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ORIGINAL ARTICLE

Vertical transition from ramp to rimmed shelf: example of the Turonian carbonate platforms in Central Tunisia

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Abstract

The Gattar and Bireno carbonate platforms developed in Central Tunisia during early and middle Turonian, respectively. Most previous geological works consider these carbonate platforms as rimmed shelves, that developed up on a substratum arranged into a series of blocks bounded by major E–W faults. The present work aims through field observation and facies record microscopic analysis to show that the Gattar platform was not a rimmed platform as mentioned in previous works but it rather matches with a homoclinal ramp whereas the Bireno platform consists of a proper rimmed shelf. Based on the sequence stratigraphy principles, it will be shown that each of these two platforms is made of a carbonate succession that developed during the highstand of a third order eustatic cycle. The Gattar carbonate ramp is overlain by the Annaba member marls that accumulated during the following trangressive cycle. On the top of the marls accumulations, the Bireno platform rudist shoal occured during the following highstand separating between an outer shelf to the north and an inner shelf to the south. The vertical transition from the Gattar ramp to the Bireno rimmed shelf seems to have been most controlled by sea-level changes and local paleotopography rather than the play of active faults and resulting tilted blocks, as reported in the previous works.

Keywords Homoclinal ramp · Shoal rimmed platform · Vertical transition · Sealevel · Turonian · Central Tunisia

Introduction

Many geological works are focused on carbonate platforms description and analyses. Nevertheless, there are still some major uncertainties about the role of the controlling factors on the development of depositional environments and facies distribution of deposits. Hence, the classification of carbonate platforms remains controversial.

Changes in the accommodation space, which are controlled by sea-level variation, subsidence and sediment supply, are the most important factors controlling the facies variation and strata architecture in carbonate platforms (Vail et al. 1991; Posamentier and James 1993). Defined as the space available for potential sediments (Jervey 1988), accommodation is mostly driven by sea-level variations and subsidence (Pomar et al. 2005).

During the upper Cretaceous, Central Tunisia was located on the southern passive margin of the Tethys Ocean, where carbonate platforms such as the Gattar [early Turonian (Razgallah et al. 1994), late Cenomanian-early Turonian (Zaghbib-Turki 2003)] and Bireno [middle Turonian (Burollet 1956; Fournié, 1978)] members developed. Both the Gattar and Bireno platforms are previously considered as rimmed platforms, marked by the development of rudistids communities on their northern edges (Bismuth et al. 1982; Razgallah et al. 1994; Touir and Soussi 2003).

According to several authors working in Central Tunisia, these platforms developed on a substratum, which was fragmented by NW–SE to E–W orientated major faults (e.g., Gafsa, Kasserine, and M'rhilla faults) into blocks which were downstepping toward the north while being tilted toward the south (Fig. 1). This tectono-structural framework is known as "tilted blocks model" (Bismuth et al. 1982; Boltenhagen 1985a, b; Chili et al. 1992).

To reconstruct the spatio-temporal evolution of the Gattar and Bireno platforms especially to know how

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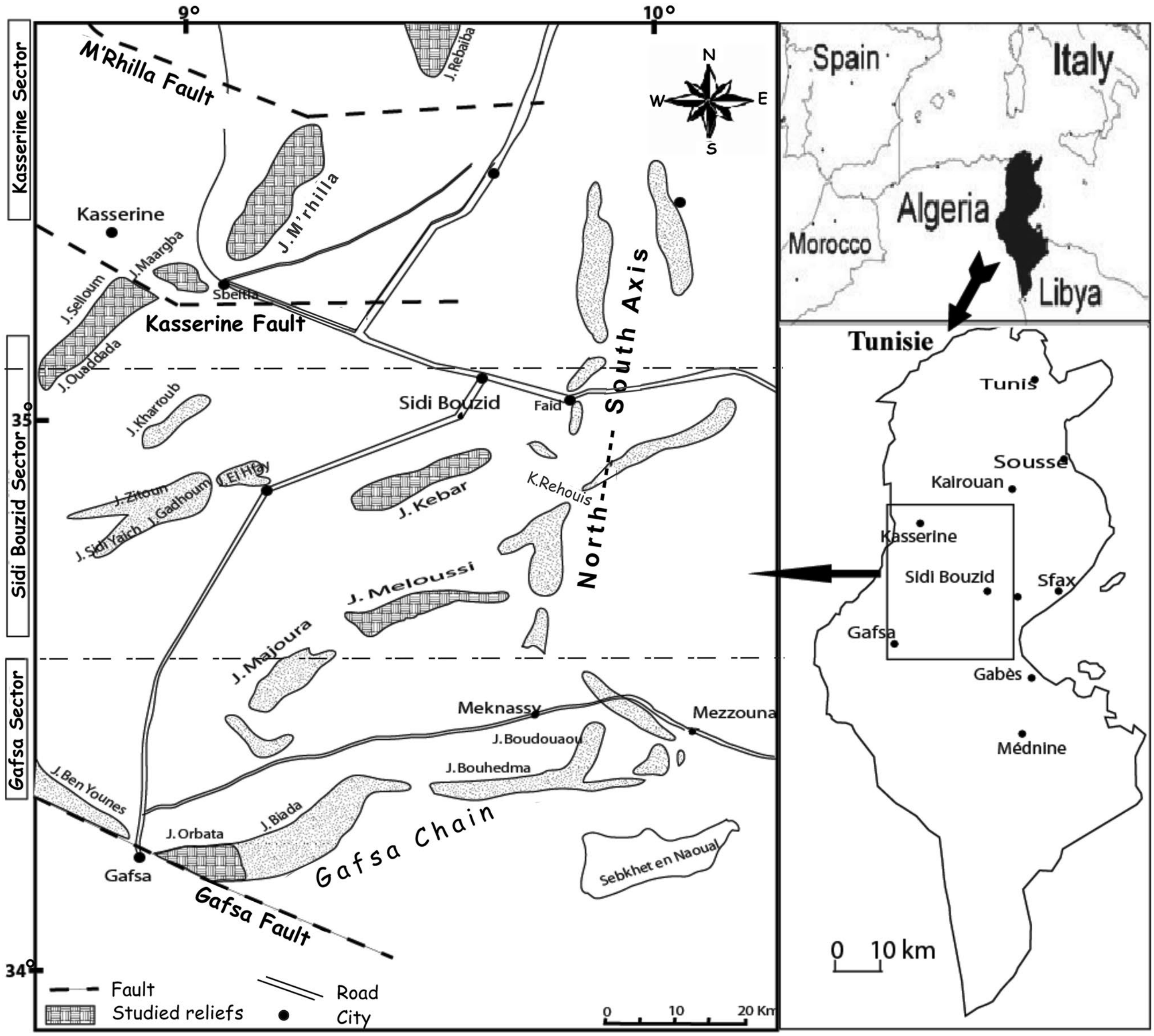

