CRETE

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ABSTRACT

The underlain the flysch carbonate sequence of Tripolis zone, as it develops in the island of Crete, is analyzed and the stratigraphic construction and evolution of the depositional environment of the formations composing it, are presented.

The results based on investigations carried out in the areas of the topographic sheets "Vrises", "Rethymno", "Perama", "Epano Archanes", "Iraklio", "Mohos", "Ano Viannos", "Aghios Nicolaos", "Ierapetra" and "Sitia" are referred to all formations constituting the whole sequence from the Triassic up to the Lower Priabonian.

The determined associations of microfossils have permitted the distinction of the horizons of upper Triassic, Lias, Dogger, Malm, Neocomian, Barremian-Aptian, Albian-Cenomanian-Touronian, Coniacian-Campanian, Maastrichtian, Paleocene, Ypresian, Lutetian and upper Lutetian-lower Priabonian.

The microfacies analysis has shown that sedimentation took places in an environment of carbonate platform, and its evolution is synthetically presented following the detailed analysis of the occurring facies.

INTRODUCTION

On the island of Crete the carbonate and clastic formations of the Tripolis zone largely occur from the Vrisses area to the west to the Sitia to the east (Fig. 1).

Since it was first described by PHILIPPSON (1892) in Peloponnesus and by CAYEUX (1902) in Crete the "Tripolis limestone", as well as, the whole sedimentary sequence of the Tripolis-Gavrovo zone, have been the subject of various studies.

Most of these works refer to the stratigraphy, as well as to the geotectonic position and the tectonic relations of the Tripolis zone sequence with the underlying and overlying formations.

The data are mainly local and details are given in the bibliographic reviews of TSAILA-MONOPOLIS (1977). FYTROLAKIS (1980). THIEBAULT (1982) and ALEXOPOULOS (1990).

A synthetic work concerning the stratigraphy of the zone in the Peloponnesus was presented by TSALIA-MONOPOLIS (1977) and some environmental information are given by ZAGER (1972) and LEPPING (1974, 1976, 1978).

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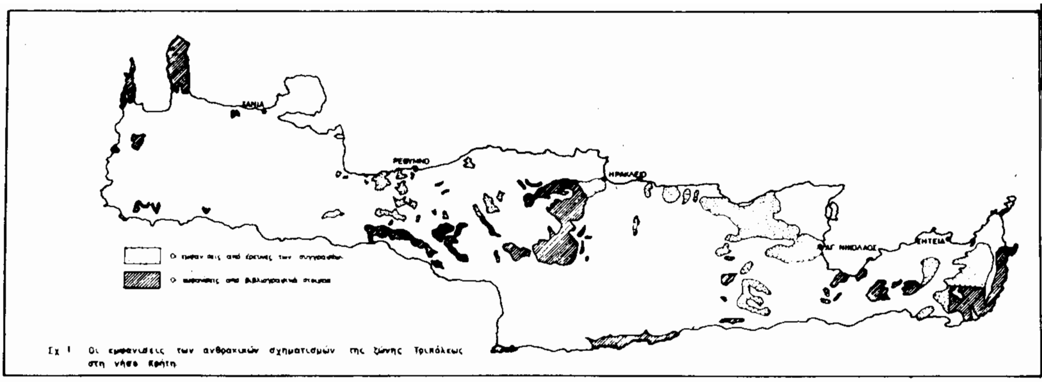


Fig. 1: The carbonate formations of the Tripolis zone in Crete.

During the last decades a systematic geological mapping of the Crete island has been carried out by I.G.M.E. (MYLONAKIS et al., 1984, 1987; VIDAKIS et al., 1987, 1989, 1992a, 1992b, 1992c, 1993) and permitted, among other researches, the detailed study of the stratigraphic evolution and the depositional environment of the carbonate sequence of the Tripolis zone, presented in this work.

GEOLOGICAL SETTING

The Tripolis series occurs mainly in central and eastern Crete, whereas in the western part is represented by small and sparse outcrops.

It is overlying locally, either a clayey-schist carbonate sequence, known as "Ravdouha beds", corresponding to the "Tyros bed" of Peloponnesus, or tectonically the "phyllitic-quartzitic" sequence and in cases where the above sequence is absent, the "Plattenkalk".

