حوادث ثنائي الزمن للمستحاثات القزمة الكلسية للتوارسيان الأسفل

د. سامر كنجو[*]

الملخص

أجريت دراسة ميكروباليونتولوجية باستخدام النانوفوسيل الكلسية في فترة بلينسباكيان / توارسيان (الجوراسي الأسفل) لمقطع ألكابيديك في حوض لوزيتانيان في البرتغال. تم مقارنة نتائج المقطع الأخير مع مقاطع أخرى مدروسة تقع في أحواض مختلفة. تتضمن دراسة أحداث أربعة أنواع مرشدة خلال فترة الدراسة، وهي الظهور الأول للأنواع:

(*Lotharangius velatus* (Bown & Cooper, 1989), *Discorhabdus ignotus* (Górka, 1957), *Carinolithus superbus* (Deflandre *in* Deflandre & Fert, 1954) ، *Mitrolithus jansa*e (Wiegand, 1984)

والظهور الأخير للنوع تم مقارنة معطيات المقطع ألكابيديك مع بيانات مقطع بينيش والذي يمثل المقطع النموذجي لطابق التوارسيان. لوحظ وجود نفس التتابع للأحداث عند مقارنة مقطعي ألكابيدك وبينيش والذين ينتميان الى حوض واحد(لوزيتانيان). تظهر المقارنة البيواستراتيغرافية لأحداث الأنواع الأربعة من النانوفوسيل وجود عدم توافق لهذه الأحداث بين مقاطع الأحواض المختلفة.

تم إجراء تحاليل إحصائية لغزارة النانوفوسيل في مقطع ألكابيدك ودراستها مع منحني نظير الكربون.

---

[*] مدرس – قسم الجيولوجيا – كلية العلوم– جامعة دمشق.

ان مقارنة الغزارة المطلقة للنانوفوسيل مع منحني نظير الكربون الثابت تظهر تناقص قيمة الغزارة المطلقة ضمن رسوبات التوارسيان الأدنى والتي توافق نطاق القيم السلبية لنظير الكربون الثابت وهذا التناقص يتوافق مع فترة سيطرة رسوبات غضارية ومارنية والموافقة لسيطرة بيئة بحرية عميقة فقيرة بالأوكسجين مرجعة.

الكلمات المفتاحية: النانوفوسيل الكلسية، البلينسباكيان، التوارسيان، البيواستراتيغرافيا، الغزارة المطلقة.

Diachronism of Lower Toarcian Calcareous Nannofossils events

Dr. Samer Kenjo[*]

Abstract

A micropaleontology study was effected using the Calcareous Nannofossils in Pliensbachian/ Toarcian interval for Alcabideque section situated in Lusitanian basin (Portugal).

The last section is correlated with other studied sections founded in different basins.

Four index spices events are identified, the FO of *Lotharingius velatus*, *Discorhabdus ignotus*, *Carinolithus superbus* and LO of *Mitrolithus jansae* in Upper Pliensbachian - Early Toarcian.

The bioevents identified in Alcabideque is compared with the data of Peniche section SSGP of Toarcian.

The same order of bioevents is noticed in Alcabideque and Peniche sections belonging to Lusitanian basin.

Biostratigraphical correlation of Nannofossils events present a diacronism between the different basins.

A quantitative analysis of Nannofossils assemblage is calculated in Alcabideque section and studied with the curve of carbon isotope.

The curve of absolute abundance decrease in Lower Toarcian correspond a negative excursion of carbon isotope. This diminution noticed in the period dominated by marl- clay sediments presenting anoxic conditions.

Keywords: Calcareous Nannofossils, Pleinsbachian, Toarcian, Biostratigraphy, Absolute Abundance.

---

[*] Lecturer, Department of Geology, Faculty of Sciences, Damascus University.

