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Fault-Block Platform Evolution between Late Cretaceous and Early Miocene along the Margin of the Latium-Abruzzi Carbonate Platform (Southern Prenestini Mountains, Central Apennines, Italy)

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Abstract: Since the origin of the carbonate platform concept, the reconstruction of the geometry and the evolution of the margin has been an intriguing topic. The Latium-Abruzzi platform is one of the largest shallow water domains of the Central Apennines, however, the reconstruction of the geometry and evolution of its margin has been classically problematic because the latter has been erased by the out-of-sequence Olevano-Antrodoco thrust system. The investigated area is placed in the Prenestini Mountains, the southernmost portion of the Sabina Domain, where a Cretaceous to Neogene carbonate succession, ascribed the Latium-Abruzzi platform margin, crops out. Stratigraphic and facies analyses showed a Late Cretaceous extensional stage that produced two main fault-block platforms, respectively, South Eastern Prenestini and South Western Prenestini platforms, developed westward of the large Latium-Abruzzi Platform domain. In these platforms, during the Paleocene–Eocene interval, pelagite deposition coincides with the main relative sea-level rise. Instead, during the following falling stage, the seafloor, consisting of the Cretaceous carbonate, was in the wave abrasion zone and the pelagic carbonate mud was swept away or trapped in local depressions or fractures (neptunian dykes), whereas the coarse sediment produced by the erosion of indented and fractured substrate formed polygenic conglomerate accumulation on the Cretaceuos carbonate platform substrate. Successively, an isolated homoclinal ramp, the Guadagnolo Fm, Aquitanian to Serravallian in age, developed on the drowned fault-block platforms, suggesting that during Neogene the articulation of the substrate of the two fault-block platforms had to be limited to host the bioclastic sedimentation of the Guadagnolo Fm and to allow the development of a carbonate ramp depositional profile.

Keywords: carbonate factory; stratigraphy; facies analysis; platform drowning; neptunian dykes

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1. Introduction

The sediment production and accumulation processes occurring in carbonate systems are very sensitive to a multiplicity of processes such as tectonic subsidence, eustatic oscillation, seawater chemistry, climate and biota evolution [1–6]. The light, and consequently bathymetric, dependence of many carbonate biota, especially autotrophic and mixotrophic organisms, provides a much more accurate record of sea-level changes and overall permits distinguishing in situ versus ex situ components, as well as the identification of the different carbonate factories existing in the carbonate platform [7].

The ability of skeletal carbonate sediments to accumulate in place or to be transported elsewhere depends on the bottom topography, the strengths of waves and currents, the wave-base depth and the capacity of the benthic community to attenuate transport or trap sediment [8,9].

The presented example encompasses the Cretaceous–Miocene interval. Different styles of carbonate production, accumulation, and diagenesis characterize the Mesozoic and the Cenozoic carbonate platforms. According to Pomar and Hallock [6], Lower and Upper Cretaceous are characterized by a high content of muddy matrix even in relatively high-energy zones, above the wave base, thanks to sediment-stabilization mechanisms due to microbial mats, calcimicrobe bafflers, binders and micrite producers, or even automicrite production, promoting the stabilization of sediment and early diagenesis. In contrast, the Cenozoic carbonate platforms are dominated by skeletal carbonate production. After the Cretaceous–Paleocene mass extinction, the carbonate platforms were originally dominated by red algae, bryozoans [10], and subordinately by corals [11]. Since the middle Paleocene, larger benthic foraminifera (LBF) became one of the main components of the photic carbonate factory until the late Eocene. The subsequent cooling trend, that began in the late Eocene, continued through the Oligocene and the Miocene, stimulating the diversification and expansion of different LBF assemblages in which lepidocyclinids, miogypsinids, amphisteginids and heterosteginids were dominant. However, these LBF assemblages did not produce massive accumulation of monospecific tests characteristic of Eocene facies [11,12]. During this time interval, seagrasses expanded in the shallow, euphotic inner ramps [13–20]. Furthermore, with the Oligocene and the Miocene stepwise cooling, coralline algae became a main component of the meso- and oligophotic carbonate factory [21–23]. From a mineralogic point of view, the Cenozoic skeletal assemblage is dominated by calcite mineralogy with the only exception of aragonitic corals and green algae [24]. Because of the early loss of metastable aragonite and high-Mg calcite, modification of the depositional components in the marine and meteoric realms are expected to be relatively unimportant, when compared with Mesozoic counterpart [25,26]. Seafloor marine cements are absent or rare in seafloors dominated by calcitic skeletal assemblages; consequently, the carbonate sediments are easily eroded from the platform and shed into the basin [27].

This work focuses on the southwestern area of the Latium-Abruzzi carbonate platform (LACP), where the marginal area is exposed along the Prenestini Mountains (Figure 1). The LACP, one of the Tethyan platforms outcropping in the central Apennine chain, records the sedimentary evolution of the Triassic to the Late Miocene interval [28,29]. The adjacent pelagic domain of the northwestern sectors is represented by the Sabina succession consisting of Lower Jurassic to Paleogene pelagites and hemipelagites, alternating with resedimented material derived from the nearby LACP [27,30]. From the late Messinian to the early Pliocene, the Sabina Domain overrode the LACP domain along the out-of-sequence Olevano-Antrodoco thrust system [31–33]. As consequence, the reconstruction of the geometry and evolution of the margin of the LACP remains poorly understood. The investigated area falls in the Prenestini Mountains, where the transition from the LACP deposits to the pelagic carbonates of the Sabina Domain is partially preserved [28,31]. This succession confirmed the occurrence of repetitive development of shallow-water carbonate production alternating with erosive phases and condensed pelagic sedimentation in a tectonically controlled marginal area [28,30].

The Prenestini sedimentary succession offers the possibility to reconstruct the depositional history of the marginal area of the LACP domain between the end of the Cretaceous and the Middle Miocene, and to analyze the interplay of different factors that controlled the succession of different carbonate factory settlement, erosion, and drowning.

