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Discussions

Interactive comment on "Shallow water carbonate platforms (Late Aptian, Southern Apennines) in the context of supraregional to global changes" *by* A. Raspini

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I sincerely appreciated the comments by Dr. Azerêdo. I agree with most of the referee's comment and consequently I have altered the text according to her suggestions, paying particular attention in separating new and previously published data (see the Revised Text attached as Supplement). In my view, this has greatly improved the paper, allowing the general message of the manuscript to be better focused. Nevertheless, hereafter I answer to some points raised by her.

General answer to the referee's comment. In my manuscript I utilised previously published isotopic data (D'Argenio et al., 2004) which have a low resolution; this is one of the reasons why the research presented here has to be considered a fundament for future, more conceptual work that I hope to realize (I am working to do this soon). For the purpose of my manuscript (the relationships between the distribution of what I call "peculiar facies", sea-level fluctuations and the complex pattern of environmental changes that led to modification of the carbon cycle during the mid-Cretaceous), I have reworked and re-assessed previously published data (sedimentologic, cyclostratigraphic and isotopic), adding new information deriving from further field and laboratory observations that allowed the bulk of the data to be discussed and interpreted in a new way, following an integrated approach. As starting point, I have considered reliable the previously published data, subjecting the ones derived from other authors (e.g. the isotopic data) to a further check, i.e. comparing them with coeval records (see below).

Specific comments. Title. I agree with the referee. Accordingly, I have modified the title as follow: "Shallow water carbonate platforms (Late Aptian, Southern Apennines) in the context of supraregional to global changes: re-appraisal of palaeoecological events as signs of carbonate factory responses".

Abstract. I have modified the abstract as follows (see also the Revised Text attached as Supplement): 1) The phrase "A preliminary study based on the comparison of recently published δ13C record of the Late Aptian Monte Tobenna and Monte Faito sections (Southern Italy) with. . .. . ..and trophic levels of the water" (p. 902, lines 2-7) has been replaced with "Sedimentological and cyclostratigraphic analyses previously carried out on the Aptian/Albian shallow water carbonate platform strata from Monte Tobenna and Monte Faito (Southern Italy) have been integrated by further field and laboratory work. This has been addressed to the description and interpretation of facies showing peculiar field appearance and/or fossil content: the "Orbitolina level", the microbial carbonates and the Salpingoporella dinarica-rich deposits. The vertical evolution of textures and diagenetic features and their cyclical organization along the sections, in tune with the related isotopic record framed within global trends and the main volcanic and climatic events of the Aptian, suggests that low frequency sea-level fluctuations played a fundamental role in regulating the deposition of the peculiar facies in the lagoonal environments of the Apenninic carbonate platform. In fact,".

2) "During the lowering. . .level formed" (lines 8-14) has been rephrased as follows ". . .in a general context of deterioration of the inner lagoon environmental conditions triggered by increasing volcano-tectonic activity and trophic levels of the water, microbial carbonates were a common product of the shallow marine ecosystem only during the lowering of the sea level. Under such a scenario, when a period of increased precipitations enhanced the nutrient transfer to the oceans, trophic levels were too high and the environmental conditions became unsuitable for the main carbonate producers of the lagoonal settings. This created perfect conditions for the spread of an opportunistic fauna rich in orbitolinids (Mesorbitolina parva and M. texana),".

3) Line 15: the phrase "and fresh/brackish water environments spread" has been eliminated.

4) Lines 20-22: the concept ". . ..that were not. . .. . ..in a healthy state" has been divided and rephrased as follows ". They easily remained in a healthy state and were not influenced by the environmental changes mostly induced by the mid-Cretaceous volcanism.".

Introduction. The following sentence has been included on p. 903, line 19: "and the marker bed correlated between widely spaced (present day distance > 100 km) carbonate platform successions cropping out in Southern Italy (D'Argenio et al., 1999, 2004),".

OBS. Following the referee's suggestion, I have added the items "Methodology" (4.1.1; see below and the Revised Text attached as Supplement).

The studied sections. The following sentences have been added: 1) On p. 906, line 8, "The section is 32 m thick and consists of well bedded carbonate strata in the first 16 m overlying by".

2) Line 12: "From about 20 m, clayey layers and marly beds with abundant charophytes alternate and form an interval about 8 m-thick, then overlain by carbonate strata.".