1. Introduction:

The lower Jurassic period were characterized by paleo-environmental changes according to the study of sediments Gradstein *et al*., 2004. In fact, the analysis of Toarcian sediments, present the negative excursion of Carbone isotope in all sections studied noticed that the thickness of the excursion interval differs from one section to the next. There were also anoxic conditions that corresponds with very clayey sediments and low values of δ13C (negative excursion) Hesselbo *et al*., 2000 ; Schouten *et al*., 2000 ; Röhl *et al*., 2001 ; Jenkyns *et al.*, 2002 ; Rosales *et al*., 2004 ; Kemp *et al.,* 2005 ; Hesselbo *et al*., 2007 ; Suan *et al*., 2008a,b ; Littler *et al.*, 2010. The data of oxygen isotopes, shows a major regression between the end of Pliensbachian and the Toarcian base. The low temperatures and low sea level in this period suggested glacio-eustatic causes for regression (Guex *et al*., 2001, Morard *et al*., 2003, Suan *et al*., 2010), Next the high paleo temperature and humid climate coincide with a transgression phase toward the middle and upper Toarcian McArthur *et al*., 2000 ; Bailey *et al*., 2003 ; Rosales *et al*., 2004 ; Suan *et al*., 2008a, 2010 ; Dera *et al.*, 2009. The biostratigraphy of these sections was effected using ammonites Duarte, 1998; Duarte *et al.*, 2003, 2004. This biostratigraphy shows that the negative excursion of the δ13C is synchronous in all studied sections (Jenkyns *et al.*, 2002 ; Rosales *et al.*, 2004). The pelagic carbonate production crisis was a joint result of the biological crisis that struck the calcareous nannofossils, probably in response to an increase in the acidity of the oceans of the time (Mattioli *et al*., 2004, Tremolada *et al*. 2005, Suan *et al*., 2008a). These paleo environments changes were affected at the nannoplanktons distribution in marine water Mattioli and Erba, 1999.

The aim is to study the bio events of calcareous nannofossils in order to verify if these events were synchronous taking as a reference the isotopic curve of δ13C, then comparison the values of absolute abundance of calcareous nannofossils with the curve of Carbone isotope stables.

We shall study the last appearance (LO) of the species *Mitrolithus jansae* and the first Occurrence (FO) for the species *Lotharingius velatus*, *Discorhabdus ignotus*, *Carinolithus superbus* by comparing with the curve δ13C. These spices present index taxa for this interval.

The absolute abundance of nannofossils is calculated in Alcabideque section. It takes paleoenvironmental importance to identify the paleogeography of studied region.

Geological -, geographical -, Stratigraphical Context:

2.1. Lusitanian Basin

The Alcabideque section selected in this study is situated in the Lusitanian Basin.

This basin is located in the center-west of Portugal, between Lisbon and Porto (fig. 1). It stretches from the center of Portugal to the Atlantic coastal region. The Jurassic sediments are dominated in this basin. These sediments compose from Marne- limestone alternance Duarte., 1998 ; Duarte *et al*., 2003, 2004.

Figure. 1 Position Lusitanian Basin (Duarte., 1998)

The birth of the Lusitanian basin is directly linked to the opening of the Atlantic proto-ocean initiated between the end of the Triassic and the beginning of the Jurassic (fig.2)

In the Lower Jurassic, Pangea began to be broken and the Atlantic Ocean open. This leads to a connection between the Tethys Ocean and the Northern Ocean through a narrow passage in North-West of Scandinavia. The climate of the northwest coast of the Tethys Ocean was hot and humid Duarte *et al*., 2003, 2004.

The West of the Tethys was an epicontinental sea, formed of the several basins more or less isolated surrounded by the presence of emerged zones (fig. 2).

The movement of these basins was active with rotation and speed deferments, the tectonics of the west of Tethys was complicated.