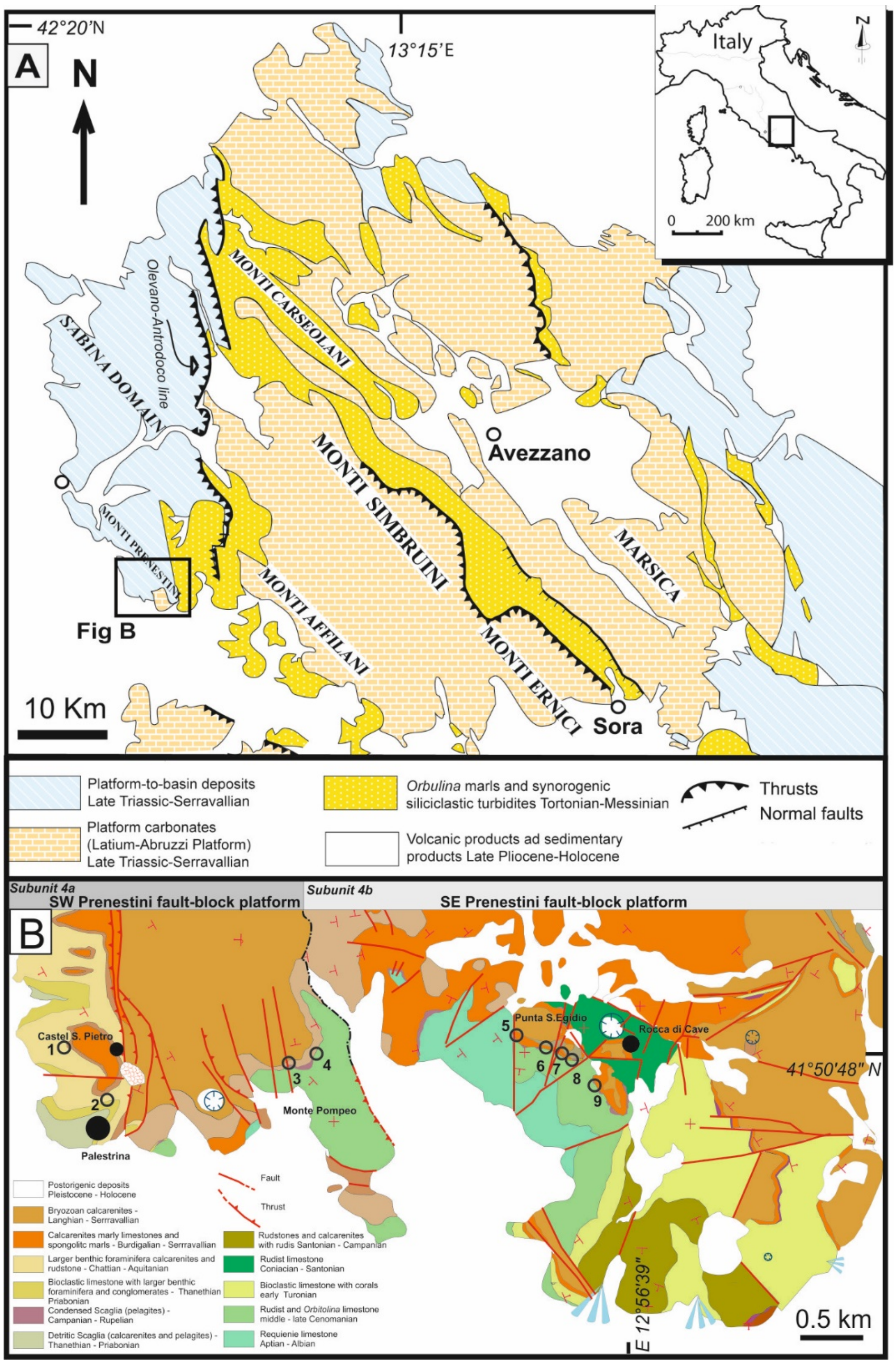

Figure 1. Geological map of the investigated area. (**A**) Basinal and carbonate platform domain of central Apennines modified from [34]; (**B**) geological map of Southern Prenestini and location of investigated outcrops modified from [35].

2. Geological Setting

The Apennine orogeny is the product of the west-directed subduction associated with the inversion of the Alpine-Betic subduction after the late Eocene [36–38]. The Apennine formed mostly between Oligocene and the Quaternary, with the east-directed migration of the accretionary wedge and front, and the contemporary extension in the western back-arc area [39].

The central Apennines are characterized by a sedimentary succession comprising two carbonate platforms and basinal domains, respectively, the LACP and the Apulian Platform, and the Monte Genzana-Molisano Basin that separated the platforms and passed to the Umbria-Marche Basin northward (Figure 1) [29,40]. From Triassic to Late Cretaceous, the LACP was a flat-topped open-shelf platform. The Mesozoic succession was then interrupted by a long-lasting hiatus. The sedimentation restarted during the Early Miocene when a carbonate ramp system developed, represented by the *Lithothamnion* and Bryozoan Limestones Fm [27,41,42]. This Paleogene hiatus reaches its maximum duration within the inner Mesozoic platform, while in the marginal areas condensed or discontinuous Cenozoic deposits occur [27,43].

Along the transition between the LACP and the pelagic domain, the stratigraphic hiatus decreases and Paleocene to Oligocene deposits, up to 500 m-thick, are represented by pelagic deposits alternating with larger benthic foraminiferal-rich intercalations (debritic Scaglia) [30,44,45]. The Chattian to Serravallian sedimentation is represented by the Guadagnolo Fm. Three main lithozones have been recognized in this formation [46,47]. The lower lithozone is Chattian to early Burdigalian in age, and consists of alternating larger benthic foraminiferal rudstone, packstone to grainstone, and planktonic wackestone with cherty nodules. The coarse bioclastic beds represent turbidites and other gravity-flow deposits containing lithic and bioclastic sand and gravel transported downslope from the shelf [46,48]. This lithozone reaches a thickness of 100 m. The second lithozone, known as the spongolitic unit, Burdigalian to Langhian in age, is made of a 600 m-thick alternation of marls, calcareous marls, and bioclastic calcarenites with abundant planktonic foraminifera, sponge spicules, echinoids, and bryozoans [46,47,49]. The upper lithozone is Serravallian-Tortonian in age and consists of coarse bryozoan-rich cross-bedded bioclastic floatstones to grainstones that unconformably overly the spongolitic unit. The Upper Miocene shallow-water carbonate sedimentation in the LACP and transitional zone terminated due to an upwelling event that promoted the development of a phosphatic hardground. Tortonian to lower Messinian hemipelagic marls lie above the phosphatic hardground and are overlain by siliciclastic turbidites that denote the development of the Apennine foredeep system [43,50].

In the Prenestini Mountains, the Meso-Cenozoic carbonate succession of the transition zone from the Latium-Abruzzi platform domain to the Sabina Basin crops out (Figure 1A,B). Two main sectors can be recognized. The Southern Prenestini area has been interpreted as a persistent structural high affected by tensional tectonics. Aptian to Santonian platform carbonates, ranging from inner to marginal shoals, crop out in the Rocca di Cave sector. This structural high was uplifted and emerged during the late Cenomanian-Turonian [51]. Successively, the platform carbonates were paraconformably overlain by a few centimeters to a few meters thick, laterally discontinuous, Campanian-to-Bartonian condensed pelagites alternating with calcarenites of Scaglia Fm, infilling cavities and neptunian dykes [52–54]. In the northern Prenestini Mountains, the Guadagnolo Fm lies on Turonian-to-Bartonian debritic Scaglia Fm up to 450 m thick [30]. The succession ends with few meters of spongolitc marls followed by the calcarenite of the upper member of the Guadagnolo Fm.

The Prenestini Mountains have been subdivided by Bollati et al. [55] in two main tectonic units: (i) the western unit (unit 4A of [55]), characterized by east-verging packed asymmetrical tectonic units and (ii) the eastern unit (unit 4B of [55]) characterized by a wide symmetrical anticline in the western portion (Figure 1B).