The deposition of the lower beds starts in the upper Triassic and the upper beds reach the upper Eocene, when flysch sedimentation starts. In most places the flysch deposition took place on a pre-flysch relief (Fig. 2)

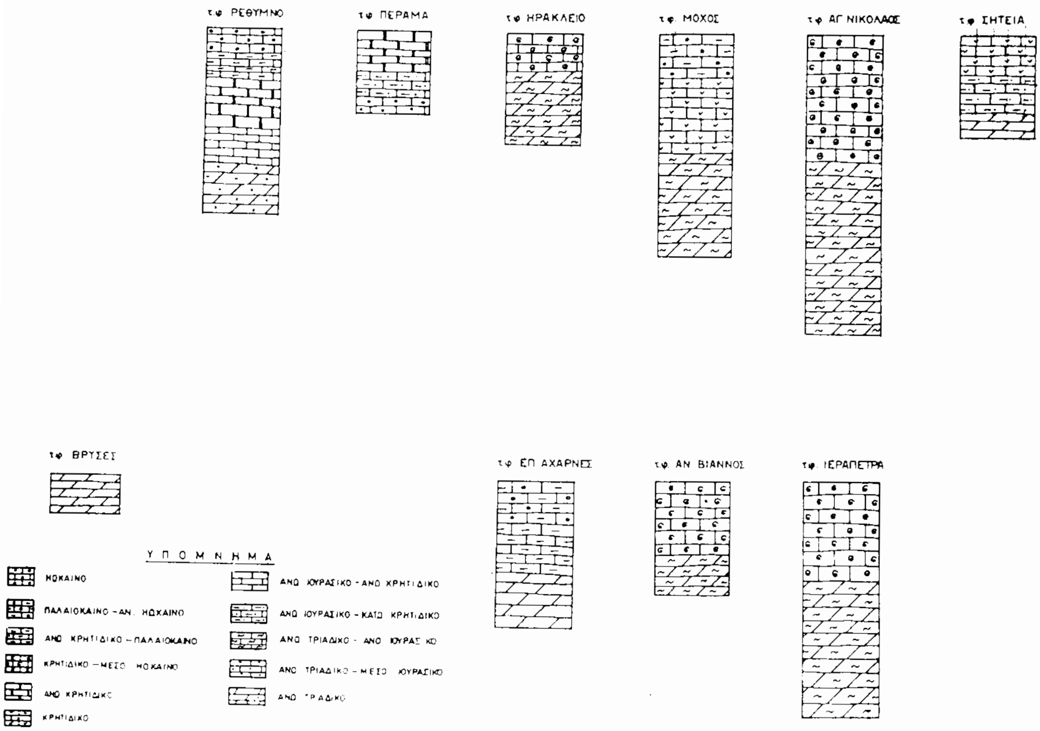
The lower beds of the carbonate formations consist of semicrystalline, intensively karstic, dolomitic limestones and dolomites, thick bedded to unbedded, grey to black-grey intensively fractured to mylonitized in places, due to tectonism. Their middle parts include light-grey, medium bedded micritic limestones, recrystallized and dolomitized. Finally the upper parts consist of black-grey limestones, medium to thin bedded, in places unbedded, micro- to medium- crystallized, bitumenous with a rich neritic fauna.

The carbonate formations of the Tripolis zone are not presented as a complete sequence in all their outcrops in Crete, since they constitute a tectonic nappe and consequently the contact with their substratum appears in different stratigraphic horizons.

STRATIGRAPHIC AND PALEOENVIRONMENTAL DATA

The Triassic

The oldest beds of the carbonate sequence are of triassic age. In spite the fact that, their identification is rather difficult in the field, due to the intensive dolomitization and the similarities of the sedimentary facies with the overlying jurassic formations, triassic beds have been discovered and micropaleontologically proved in the areas of Rethymnon, Perama and Sitia.



Σχ. 2: Συνθετικές στρωματογραφικές στήλες της ζώνης Τριπόλεως στις περιοχές μελέτης.
Fig. 2: Synthetic stratigraphic columns of the Tripolis zone in the studied areas.

Their main macroscopic paleontological feature is the presence of big-sized Megalodon and numerous algal sections of the family Dasycladaceas, highly recrystallized, among which some may represent specimens of the genus Gyroporella. The microfossils are scarce and the associations are rather monotonous. The foraminifera are mainly badly preserved Involutinidae, Ammodiscidae, Ataxophragmiidae and Trochamminidae.

The following microfacies and fossil assemblages have been observed.

- Biomicrites (wackestones) and intra-biosparites (grain-stones) with numerous Involutinidae sections, mollusc fragments and rare Ammodiscidae. Dissolution results to the formation of shell solution molds, filled with saddle dolomite. Among the foraminifera the species Aulotortus sinuosus WEYNSCHENK and Aulotortus tumidus (KRISTAN-TOLLMANN) have been determined. The stratigraphic range of Aulotortus sinuosus, after ZANINETTI (1976), is Ladinian-Hettangian, whereas after SALAJ & al. (1983) it is limited to Carnian-Rhaetian. Aulotortus tumidus is considered to be of upper Triassic (Carnian-Rhaetian) age (ZANINETTI, 1976; PILLER, 1978). It is therefore, assumed that deposition of these facies took place during the upper Triassic (Carnian-Rhaetian).