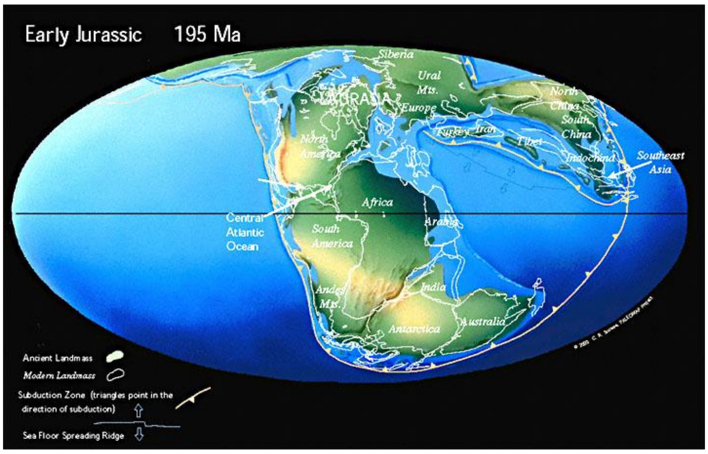


Figure. 2 Early Jurassic paleogeography (http://www.scotese.com/jurassic.htm)

Three major paleogeographic provinces have been defined around these landmasses: the Tethyan province, the boreal province, and the Pacific province Ziegler 1988, Dercourt *et al*., 1993, 2000 (fig.2).

3.Materials and methods:

The work is divided into two parts:

A-Fieldwork has already been done with drawing of geological section and regular and homogeneous sampling within the sedimentary succession.

The sedimentary succession in Alcabideque section consists from Limestone- Marne alter Nance dominated by limestone bed in the upper part of Pliensbachian. This succession changes in the Lower Toarcian and becomes dominated by Marne with thickness about of 10m.

B- A laboratory work consists of several stages such as the transformation of samples into fine and homogeneous powders using an agate mortar.

1- The powders were packaged in small paper bags. These powders were dried in an oven at 50 ° C.
2- We begin to weigh the powders, which should be between 20 mg and 30 mg for Jurassic sediments. This is to limit the variability of nannofossils concentration in the different slides and to facilitate their recognition under the microscope.
3- Each powder sample is mixed with about 15-30 ml of soapy water in graduated tube. The addition of a small amount of Marseille soap increases the pH of the water used and avoids the dissolution of calcareous nannofossils.
4- The graduated tubes are exposed to ultrasound for about two minutes to completely deflocate the clay particles.
5- The contents of the graduated tubes are turned in beakers and complete the level of soapy water to 450ml.
6- The beakers are placed on a magnetic stirrer so that the solution containing the powder is homogenized for about ten minutes.
7- The contents of the beakers are poured into a suitable device (settling box) where a slide is arranged to receive the powder in suspension.
8- The boxes are then left to rest for 24 hours. Finally, the boxes are slowly emptied and it takes about one hour for the slides to dry, then the slats are glued to the hot slides using Rhodopas resin.
9- The slides are then ready to be studied under an optical microscope.

The absolute abundance have been studied through the determination of nannofossils species. In each slide, 300 nannofossils have been counted.

We calculate the absolute abundance using the following equation:

$X = (N * V) / (M * A * F * H)$ after (Geisen et al., 1999)

X (absolute abundance): Number of nannofossils per gram of rock
N: Total number of specimens counted
V: Volume of water used (475 ml)
M: Mass of powder used
F: Number of fields of view observed under the microscope
A: Surface of a field of view ($2011 * 10^{-4}.cm^{-2}$)
H: height of the water column above the slide in the settling box (2.1 cm).

Many samples are studied using the optical microscope to identify the bioevents of Calcareous Nannofossils in different sections. 20 samples in Alcabideque section, 21 samples in Pozzale (Italy), 19 samples in Brown Moor- Yorkshire (England), 21 samples in Dotternhausen (Germany), 18 samples in Tournadous (France).

4. Results:

4.1. Position of calcareous nannofossils events in relation to the isotopic curve (Fabien memory) in Alcabideque section

The first appearance of the species *Lotharingius velatus*, *Discorhabdus ignotus*, *Carinolithus superbus* and the last appearance of the species *Mitrolithus jansae* is remarked.

In Alcabideque (Fig. 3), *Lotharingius velatus* is seen from the base of this section in the first sample, and *Discorhabdus ignotus* in the third sample. They were located at the base of this section below the negative excursion, but *Carinolithus superbus* was not found in this section. The last appearance of *Mitrolithus jansae* was observed in sample 29 during this negative excursion.