According to Tavani et al. [56], the eastern unit of the Rocca di Cave fault system subdivides the Eastern Prenestini (unit 4B [55]) into the northern and the southern portions. In the southern, the Late Cretaceous (Campanian) transition from rudist-dominated carbonate platform to a pelagic environment (i.e., Scaglia Formation) was predated by normal faulting and erosion. According to these authors [56], the Scaglia Formation rests on top of progressively younger carbonate platform deposits toward the east, from Turonian-to-Santonian in the eastern sector, Cenomanian in the central area, to Aptian-to-Albian in the western sector. The eastward rejuvenation of the substratum takes place across east dipping normal faults whose activity predated the uplift and erosion of the Cretaceous carbonate platform. These N-S faults display a polyphasic activity documented by displacement of the entire Campanian-to-Miocene succession. In the northern block of this fault system, the Guadagnolo Fm lies directly on Cenozoic pelagic deposits of the Sabina succession. Tavani et al. [56] interpreted the Rocca di Cave Fault System as a longitudinal and transverse extensional fault produced by the development of the Apennine forebulge that predated the Tortonian-to-Quaternary Central Apennine structuration.

3. Methods

Nine outcrops located in the southern sectors of Prenestini Mountains were investigated (Figure 1B). The structural subdivision of Prenestini Mountains proposed by Bollati et al. [55] was used in this work. Five outcrops are in the Western Prenestini and four outcrops in the Eastern Prenestini. The field observations were integrated with microfacies analysis of 75 thin sections, providing data on texture and carbonate grains.

The age of investigated outcrops is based on Danese and Mattei [57]. Biostratigraphic data were integrated with calcareous nannofossil biostratigraphy.

Calcareous nannofossil assemblages were analyzed on 15 smear-slides belonging to different marly interlayers of the Cenozoic stratigraphic interval. Smear-slides were prepared from unprocessed material following the standard techniques suggested for simple smear slide preparation by Bown and Young [58].

Test shape variation (T/D) of the larger benthic foraminifer (LBF) *Amphistegina* was used to constrain bathymetry of the depositional setting, according to the model proposed by Mateu-Vicens et al. [59]. The preservation levels of large benthic foraminiferal tests were used to determine taphonomic processes related to sediment transport. The latter is based on Beavington-Penney's [60] studies on abrasion of macrospheric *Nummulites* as an indicator of transport processes. Assessments were provided using the Beavington-Penney Taphonomic Scale (i.e., BPTS).

4. Results

The analyzed outcrops include the Cretaceous–Miocene sedimentary interval.

The pre-Miocene substrate in the investigated area appears to be differentially articulated in the two investigated areas: South Western and South Eastern Prenestini.

In the South Western Prenestini, the Cretaceous substrate consists of Cenomanian carbonate platform lithofacies, represented by horizontally bedded, bioclastic packstone-grainstone to rudstone with rudist fragments and orbitolinids. This lithofacies is overlain by rudist-rich packstone to rudstone and floatstone, late Campanian to Maastrichtian in age. The Cretaceous substrate is unconformably overlain by lenses of conglomerates, up to 4 m thick, containing clasts of Upper Cretaceous platform limestones, clasts of marly limestones with planktonic foraminifera referable to the middle Eocene Scaglia Fm, and clasts of limestones with larger benthic foraminifera (Figure 2A). Above, the conglomerates rest up to 50 m of medium-to-thick-bedded bioclastic calcarenites and calcirudites rich in larger foraminifera interbedded with planktonic foraminiferal mudstones to wackestones (Figures 2B and 3A). Typically, sets of planar laminae occur within the beds, although occasionally low-angle cross lamination may also be recognized. These beds show a fining upward trend. Within the lower beds of this unit, *Amphistegina* T/D values range between 0.42 and 0.7 (mean 0.60, median 0.65), LBF tests yield BPTS abrasion values between 1 and 3 (mean 2.1, median 2). In the upper beds, *Amphistegina* values are between 0.46 and 0.7 (mean 0.53, median 0.5), LBF tests show BPTS abrasion values between 1 and 3 (mean 1.7, median 2) and the skeletal fraction is characterized by frequent epiphytic foraminifers. This portion is covered with spongolitic marls and bioclastic calcarenites referable to the Miocene Guadagnolo Fm.

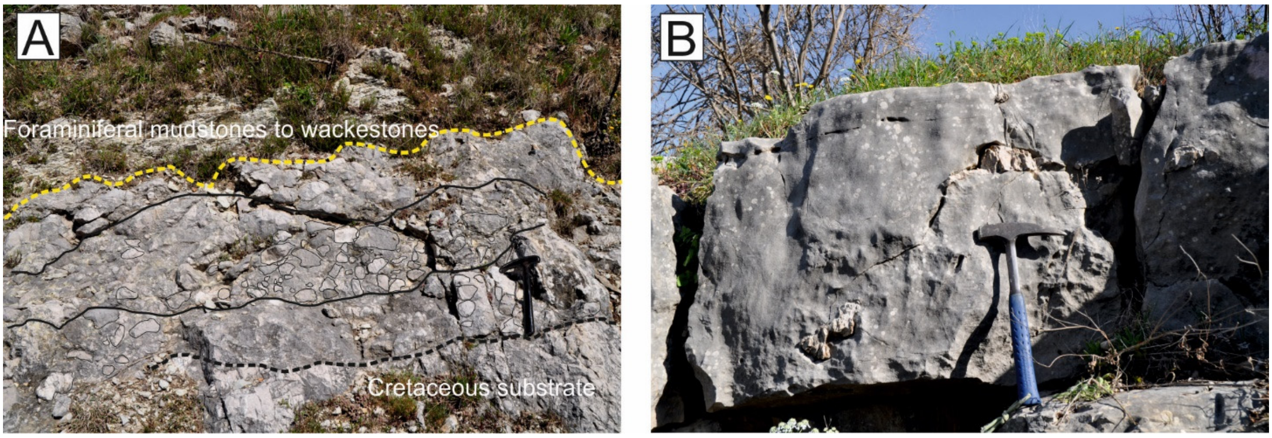

Figure 2. (**A**) Lenses of conglomerates with clasts of Upper Cretaceous platform limestones, clasts of Eocene Scaglia Fm, and clasts of limestones with larger foraminifera lie above the Upper Cretaceous substrate of Southern Western Prenestini (SWP) (Palestrina Castel S. Pietro outcrop); (**B**) in the western portion of the SWP, the Chattian interval is represented by bioclastic calcarenites and calcirudites, rich in larger foraminifera, produced by gravity flows (Palestrina outcrop).

Scattered mound bodies may overlie the Cretaceous substrate (Figure 4). These mounds do not show internal structures, bedding is very obscure and only identified by subtle changes in the rock texture. The mounds are up to 5 m thick and up to 20 m wide. Between the corals, the matrix consists of poorly sorted packstone to wackestone and in some cases grainstone. The main components of the matrix are miliolids, green algae (dasycladaleans and halimedaceans), molluscs, encrusting foraminifers, represented by acervulinids (*Gypsina*), that encrusted peyssonnelliacean red algae (Figure 5A–D). Coralline algae mostly correspond to fragments of crusts and nodules of non-articulated taxa (including mastophoroids and melobesioids). Rare fragments of articulated forms also occur. The mounds are onlapped by planktonic and spiculitic wackestone of detritic Scaglia (Figure 4). Calcareous nannofossil biostratigraphy indicates a Rupelian-Chattian age (CNO4).

