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LAGOONAL TO TIDAL CARBONATE SEQUENCES OF UPPER JURASSIC/LOWER CRETACEOUS AGE IN THE CORINTHIAN AREA: MELANGE BLOCKS OF THE PARNASSUS ZONE

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ABSTRACT

In the Corinthian area (Acrocorinth/NE-Peloponnesus and Perachora Peninsula), decameter scaled sequences of lagoonal to tidal packstones and wackestones comprise the stratigraphic range of the Thithonian to the Valanginian. The biostratigraphical data are based on algae (Cyanophyta, Chlorophyta) and shallow water foraminifers.

The sequences are rich in coated grains - especially cortoids and oncoids. Pseudomenisci between particles are due to cyanobacterial mucilage in lagoonal environments, comparable to the grapestone facies of the Bahamas. First generations of cements are of marine - phreatic and marine - vadose origin. All facts together are typical of lagoonal to tidal environments.

Microfacies and age indicate that these sequences are part of the Parnassus Zone. On the other hand, tectonically adjacent sequences of deep water facies (cherty limestones with gravity flows, radiolarites) are of the same stratigraphical range. Based on these facts and the chaotic arrangement of the geological units (radiolarites, flysch, ophiolites, cherty limestones, km^3 sized blocks of shallow water limestone) we interpret the pre- Neogene Corinthian area as a melange of parts of the Parnassus Zone and the Beotian Zone.

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1. INTRODUCTION

The placement of the southern boundary of the Parnassus Zone often has been discussed in the past. Following different authors, the zone ends at the gulf of Corinth (JACOBSHAGEN, 1986) or stretches to the NE Peloponnesus (CELET, 1962, DERCOURT, 1964). According to the latter authors, especially the interpretation of the Perachora peninsula seems to be problematic. Some maps even show a white area with question marks (e.g. AUBOUIN et al. 1960).
The Parnassus Zone is part of the western Pelagonian carbonate platform until the middle of Jurassic. In the Upper Jurassic, the area of the Beotian Zone settles down (first flysch sedimentation), and thereafter the Parnassus Zone is an independent carbonate platform between Beotian Zone and Pindos Zone until the Upper Cretaceous (cf. HOFGEBAUER, 1985).
Equivalents of the Parnassus Zone, south of continental Greece, can be identified by sequences of Jurassic/Cretaceous transition-beds built up by a neritic facies, because the adjacent areas of Beotian Zone and Pindos Zone are showing pelagic facies at the same time (i.e. radiolarites, pelagic limestones, some kinds of flysch sediments) and the eastern Pelagonian Zone shows stratigraphic gaps (phases of erosion) (JACOBSHAGEN, 1986).
During revision of geological mapping in the area of Corinth and at the Perachora peninsula some locations were found, which contain sediments of the Jurassic/Cretaceous transition zone in different facies (neritic and pelagic).
In this paper, we present two sequences from the Acrocorinth (NE Peloponnesus) and the Perachora peninsula, which are both composed of neritic limestones of the Jurassic/Cretaceous transition zone. Their importance for the isotopic zoning of Greece will be discussed.

2. GEOLOGICAL SETTING

The Mesozoic massive limestones of the Acrocorinth (location A, Fig. 1) and Perachora peninsula (location B, Fig. 1) are limited tectonically by deep water sediments of Jurassic and Cretaceous