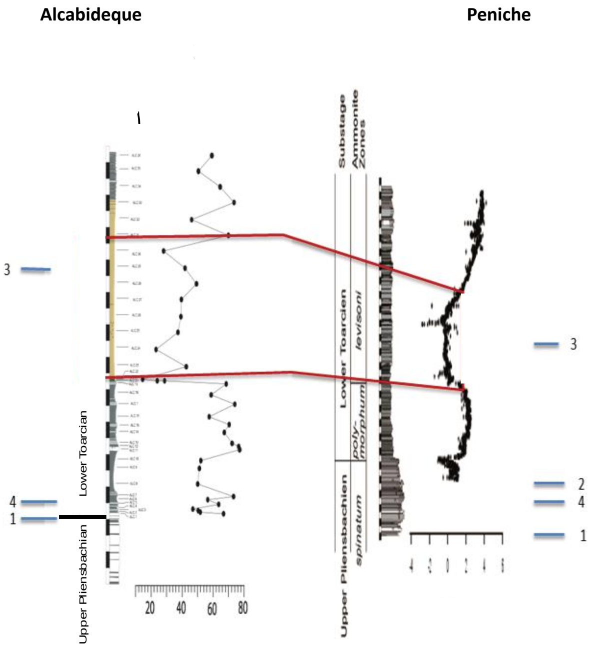
The FO of *Lotharingius velatus* is observed at 4m, *Discorhabdus ignotus* at 5m below the negative excursion of $\delta 13C$ isotope and LO of *Mitrolithus jansae* at 19,5m in the middle of negative excursion in Alcabideque section (fig.3).

4.2. Comparison between the Alcabideque and Peniche sections

The Alcabideque section is selected to compare bioevents of calcareous nannofossils with Peniche section because they are belonging to the same basin and the second section is selected as the GSSP of Toarcian (fig. 3). The species appear in the same order described previously in both sections.

In Peniche section, we observe from the base at 0.56m *Lotharingius velatus* then *Discorhabdus ignotus* at 5.90m, *Carinolithus superbus* at 8.20m. They are located below the negative excursion. Finally LO of *Mitrolithus jansae* at 27.10m in the middle of the negative excursion (fig. 3).

The FO of *Lotharingius velatus*, *Discorhabdus ignotus* are located below the negative excursion of carbon isotope and LO of *Mitrolithus jansae* is found in the middle of negative excursion in two sections. The biostratigraphic correlation indicate that the bioevents of Calcareous Nannofossils are synchronic in the Alcabideque and Peniche sections (fig. 3).



1= FO *Lotharingius Velatus,* 2= FO *Carinolithus Superbus,* 3= LO *Mitrolithus Jansae,* 4= FO *Discorhabdus Ignotus*

Figure 3 Correlations of Calcareous Nannofossils bioevents between Alcabideque and Peniche sections

The difference of bioevents between the two sections noticed in the appearance of *Carinolithus superbus* which is absent in Alcabideque but it was found in the upper part of Pliensbachian in Peniche section.

4.3. Absolute Abundance of Calcareous Nannofossils in Alcabideque section

The curve of absolute abundance is calculated in studied section. The boundary between Pliensbachian and Toarcian correspond high values of absolute abundance about of $120x10^6$.

These values vary between $5x10^6$ and $100\ x10^6$ in the lower part of Early Toarcian (fig. 4). This curve began to decreases toward the Upper part of Early Toarcian until the absence of Calcareous Nannofossils noticed in the last sample located at 25m of this section (fig. 4).