In the easternmost outcrop of South Western Prenestini (Figure 1B), the Mesozoic substrate can be observed in the Monte Pompeo area. Here, a paleostructure consisting of a footwall block bounded by paloescarpments can be observed. The paleostructure is represented by tabular beds of obitolinids-rich grainstones with cortoids and small oncoids. These lithofacies are dated from the late Albian to the early Cenomanian [57] (Figures 3C and 6). Above the Cretaceous unconformity, marked by chert nodules and irregular crusts, breccias and red soil infilling fractures can be observed (Figure 7A). The Cretaceous substrate is characterized by cavities and neptunian dykes, up to 80 cm wide, filled with condensed pelagic sediments of different ages (Figure 3D), ranging from the middle Paleocene (Selandian) to middle Eocene (Lutezian) [57]. In this outcrop, at the base of the paleostructure, Miocene carbonates lie in onlap on the Cretaceous substrate and consist of marly limestones passing upward into marly limestones interbedded with laminated calcarenites represented by skeletal packstone to grainstone rich in echinoids and bryozoan fragments (Figure 6). A characteristic feature of this portion is the occurrence of conglomeratic levels, with a thickness ranging between 20 and 80 cm, mostly lenticular in shape, containing lithoclasts of the Cretaceous platform, larger benthic foraminifera calcarenites, and glauconitized pelagites (Figure 3E). At the top of the paleostructure, the Miocene carbonates lie paraconformably on the Cretaceous substrate and consist of cross-bedded skeletal grainstones dominated by bryozoans, echinoids, small benthic foraminifers (*Elphidium*), and rare amphisteginids (Figure 3F).

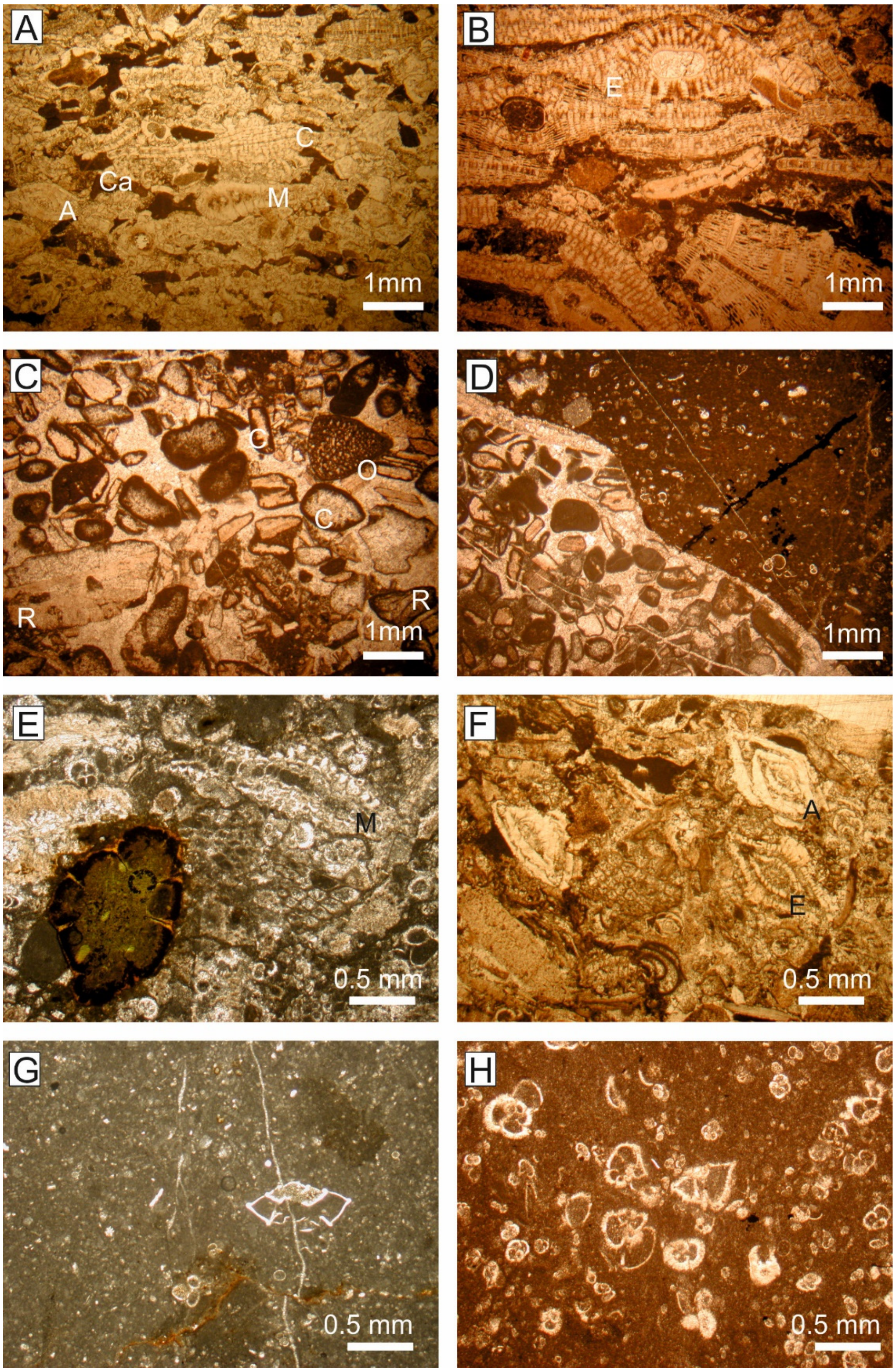

Figure 3. (**A**) The larger benthic foraminiferal assemblages of Chattian deposits of South Western Prenestini comprises *Amphistegina* (A), *Miogypsinoides* (M), and *Cicloclypeous* (C), other common components are coralline algae (Ca) and echinoid plates; (**B**) calcirudites dominated by *Eulepidina* (E) and *Nephrolepidina* form beds alternating with planktonic foraminiferal mudstones to wackestones. (**C**) The Cretaceous substrate of SWP in the Colle Pompepo outcrop is represented by bioclastic grainstone with Orbitolinids (O), rudist fragments (R), and cortoids (C); (**D**) neptunian dykes filled by condensed Scaglia pelagites; (**E**) the Lower Miocene deposits in the Colle Pompeo outcrop consist of packstone to grainstone rich bryozoan fragments, *Miogypsina* (M) and containing glauconitized

pelagites; (**F**) the uppermost Miocene carbonate of the Colle Pompeo outcrop is represented by cross-bedded skeletal grainstones dominated by bryozoans, echinoids, and small benthic foraminifers, in particular *Elphidium* (E) and amphisteginids (A); (**G**) *Globutruncana* in the pelagites of South Eastern Prenestini (Campanian) (Rocca di Cave Sud outcrop); (**H**) the planktonic assemblages of upper Paleocene Scaglia are dominated by *Morozovella*, *Acarinina*, and globigerinid specimens (Rocca di Cave nord outcrop).