- Bindstones, with well developed laminoid fenestrae and rare Aulotortus friedli (KRISTAN-TLLMAN). The age of Aulotortus friedli is mainly considered to be Norian-Rhaetian (ZANINETTI, 1976; SALAJ et al., 1983), but also Carnian (GODZAN et al., 1983, CATALOF &

TRIFONOVA, 1985) and even Anisian (TRIFONOVA, 1972, 1984). We attribute a Norian-Rhaetian age in this facies.

- Boundstones with algal plates and bacterial peloids. The microfauna is poor and contains rare, small-sized Ataxophragmiidae and Trochamminidae among which Trochammina almtalensis KOEHN-ZANINETTI, Trochammina jaunensis BROENNIMANN & PAGE, Valvulina azzouzi SALAJ, as well as Earlandia tintiniformis (MISIK). Trochammina almtalensis is known the Anisian-Ladinian of many areas of Europe and Asia (ZANINETTI, 1976; TRIFONOVA, 1984) but also from the Carnian-Rhaetian of many tectonic units of the Carpathian (SALAJ et al., 1983). The stratigraphic range of Trochammina jaunensis is Cordevolian-lower Rhaetian (SALAJ et al., 1983) or is restricted to Norian (TRIFONOVA, 1984). Finally Valvulina azzouzi is considered to be of middle Anisian-lower Rhaetian age (SALAJ et al., 1983; ORAVECZ-SCHEFFER, 1987). This facies is considered to be of (Carnian), Norian-lower Rhaetian age.

- Biopelsparites (grainstones) with "in-situ" formation of peloids. The microfaunal assemblages contain gastropods and other mollusc fragments and rare poorly preserved Ammodiscidae and Trochamminidae. The species Glomospirella expansa KRISTAN-TLLMANN, of uppermost Norian-lower Rhaetian age (ZANINETTI, 1976; SALAJ et al., 1983) and Glomospirella parallela KRISTAN-TOLLMANN of Norian-Rhaetian age (ZANINETTI 1976) have been determined. An upper Norian-lower Rhaetian age is attributed to this facies.

It is therefore implied that the deposition of the calcareous Triassic formations of the Tripolis zone took place during the Upper Triassic since no older than Carnian beds have been found up to now.

The depositional environment is this of a shallow carbonate platform, with normal subtidal to peritidal marine conditions with periodical subaerial exposure (TUCKER et al., 1990). In protected areas of low energy the Involutinidae associations are common (ZANINETTI, 1976), while when hypersaline conditions prevail the Glomospirella-Glomospira assemblages are observed (TRIFONOVA & VAPTSAROVA, 1982).

During intertidal periods micrites with bird's eyes and stromatolithic facies are formed. Early freshwater influxes are indicated by blocky cement that overprints marine cement.

Early dolomitization of unlithified sediments took place.

The Jurassic

The Jurassic strata have often been mentioned by many authors since their upper horizons are easily recognized by the presence of Cladocoropsis mirabilis FELIX and the microscopic study revealed in some cases characteristic microflora and microfauna, permitting the distinction of beds of lower, middle and upper Jurassic age.

The Lias

Liassic beds have been recognized in the areas of Rethymno, Perama and Sitia.

They are characterized by the intensive recrystallization and dolomitization, which in most cases have destroyed the original texture of the rocks.

Macroscopically they can be recognized by the usual presence of small-sized Megalodon and the numerous sections of Dasycladaceaen algae, which can be easily traced but their bad preservation makes their specific and in some cases even their generic determination quite difficult. However, in the lowermost parts some specimens are attributed with reserve to the species Petrascula? heraki SOKAC & NIKLER of lower liassic (Hettangian-Sinemurian) age (BASSOULLET et al., 1978). But, widely, the age of the liassic beds is well established by the presence of Paleodasycladus mediterraneues (PIA) with a stratigraphical range Hettangian - Pliensbachian (BASSOULLET et al., 1978) which may be extended to the Toarcian (SARTORIO & VENTURINI, 1988).

The microfacies are biomicrites (packstones or wackestones) recrystallized and dolomitized. The bioclasts have often been dissolved and filled with blocky sparite, whereas the surrounding matrix has been recrystallized and dolomitized (dolomicrosparite). By prolongated diagenetic procedure, the initially micritic matrix became pelmicritic-pelsparitic with isopachus marine cement, indicating shallow subtidal conditions of an open marine environment (TUCKER & BATHURST, 1990).

The "Thaumatoporellas" which already made their appearance in the upper Triassic beds, with small-sized isolated specimens, present an explosion during the Liassic and they form, locally, well developed colonies.

The produced microfacies are biolithites (bindstones) which have suffered intensive dolomitization. Locally coarse crystals of saddle dolomite occur. In "stromatactis" cavities botryoidal calcite has precipitated which alternates with biopelsparite laminae. Peloids are cemented by Mg-calcite. The facies indicate intertidal conditions of a semi-closed lagoonal environment with low to medium water energy.