Fig. 1 Location map of the studied outcrops

the Gattar platform developed vertically into the Bireno platform many outcrops in Central Tunisia are studied especially through geological sectors achieved in Jebel M'rhilla, Jebel Kebar and Jebel Orbata (Fig. 1). In addition to the field observation, the depositional facies and thickness distribution through these two carbonate platforms are examined, taking into account different concepts of carbonate platforms such as homoclinal ramps, rimmed shelves (Pomar 2001; Bahamonde et al. 2004; Bosence 2005; Luca Basilone et al. 2016) and sequence stratigraphy carbonate successions (Sarg 1988; Hanford and Louks 1993; Pittet et al. 2000).

The present work aims to: (1) characterize the sedimentary record of the Gattar and Bireno carbonate platforms, (2) reconstruct their depositional environments, (3) compare the studied platforms with the platform models as reported in the literature show that Gattar platform was a homoclinal ramp and, (4) discuss the transition from the Gattar carbonate ramp to Bireno rimmed platform and their controlling factors.

Geological setting

Central Tunisia shows several folded structures forming the so called Central Tunisian Atlas. It shows several anticlinals, the cores of which are generally made of lower Cretaceous rocks, whereas their rims are composed of upper Cretaceous to Neogene sediments. Central Tunisia is cut by E–W, NE–SW and

NW–SE trending faults, particularly those named the Gafsa, Kasserine and M'rhilla faults (Fig. 1) (Bismuth et al. 1981; Chihi and Ben Ayed 1987). The NW–SE trending faults in particular were active during Late Cretaceous and cut up Central Tunisia into a series of blocks downstepping northward while being tilted southward known as "tilted blocks structure", and the latteris largely adopted by several geological works in Tunisia. (Bismuth et al. 1982; Chihi et al. 1987; Boltenhagen 1985a, b; Boukadi et al. 1990; Ben Ayed 1993).

Previous sedimentological studies of Central Tunisia outcrops show that the Gattar member (Early Turonian) (Razgallah et al. 1994; Abdallah et al. 1997) and the Bireno member (early-middle Turonian) (Touir et al. 1989; Troudi 1997; Jomaa Salmouna et al. 2014) are carbonate platforms. Paleogeographic maps of these two platforms (Touir and Soussi 2003; Touir 2009) show significant changes in deposit facies and thickness distributions related to depositional environment variation, from southern to northern Central Tunisia.

In the present work, we subdivide the study region into three areas, based on facies distribution and paleogeographic setting of the studied platforms. These three areas are from south to north: Gafsa area, Sidi Bouzid area, and Kasserine area (Fig. 1).

According to our field observations and previous works (Burollet 1956; Touir and Soussi 2003), the studied platforms are stratigraphically arranged from bottom to top as following:

a. The Gattar platform corresponds to the Gattar member (Early Turonian), it is formed by a carbonate succession.
b. The Annaba member (early to middle Turonian) is composed of fossiliferous marls at the bottom and interbeds of marls and limestone at the top. It occured in Kasserine area, it is relayed laterally by solution breccias and paleosoils in Sidi Bouzid area and by anhydrites in Gafsa area (Burollet 1956; Fournié, 1978; Bottenhagen 1981).
c. The Bireno platform corresponds to the Bireno member (Middle Turonian), it consists of a rudist-bearing carbonate succession in Kasserine area that grades laterally into solution breccias in Sidi Bouzid area, and anhydrites with thin laminated dolomitic intercalations in Gafsa area (Touir et al. 2009).

Methods

The present study is based on field examination of outcrops representing the studied platforms in different areas in Central Tunisia (Fig. 1). From South to North studied areas, seven geological sections have been surveyed, and thin sections are cut in the carbonate levels and observed under photonoc microscope. The field and microscopic observations of the rocks led us to describe deposits facies and reconstruct the depositional environments. The sequence stratigraphy of the studied carbonate platforms is based on the vertical change in deposits facies, especially carbonate facies, and the presence of unconformities surfaces taking into account the sequence stratigraphy principles of Vail et al. (1977), Vail (1991), Sarg (1988) and Haq et al. (1988). The establishment of the development model of the Gattar and Bireno carbonate platforms is discussed both from the data of the present work and from the bibliographic well-known platform models (Pomar 2001; Bosence 2005).

Results

Gattar carbonate platform

Lithofacies description (Figs. 2 and 3)

The Gattar platform consists of a carbonate succession that extends for more than 300 km from the Tunisian Dahar (Saharan craton, Southern Tunisia) to the Kasserine area (Central north Tunisia) (Fournié 1978; Bottenhagen 1981; Touir and Soussi 2003). Both facies and thickness of the Gattar platform deposits are varying from South to North.

Indeed, in the Gafsa area (e.g., Jebel Orbata, Oued Zannouch section) (Fig. 2), the Gattar platform consists of an almost 90-m-thick dolomitic limestone succession, which is composed of two units. The lower unit, up to 40-m-thick, consists of rudistids (radiolitids) biostromes (Fig. 4B) associated to rudist debris-rich floatstone. The upper unit (50 m) corresponds to a succession of dolomitic limestone showing microbialites. It consists of ostracod-rich wackestone with bird eyes (Pl. 1).

In Sidi Bouzid area (i.e., Jebel Kebar, Jebel Boudouaou, Jebel Melloussi) (Fig. 2), the thickness of the carbonate platform falls from 65 m to the South to 40 m to the North of this area. The Gattar platform includes at the base a succession of bedded domomtitic bioclastic packestone (Pl. 1). At the top, the platform shows some patches of monospecific rudistids (*Durania arnaudi*) associated to bioclastic packestone with benthic fauna (Gastropods) (Pl. 1).