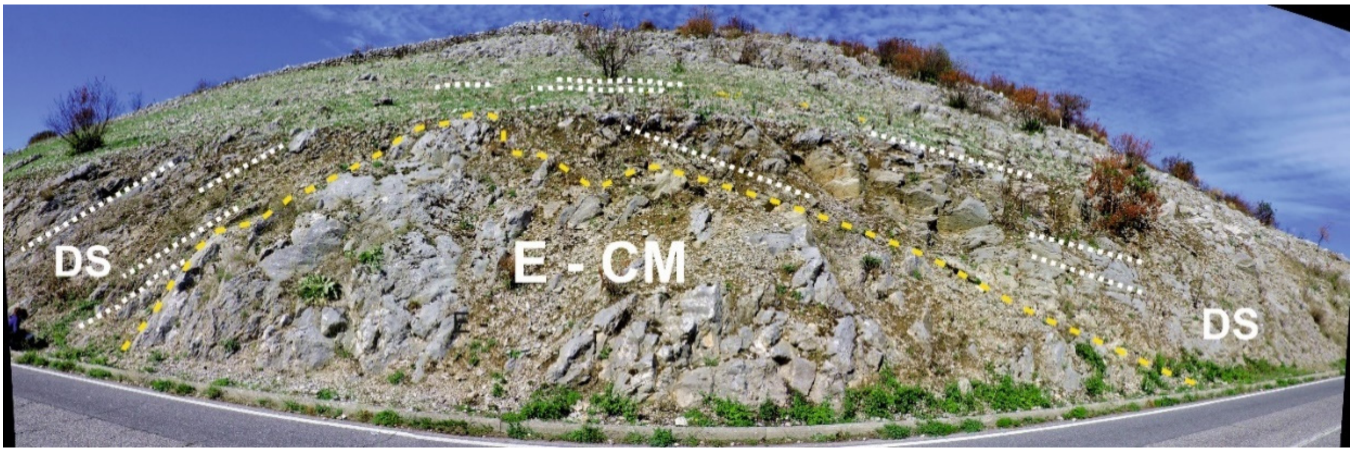

Figure 4. In the South Eastern Prenestini crudely stratified Eocene coral mounds (E-CM) overlie the Cretaceous substrate. These mounds are onlapped by planktonic and spiculitc wackestone of detritic Scaglia (DS).

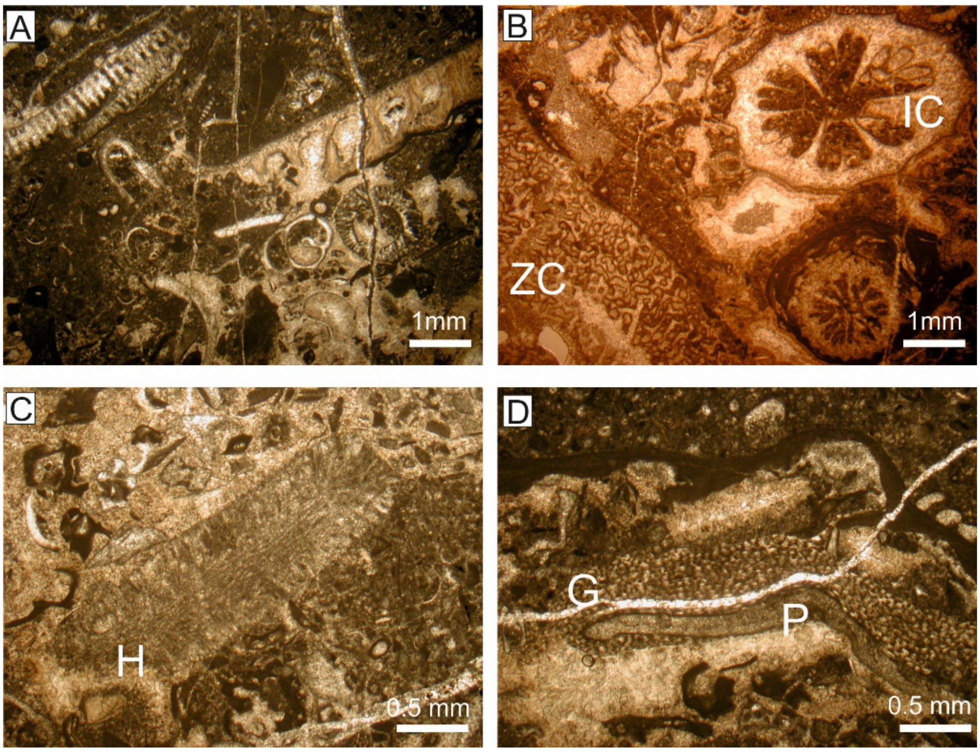

Figure 5. (**A**) Dasycladaleans are common components in the mud-supported matrix of coral mounds; (**B**) detail of coral framestone of mound including z-corals (ZC) and isolated corals (C); (**C**) the green algae assemblage of the coral mound includes also halimedaceans (H); (**D**) different encrusting biota characterize the coral mound, between these encrusting foraminifers (*Gypsina*) (G) formed a hooked form developing on peyssonnelliaceans (P).

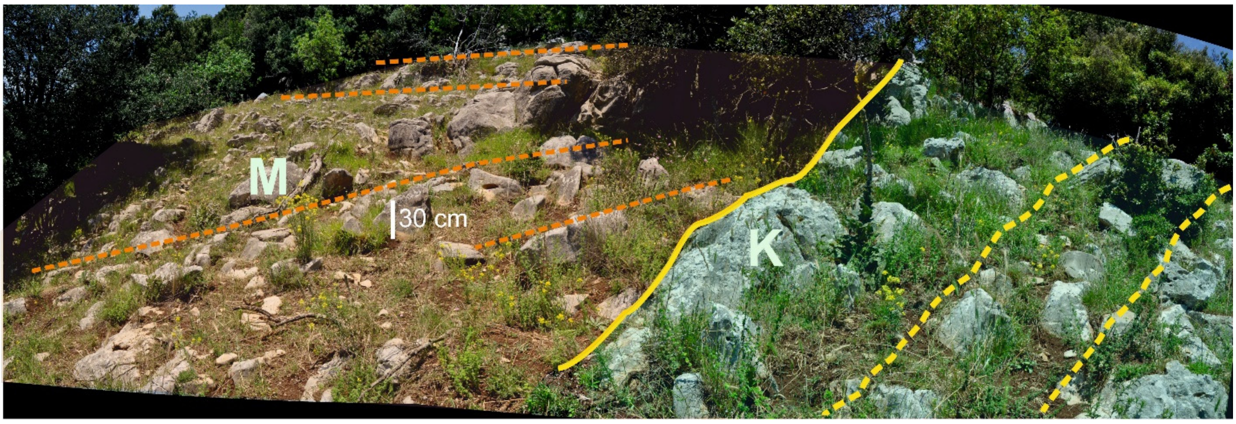

Figure 6. In the easternmost outcrop of South Western Prenestini, the Miocene carbonates (M) lie in onlap on the Cretaceous substrate (K) represented by Cenomanian obitolinids-rich grainstones.

