GEOLOGIA CROATICA	45	87 - 93	3 Fig.	2 Pl.	ZAGREB 1992

UDC 551.763.31 (450) Scientific paper

Open Circulation Facies in the Cenomanian of the Northeastern Margin of the Friuli Platform: the Iudrio Valley Case (NE Italy)

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Key words: Early-Middle Cenomanian, Margin Sequence, Friuli Platform, Calcisphaerulidae, *Favusella*, transgressive events

The Early-Middle Cenomanian margin sequence of Val Iudrio, connected with the northeastern margin of the Friuli Platform shows intercalated layers with pelagic organisms: Calcisphaerulidae and planktonic forams, among which is *Favusella*. These are interpreted as transgressive episodes recorded in a carbonate ramp sequence related to a tectonically subsiding margin. In the Dinaric and Friuli Platforms two distinct Calcisphaerulidae and planktonic forams facies are distinguished for the Cenomanian. The first one, of early-middle Cenomanian age, which is also present in the Iudrio sequence, developed in platform margin zones subjected to drawning. The second one, of late Cenomanian age, developed in more internal areas of the Dinaric and Friuli Platforms, and can be related to the transgression associated with the OAE 2 event.

1. INTRODUCTION

Several margin sequences of the Friuli Platform, representing the northwestern extension of the Dinaric Platform (Fig. 1) during the latest Albian and Cenomanian, are characterized by pelagic influxes with planktonic organisms (COUSIN, 1981; GHETTI, 1987; KOCH et al., 1989; VENTURINI & TUNIS, 1990).

The sequence of the Iudrio Valley (Fig. 2) consists of platform margin carbonates, the outcropping lower part of which is Valanginian, whereas the top is Senonian. This paper takes into consideration the Early-Middle Cenomanian limestones showing marked open facies as indicated by the presence of planktonic organisms, with the aim of explaining the significance of these facies.

2. THE CENOMANIAN OF THE IUDRIO VALLEY

The latest Albian of the Iudrio sequence marks a change of depositional pattern. In fact, latest Albian facies, represented by bioclastic packstones and grainstones, can be referred to as a more open environment of deposition with respect to the underlying platform carbonates belonging to the Cellina Limestone unit. The following Early-Middle Cenomanian sequence consists of even more open facies, characterized by an increased energy of the system and very high organic productivity. The unit analyzed, about 250 m thick, outcropping in the southwestern sector of the Iudrio Valley between Albana and Bodigoi, consists of a succession of bioclastic sands: alternating bioclastic packstones and grainstones and subordinate rudstones. Mudstones seem to be lacking.

Most of the grains of these carbonate sands are fragments of fossils (Pl. I, 1 and 2 ; Pl. II, 1 and 2) which are subjected to breakage, abrasion, and sometimes, rounding processes. Fine to medium sized granular calcite cements fill intergranular porosity in packstones and grainstones. Relict of marine phreatic cements can be also recognized. Rare vadose crystal silt possibly indicates the occurence of sporadic subaerial exposure episodes. Many calcitic cemented fractures of tectonic origin are present.

Orbitolina (Conicorbitolina) conica (D'ARCHIAC) (Pl. I, 1,2,3,4) is the most common macroforaminifer observed in bioclastic sands from the bottom to the top of the studied sequence. Some layers contain *Praealveolina* gr. *cretacea* (D'ARCHIAC) (Pl. I, 4,5,6).

Other foraminifers such as *Trocholina* sp., *Pseudorhapydionina* sp., *Cuneolina pavonia* D'ORBIGNY, *Nezzazata simplex* OMARA, Nezzazatidae, Miliolidae, Ophthalminidae, Textulariidae, Valvulinidae, Lituolidae, etc. have also been observed.

Macrofossils are represented by rudists (mostly Radiolitidae and also Caprinidae) and subordinate echinoids, corals, brachiopods, gastropods (among which are nerineids). However, most of these fossils have been broken into fragments and compose the bioclastic fraction of the carbonate sands.

These facies developed in high energy ramp environments in which bioclastic sediments were transported and accumulated by wave activity. These environments were also influenced by sea level fluctuations which led to sporadic subaerial exposures.