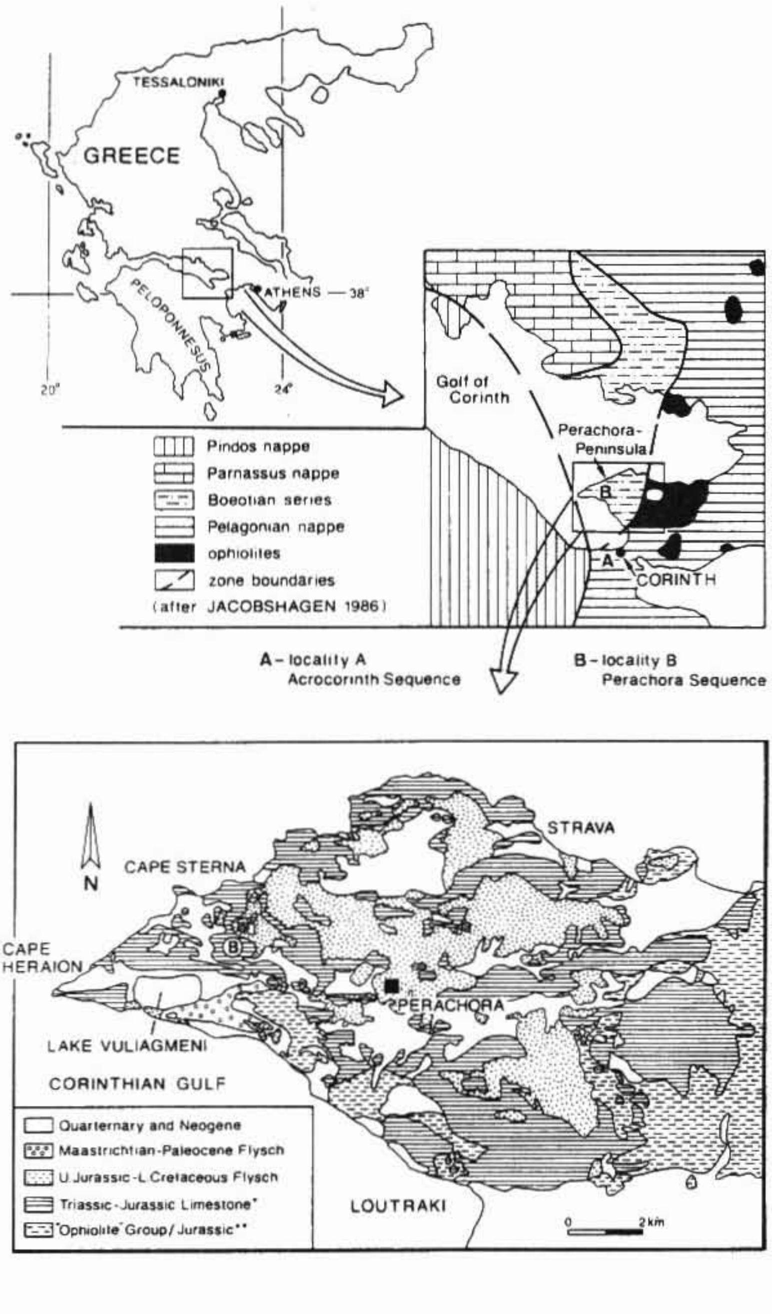

Fig. 1 Study area in middle Greece with localities A (Acrocorinth) and B (Perachora). Geological sketch map of the Perachora peninsula simplified after IGME sheets Perachora, Kaparellion, Sofikon and Korinthos.

age (i.e. radiolarites, some kinds of flysch sediments) apart from postorogene sequences of the Neogene and the Quarternary. Samples of red, sometimes clayish, radiolarites, which relictly cover the Acrocorinth-limestone without any sedimentary contact, show associations of radiolarians determined to be Dogger (pers. comm. by T. Steiger/Univ. of Munich). A sample of lithologically similar radiolarites, taken from the southcoast of the Perachora peninsula south of lacality B, yielded an Upper Jurassic community of *Mirifusus mediolatatus, Sethocapsa cethia, Triactoma tithonianum* (det. T. Steiger/Univ. Munich). In other places a radiolarian facies with frequent Sphaerolaria and sparse Nasselaria - probably proximal - basinal facies of Callovian was found. This Middle to Upper Jurassic radiolarites are attributed to the Beotian Zone by BORNOVAS et al. (1984), which, on the Perachora peninsula, is built up by Jurassic to Lower Cretaceous sediments (chiefly radiolarites, pyroclastics, mudstones, different gravity flow sediments). The Tithonian to Lower Cretaceous clastic sediments of the Perachora peninsula are due to the eohellenic flysch after BACHMANN & RISCH (1976). Locally, an Upper Cretaceous to Lower Tertiary flysch covers the Mesozoic units (Fig. 1B). Southeast of the Vouliagmeni-Lake (southcoast of the Perachora peninsula) this unit shows all transitions from normal flysch through a broken formation to a melange formation (wildflysch sensu BORGER, 1976). Following M. Filewicz (Union Oil Company of California, Ventura/ USA), samples of this flysch formation include nannoplankton of late Paleocene to early Eocene age.