3) Line 17: "Its basal portion consists of strata thicker than the ones forming the medium and upper portions.".

Facies analysis. To separate previously published data and new data, the section 4 (now named "Sedimentology") has been divided as follows: 4.1 Previous data and their interpretation; 4.1.1 Methodology; 4.1.2 Lithofacies and their associations; 4.2 Peculiar facies of the Tobenna-Faito section (it reports data from further field and laboratory work). The latter section consists of the following three levels of sectioning: 4.2.1 The "Orbitolina level"; 4.2.2 Microbial carbonates; 4.2.3 Salpingoporella dinarica-rich facies. 1) On p. 907, line 2, the word "Previous" has been added at the beginning of the section 4.

2) Line 17: I have replaced "features related to emersion" with "mm-size cavities filled by calcite and/or with geopetal infills".

3) To avoid confusion between data presentation and data interpretation, the periods on p. 907 (lines 21-28)-through p. 908 (line 1), have been rephrased as follows: "Scattered cavities of irregular shape and less than 1 mm in size that show crystal silt at the base passing upward to sparry calcite characterize the uppermost part of many beds. These features were interpreted as evidence of exposure (Raspini, 1998, 2001). In addition, the microbrecciation affecting the top of some characean-rich beds was interpreted as the effect of wetting and drying processes producing mm-size intraclasts which give rise to an in situ breccia, similarly to the examples described by Riding and Wright (1981) in the paleosols of the Lower Carboniferous in southern Britain (Raspini, 1998; Fig. 2g).".

4) On p. 908 (line 4), the sentence "Particular attention has been paid to the analysis" has been replaced with "Further field observations and laboratory work have been addressed to the description and interpretation".

SED

3, C568–C578, 2011

5) After the phrase "Salpingoporella dinarica-rich-strata." (p. 908, line 6), the following sentences have been added: "This allowed us to identify distinctive fossil traces in the sediments underlying the orbitolinid-rich layer and to interpret lithofacies B4 and B3 as microbially-induced carbonates, outlining both their and the S. dinarica-rich facies distribution along the sections.".

6) Lithofacies B4 and B3. The substantial difference between lithofacies B4 and B3 is the cryptalgal lamination that characterizes only the lithofacies (B4). Sometimes, Thaumatoporella sp. is abundant in the lithofacies B3, but it also occurs in the lithofacies B4 (see p. 910, line 1). Based on data I have, probably lithofacies B4 and B3 have a similar significance considering them within the complex pattern of environmental and oceanographic changes of mid-Cretaceous. In particular, at Monte Tobenna lithofacies B4 is more diffused during the long-term highstand, before the settlement of the Orbitolina level; the lithofacies B3 is located around the biostratigraphic marker and within the SBZ1 (but this is also the case for lithofacies B4, although it shows a minor thickness; see Fig. 4). At Monte Faito, lithofacies B3 is well developed, while the lithofacies B4 has been rarely found. When the lithofacies crop out together (e.g. are part of a same bed-scale cycle, (but it occurs very rarely), the B3 is always underlying the B4. It is not excluded that these lithofacies represent the product of deposition in laterally contiguous "sectors" of the inner lagoon. Therefore, in my view, the indication of the relative proportion and distribution of both types of microbial dominated-lithofacies as well as a separate discussion on lithofacies B4 and B4 are unnecessary because they do not add much to the manuscript.

7) On p. 909 (lines 1-9), the fossil traces which characterize the deposit immediately underlying the orbitolinid-rich bed have been better described as follow: "Orbitolina floatstone with a marly matrix penetrates downward into the carbonate strata, filling the underlying cm-sized cavity-like features. Owing to the abundant vegetal covering that prevented extensive observations, these latter features have been previously interpreted as the product of paleokarstic processes related to a prolonged emersion

SED

3, C568–C578, 2011

of the platform subsequently sealed by the orbitolinid-rich marls when marine conditions returned (Raspini, 1996, 1998). By contrast, further field work carried out on a well exposed outcrop along a road cut has revealed that, as a matter of fact, the cavity-like features are sinuous and irregularly anastomosed "tunnels" traced in the deposits underlying the litho and biostratigraphic marker. The "tunnels" may reach 3 cm in diameter and 12 in length and are interpreted as Thalassinoides-like burrows (e.g., Seilacher, 2007) filled with orbitolinid-rich sediment (Figs. 3c). Based on the above observations, the "Orbitolina level" of the Monte Tobenna represents transgressive deposits that settled on the platform following a period of interrupted or very low sedimentation.".