Wackestones and packstones with planktonic organisms, the most common of which are Calcisphaerulidae (Pl. II, 1,2,3), alternate with the forementioned bioclastic packstones and grainstones. In these facies there are also some planktonic foraminifers, among which are *Favusella washitensis* (Pl. II, 3, 5, 7), *Favusella* sp. (Pl. II, 4), *Hedbergella* sp. (Pl. II, 6) and extremely rare *Rotalipora*. The observed planktonic forms may also

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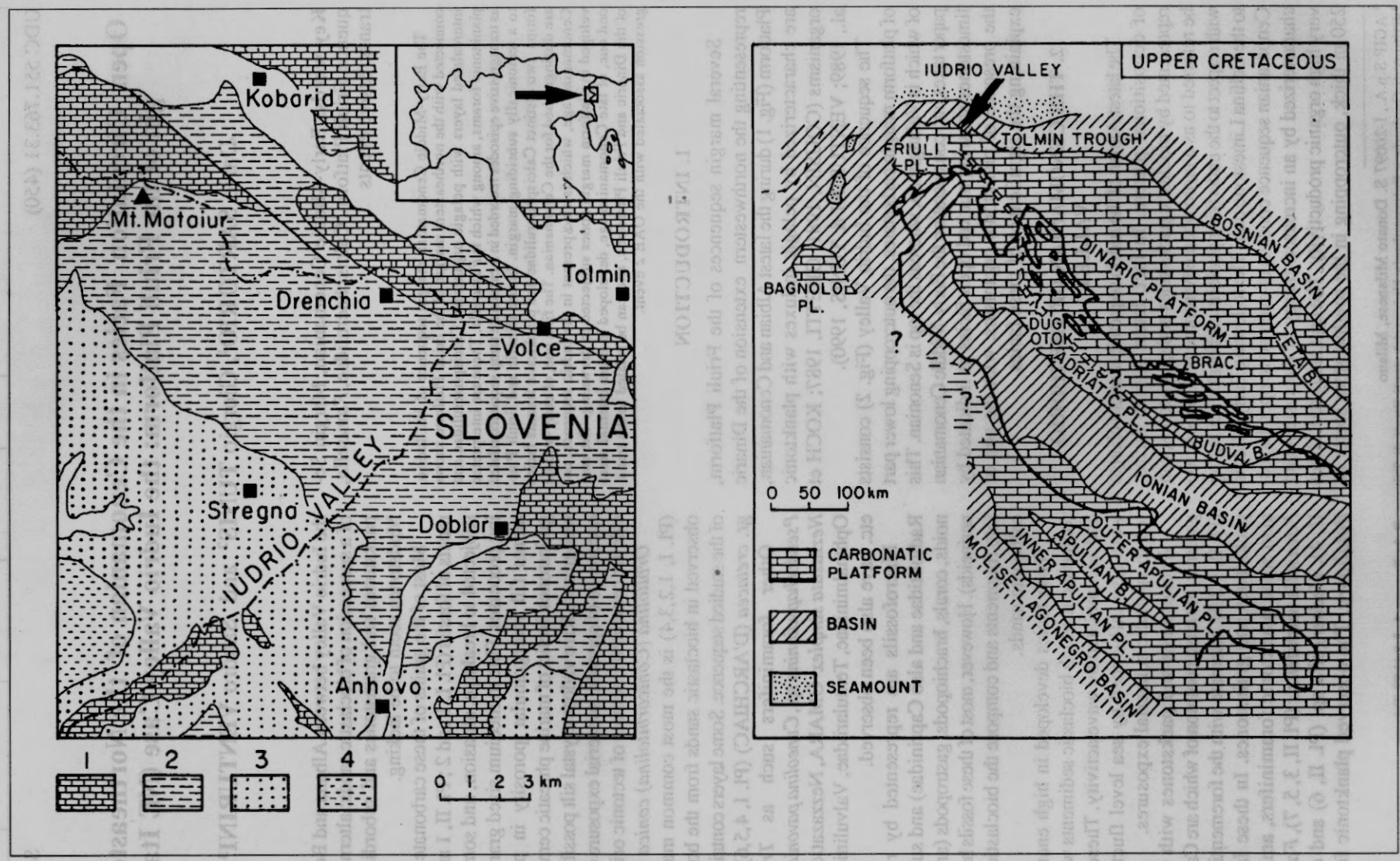


Fig. 1 - Location of the Iudrio Valley (left): 1. Mesozoic limestones, 2. Maastrichtian flysch, 3. Paleocene flysch, 4. Lower Eocene flysch. Paleographic map of Upper Cretaceous of Peri Adriatic area (right), modified from CATI et al. (1987). The arrow shows the location of the examined area.