3. CARBONATE SEQUENCES

3.1 MICROFACIES

Macroscopically, the 200m thick Acrocorinth-limestone sequence at the northeastern flank of the Acrocorinth (loc. A, Fig. 1) and the 70m thick limestone sequence west of the village Perachora (loc. B, Fig. 1) consist of mostly structureless, bedded to massive limestones. In both sequences coated grains are the dominating components. Occasionally levels with gastropods and - cm to dm -

thick radialcalcitic cemented cavities (sheet cracks or solution vugs) are found.

The limestones are packstones and wackestones, rich in algae. The components are agglutinated mostly by meniscuous, micritic - pelsparitic links. All gradations to real grapestones can be observed. Similar micritic links are described by PURDY (1963), WINLAND & MATTHEWS (1974) and CROS (1979) in recent grapestone-sediments of the Great Bahama Bank. They interpret these micritic links to be formed through participation of organic substance (Cyanophyceae). In the Greek sequences, these links were generally formed prior to the first phreatic/vadose cementation. Therefore, their genesis could be related to the environment of the coated grain sediments. After RICHTER et al. (in press), these pseudomenisci can form in subaquatic areas, because in aquatic environments the agglutination of components through organogenic mucilage (bacteria, algaea.o.) as a result of surface tension leads to meniscuous character. A syngenetic stabilisation by carbonate cementation finally preserves these links. KALPAKIS & SIDERIS (1981) and STEUBER (1989) described such menisci from the Upper Jurassic/Lower Cretaceous neritic limestones of the Parnassus Zone at Delphi and from the Carnian lagoonal pel-sparites of the Helicon-Mountains, indeed as formations in vadose environments.

Bladed, radiaxial, radialfibrous and blocky cements can be identified in which the first two types occur as gravitational cements (vadose environment) and as even style cements (phreatic environment). Primarily, the bladed, radiaxial and radialfibrous cements had a Mg-calcitic composition. It can be seen through homoaxial microdolomites interlayered in the calcite-cristals. This is traceable to a change from Mg-calcite to calcite and dolomite in a closed system, similar to syntaxial overgrowths on echinoderms and for radiaxial cements of the Mississippian of New Mexico described by LOHMANN & MEYERS (1977) and for rimcements of the Middle Triassic Trochitenkalk of northwest Germany (RICHTER, 1985).

Using cathodoluminescence-studies it was possible to verify that in the Acrocorinth sequence the spectrum of cementation bridges the eo-, meso- and telogenesis (RICHTER et al., in press). Thereby, during eogenesis, meteoric phases of cementation could be intercalated in the marine phases of cementation adjacent to plane, emerged areas of the carbonate platform.

3.2 BIOSTRATIGRAPHY

3.2.1 ACROCORINTH SEQUENCE

The Acrocorinth limestone-sequence (Fig. 2) predominantly exhibits an organogenic sedimentation, composed of algae, foraminifera, shell-debris of pelecypods, brachiopods, gastropods, plates of echinoderms and small debris of hydrozoans and corals.
Although most of the microfossils (algae and foraminifera) have a statue of facies fossils, some of them are of biostratigraphical value, however, only in assemblages.
The Upper Jurassic assemblage contains the following taxa:

Foraminifera: *Valvulina lugeoni* Septfontaine, *V. alpina* Dragastan and *Pseudocyclammina lituus* (Yokoyama);

Cyanophyta: *Rivularia lissaviensis* (Bornemann), *R.fruticulosa* (Johnson & Kaska), *R.piae* (Frollo), *R.atanasiui* (Dragastan), *R.thadeuszi* Dragastan and *Paraortonella richteri* Dragastan;

Chlorophyta:

Dasycladaceae: *Salpingoporella pygmaea* (Gümbel), *Teutloporella obsoleta* Carozzi and *Neoteutloporella socialis* (Praturlon);

Rhodophyta: *Solenopora jurassica* (Brown).

This assemblage is dominated by cyanophyceae, some dasycladaceae and sparse foraminifera. The stratigraphical range of species is variable and different, as follow:

- for cyanophyceans: *Rivularia lissaviensis* appears from Norian to Lower Cretaceous; *R.thadeuszi* occurs since the Upper Oxfordian; *R.fruticulosa* from Tithonian up to Neocomian; *R.piae* from Lias to the Lower Aptian and *Paraortonella richteri* only in the Tithonian (DRAGASTAN, 1985, 1989).