During the Liassic starts, in places, the deposition of coprolites bearing facies which continue through out the Jurassic and reach their maximum evolution during the lower Cretaceous (Neocomian). In Liassic they are poorly washed biopelsparites (grainstones). Most of the bioclasts have been dissolved due to the strong freshwater influx. Shell molds are filled with dog-teeth like dolosparite and poekilitic calcite. The environment is intertidal to supratidal with strong meteoric influx. The liassic age is certified by the scarce presence of Involutina liassica (JONES).

In all the above described facies a few benthic foraminifera of the families Textulariidae and Valvulinidae are rarely observed.

The Dogger

In the Dogger the Dasycladaceae disappear. The regression of these algae during this time span is observed in the whole Tethyan region and only a few species are locally mentioned (BASSOULLET et al., 1978).

Among the foraminifera the Pfenderinidae become widespread and together with the Valvulinidae, which were already developed in Liassic, are the predominent taxa of a quite monotonous microfauna characterizing this time span. The genera Praekunubia, with a stratigraphical range Bajocian to Callovian (Oxfordian?) and Paleopfenderina of Bathonian-Callovian? Age (SEPTFONTAINE, 1988), appear sporadically, while Siphovalvulina and Valvulina, having a wider extension, are common.

Finally the species Mesoendothyra croatica GUSIC of Aalenian-Bathonian age (SARTORIO & VENTURINI, 1988) and Nautiloculina oolithica MOHLER are located in Sitia area.

The facies are biopelmicrites (packstones), pelsparites and intrapelsparites (grainstones) and no considerable changes of the environment are implied.

Further more the coprolitic facies are often present and quite well developed.

The Malm

The upper Jurassic formations have been refered in many places of the island on the base of the presence of Cladocoropsis mirabilis FELIX, easily recognizable macroscopically.

In the Malm the evolution of Pfenderinidae and Valvulinidae continues. Among them the species Kurnubia palastiniensis HENSON Siphovalvulina variabilis SEPTFONTAINE, Pfenderella arabica REDMOND and Valvulina lugeoni SEPTFONTAINE have been determined. Kurnubia Portlandian) (SEPTFONTAINE, 1988) while Pfenderella arabica appears in the top of the Bajocian (Dogger) and continues up to the Kimmeridgian with sporadic presence in its upper part. The other species have a wider stratigraphical range.

In the lower horizons the above foraminiferal assemblages are associated with blue algae nodules and Cladocoropsis mirabilis FELIX, which is considered to attend its maximum evolution in Oxfordian-lower Kimmeridgian. (SARTORIO & VENTURINI, 1988), while in upper Kimmerdigian-Portlandian the presence of well developed Clypeina jurassica FAVRE is characteristic (BASSOULLET et al., 1978; SARTORIO & VENTURINI, 1988). The "Thaumatoporellas" are also very common.

Occasionally, assemblages with plentiful echinoid, and mollusc fragments and highly recrystallized and dolomitized algal sections are observed. These sections are to be reported with reserve to the species Salpingoporella annulata CAROZZI, of upper Bathonian-Valanginian age or S. grudii (RADOICIC) of Upper Kimmeridgian age (BASSOULLET et al., 1978).

The sedimentary facies are mainly biomicrites or biopelmicrites (wackestones and rarely packstones) and intrapelsparites (grainstones). Fenestrae are often observed, filled with blocky sparite. The environment is shallow subtidal to intertidal. Coprolitic facies are locally observed.

Beds of Dogger and Malm age are identified in Rethymno, Perama, Mohos and Sitia areas.

The Cretaceous

The lower Cretaceous had been only locally observed and even then it was neither clearly identified nor definitely divided, while the upper Cretaceous had been easily recognized due to the presence of abundant rudist fragments. However, the systematic microscopical research revealed characteristic fossil assemblages permiting in several cases the precise datation both of lower and upper Cretaceous levels.

The Neocomian

Neocomian beds have been located in the areas of Rethymno, Perama, Mohos, Ano Vianos and Sitia.

During this interval coprolitic facies prevail. They contain well developed fecal pellets and it seems that they invaded almost the whole platform.

The facies are biopelmicrites (packstones) with numerous sections of Favreina salevensis (PAREJAS) and mollusc fragments. The sediments have suffered penecontemporaneous to early dolomitization with concomitant dissolution of the initially CaCO3 sediment, due to which vuggy porosity is produced. Moreover dissolution of skeletal calcite crystals took place and most of the produced shell molds are filled with dolospar. The remaining or enlarged shell molds are filled with sparite. The environment is of low energy, subtidal to intertidal. Upwards the facies change to micrites (mudstones to wackestones) with rare foraminifera among which some sections can be reported to Cmpanellula capuensis DE CASTRI of upper Hauterivian-lower Barremian age (SARTORIO & VENTURINI, 1988, CHIOCCHINI et al., 1988). Locally recrystallized Dacycladacean algae are added to the association, to be reported with reserve to the genus Macroporella or Triploporella.