Cyclic stratigraphy. 1) Following the referee's suggestion, and to avoid confusion, I have split the section 5 into 5.1 (Previous data and their interpretation) and 5.2 (Sequence stratigraphy). In addition, on p. 912 (lines 10-12), the sentence "Similarly……emersion-related features – that" has been rephrased as follow "Then, a sharp shift towards the most-open marine lithofacies occur across the 6 m-thick overlapping zone (Fig. 4). These deposits show minor evidence of emersion-related features and form the thickest superbundles recognized in the section studied. They".

2) Lines 18-21: no misinterpretation at these intervals. Talking about the sequence stratigraphic interpretation of the section studied, I just wanted to point out that sequence boundaries and sequence boundary zones (that are zones of minimum accommodation space on the platform) are the most predictable locations of possible gaps (e.g., at least of bed-scale cycles) and/or cycle condensation in the stratigraphic record of shallow marine carbonates (see also p. 911, lines 11-16 of the ms). However, to avoid confusion, this paragraph has been cancelled.

Chemostratigraphy. In order to assign the right role to the isotopic data, that in this study derive from D'Argenio et al. (2004), the item 6.1 ("Regional-to-global significance of the isotopic record") has been added: it includes lines from 27 (p. 913) to 22 (p. 914). Also, several sentences have been eliminated (I agree with the referee: my manuscript is not a typical chemostratigraphy paper) as follows: 1) On p. 912 (line 27) through 913 (lines 1-4), the phrase “The C and O....refer to D’Argenio et al., 2004).” has been eliminated and the following sentence added “In this paper, the trends of δ13C and δ18O values of the Tobenna-Faito composite section are utilised. The trends have been reproduced applying three and five-points moving averages to the carbon and oxygen stable isotope composition, respectively: they allow a better comparison between the isotopic record of the sections studied and the reference curves, damping the possible local interferences due to environmental/diagenetic effects.”.

2) On p. 913, the lines 6-26 have been eliminated.

On the reliability of the isotopic data I utilised. As previously stated (see my “General answer to the referee’s comment” above), I have utilised the well-grounded isotopic data set published by D’Argenio et al. (2004) that have a low resolution. To verify a possible supraregional significance of the “Orbitolina level”, I needed reliable trends of isotopic values (not the absolute isotopic values) recorded in the studied section to be compared with reference curves of the Aptian. Firstly, I have compared the above δ13C trends with the ones obtained from a succession that encases the Orbitolina level, is now located more than 100 km from the Tobenna-Faito one and, according to some authors, pertains to a different carbonate platform domain (cf. D’Argenio et al., 1975; Laubscher & Bernoulli, 1977; Channel et al., 1979; Finetti et al., 1996). From this, it emerged that: i) similar trends of δ13C values are recorded in both sections; ii) the main trends of δ18O values of both sections (used as a tool to confirm the previous correlation of the δ13C trends) are well comparable regardless of diagenetic effects the oxygen isotope absolute values locally suffered; this lends further support to the regional correlation of the δ13C trends (Fig. 5 of my ms). Secondly, the trends of δ13C and δ18O reproduced at a regional scale have been also compared with global trends as recorded by reference curves (Figs 6 and 7 of the ms). The good correlation implies that, the studied successions record global - rather than local - trends of δ13C and δ18O values not significantly influenced by environmental/diagenetic effects. From all of the above considerations, I think that isotopic trends extracted from the Tobenna-Faito section are reliable, although diagenetic effects could have locally shifted the absolute isotopic values from the original ones and data have a low resolution. This is what I needed in order to frame the orbitolinid-rich regional marker within the complex pattern of environmental changes of mid-Cretaceous and to hypothesize its possible comparison with the Niveau Fallot. 2) About the major/minor role assigned to the different methodologies see below (discussion).

Discussion. To allow the reader to focus better on what I call "peculiar facies" and to emphasize the cyclo- and sequence stratigraphic interpretation of data, the item 7.1 has been re-organized as follows: 1) The first paragraph, from p. 914 (lines 26-27) to p. 915 (lines 1-17), has been shifted on p. 916, line 17, after the sentence "…appears to be plausible.".