- for dasycladaceans: *Salpingoporella pygmaea* and *Teutloporella absoleta* are reported from the Kimmeridgian and the Tithonian. *Neoteutloporella socialis* occurs since the Tithonian up to the Neocomian (BASSOULLET et al., 1978; BARATTOLO, 1991).

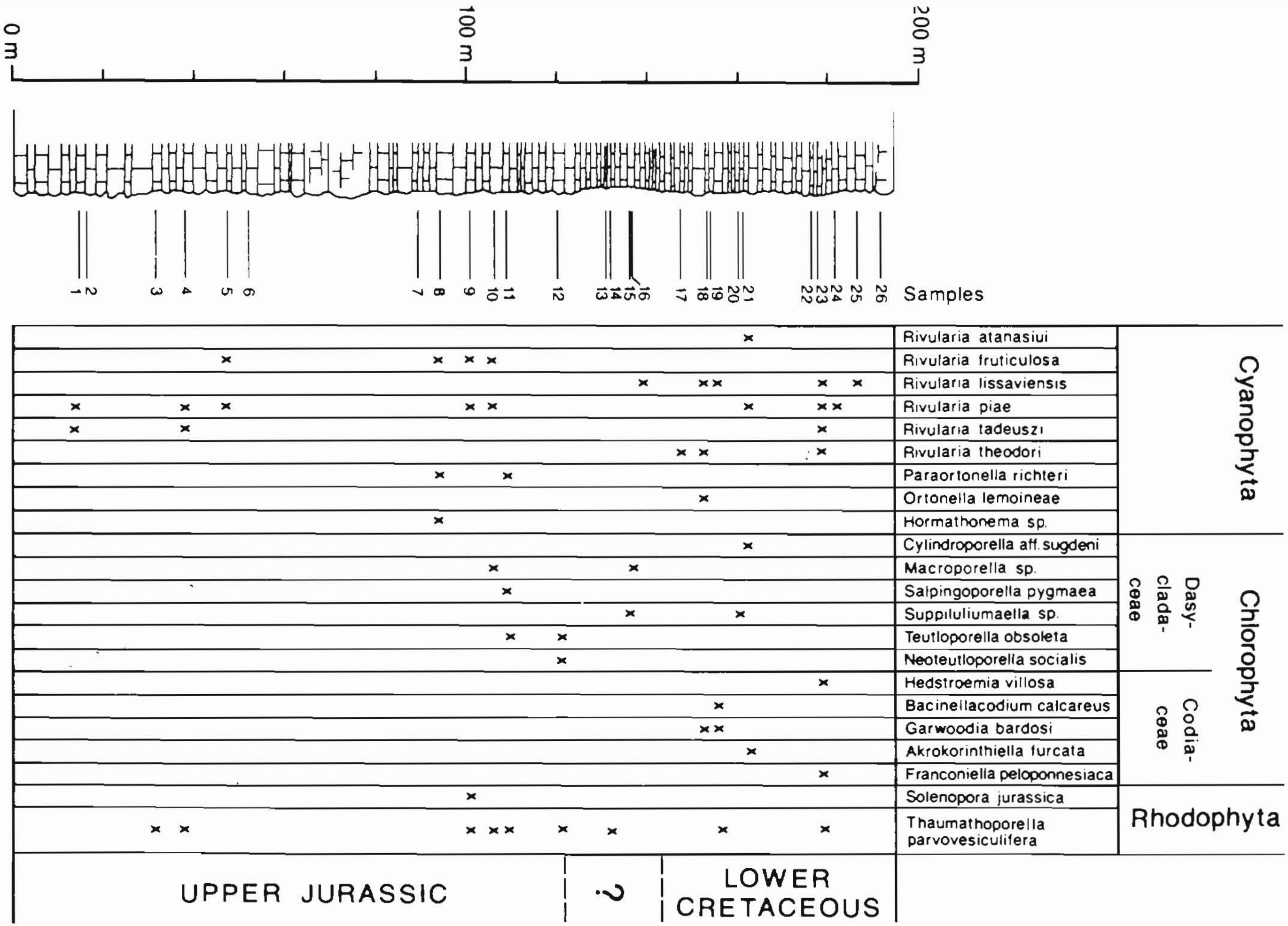

Fig. 2 Stratigraphical sequence of the Acrocorinth-limestone (locality A); slightly modified after RICHTER et al. (in press).