In both cases the micritic sediment is disturbed due to intensive desiccation, resulting, in places, to the formation of biopelmicrite and biopelsparite with characteristic ped and fenestrae structure which indicates an alternation of dry and humid periods. This indicates shallower environmental conditions of the intertidal to supratidal parts of the inner platform where Campanellula capuensis inhabits (CHIOCCHINI et al., 1988).

Finally, Bacinella irregularis RADOICIC and Lithocodium aggregatum ELLIOT are rather developed in the upper part of Neocomian and form extended colonies, present also in higher horizons (Barremian and Aptian).

The Barremian-Aptian

It is well established in Rethymno, Ano Vianos and Sitia areas.

Its identification is mainly based on the determination of rich foraminiferal and algal associations dominated by the presence or Salpingoporella dinarica RADOICIC, which seems to be well developed and widespread in the whole inner platform. The presence or Preachrysalidina infracretacea LUPERTO-SINNI is common, while Palorbitolina lenticularis

(BLUMENBACH) and Cylindroporella sugdeni ELLIOTT appear sporadically.

Miliolidae, Textulariidae and Lituolidae become more numerous to the upper parts of the S. dinarica bearing beds, where Vercorsella also appears.

Salpingoporella dinarica is considered to be of (?) Valanginian-Aptian-Albian (?) age (BASSOULET et al., 1978) with a maximum development in the lower-middle Aptian (SARTORIO & VENTURINI, 1988). Praechrysalidina infracretacea covers the Aptian - Albian time span while Palorbitolina lenticularis, disappears in middle Aptian (CHIOCCHINI et al., 1983). It is considered therefore, that the facies with Salpingoporella dinarica are of (?) Barremian-Aptian age.

This datation is also supported by the fact the S. dinarica bearing beds are directly overlaid by biopelmicrites (packstones) with rich and diversified microfauna, containing among others Sabaudia minuta (HOFKER) and Sabaudia auruncensis (CHIOCCHINI & DI NAPOLI ALLIATA). The first has a large stratigraphical range (Valanginian-lowermost Cenomanian) but the second is restricted to the upper Aptian-lowermost Albian (ARNAUD - VANNEAU & CHIOCCHINI, 1985). So it is accepted that this facies is of upper Aptian-lower Albian age and consequently that the stratigraphical range of Salpingoporella dinarica does not exceed the upper Aptian.

Lithocodium aggregatum ELLIOT and Bacinella irregularis RADOICIC are locally present.

The facies are biomicrites to biopelmicrites (wackestones to packstones) and in places poorly washed intrabiopelsparites (grainstones) indicating a shallow subtidal to intentidal environment of low and locally medium energy.

The Albian - Cenomanian-Turonian

Lower middle Albian beds have been recognized in Perama and Sitia areas.

The facies are biomicrites (wackestones to packstones) with small-sized monotonous microfauna containing almost exclusively primitive Nezzazatidae-like foraminifera. Some of them are to be reported to "Valvulineria" sp. ARNAUD-VANNEAU, with a stratigraphical range that does not exceed the middle Albian. Rare Miliolidae and Textulariidae are also observed. These oligotypic microfauna implies conditions of restricted lagoonal environment of moderate energy and reduced water circulation (CHIOCCHINI et al., 1984).

A tendency to peloids differentiation of variable shape and size is traced, indicating slight desiccation. The solution cavities are filled with sparite. An in-situ brecciation is observed producing dedolomitic breccia. That may correspond to 'solution-collapse breccia". Dedolomite crystals are xenomorphic and contain dolomitic inclusions. Dedolomite tends to assimilate the dolomicrite that constitute the breccia fragments. A subaerial exposure is suggested.

Upwards, facies of biomicrites (packstones) to biopelmicrosparites (grainstones) with plentiful Miliolidae and ostracods prevail all-over the platform. These assemblages are of small stratigraphic interest and they are considered to cover the Albian-Cenomanian-Turonian interval.

In places more deversified associations containing among others Neoiragia insolita (DECROUEZ & MOULLADE) and Ovalveolina crassa DE CASTRO both of uppermost Albian-lowermost Cenomanian age (SARTORIO & VENTURINI, 1988), Nezzazatinella picardi (HENSON), Nummoloculina heimi BONET and Sabaudia minuta HOFKER, permit the identification of upper Albian-lower Cenomanian beds while the presence of Pseudolituonella reicheli MARIE and Pseudorhapydionina dubia (DE CASTRO), both restricted in the Cenomanian (SCHROEDER & NEUMANN, 1985), characterized the Cenomanian. Finally associations containing Cuneolina pavonia D' ORBIGNY, Nezzaxatinella picardi (HENSON) are probably extended to the Turonian.