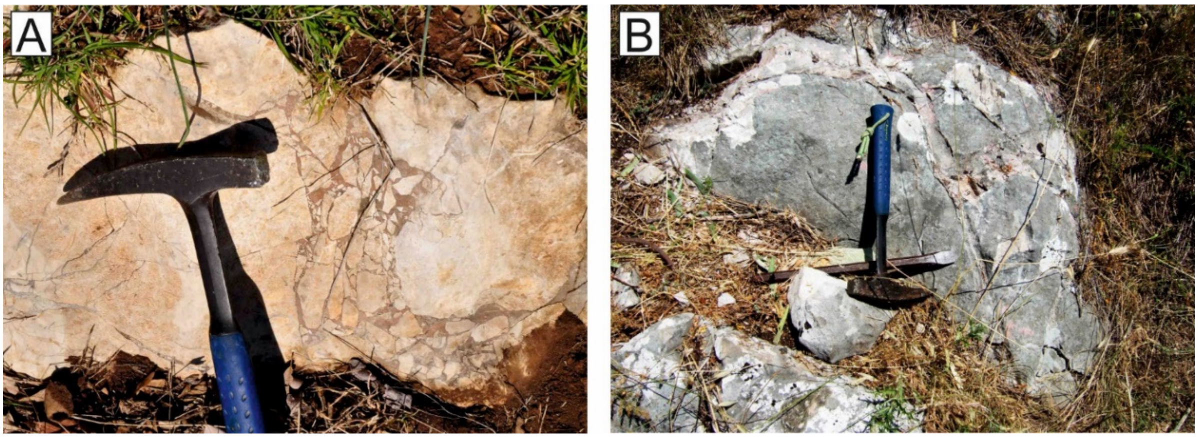

Figure 7. (**A**) The Cretaceous unconformity in the eastern sectors of South Western Prenestini (Colle Pompeo outcrop) shows karst features represented by breccias and red soil infilling fractures; (**B**) detail of pelagites infilling fractures developed on the Cretaceous platform substrate in the South Eastern Prenestini.

In the South Eastern Prenestini sector (Figure 1B), carbonate platform sedimentation is represented by skeletal orbitolinid grainstones alternating with skeletal wackestones, and in the easternmost area of this sector, with rudist and coral rudstones. Pelagites with ages ranging between Campanian to Rupelian rest paraconformably on top of the Cretaceous carbonate platform limestones [57] and occur also in cavities and fractures (Figure 3G,H, Figures 7B and 8). The age of the Cretaceous platform substrate is progressively younger moving toward the east: Turonian-to-Santonian in the eastern sector, Cenomanian in the central area, and Aptian-to-Albian in the western sector (Figure 1B). In the southernmost sector of this area, breccia intervals, with clasts of the Cretaceous platform limestone and of the Scaglia Fms, up to 3 m thick, are overlain by spongolitic marls and marly limestones of the Miocene Guadagnolo Fm. The Guadagnolo Fm is here represented by a 20 m-thick interval of alternating greenish to reddish marly limestones (bioclastic wackestones), conglomerate beds and cross-bedded bioclastic calcarenites (packstones). Sponge spicules and planktonic foraminifers are the main components of the bioclastic wackestone. The lithoclasts of the conglomerates are represented by glauconitized pelagites and Cretaceous carbonate platform limestones. The bioclastic calcarenites are dominated by a skeletal debris where larger benthic foraminifers (*Nephrolepidina*, *Miogypsina*, *Amphistegina*), echinoids, molluscs, and bryozoans are recognizable. The following 90 m are represented by cross-bedded calcarenites. From a textural point of view, they can be defined as packstones to grainstones, with a skeletal assemblage dominated by bryozoans, echinoids, mollusc fragments, and small benthic foraminifers.

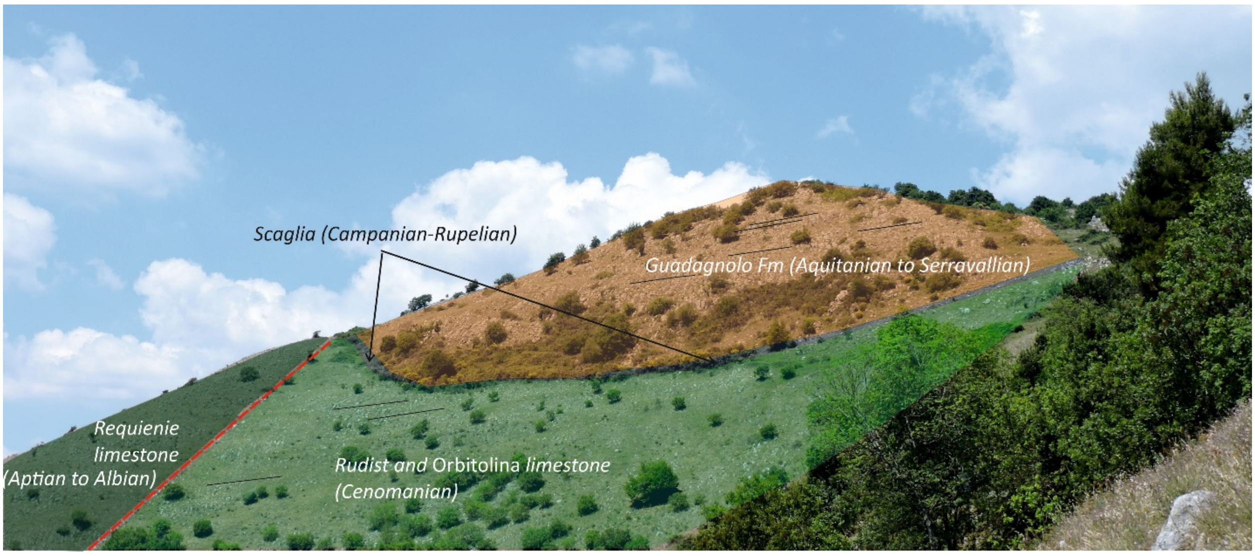

Figure 8. Panoramic view of Punta S. Egidio showing Scaglia Fm paraconformably resting on top of the Cretaceous carbonate platform.

Lastly, in the North Eastern Prenestini, the Guadagnolo Fm lies on the Cenozoic pelagic deposits represented by the detritic Scaglia.

5. Discussion

The Latium-Abruzzi marginal domain in the Southern Prenestini appears to be differentially articulated in two main sectors, respectively, South Western and South Eastern Prenestini, delimited by roughly N–S oriented striking faults, as already presented by Bollati et al. [55], and characterized by different ages of the pre-Miocene substrate and by a general stratigraphic architecture. The two sectors can be considered as two main fault-block platforms developed towards the basin, west of the large Latium-Abruzzi Platform domain. The fault-block platform concept is strictly connected to extensional basins [4,61] where shallow carbonate deposition commonly starts when fault-generated topography and eustatic sea-level changes begin to control sedimentation [4]. Tilt-block carbonate platforms have been described in the Miocene extensional setting of the Red Sea, e.g., [62], SE Asia, e.g., [63], Sardinia [64,65], in the Jurassic and Cretaceous deposits of Spain and Italy [66–68], and in the Triassic of Dolomites [69]. In contrast, the main mechanisms causing the drowning and demise of carbonate platforms are sea-level rises [70], tectonic processes [4,66,67,71–74], environmental deterioration connected with upwelling currents or nutrients input [75–78].