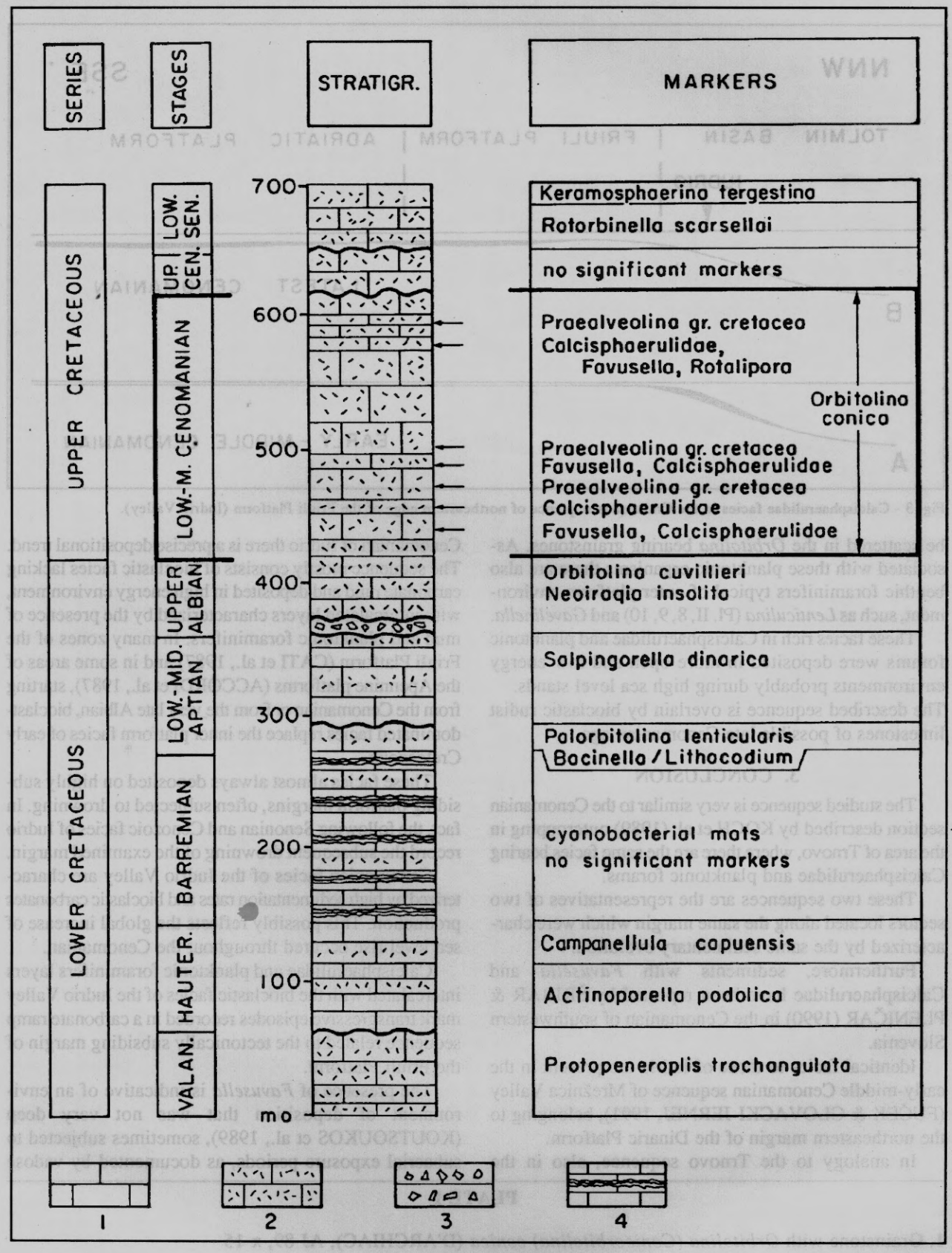


Fig. 2 - Stratigraphic column of the Cretaceous limestones outcropping in the Iudrio Valley. The arrows show pelagic influxes.
1. Mudstone-wackestone, 2. Packstone-grainstone, 3. Intraformational breccias. 4. Bacterial mats.