The Gattar platform becomes thinner (17 m) towards the Kasserine area (i.e., Jebel Ouaddada, Jebel Selloum) (Fig. 2) in comparison with that observed in the previous areas (Fig. 2). It shows in the lower part a fine-grained limestone succession including benthic fauna (lamellibranches, rudists,…) (Pl. 1), associated with scarce ammonites (*Thomasites rollandi* TH. Et PERV.). In the upper part, the limestone shows oysters… Farther North, in Jebel M'rhilla area (Fig. 2), the Gattar carbonate platform is reduced to only 2-m-thick carbonate succession including bioclastic

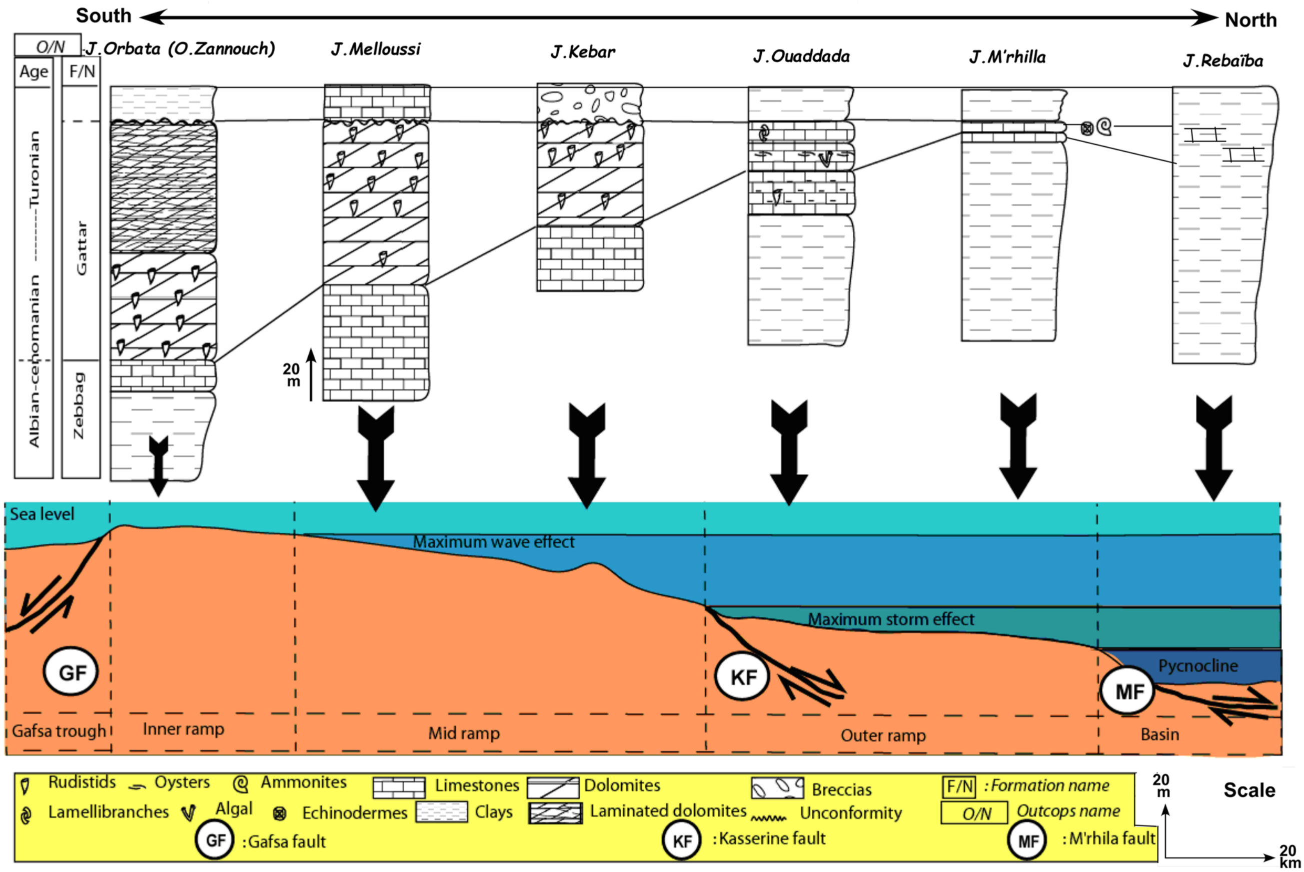

Fig. 2 South-North correlation of the Gattar ramp (Early Turonian) in Central Tunisia, and interpretative reconstitution of the ramp

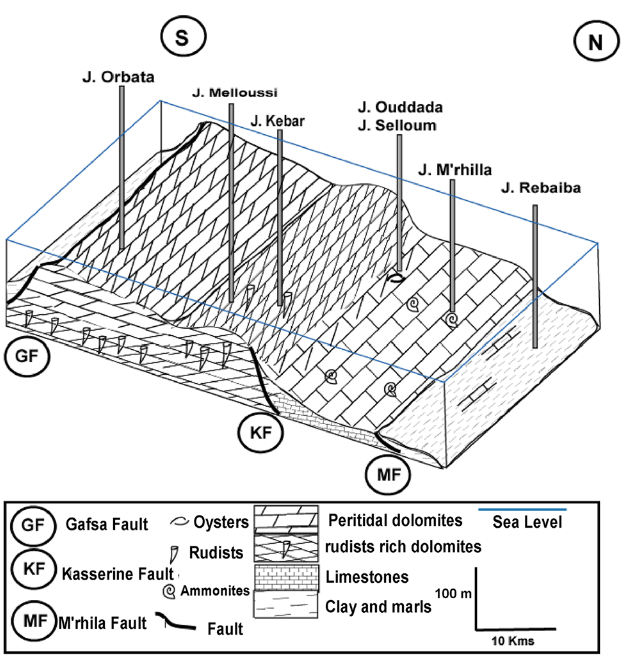

Fig. 3 3D sedimentary model of the Gattar ramp during the earliest Turonian. Note the variations in deposits facies and thickness distribution

wakcestone with echinoids, ammonites (*Mortoniceras* et *Phylloceras*), and benthic and planktic foraminifera (thomasinelles, Lenticulines, *Dentalina, Tristix)* (Pl. 1). The carbonates disappear North of Jebel M'rhilla (Jebel Rebaïba) and is relayed by hemipelagic marls with thin argillaceous carbonate intercalations.