The Prenestini fault-block platforms show a different stratigraphic architecture and tectonic arrangement. The southwestern platform developed on a tilted fault-block. Laterally extensive outcrops reveal tectono-sedimentary features distinctive of block-tilting in the different margins of the fault-block. In this fault-block platform, the age of the Cretaceous carbonate platform deposits is younger moving westward, passing from Cenomanian in the east to Maastrichtian in the west. Phases of shallow water sedimentation occurred also during Paleocene and middle Eocene in the western outcrops producing the mound-shaped coral units. This stratigraphic relationship evidences a general westward tilting not appreciable at the outcrop scale. This tilting produced additional accommodation space for the accumulation of the Paleogene conglomerates and of the Chattian to Aquitanian larger benthic foraminiferal calcarenites representing redeposited sediment through gravity flow. These deposits are absent in the eastern portion of the southwestern platform. Furthermore, in the east, the change in Miocene strata termination from onlap to paraconformity, at the top of Colle Pompeo structure, evidences a preserved portion of paleoescarpment. In the South East Prenestini platform, the Paleogene interval is represented mainly by pelagites and the Neogene deposits of the Guadagnolo Fm. lie paraconfomably above the Cretaceous substrate (Figure 8). In this platform, the Cretaceous substrate is progressively younger moving toward the east. Tavani et al. [56] proposed a tectonostratigraphic evolution of this platform. After deposition of shallow water carbonates during the Santonian, N–S striking, east dipping faults developed in response to regional E–W oriented stretching, followed by subaerial exposure of the carbonate platform and then by pelagic sedimentation from Campanian until the end of Eocene. A subsequent Eocene-to-Early Miocene erosion phase occurred as indicated by the fact that this pelagic formation remains preserved only in small, topographically depressed areas or in karst cavities, and the overlying units frequently directly rest on top of carbonate platform sediments. The age of the two platforms substrate indicates the presence of a Cretaceous extensional stage that produced the two fault-block platforms. The existence of a middle-to-late Cretaceous extensional stage in the Apennines was proposed long time ago, e.g., [52,79,80] and now definitely recognized [51,56,57,81–83]. More recently, a prolonged extensional phase occurring between the Albian and Eocene, associated also with anorogenic magmatism in the southern Adria domain, has been proposed by Vitale et al. [84]. According to these authors, this extensional tectonic is the result of a rifting episode starting in the Albian and reaching its climax in the Eocene times. The extensional tectonic extended toward the south of Adria Domain, from the southern margin of the Ligurian Ocean to the Hyblean, Pelagian, and Sirte Basin Province Rift. This tectonic activity could have a control on the evolution of the Latium-Abruzzi platform margin. The stratigraphic reconstruction testifies that the younger Cretaceous deposits characterize the west portion of South Western Prenestini platform (toward the basinal area) and the eastern part of South Eastern Prenestini platform (toward the LA platform domain). Consequently, the Cretaceous extensional tectonic produced the detachment of the two fault-block platforms from the LA platform marginal domain. The two platforms underwent a general fate, the drowning at the end of the Cretaceous, as testified by the Campanian pelagites, until the Aquitanian, when spongolitic marls of the Guadagnolo Fm were deposited (Figure 9). However, the sedimentary record of South Eastern Prenestini contains more phases. The presence of karst features on the Cenomanian interval in the eastern portion of South Western Prenestini indicates a phase of emersion before the Campanian drowning, while in the western portion the shallow water sedimentation continued until the end of the Cretaceous and recovered partially also in the Paleogene, producing the bioclastic mounds (Figure 10). These are overlaid by spongolitic marls of the Guadagnolo Fm, while in the east the bioclastic calcarenite of this formation directly onlapped the Cretaceous paleoescarpment and lies paraconformably on its top.

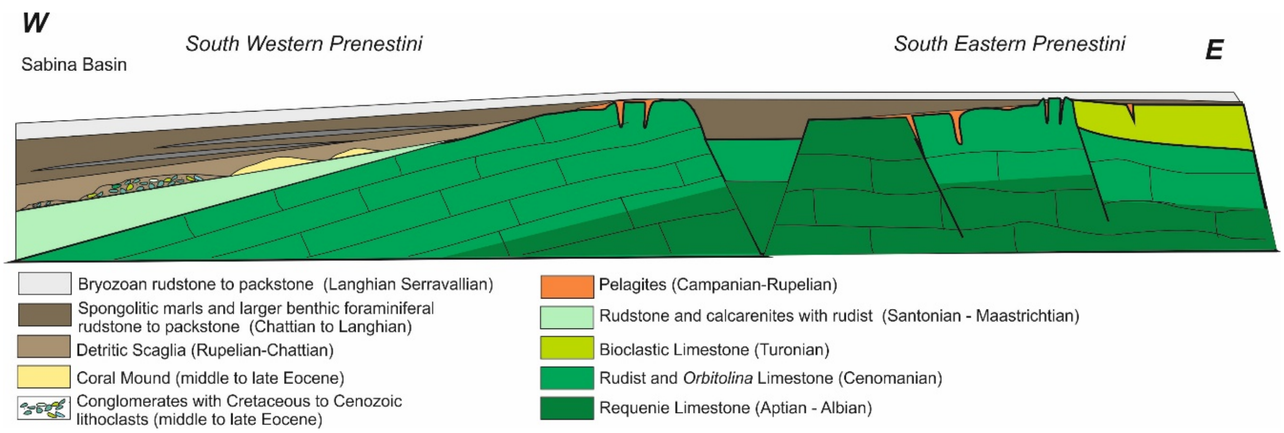

Figure 9. Schematic tectono-stratigraphic architecture of the Prenestini fault-block platforms. See text for details.