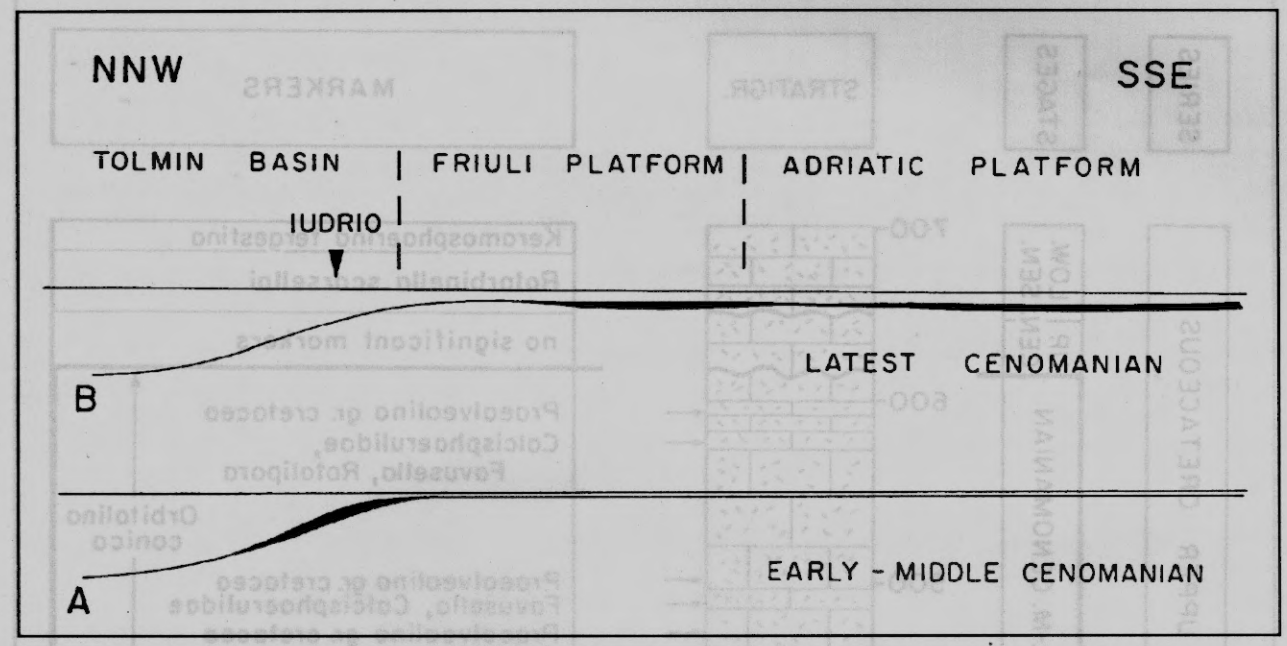


Fig. 3 - Calcisphaerulidae facies in the Cretaceous sequence of northeastern edge of the Friuli Platform (Iudrio Valley).

be scattered in the *Orbitolina* bearing grainstones. Associated with these planktonic organisms there are also benthic foraminifers typical of outer platform environment, such as *Lenticulina* (Pl. II, 8, 9, 10) and *Gavelinella*.

These facies rich in Calcisphaerulidae and planktonic forams were deposited in more open and low energy environments probably during high sea level stands. The described sequence is overlain by bioclastic rudist limestones of possible late Cenomanian age.

3. CONCLUSION

The studied sequence is very similar to the Cenomanian section described by KOCH et al. (1989) outcropping in the area of Trnovo, where there are the same facies bearing Calcisphaerulidae and planktonic forams.

These two sequences are the representatives of two sectors located along the same margin which were characterized by the same sedimentary evolution.

Furthermore, sediments with *Favusella* and Calcisphaerulidae have been reported by ŠRIBAR & PLENIČAR (1990) in the Cenomanian of southwestern Slovenia.

Identical facies to those of Iudrio are present in the early-middle Cenomanian sequence of Mrežnica Valley (FUČEK & GLOVACKI-JERNEJ, 1991), belonging to the northeastern margin of the Dinaric Platform.

In analogy to the Trnovo sequence, also in the Cenomanian of Iudrio there is a precise depositional trend. The sequence mostly consists of bioclastic facies lacking carbonate mud and deposited in high energy environment, with intercalated layers characterized by the presence of mud and planktonic foraminifers. In many zones of the Friuli Platform (CATI et al., 1987) and in some areas of the Apennine platforms (ACCORDI et al., 1987), starting from the Cenomanian or from the very late Albian, bioclast-dominated facies replace the inner platform facies of early Cretaceous.