- for foraminifera: *Pseudocyclammina lituus* has a stratigraphical range from Kimmeridgian up to Berriasian. *Valvulina alpina* evolve in the Tithonian and *V. lugeoni* from Bajocian up to Kimmeridgian - Tithonian.

Taking into account the stratigraphical range of dasycladaceans and of some species of foraminifera, the assemblage is characteristic for the Upper Jurassic, Kimmeridgian - Tithonian in age.

The Jurassic-Cretaceous boundary can not be accurately placed, although *Neoteutloporella socialis* and *Pseudocyclammina lituus* were reported in the Berriasian or Neocomian interval.

The Lower Cretaceous deposits are mainly organogenic with small-sized *Nerinea, Natica,* codiaceans, sparse dasycladaceans and foraminifera.

The assemblage with *Rivularia theodori* Dragastan, *Ortonella lemoineae* Dragastan and *Trocholina alpina* (Leupold) points to a Neocomian, Valanginian age.

The codiaceans species worth mentioning are: *Garwoodia bardosi* Dragastan. *Hedstroemia villosa* Dragastan and *Bacinellacodium calcareus* Dragastan, which have a stratigraphical range from the Neocomian up to Barremian - Lower Aptian.

The dasycladaceans sparsely represented include *Cylindroporella aff. sugdeni* Elliott and *Suppiluliumaella sp.*, species from the Lower Cretaceous. The frequently encountered species *Trocholina alpina* (Leopold) and *Rectocyclammina chouberti* Hottinger have both been reported also from the Neocomian.

The algal-foraminifera assemblages are widespread in the alpine carbonate platforms and were mainly found in the shelf lagoon facies.

3.2.2 PERACHORA SEQUENCE

In the Perachora peninsula sequence, an incomplete limestone sequence of Lower Jurassic to Upper Jurassic-Neocomian (?) age is exposed (Fig. 3).