2) The sentence "According to Hottinger (1982)…foraminifera. Conversely, other" (p. 916, lines 18-20) has been rephrases as follow: "Although orbitolinids were considered light-dependent foraminifera (Hottinger, 1982), several".

3) From p. 916 (lines 27-29) to p. 917 (line 1), the sentence has been modified as follows: "This would have resulted in mesotrophic or eutrophic conditions on carbonate platforms and in hemipelagic settings, creating perfect conditions for the spread of an opportunistic fauna rich in orbitolinids in shallow lagoons and the formation of black shales in deeper environments.

4) I acknowledge the invitation to cite Immenhauser et al. (2005) on the documentation of microbial-foraminiferal episodes in the Early Aptian of the southern Tethyan margin and their possible relation with the OAE 1a.

5) Following the referee's suggestion, I have added the following item 7.4 (that precedes the "Conclusions"; see also the Revised Text attached as Supplement): 7.4 Summary The vertical evolution of the facies and their cyclical organization along the Tobenna-Faito composite section suggests that the "Orbitolina level" of the Gargasian

SED
3, C568–C578, 2011

Interactive Comment

deposited in the lagoonal environment of the Apenninic carbonate platform after a period of interrupted (or very low) sedimentation, during a time of long-term eustatic lowering of the sea level. The correlation of the long-term trends of δ13C and δ18O values recorded in the studied sections with reference curves of the Late Aptian (Figs. 6 and 7) confirms that the orbitolinid-rich marker settled during a global climate cooling (even though the Late Aptian was a time of increasing volcano-tectonic activity) and is coeval with part of the Niveau Fallot that deposited in a hemipelagic setting connected to the Tethyan Ocean. In the marly biostratigraphic marker of the central-southern Apennines the low conical foraminifera are associated to echinoderms, calcareous algae and rare pelecypods, suggesting high trophic levels of surficial waters. It is argued that high trophic levels in the sea and an overall paleoenvironmental deterioration were induced by a period of increased precipitations linked to a strong monsoonal circulation (supraregional events) that amplified the effects of the volcanic activity (global forcing factor), creating perfect conditions for the spread of an opportunistic fauna rich in orbitolinids in the shallow lagoons during a long term fall of the sea level. During the lowering of the sea level, however, the volcano-tectonic activity remarkably influenced the stratigraphic record of Monte Tobenna-Faito, as testified by the development of microbial carbonates and the distribution of Salpingoporella dinarica-rich deposits along the composite section. The injection of CO2 in the ocean-atmosphere system and the consequent progressive enhancement of the continental weathering, caused an increase of dissolved Ca2+ and HCO3- in the ocean which facilitated a microbial colonization on large areas of the shallow water environments. Also, Salpingoporella dinarica, whose skeleton was originally made of low-Mg calcite, shows its maximum abundance (acme) below the orbitolinid-rich layer, disappearing above it. Probably, the concomitant low Mg/Ca molar ratio and high concentration of Ca in the Aptian seawater (Fig. 8A) fostered the production of low-Mg calcite skeleton of S. dinarica that was able to bloom in the shallow lagoonal environment. Thus, the neritic ecosystem of the Apenninic carbonate platform was principally sensitive to changes of alkalinity and trophic levels rather than to ocean acidification during a period of long-term sea level fall (Fig.

SED

3, C568–C578, 2011

Interactive Comment

8B). During the sea-level rise and the early highstand, despite the volcano-tectonic activity, no microbial carbonates formed in the shallow lagoon and also S. dinarica disappeared probably because the physico-chemical conditions of the seawater became definitively unsuitable for secreting its skeleton. Therefore, the sedimentary record of the Tobenna-Faito is not punctuated by peculiar facies testifying to a deterioration of the environmental conditions as during the long-term sea level lowering; this suggests that the marine ecosystem was not influenced by the paleoenvironmental changes related to the mid-Cretaceous volcanism and easily remained in a healthy state.

6) Litofacies B4 and B2: see my answer above (facies analysis, point 6).

Final remarks. I have replaced “Final remarks” with “Conclusions”, modifying two sentences as follows: on p. 922 (line 2), the phrase “In view of the above, it emerges that,” has been eliminated and the phrase “Under these environmental conditions,” (line 6) has been added.

Technical corrections 1) Yes, “forcing factor” is better than “dictator”.

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Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/3/C568/2011/sed-3-C568-2011-supplement.pdf

Interactive comment on Solid Earth Discuss., 3, 901, 2011.