The facies are mainly biopelmicrites (packstones), often differentiated to poorly washed biopelsparites-intrabio-pelsparites (grainstones). Biomicrudites to biopelmicrudites (floatstones to rudstones) also occur.

The environment is that of a restricted platform, shallow subtidal to intertidal, with low to medium energy (GUSIC et al., 1988). Micritizationof the bioclasts and borings existence suggest marine diagenesis. However marine cement has been obscured by meteoric influx. Differentiation of peloids starts in the intertidal environment and suggests slight dissolution and desiccation. The environment shows locally a strong tendency of shallowing to intertidal-supratidal.

The possibility of emersion episodes during this time span and especially during the middle Cenomanian-Turonian cannot be excluded. In fact the almost complete absence of the common index species of foraminifera and the described sedimentological features support this idea.

The Coniacian-Campanian

Beds of Coniacian-Campanian age have been identified in the areas of Rethymno, Perama, Archanes, Ano Vianos, Agios Nikolaos and Sitia.

Different types of facies are observed, clearly indicating the differentiation of the environment.

A characteristic biofacies with abundant Aeolisaccus Koroti MISIC occasionally associated to well developed "Thaumatoporellas" is a good maker of this beds. The facies are biomicrites (packstones to bindstones) intenssively dolomitized. The dolomitization has firstly affected the micritic matrix forming random dolomite euhedra. In places, the presence of "birds eyes" and desiccation cracks implies a subaerial exposure. The environment is of low energy intertidal to supratidal.

Gradually various foraminifera taxa, mainly Miliolidae are added to the above association with concomitant decrease of the Aeolisaccus and "Thaumatoporella" specimens. The facies are dolomitized biomicrites (wackestones) with low deversity and number of fossils to biomicrites and biopelmicrites (packstones), biopelsparites-biopelmicrudites (packstones and floatstones to rudstones) with rare rudist fragments. Marine diagenesis prevails in the last types of facies.

The environment changes from intertidal to shallow subtidal of low energy of the restricted parts of the platform to shallow subtidal protected platform, or back-reef lagoonal, of moderate energy (CUSIC et al., 1988).

Among the benthic foraminifera of the above facies several species have been determined.

Montcharmontia appenninica (DE CASTRO) and Pseudocyclammina sphaeroidea GENDROT, with a quite wide stratigraphical range of (?) Turonian-Coniacian-Campanian-Maastichtian (SARTORIO & VENTURINI, 1988) are very common.

In the lower parts an association with Dicyclina schlumbergeri MUNIER-CHALMAS and Accordiella conica FARINACCI implies a Coniacian-lower Campanian age of the beds and where Scandonea sammitica DE CASTRO appears the age of the beds does not exceed the middle Santonian. Finally the Campanian is identified by the presence of Murciella cuvillieri FOURCADE (DE CASTRO, 1988) which probably extends up to the lowermost Maastrichtian.

The Maastrichtian

Maastrichtian beds have been micropaleontological testified in the areas of Rethymno, Perama, Ano Archanes, Ano Vianos, Agios Nikolaos and Sitia.

They can be easily recognized macroscopicaly by the presence of abundant rudists which already made their appearance in the Campanian, with isolated specimens.

Rich microfaunal assemblages permit the exact datation of the strata. Two different types of foraminiferal assemblages are identified. The first is dominated by the presence of Orbitoididae. Among them Orbitoides faujasi DEFRANCE, Hellenocyclina beotica REICHEL, Siderolites calcitrapoides LAMARCK and Omphalocyclus macroporus (LAMARCK) are determined and certify the Maastrichtian age of the beds.

The second assemblage contain Rhapydionina liburnica (STACHE) and Laffiteina marsicana FARINACCI. The stratigraphical range of Rhapydionina liburnica is restricted to the upper Maastrichtian. It is therefore considered that the Rhapydionina bearing beds represent the uppermost horizons of the Cretaceous. The facies are biomicrites to biomicrudites (pseudopackstones to floatstones). The primary sediments are of boundstone type, however due to strong marine micritization and boring by endolithic algae a calcarenite-calcirudite is generated giving the impression of packstone-floatstone composed of rudist fragments of variable size and shape. The environment is this of medium energy subtidal of the reef crest-backreef and forereef.

Locally indices of subaerial exposure have been detected. This may implie ana emersion connected with the general uplift tendencies that predominated in this part of the Tethys during the uppersmost Maastrichtian-lower Paleocene. This conception is highly supported by the fact that up to now lower Paleocene beds have never been discovered in the Tripolis zone.

The Paleocene

The Paleocene has been found in Rethymno, Ano Archanes, Mohos, Ano Vianos and Sitia areas.