Interpretation

The deposit facies and thickness distribution of the Gattar platform vary from South to North indicating a significant northward deepening of the depositional environment (Boltenhagen 1981; Touir and Soussi 2003). As a matter of fact, the Gattar platform shows a progressive thinning of the carbonate deposits which in addition become from South to North finer and richer in pelagic organisms (Fig. 2). Based on the platform models of Read (1982) and Pomar (2001), such a spatial variation of deposit facies and thickness of carbonates is rather consistent with a homoclinal ramp (Fig. 3) than with a rimmed platform, as previously reported in many studies carried out in Central Tunisia (Bismuth et al. 1982; Razgallah et al. 1994; Touir and Soussi 2003).

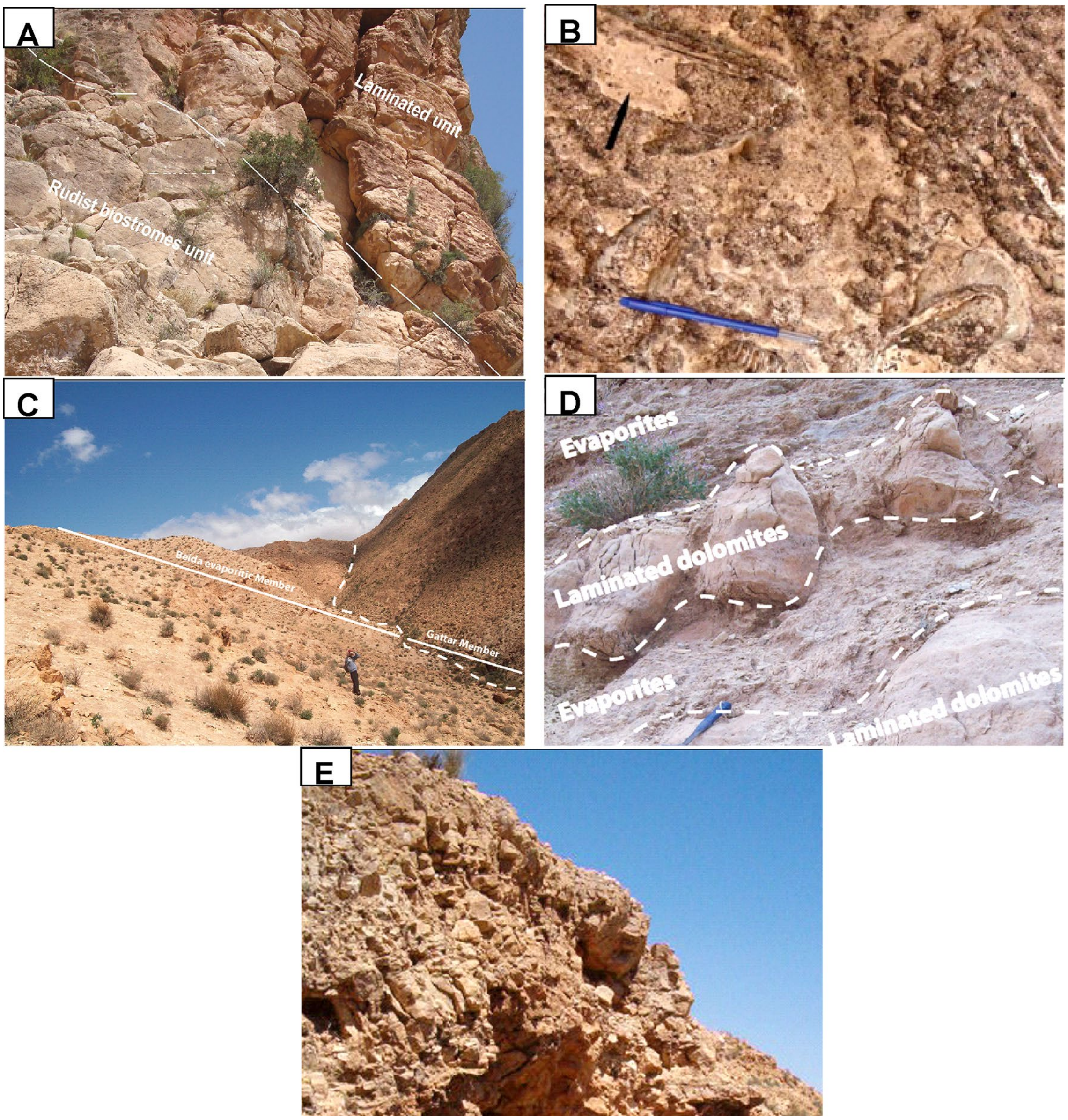

Fig. 4 Field views from the study area **A** Gattar ramp (Jebel Orbata,Gafsa area) showing a lower dolomitic unit with rudistids (radiolitids) biostromes, and an upper unit including a succession of peritidal parasequences with microbialites, **B** Gattar lower unit with rudistids (arrow) (Jebel Orbata, Gafsa area), **C** interbedded Anhydrite and dolomite of Beida succession overlying the dolomitic Gattar ramp (Jebel Orbata, Gafsaarea), **D** evaporites and laminated dolomites intercalations (Jebel Orbata, Gafsa area), **E** details of the Rouana member solution breccias overlying the Gattar member in Jebel Kebar (Sidi Bouzid area)

According to the vertical change of the deposits facies, taking into account the work of Touir and Soussi (2003), the Gattar carbonate ramp can be vertically subdivided into a highstand systems tract overlain by forced regressive parasequences (sensu Hunt and Tucker 1992) of a third order depositional sequence which are correlative with the UZA.2–5 global eustatic cycle of Haq et al. (1987). The Gattar platform is capped by a subaerial exposure surface correlative with SB-91 Ma unconformity of Haq et al. (1987), as well as with the long-term boundary kTu4 of Haq (2013).