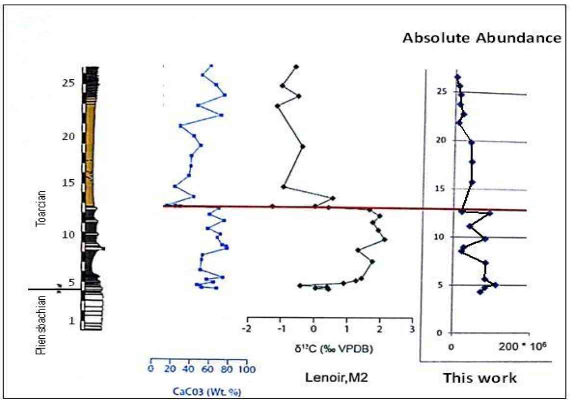


Figure 4 Absolute abundance of Calcareous Nannofossils
in Alcabideque section

5. Discussion:

5.1. Comparison with other basins (refer to the isotopic curve)

Pozzale section (Italy) contains the species *Lotharingius velatus*, *Discorhabdus ignotus* and *Carinolithus superbus* appear respectively in a certain order: 5.60m-6.60m-3.30m during the negative excursion, and *Mitrolithus jansae* disappears at 7.70m above the negative excursion (fig. 5**).** At the Dotternhausen section in Germany, *Lotharingius velatus* is seen from 8.3m and *Discorhabdus ignotus* at 8.5m in the middle of the negative excursion. The last appearance of *Mitrolithus jansae* is at 10.5m above the negative excursion. *Carinolithus superbus* is absent in this section. In England (Brown Moor), *Lotharingius velatus* appears at the top of the negative excursion and *Discorhabdus ignotus* appears below this excursion; *Mitrolithus jansae* and *Carinolithus superbus* are absent.

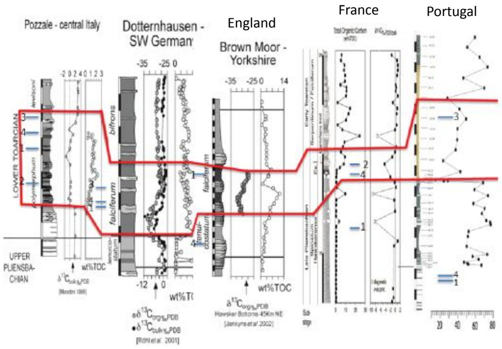
In France (Tournadous section in the Causses basin), *Lotharingius velatus* is observed from 1.54m in a level which is much lower compared to negative excursion, *Discorhabdus ignotus* at 2.68 m and *Carinolithus superbus* at 2.7 3m, is in the middle of the negative excursion; however, *Mitrolithus jansae* is absent in this section

The species *Lotharingius velatus* and *Discorhabdus ignotus* are located very close in several sections except the sections of Tournadous in France and Brown Moor in England where these two events are well separated. The different distance between the two species in the sediments of the two basins was probably interpreted to difficulties in the migration of species, depending on the currents and the presence of emergent areas that represented thresholds.

The correlations of the appearances of species with the isotope curve, observe that all Pozzale species appear in the negative excursion, as well as in Dotternhausen, but at Peniche and Alcabideque sections, just the last appearance of *Mitrolithus jansae* was observed in the negative excursion.

The diachronism of Calcareous nannofossils events between the different basins is linked to the different latitudes between the basins where the movement of the currents played a very important role in making a strong emersion. This emersion with time was stronger in the high sections (Pozzale Italie; Dotternhausen Germany).

The circulations currents in some areas west of Tethys were very strong; it has stopped sedimentation in certain sections. On the other hand, the sea current was weak in other regions, so sedimentation was stable with some disturbances in the environmental parameters.



1= FO *Lotharingius Velatus*
2= FO *Carinolithus Superbus*
3= LO *Mitrolithus Jansae*
4= FO *Discorhabdus Ignotus*

Figure.5. Correlation of Calcareous Nannofossils between the different basins

5.2. Correlation of bioevents of calcareous nannofossils in Lusitanian Basin

The occurrence of *Lotharingius velatus*, *Discorhabdus ignotus* and *Mitrolithus jansae* in the Alcabideque and Peniche indicates that the connection was very strong between the two sections by the sea currents that brought the nannoplanktons and the paleoclimate conditions were appropriate for these species.

The interpretation of the absence of *Carinolithus superbus* in the Alcabideque section and its existence in the Peniche section as there were small local climatic variations between the two sections in the same basin Mattioli *et al*., 2004.