The main facies are biomicrites to biosparites and intrabiomicrudites, (packstones to rudstones) with rich Miliolidae and Ataxophragmiidae microfauna. The surrounding matrix has been dolomitized (dolomicrospar) and often differentiated to peloid intraclasts.

Among the forminifera the following species have been determined indicating an upper Paleocene (Thanetian) age (BIGNOT, 1972), Idalina sin jarica GRIMSDALE, Glomalveolina primaeva (REICHEL), and a characteristic population of the genera "Valvulina", "Criborgoesella" and "Pseudochrysalidina". The environment is shallow subtidal to intertidal of low energy.

Besides the above facies, biomicrites (rudstones to wackestones) with monotypique microfauna of bivalve shells. Miliolidae or Discorbidae are observed, mainly in the lower horizons. Important diagenetic phenomena as desiccation cracks and silt-vadose filling fenestrae are to be noticed. More over the spares presence of ophiolite, quartz, glauconite and antigorite indicate continental important as indicating a very restricted lagoonal or even lacustrine environment of very low energy, probably connected with the lower Paleocene emersion, suggested above.

The Eocene

Eocene beds have been micropaleontologically testified and divided in Ypressian Lutetian and upper Lutetian-lower Priabonian in the areas of Rethymno, Perama, Mohos, Ano Vianos, Agios Nikolaos and Sitia.

In most of the cases the facies are very rich in fossils biomicrudites to biosparudites (floatstones to rudstones) and locally boundstones, which suffered strong marine diagenesis. The environment is very shallow subtidal of low to medium energy.

The different microfaunal assemblages permitted the subdivision of the Eocene strata (BIGNOT, 1972).

The Ypresion

It is testified by a foraminiferal association containing among others Nummulites globulus LEYMERIE, Nummulites rotularius DESHAYES, Discocyclina augustae WEIJDEN, and numerous specimens of the genera Assilina and Operculina, echinoid, bryozoan and other macrofossil fragments.

The above assemblage indicates a platform edge environment.

At the same time in the inner platform assemblages with Miliolidae, Rotaliidae and Coskinolina (Coskinolina) liburnica STACHE occur (SARTORIO & VENTURINI, 1988).

The Lutetian

During the Lutetian a notable evolution of the Melobesioideae and Coralinoideae algae takes place, with a parallel diversification of the foraminifera with numerous specimens of the genera Nummulites, Discocyclina, Actinocyclina, Asterodiscus, Operculina and Alveolina and the families Miliolidae, Gypsinidae, Rupertiidae, Gymbaloporidae, Rotaliidae et al.

In the upper Lutetian the genera Grzybowskia and Pellatispira are added to the above association. Locally the species Fabiania cassis (OPENHEIM) Cyroidinella magna LE CALVEZ and Orbitolites complanatus LAMARCK are identified. The environment is always the carbonate platform edge.

The upper Lutetian-lower Priabonian

In cases when the species Champanina gasinensis (SILVESTRI) and Baculogypsinoides sp. Are added to the above association an upper Lutetian-lower Priabonian age is attributed to the beds.

CONCLUDING REMARKS

On Crete island the carbonate formations of the Tripolis zone are widespread. They are overlying the “Ravdouha” detritic formation and are overlaid by the flysch sediments, often, over a pre-flysch erosional surface.

The whole sequence is dated to be of Carnian-lower Priabonian age, but its isolated occurences never cover this entire stratigraphical range,. Inspite the intesive ercrystallization and colomitization of the rocks, rich fossil assemblages have been found in many places permiting the identification of different stratigraphic levels and in combination with the sedimentary features of the facies the definition of the depositional environment, briefly presented below.

The upper Triassic

During the upper Triassic (Carnian to Rhaetian) deposition of biomicritres and intrabiosparites with Melagodon and Dasycladaceae algae took place in the subtidal part of the carbonate platform while in the peritidal part bindstones with algal plates and laminoid fenestrae and rare microfauna are formed. In periods of high evaporation hypersaline conditions prevail certified by the presence of a poor Ammodiscidae assemblage.

The age determinations are based on the presence of Aulotortus sinuosus, Au. Tumidus, Au. Friedli, Trochammina almtalensis, Tr. Jaunensis, Valulina azzouzi, Glomospirella expansa, Gl. Parallela.

The jurassic

Jurassic beds were subdivided to Liassic, Dogger and Malm.

The Liassic

During the Liassic biomicrites with Dasycladaceae and small-sized Megalodon are formed in the shallow subtidal part of the platform. In intertidal semi-closed laggonal environment “Thaumatoporella” and bindstones are developed. Finally in the intertidal to supratidal environment biopelsparites with coprolites occur.

The age is certified by the presence of Petrascula? Heraki, Paleodasycladus mediterraneus and Involutina liassica.