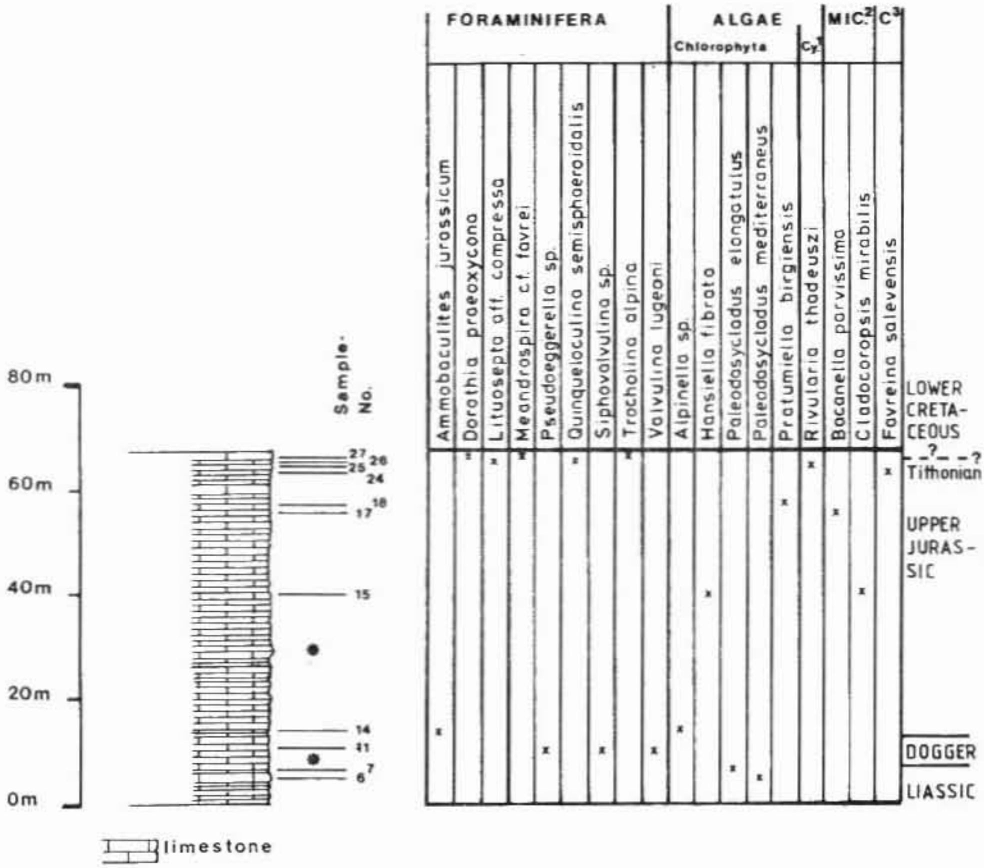

Fig. 3 Stratigraphical sequence west of the village Perachora (locality B). *-intraformational faults (?), Cy[1]-Cyanophyta, MIC[2]-microproblematica, C[3]-coprolites.

<u>Lower Jurassic</u> - The lower part of the limestone-sequence corresponds to the *Paleodasycladus mediterraneus* biozone (Fig. 3), a widespread Mesogean assemblage during the Liassic. The large paleogeographical distribution during Liassic times was connected with the extensional-areas of carbonate platforms.
The *Paleodasycladus* biozone has a stratigraphical range from the Hettangian up to the Domerian. So far the presence of *Paleodasycladus* in the Toarcian couldn't be demonstrated. Thes limestones show many similarities with the Jurassic sequence described from Hydra (SCHÄFER & SENOWBARI-DARYAN, 1983 - p. 86).
No Upper Liassic deposits were found, which could indicate an unconformity between Middle Liassic and Dogger. This probably corresponds to the condensed phase of Ammonitico Rosso limestone (Domerian? - Toarcian) deposition.

<u>Middle Jurassic</u> - The Liassic limestone deposits are overlain by limestones of Dogger in age. The reduced thickness of this sequence is probably due to an intraformational fault or a transgressive (?) phase. The contact between these two series is apparently conformable.
The assemblage contains only small benthic foraminifera: *Pseudoeggerella sp.*, (Bathonian-Callovian), *Siphovalvulina sp.* (Sinemurian-Carixian, Dogger-Lower Malm) and *Valvulina lugeoni* Septfontaine (Bajocian-Kimmeridgian/Tithonian) similar to the *Valvulina lugeoni* biozone which is Upper Bajocian-Callovian in age (DE CASTRO, 1987).

<u>Upper Jurassic</u> - The upper part of the limestone sequence corresponds to the Malm and conformably overlies the Dogger limestones. The limestones contain a variety of bioclasts, oncoids, **foraminifera**, algae, molluscs and only one level with *Favreina salevensis*.
A lagoonal facies association was found with the following species:

<u>Foraminifera:</u> *Lituosepta sp. aff. compressa* Hottinger, *Pseudocyclammina lituus* (Yokoyama);

<u>Cyanophyta:</u> *Rivularia thadeuszi* Dragastan;

<u>Chlorophyta:</u> *Pratumiella birgiensis* Dragastan & Düzbastillar (DRAGASTAN & DÜZBASTILLAR, in press); *Hansiella fibrata* Dragastan and *Alpinella n. sp.*;

Microproblematicae: *Bacanella parvissima* (Dragastan) Pantic;
Coprolites: *Favreina salevensis* (Parejas);
Hydrozoa (?): *Cladocoropsis mirabilis* Felix.

The assemblage is Upper Oxfordian/Tithonian in age. The occurrence of the coprolite *Favreina salevensis* (Parejas) (Tithonian-Neocomian) reflects a period of facies change.
The records of Neocomian deposits must be reinvestigated and proven with more data. The occurrences of *Trocholina alpina*, *Meandrospira cf. favrei* and *Dorothia aff. praeoxycona* are yet inconclusive.