In the Gafsa area, the highstand systems tract corresponds to the rudistid-bearing succession that indicates a shallow marine euphotic environment exposed to marine currents in accordance with Gili et al. (1995). The Gattar platform ends with a shallowing up peritidal carbonate succession showing microbialites. The latter are arranged into a succession of peritidal parasequences indicating a restricted shallow marine environment. Such features are convenient with a forced regressive systems tract or an upper highstand systems tract (Van Wagoner et al. 1988; Hunt and Tucker

1992) The Gattar platform ends with the a subaerial exposure surface.

In Sidi Bouzid area, the deposit facies is indicating an open marine deep water environment as indicated by the development of bedded bioclastic limestone with various marine fossils (lamellibranches, gastropods, foraminifera, rudists). The Gattar platform ends with thin bedded limestone with oysters indicating restricted marine environment area.

In Kasserine area, the absence of rudistid biostromes versus the presence of benthic to pelagic fauna indicate an open marine outershelf environment. In another hand, the presence of oysters at the top of the platform suggests a shallowing up of the depositional environment, without emergence of the platform.

The more or less gradual thinning of the carbonate platform from South to North of Central Tunisia that should indicate a carbonate production decrease seems to be related to the progressive disappear from south to north of rudistids bisotroms. In this regard, Skelton (2000) and Sebei (2019) assume that the water deepening should have reduced the growth capacity of rudistids and consequently the growth of the platform.

As for the spatial variation of the deposit facies, it seems that the Gattar platform represents a carbonate ramp, which may be subdivided into inner, mid and outer ramps that correspond respectively to Gafsa, Sidi Bouzid and Kasserine areas. Such spatial distribution of deposit facies through Gattar ramp is common in general to carbonate ramps as reported on several works (Wright and Burchette 1986; Pomar 2001) (Fig. 2). Nevertheless, the Early Turonian Gattar ramp in Central Tunisia shows some proper features compared to the ramp models as reported in the literature:

- In the ramp model of Pomar (2001), conceived for the upper Miocene ramp in Spain, the carbonate ramp covers one third order depositional sequence, whereas the Gattar ramp records only a highstand systems tract with a forced regressive systems tract at the top.
- According to the Pomar ramp model, as well as to other modern ramps described in the Mediterranean Sea (Fornos and Ahr 1997; Ros et al. 1985), the highstand systems tract in the inner ramp shows infratidal deposits, with diversified faunal associations, whereas in the study case the highstand is characterized by peritidal deposits which are rather poor in fauna (microbialites).
- In the Pomar homoclinal ramp model, the ramp slope break marks the transition between mid and outer ramps, where packstone with benthic and accessorly planktic microfauna grades into planktic microfauna-rich wackestone. In the Gattar ramp however, the ramp slope break may be located around the Jebel Selloum and the Jebel Ouaddada (Kasserine area) (Fig. 1), where dolomites with rudistids and microbialites grade northward into limestone showing basically planktic microfauna and ammonites. Considering the paleogegraphy of Central Tunisia, the slope break is clearly more distal (> 100 km) than that in the Pomar model which allows us to classify the Gattar ramp as a "distally steepened ramp" (Burchette and Wright 1992)

Bireno carbonate platform

Lithofacies description

The Bireno carbonate platform occured during the middle Turonian in Central Tunisia. It extends over more than 150 km from the Gafsa area (to the South) to the Kasserine area (to the North) (Bismuth et al. 1981; Touir and Soussi 2003) (Figs. 1, 5), but it is mainly developed and its thickness is the higher in Kasserine area.

In Gafsa area (Jebel Orbata), the Bireno platform includes laminated anhydrite, interbedded with thin beds of laminated dolomites showing microbialites (Fig. 4C, D). The carbonate intercalations show evaporitic nodules associated to birds' eyes and geopetal sediments (Pl.2), such a facies was also mentioned by Boughalmi et al. (2019).

In Sidi Bouzid area (Jebel Kebar, Jebel Rouana) (Fig. 1), the Bireno platform is reduced to a 10-m-thick succession of peritidal parasequences, with intercalations of solution and collapse breccias and anhydrites, called the Rouana member (Khessibi 1978; Touir and Soussi 2003). The platform is capped with continental deposits including palustrine limestones, paleosoils and alluvial conglomerates (Fig. 4E).

In North Central Tunisia, in Kasserine area (Jebel M'rhilla, Jebel Ksar Tlili,and Jebel Bireno), the Bireno platform, consists of a 15–20-m-thick succession of interbedded massive dolostones and limestones showing rudistid biostromes (*Hippurites*) (Fig. 7C, D). (Fig. 5) The Bireno platform ends with a 20-m-thick succession of peritidal laminated dolomites showing microbialites which are interbedded with dessiccation breccias (Pl.2). Particularly in Jebel Maargba (Fig. 5), the Bireno platform shows a 15 m unit of dessiccation breccias (Pl.2).

North of M'rhilla fault, in Jebel Rebaïba (Fig. 1), the Bireno platform progressively grades into hemipelagic marls with thin carbonate intercalations called Aleg Formation (Fournié 1978; Boltenhagen 1981; Touir and Soussi 2003).

Interpretation

The variation of deposits facies from south to north of Central Tunisia suggests that the Bireno platform consists of a rimmed carbonate shelf, which shows at its northern margin by a shoal barrier rich in rudistids biostromes (hippuritides) (Saïdi 1997; Troudi 1997, Touir and Soussi 2003). Indeed,