The Dogger

In the Dogger biopelmicrites, pelsparites and intra-pelsparites with Valvulindae and Pfenderinidae are deposited in a shallow subtidal environment. In the intertidal to supratidal part of the platform the formation of coprolitic facies continues.

Mesoendothyra croatica, Praekurnubias and Paleopfenderinas are the age markers.

The Malm

During the Malm an evolution of Pfederinidae and Valvulinidae and a redevelopment of the Dasycladaceae take place. The facies are biomicrites and biopelmicrites formed in the shallow subtidal part of the platform, while towards the platform edge Cladocoropsis mirabilis is presented in the facies. To the intertidal parts coprolites are widespread.

The age determinations are based on the presence of Kurnubia palastiniensis, Siphovalvulina variabilis, Pfenderella arabica and Clypeina jurassica.

The Cretaceous

The Neocomian

During the Neocomian the coprolitic facies predominate, with well developed Favreina salevensis, indicating intertidal to supratidal conditions. The presence of Campanellula capuensis testifies an upper Hauterivian-lower Barremian age.

The Barremian-Aptian

Biomicrites and biopelmicrites with plentiful Dasycladaceae and foraminifera are formed in shallow subtidal conditions of the inner platform.

The age is certified by the presence of Salpingoporella dinarica, Cylindroporella sugdeni, Praechrysalidina infracteracea, Palorbitolina lenticularis, Sabaudia minuta and Sabaudia auruncensis.

The Albian-Cenomanian-Turonian

This time span is dominated by the presence of biomicrites to biopelmicrosparites with plentiful Miliolidae, deposited in shallow subtidal to intertidal part of a restricted platform. A strong tendency of shallowing to intertidal-supratidal is observed and possibility of emersion episodes is discussed.

The following levels are recognized.

Upper Albian-lower Cenomanian, with Neoiragia insolita, Ovalveolina crassa, Sabaudia minuta,

Cenomanian, with Pseudorhapydionina dubia and Pseudolituonella reicheli and,

Cenomanian-Turonian with Cuneolina pavonia and Nezzazatinella picardi.

The Coniacian-Campanian

A characteristic facies of biomicrite with Aeolisaccus Kotori and "Thaumatoporellas" is deposited in the low energy intertidal to supratidal parts of the platform. In the shallow subtidal parts rich foraminiferal assemblages occur. Rudists facies appear in the platform edge.

The index species are Montcharmontia appenninica, **Pseudocyclammina sphaerodea**.

Coniacian-Santonian levels are dated by the presence of Accordiella conica, Scandonea smnitica and **Campanian-(?) lowermost Maastrichtian** by Murciella cuvilieri.

The Maastrichtian

The facies are biomicrudites and biomicrites with abundant rudists and rudist fragments.

The main rudist facies is formed in the platform edge (reef-crest) while in the back-reef Rhapydionina is present and in the forereef the Orbitoitidae microfauna prevail.

Orbitoides faujasi, Hellenocyclina beotica, Siderolites calcitrapoides, and Omphalocyclus macroporus certify the Maastrichtian and Rhapydionina liburnica the upper Maastrichtian age.

The Paleocene

No indice of the lower Paleocene has been found.

In the upper Paleocene the establishment of a very restricted lagoonal to lacustrine environment resulted to the formation of biomicrites with monotypic faunal assemblages.

At the same time in the shallow subtidal to intertidal parts of the platform biomicrites, biosparites and intrabiomicrudites with rich Miliolidae and Textulariidae microfauna are deposited.

The age determination is based on the presence of Idalina sinjarica, Glomalveolina primaeva, "Valvulina" sp., "Cribrogoesella" sp. and "Pseudochrysalidina" sp.

The Eocene

During the Eocene biomicrudites and biosparudites are formed in the edge and the inner platform.

The Ypresian is dated on the base of Nummulites globulus, N. rotularius, Discocyclina augustae (edge environment) or Coskinolina liburnica (inner platform).

The Luterian present very rich fossil assemblages with foraminifera and algae among which the species Fabiania cassis, Gyroidinella magna and Orbitolites complanatus.

The upper Lutetian-lower Priabonian is characterized by the presence of Champanina gasinensis and Baculogypsinoides sp.

From the above data it is demonstrated that the deposition of the carbonate sequence of the Tripolis zone, presented on Crete island, took place from Carnian to lower Priabonian mainly in the inner carbonate platform.

In the upper Jurassic, upper Cretaceous and Eocene deposition took also place in the platform edge and occasionally in the forereef. The conditions are mainly shallow subtidal but also intertidal to supratidal with short subaerial exposures during the Jurassic-Neocomian and in the upper Cenomanian-Turonian.

In Paleocene restricted lagoonal to lacustrine environment is locally established. Finally emersions took probably place (periodically) during the upper Cenomanian-Turonian and in the lower Paleocene.

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