These facies almost always deposited on highly subsiding platform margins, often subjected to drowning. In fact, the following Senonian and Cenozoic facies of Iudrio record the subsequent drowning of the examined margin.

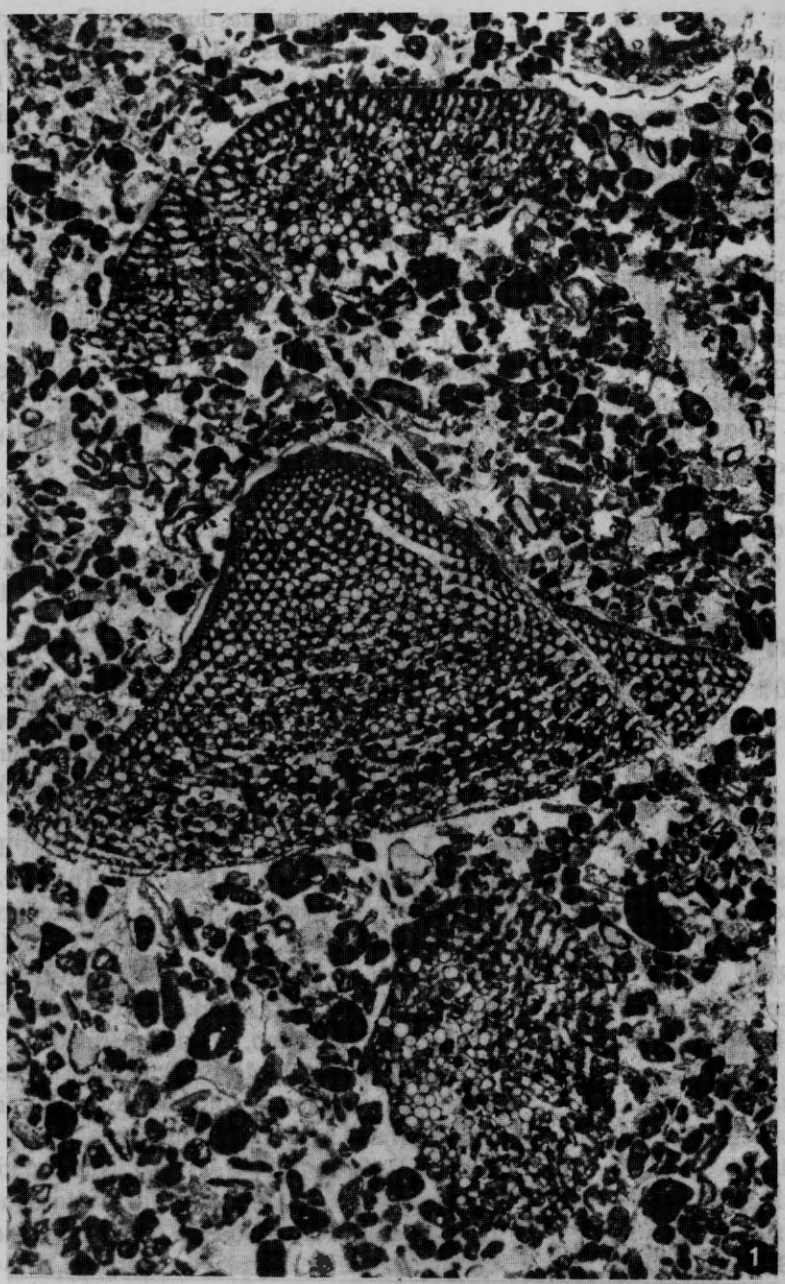
Cenomanian facies of the Iudrio Valley are characterized by high sedimentation rates and bioclastic carbonates production. This possibly reflects the global increase of sea level rise occured throughout the Cenomanian.

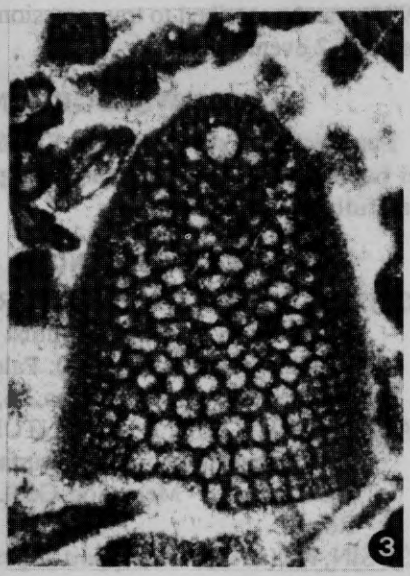
Calcisphaerulidae and planktonic foraminifers layers intercalated with the bioclastic facies of the Iudrio Valley mark transgressive episodes recorded in a carbonate ramp sequence related to the tectonically subsiding margin of the Friuli Platform.