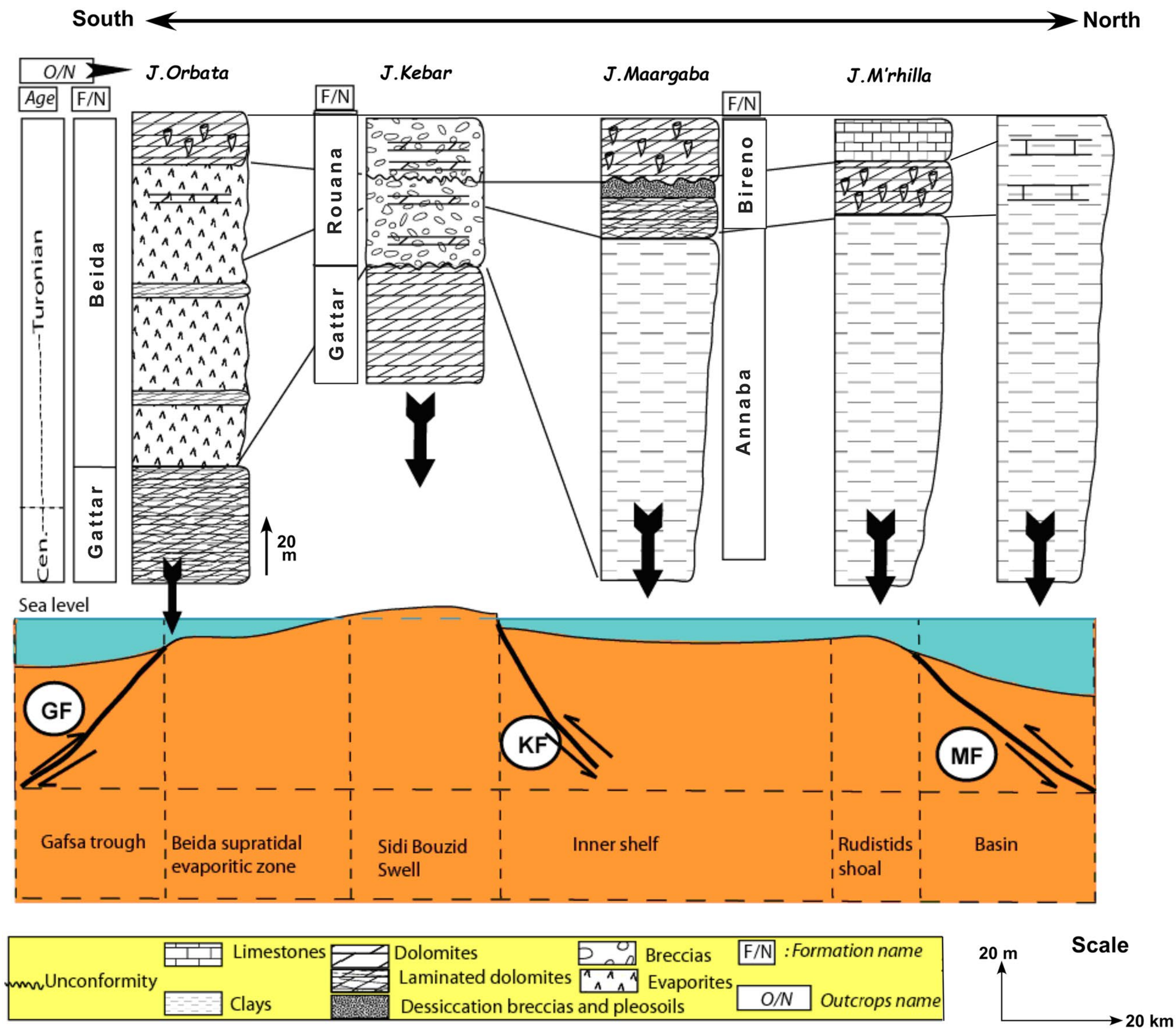

Fig. 5 South–North correlation of the Bireno platform (middle Turonian) in Central Tunisia, and interpretative reconstitution of the rimmed shelf

in Gafsa area, the anhydrites and microbialites indicate a supratidal evaporitic environment. In Sidi Bouzid area, the deposits facies are compatible too with an upper intertidal to evaporitic supratidal environment. The overlying paleosoils indicate long lasting emergence periods of the platform in this area under subaerial exposure conditions. In Kasserine area, the rudistids-rich biostroms are indicating an open-marine outer shelf environment that was interpreted as a shoal barrier by Touir and Soussi (2003). This shoal represents the northern margin of the Bireno platform. In Jebel Maargba, the development of microbialtites and dessication breccias indicates a restricted inner shelf environment developed in a back-shoal setting.

In Sidi Bouzid area, the thinning of the bireno platform and the presence of some palustrine deposits and paleosoils intercalations suggest that a high domain (uplift) would have occurred in this area. Such a high domain (uplift) would have separated during Middle Turonian between the rudist shoal and the intertidal back-shoal zone in the north (Kasserine area) and the large evaporitic supratidal zone in the south (Gafsa area) (Fig. 6).

According to vertical variation of the deposits facies, considering the unconformity surfaces observed in the field, the Bireno platform records the highstand of an eustatic cycle correlative with the UZA.2–6 cycle of Haq et al. (1987). The Bireno platform is capped with a subaerial exposure surface related to a sea level fall which may be correlated with the global SB 90 Ma of Haq et al. (1987) and with the short-term sequence boundary Ktu5 of Haq (2013). This surface is overlain by the middle Turonian transgressive limestone of the Aleg Formation. In this regard, the underlying Annaba marls should represent the transgressive systems tract.

It is worth noting that the middle Turonian Bireno rimmed platform presents some proper features compared to the rimmed platforms models as reported in the literature (Read 1985; Pomar 2001; Wright and Burchette 1986):

- In the bibliographic models, the rimmed inner shelf typically corresponds to a relatively high-energy shallow marine lagoon commonly characterized by packstone-grainstone rich in algae and benthic microfauna. In the Bireno platform, however, the inner shelf includes tidal parasequences and supratidal evaporitic deposits indicating a shallow-water restricted environment.
- As for the width of rimmed platforms, Pomar (2001) consider wide the platforms more than 10 kms with a maximum of 100 km in width. The Bireno platform however is relatively very wide and extends over, more than 150 km from South to North of Central Tunisia. The inner shelf, in particular, covres about 100 km large area.
- By comparison with the Pomar's carbonate rimmed platform model, the Bireno platform show significant deposit facies and thickness variations related to an irregular substratum morphology. As a matter of fact, in Sidi Bouzid area, the inner shelf of Bireno platform is separated from the open marine environment in Kasserine area by an uplift (Touir and Soussi 2003). This high domain (uplift) seems to have controlled the marine water incursions into the evaporitic supratidal zone located in Gafsa area. This water incursion was only possible during high sea level periods, during which seawater was able to overflow the uplift and to flood the evaporitic supratidal domain in Gafsa area. Such likely short-time periods of seawater overflow are recorded by thin laminated dolostones (microbialites). In contrary, during the periods of sea level fall, solution collapse breccias, paleosoils and locally palustrine limestones occurred.