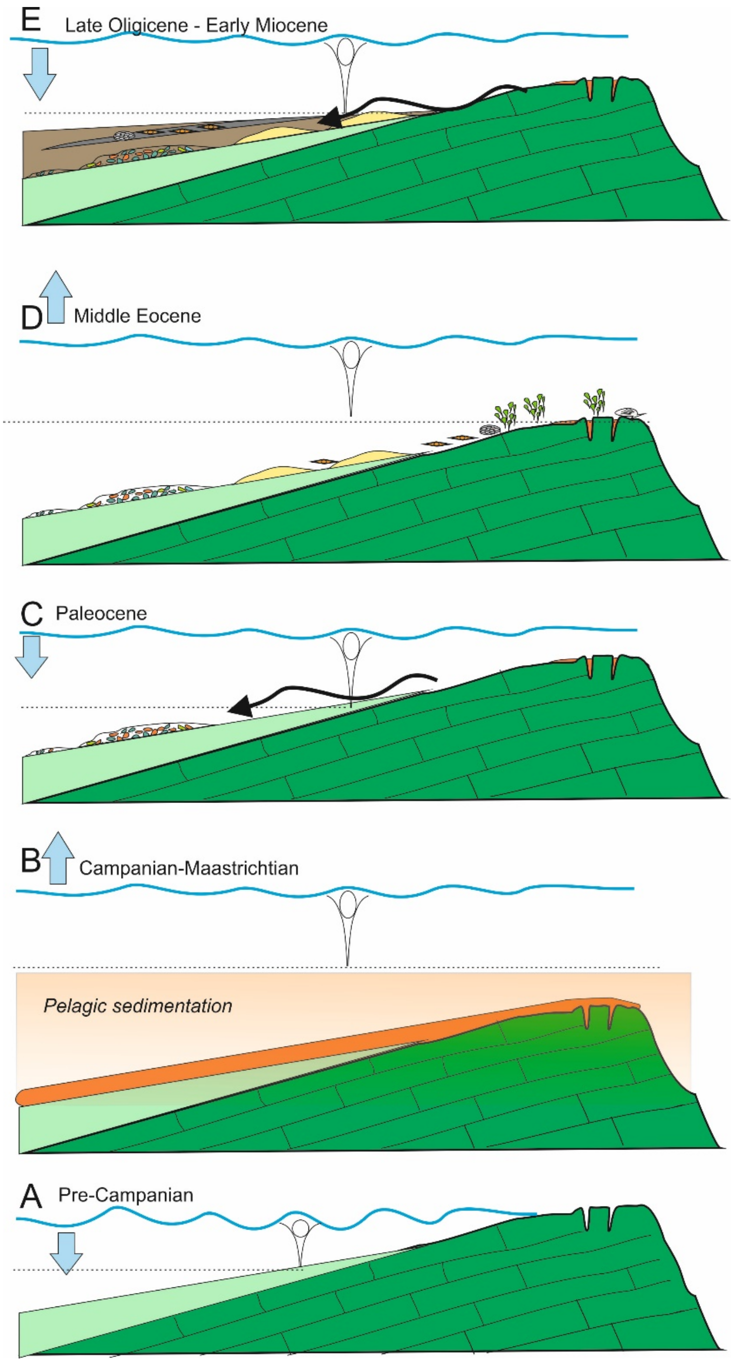

Figure 10. (**A**) Schematic reconstruction of the South Western Prenestini fault-block platform. After a phase of subaerial exposure, the eastern-most sector of the fault-block platform was a shaved platform exposed to the wave action. (**B**,**D**) The sedimentation on the platform took place during transgressive and sea-level highstand phases, (**C**,**E**) whereas in the following lowstand, sediment was eroded as the seafloor came into the zone of wave abrasion. These sediments were shed into the western side of the fault block platform to form detrital intercalations.

In this paleogeographic context, the Guadagnolo Fm represents the recovery of carbonate sedimentation on the drowned fault-block platforms, and the development of a homoclinal ramp [54,85]. This reconstruction has two implications. At the end of the Oligocene, the Guadagnolo ramp development suggests that the indent and articulation of the substrate in the two fault-block platforms had to be limited to host the skeletal carbonate production and accumulation, to allow the development of a ramp profile. The second implication is that the Guadagnolo Fm represents an isolated ramp, detached from the large Latium-Abruzzi platform domain where the coeval Miocene carbonate sedimentation is represented by the Bryozoan and *Lithothamnion* Limestone Fm [34,85].

However, before the instauration of the Guadagnolo Fm, the evolution of the Prenestini fault-block platforms, the carbonate production, and sedimentation took place in very different sedimentary conditions ranging from pelagic to continental settings (Figure 10). Evidence of exposure of the platforms ended during the Cretaceous (Figure 10A) and the definitive drowning of Cretaceous platform occurred in the Campanian. The pelagites infilling the ponds, cavities, fractures and, more in general, forming the neptyunian dykes, obviously accumulated during main relative sea level rise that created pelagic conditions from Maastrichtian to the Rupelian (Figure 10B). Evidence of the paleokarst is limited to breccias and red sediment, representing an epikarst, while evidence of vadose or phreatic zones are not recorded in the area as well as in all the Latium-Abruzzi platform domain [27]. In general, these neptunian dykes developed on fractures, implying a repeated extensional brittle fracturing of lithified Cretaceous platform carbonates, c.f., [86]. From the Paleocene to the Eocene, during lowstand phases, the seafloor, represented by the Cretaceous carbonates, falls within the zone of wave abrasion (Figure 10C). The sediment produced in such settings is either swept away or is lodged in local depressions like in Rocca di Cave outcrop of the South Eastern Prenestini platform or in the fractures forming the neptunian dykes or, more typically, is moved seaward to accumulate in the depressions. The erosion of the fractured substrate can also produce the conglomerate deposits characterized by the coexistence of lithoclasts made up of pelagites and Cretaceous carbonate platform limestone. The middle Eocene mounds represent the remainder of episodes of shallow carbonate production. These mounds deposited in a low-energy environment. This facies contains green algae and seagrass-related bioclasts placing the site in meso-euphotic conditions at a relatively shallow depth, but below the base of wave action. Additionally, the Chattian to Aquitanian bioclastic deposits dominated by LBF started with epiphytic elements, suggesting the episodic instauration of a shallow-water carbonate factory followed by a lowstand stage, during which the seafloor came in the wave base zone and the bioclastic accumulation interrupted and the previously accumulated sediment was reworked in the depressed zones (Figure 10E).

Lastly, the transgressive Guadagnolo Fm roughly smoothed the antecedent articulated palaetopography. The Miocene transgression is almost always marked by detrital glauconite grains probably deriving from hardgrounds developed due to very low sedimentation rates during the Chattian-Aquitanian sea level rise.

6. Conclusions

The Late Cretaceous extensional stage in the Apennines had a clear control on the evolution of the Latium-Abruzzi platform margin. In the southern Sabina domain, two main sectors are represented by two main fault-block platforms, respectively, South Eastern Prenestini and South Western Prenestini, developed to the West of the large Latium-Abruzzi Platform domain.

The South Western Prenestini platform is characterized by a westward tilting and, in the west Upper Cretaceous platform, carbonates are overlain by Paleogene conglomerates and Chattian to Aquitanian larger benthic foraminiferal calcarenites, followed by Lower Miocene deposits of the Guadagnolo Fm. Conversely, in the eastern sector, these deposits unconformably lie directly on Cenomanian platform carbonates, characterized by Maastrichtian to upper Eocene pelagites ponds and neptunian dykes.

In the South Eastern Prenestini these pelagites and the Neogene deposits of the Guadagnolo Fm lie paraconformably above the Cretaceous carbonate platform substrate, that is affected by N–S striking east dipping faults developed in response to regional E–W oriented Late Cretaceous extensional tectonics.

The Cretaceous extensional tectonic produced the detachment of the two fault-block platforms from the Latium-Abruzzi platform marginal domain. In these platforms, from the

Paleocene to the Eocene, the pelagites deposited during main relative sea level rise, whereas during phases of lowstand the seafloor, consisting of the Cretaceous carbonates, was in the wave abrasion zone. The pelagic sediment produced in such setting was swept away and lodged in local depressions or fractures, while the coarse sediment produced by the erosion of fractured substrate accumulated as polygenic conglomerates on the Cretaceuos carbonate platform substrate. Lastly, the Chattian to Aquitanian Larger Benthic foraminiferal-rich carbonates suggest phases of shallow water carbonate factory activity followed by erosion during subsequent lowstands.

During the Early Miocene, an isolated homoclinal ramp, represented by the Guadagnolo Fm, developed on the drowned fault-block platforms, suggesting that the indented substrate of the two fault-block platforms had to be limited to host the skeletal carbonate production and accumulation to allow the development of a ramp profile.

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