4. REGIONAL GEOLOGICAL IMPLICATIONS

The carbonate sequences of Acrocorinth and of the Perachora peninsula must be interpreted to lagoonal facies areas of a carbonate platform, which at least existed from Upper Jurassic to Lower Cretaceous time. This neritic character during the Jurassic/Cretaceous transition zone suggests that "our" carbonate sequences are part of the Parnassus Zone (Fig. 4). This carbonate platform was lowered not earlier than during the Upper Cretaceous, whereas the adjacent units (Pindos Zone in the west, Beotian Zone in the east) are composed of different pelagic sediments at the same time (cf. columns of HOFGEBAUER, 1985).
Following these data, it is possible to trace the Parnassus Zone from continental Greece over the Perachora peninsula to the NE Peloponnesus. It is, however, not everywhere possible to find evidence of the Parnassus Zone, because from the Perachora peninsula, southward to the Argolis and at least to the island of Hydra, southeast of the Argolis, the unit is part of a melange belt, which rests west of the Pelagonian platform (RICHTER & FÜCHTBAUER, 1981). In this area Jurassic oceanic crust of the Pindos Zone was obducted, during subduction to the east, in direction to the pelagonian platform (cf. CLIFT & ROBERTSON, 1990, P. 834). During the collision, parts of Pindos-, Parnassus- and Beotian-Zone were mixed. Particles, containing the investigated sequences, and "swimming" in a matrix of identical (Perachora

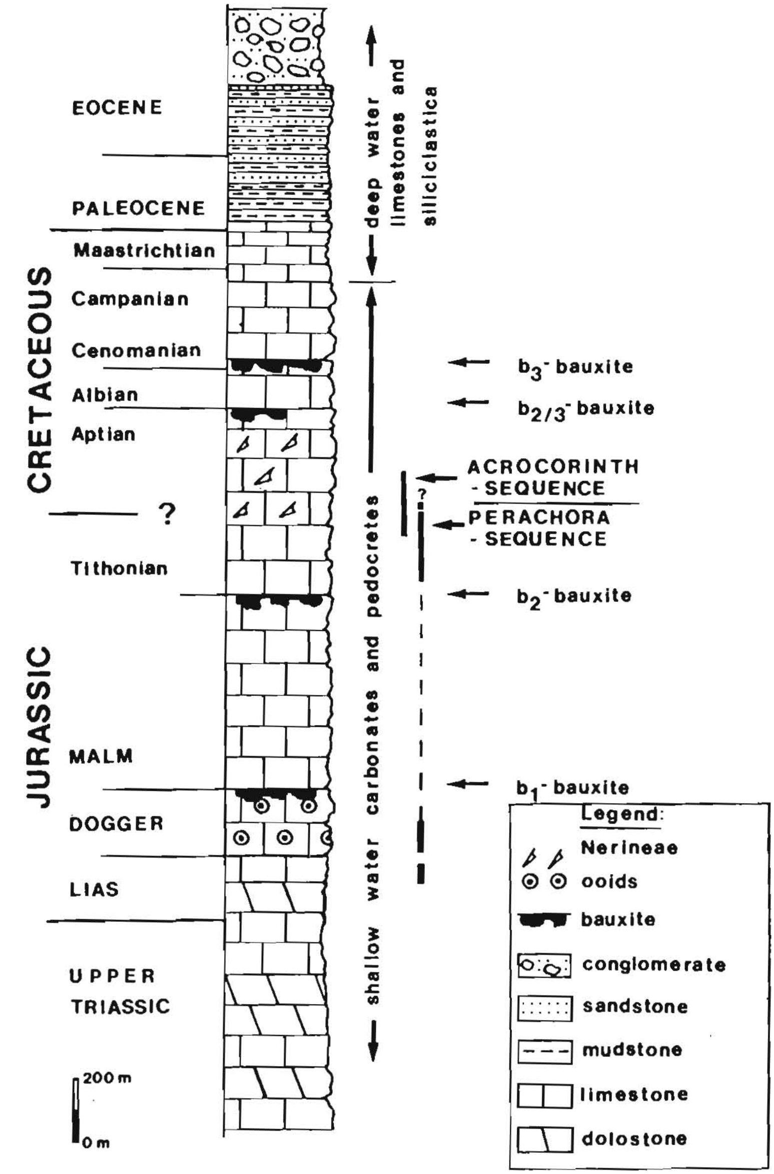

Fig. 4 Generalized geological column of the Parnassus Zone after HOFGEBAUER (1985) and KEUPP (1976).

peninsula) or older (Acrocorinth) age, both built up by deep water sediments, corroborate the interpretation as a melange.

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