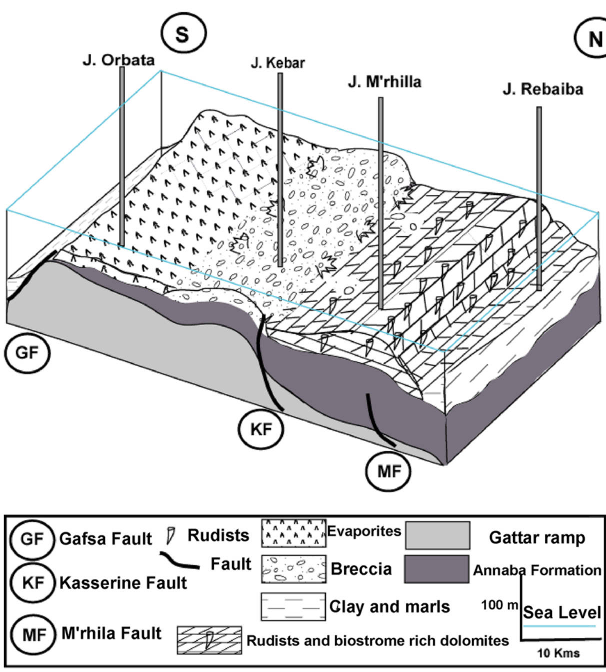

Fig. 6 3D sedimentary model of the Bireno rimmed platform, showing the shoal barrier at the northern platform margin with rudistid biostromes (*Hippurites*) developedon the Annaba marls wedge

Discussion of the vertical transition from the Gattar ramp to the Bireno rimmed platform

The vertical transition from a ramp to a rimmed platform is already discussed by many workers in particular Read (1985) and Pomar (2001). In Pomar's model, the vertical transition is related to changes in ecological parameters during the platform growth. Accordingly, the physical control of the carbonate ramp by sea level change (eustasy) is replaced by a biological control leading to an extensive carbonate production. This production is due to the development of organisms able to build a rimmed platform.

In the study case of Central Tunisia, the vertical transition from the early Turonian Gattar ramp to the middle Turonian Bireno rimmed platform seems to have a different development history compared to the model proposed by Pomar (2001). First, Gattar and Bireno carbonate platforms are not stratigraphically superimposed like that mentioned in the model of Pomar (2001), they are in fact separated by the early Turonian Annaba member marls (Fig. 7A, B). These hemipelagic marls would have filled up the available accommodation space during the transgressive interval of the global eustatic cycle UZA-2.6 (Abdallah 2001; Touir and Soussi 2003).Taking into account the structural framework of Central Tunisia during early Turonian, which was characterized by titled blocks limited by major E–W faults and dowstepping northward (Bismuth et al. 1982; Chihi and Ben Ayed 1987; Kadri and Merzeraud 2015; Jaballah et al. 2020), it seems that the Annaba marls has simultaneously sealed the early Turonian Gattar carbonate ramp and buried the tilted blocks framework and major bordering faults in Central Tunisia. Nevertheless, the Annaba marls are lacking in Sidi Bouzid and Gafsa areas, where they are replaced by collapse breccias and evaporitic layers. The central uplift in Sidi Bouzid area, already mentioned above, would have played as a morphological and paleogeographic barrier between open marine hemiplegic sedimentation to the north and shallow water restricted to evaporitic sedimentation to