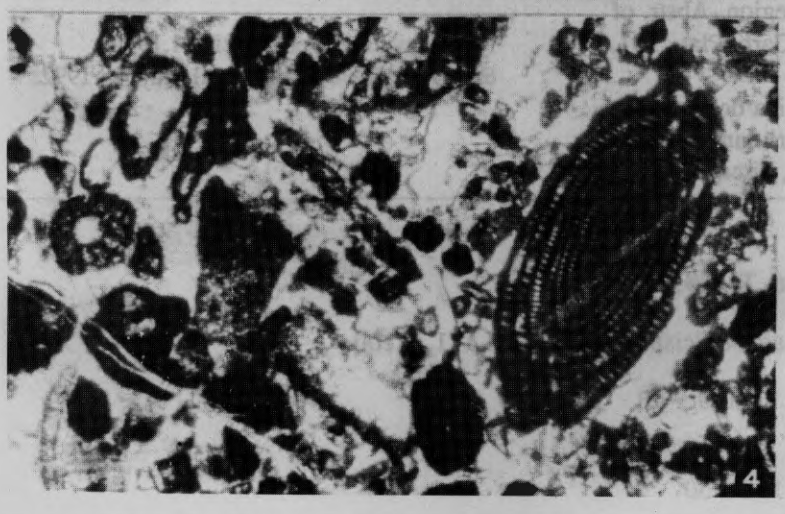
The presence of *Favusella* is indicative of an environment of deposition that was not very deep (KOUTSOUKOS et al., 1989), sometimes subjected to subaerial exposure periods, as documented by vadose

PLATE I

1. Grainstone with *Orbitolina (Conicorbitolina) conica* (D'ARCHIAC), AJ 89, x 15
2. *Orbitolina (Conicorbitolina) conica* (D'ARCHIAC), AJ 94 x 40
3. *Orbitolina (Conicorbitolina) conica* (D'ARCHIAC), GI 134, x 45
4. *Praealveolina* gr. *cretacea* (D'ARCHIAC), and embryonic apparatus of *Orbitolina (Conicorbitolina) conica* (D'ARCHIAC), TJ 16 x 30
5. *Praealveolina* gr. *cretacea* (D'ARCHIAC), AJ 115, x 40
6. *Praealveolina* gr. *cretacea* (D'ARCHIAC), TJ 16, x 45







cements observed in some levels. In the Dinaric and Friuli Platforms, two different transgressive facies, with Calcisphaerulidae and planktonic foraminifers characterize the Cenomanian sediments. The first one (Early-Middle Cenomanian) is associated with the *Orbitolina* (C.) *conica* bioclastic sands and is typical of platform margins subjected to drowning (Fig. 3A). This facies, which is present in the Iudrio sequence, is characterized by Calcisphaerulidae and *Favusella*.

The second facies, ascribed to the Cenomanian-Turonian boundary, and more precisely to the latest Cenomanian, if correlated with coeval facies of the Apennines (PARISI et al., 1989) and of South-East France (GROSHENY & TRONCHETTI, 1991) is characterized by Calcisphaerulidae and *Whiteinella* (GUŠIĆ & JELASKA, 1990). This facies, almost always associated with anoxic or euxinic environments, is recorded in more internal areas of the platform (Fig. 3B), and, as put to evidence by JENKYNS (1991), can be ascribed to transgression associated with the OAE 2 event.

ACKNOWLEDGEMENT

Financial support from M.U.R.S.T. 60% "Evoluzione dei bacini sedimentari terziari" (resp. G. Catani) is gratefully acknowledged.

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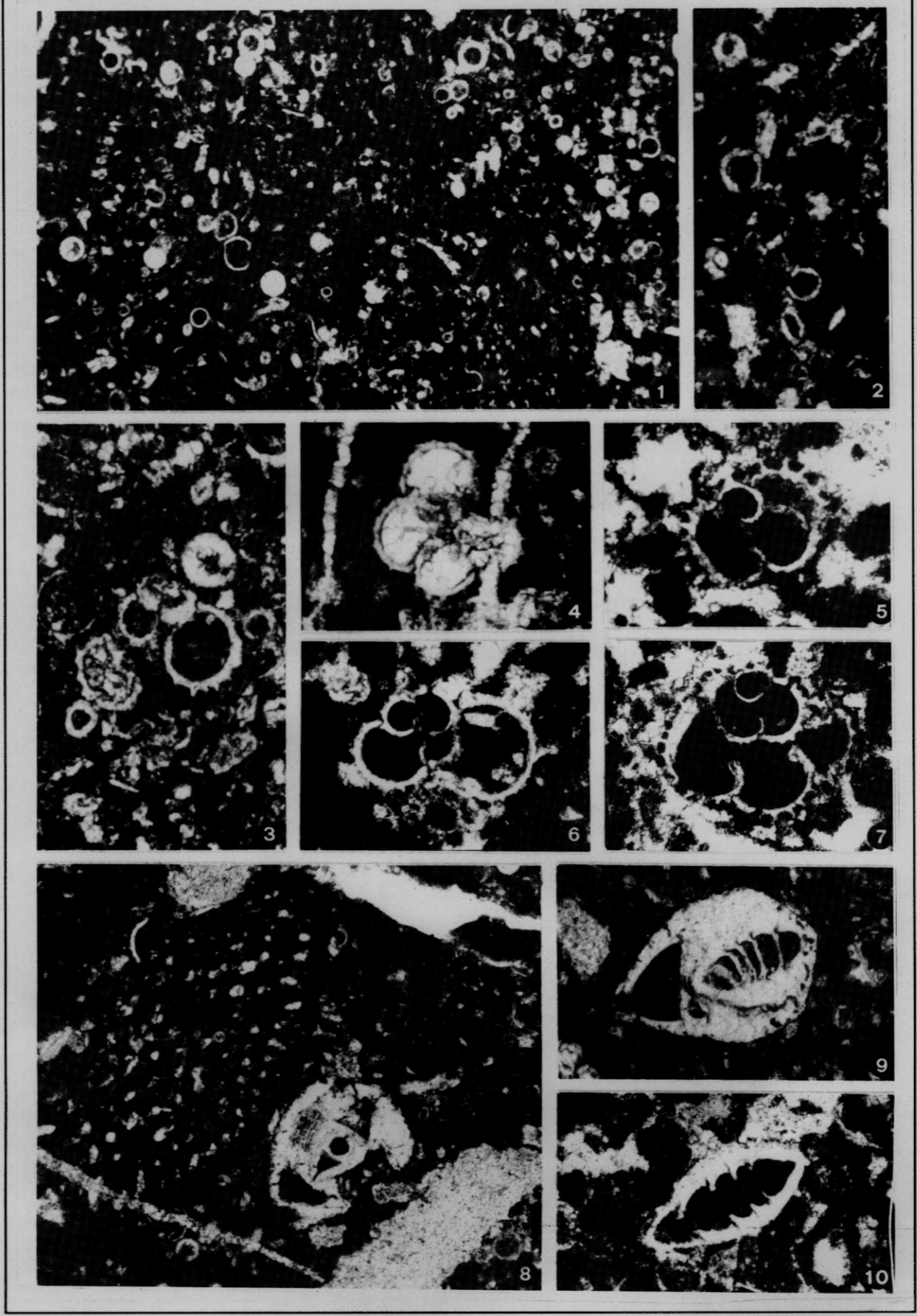
Manuscript received March, 31.1992.
Revised manuscript accepted May, 18.1992.

PLATE II

1. Wackestone with Calcisphaerulidea, TJ 28, x 50
2. Calcisphaerulidea, GI 141, x 120
3. *Favusella washitensis* (CARSEY) and Calcisphaerulidea, GI 141, x 100
4 *Favusella* sp., GI 136 x 90
5. *Favusella washitensis* (CARSEY), GI 139 x 90
6. *Hedbergella* sp., GI 139 x 70
7. *Favusella washitensis* (CARSEY) GI 139 x 70
8. *Lenticulina* sp. and *Orbitolina* sp, 136 x 50
9. *Lenticulina* sp., TJ 28, x 50
10. *Lenticulina* sp., GI 139, x 70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