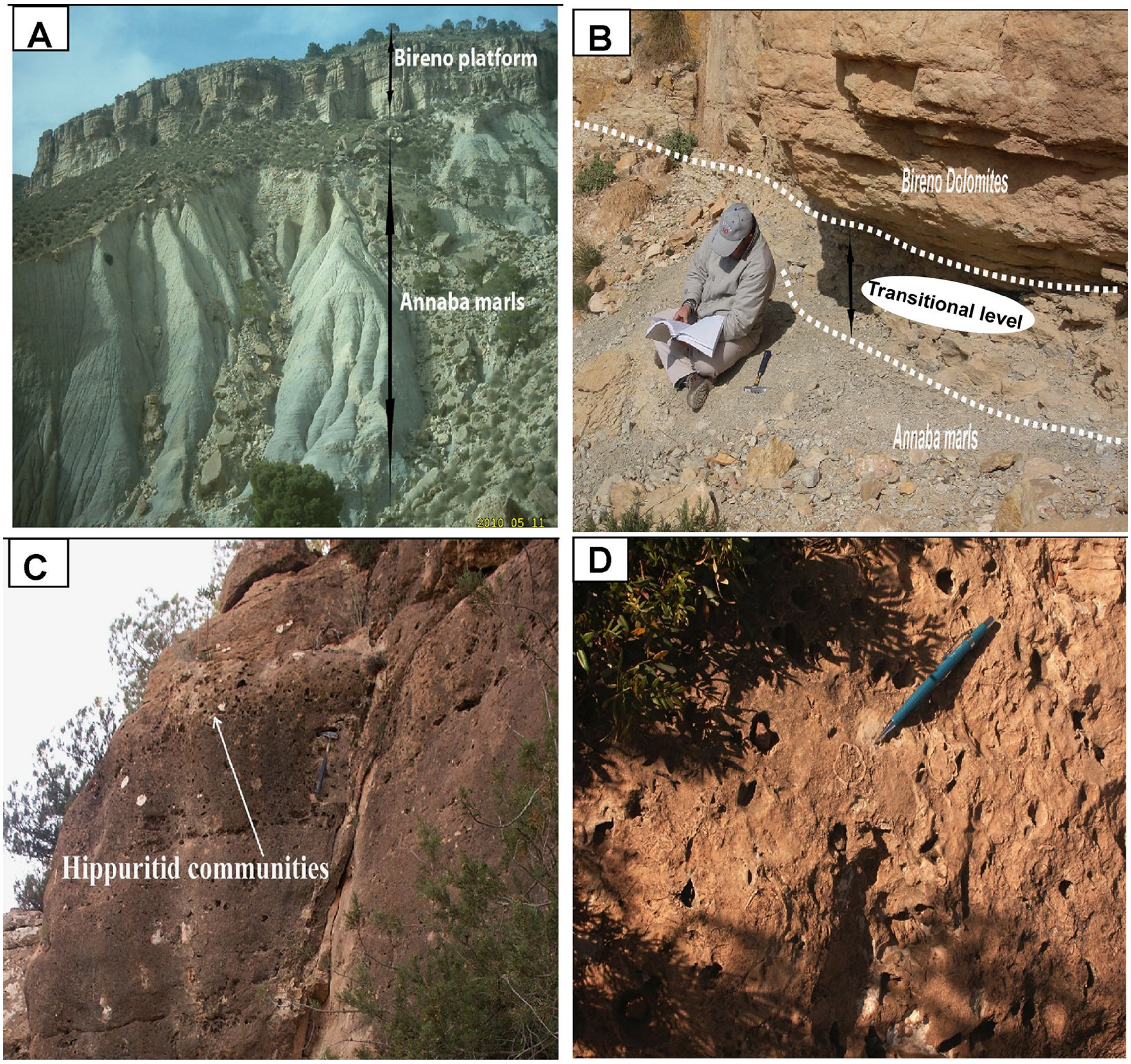

Fig. 7 Field views from the study area (Kasserine area): **A** thick Annaba marly unit covered by the Bireno carbonate platform (Jebel M'rhilla), **B** gradual vertical transition from the Annaba member marls to the Bireno member carbonates (Jebel M'rhilla), **C** rudistids (hippuritids) biostrome in the shoal barrier (Jebel M'rhilla), **D** focus on the surface of the Bireno platform (SB 90.5 Ma) showing dissolved rudistids sections (Jebel M'rhilla)

the south (Fig. 8). Such an assumption is also mentioned by Touir and Soussi (2003).

Accordingly, the progradation of the Annaba marls north of Sidi Bouzid uplift during the early highstand of the UZA-2.6 eustatic cycle (Haq et al. 1987) would have resulted in a wedge-like sedimentary accumulation (Fig. 8). On the top of this marls wedge, which was most likely located in Jebel M'rhilla area, rudistids lithosomes should have occurred giving way to the shoal barrier of the Bireno platform (Negra and Jaballah 2018, 2020). This barrier extended along a NW–SE trend crossing Jebel M'Rhila and Jebel Bireno. This rimmed platform developed during the late highstand, when the slowly sea level rise would have balanced the carbonate production rate (Sarg 1988; Handford and Louks 1993; Pittet 2000).

Thus, as discussed above, it seems that the rudistids barrier of the Bireno platform is not visibly controlled by the tilted blocks framework of Central Tunisia as assumed by Bismuth et al. (1982), Boltenhagen (1985a; b) and Jaballah and Negra (2016). Our findings suggest instead that the development of the rudistids-built barrier during the Middle Turonian was rather related to the presence of the marls wedge of Annaba member. Such a marls wedge provided a submarine high topography upon which rudistid-built barrier developed.

The vertical transition from the ramp to the rimmed platform, in our study case, differs from that of the models of Read (1982) and Pomar (2001). According to these models, the increase of accommodation space related to transgressive interval can modify the faunal and floral associations on the

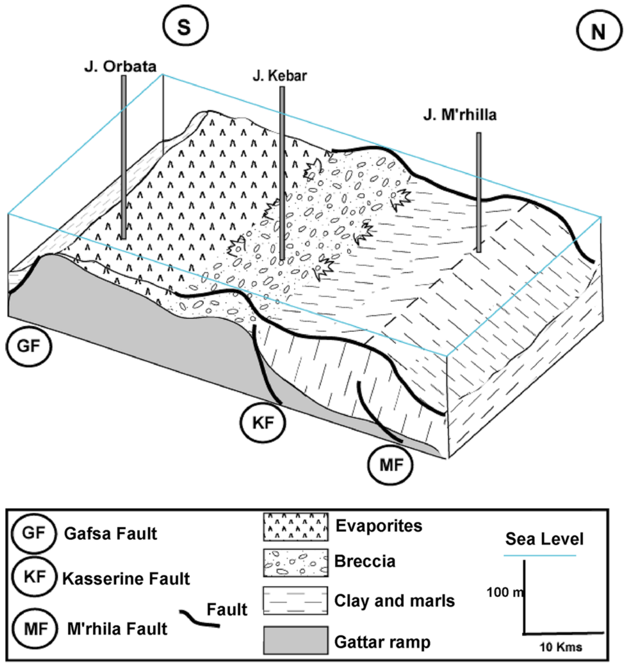

Fig. 8 3D sedimentary model of Central Tunisia during the deposition of the Early Turonian Annaba member, showing the northward prograding Annaba marly wedge blocked against the Central swell (Sidi Bouzid area)

ramp leading to increasing carbonate production rates and development of rimmed shelf. In our case, the eustatic factor did not clearly modify the faunal and floral associations and consequently the carbonate production rates, but would have drowned the Gattar ramp and sealed the local structure framework with the Annaba marls. The accumulation of this marls resulted in a submarine morphology the top of which reached the euphotic zone favoring the recovery of the carbonate sedimentation and the development of a rudistids shoal barrier (Fig. 6).

Conclusions

During early Turonian and middle Turonian, two carbonate platforms occurred respectively in Central Tunisia: the Gattar platform and the Bireno platform, they are separated by hemipilagic marls of early Turonian Annaba member:

- The Gattar platform consists of a carbonate ramp that developed during the late highstand correlative with UZA-2.5 eustatic cycle. The ramp developed on a substratum arranged into northward stepping titled blocks bounded by E–W major faults.
- The Bireno platform consists of a rimmed shelf developed during the highstand correlative with UZA-2.6 eustatic cycle. The barrier consists of rudistids lithosomes. The inner shelf, very extended southword, was seperated by a shallow water uplift in Sidi Bouzid area and an evaporitic peritidal domain in Gafsa area.

The vertical transition from the carbonate ramp to the rimmed platform was controlled by eustatic sea level changes and local tectonic and structural framework. During the transgressive interval correlative with UZA-2.6, the accommodation space increasing has led to the accumulation of a wedge of hemipilagic marls at the north of Sidi Bouzid uplift upon the top of which occurred the rudistids platform barrier, whereas south of this uplift occurred shallow marine evaporitic domain.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s13146-021-00744-3.

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