This absence interpret also the existence of sedimentary lacuna in Alcabideque translate the absence of *Carinolithus superbus*.

5.3. Paleogeography of Lusitanian Basin

The decrease of absolute abundance of calcareous nannofossils in Toarcian sediments correspond the interval of high level of marine. This diminution coincide a period characterized by the domination of marl sediments in calm environment corresponding an interval of transgression. This interval presents the anoxic conditions environment record negatives values of stable isotope of Carbon.

The increase of the acidity degree of marine water affects at the dissolution of calcareous nannofossils in marine sediments indicating the low values of nannofossils in Lower Toarcian Mattioli and Erba., 1999., Mattioli *et al*., 2004.

6. Conclusion:

The correlation of calcareous nannofossils events appears a diachronism between the different basins. This difference is linked to different altitudes between the basins where the movement of the currents played a very important role in making a strong emersion. This emersion with time was stronger in the high sections. The bioevents remarked in the sections belonging to the same basin are synchronic. This indicate the strong connection of marine current between the sections of the same basin.

The absolute abundance of Calcareous Nannofossils curve indicates a diminution from the Pliensbachian to the upper part of Lower Toarcian correspond the period of transgression in Lower Toarcian and negative excursion of carbon isotope. Anoxic events with the increase the degree of PH of marine water interpret the decrease in the values of absolute abundance of nannofossils in Lower Toarcian.

References:

- Bailey, T.R., Rosenthal, Y., McArthur, J.M., van de Schootbrugge, B., Thirwall, M.F., 2003. Pale oceanographic changes of the Late Pliensbachian–Early Toarcian interval: a possible link to the genesis of an Oceanic Anoxic Event. Earth Planet. Sci. Lett. 212, 307–320.
- Dera, G., Pellenard, P., Neige, P., Deconinck, J.-F., Pucéat, E., Dommergues, J.L., 2009. Distribution of clay minerals in Early Jurassic Peritethyan seas: Palaeoclimatic significance inferred from multiproxy comparisons. Palaeogeogr. Palaeoclimatol. Palaeoecol. 271, 39–51.
- Dercourt, J., Ricou, L.E., Vrielynck, B., 1993. Atlas Tethys, Palaeoenvironmrnt maps. Gauthier-Villiers, Paris, pp.307.
- Dercourt, J., Gaetani, M., Vrielynck, B., Barrier, E., Biju Duval, B., Brunet,M.F., Cadet, J.P., Crasquin, S., Sandulescu, 2000. Atlas Peri-Tethys, Palaeogeographical maps. Paris, pp.269.
- Duarte, L.V., 1998. Clay minerals and geochemical evolution in the Toarcian-Lower Aalenian of the Lusitanian Basin. Cuadernos de Geologia Ibérica, Madrid 24, 69-98.
- Duarte, L.V., Rodrigues, R., Dino, R., 2003. Carbon stable isotope analysis as a sequence stratigraphy tool. Case study from lower Jurassic marly limstones of Portugal. Short papers *IV* south American Symposium on isotope Geology, Salvador, 341-344.
- Duarte, L.V., Perilli, N., Dino, R., Rodrigues, R., Paredes, R., 2004. Lower to middle Toarcien from Coimbra region (Lusitanian basin, Portugal) : sequence stratigraphy, calcareous nannofossils and stable-isotope evolution. Rivista Italiana di Paleontologia e Stratigrafia 110, 115-127.
- Hesselbo, S.P., Gröcke, D.R., Jenkyns, H.C., Bjerrum, C.J., Farrimond, P., Morgans Bell, H.S.,Green, O.R., 2000. Massive dissociation of gas hydrate during a Jurassic oceanic anoxic event. Nature 406, 392–395.
- Hesselbo, S.P., Jenkyns, H.C., Duarte, L.V., Oliveira, L.C.V., 2007. Carbon-isotope record of
- the Early Jurassic (Toarcian) Oceanic Anoxic Event from fossil wood and marine carbonate (Lusitanian Basin, Portugal). Earth Planet. Sci. Lett. 253, 455–470.

- Geisen, M., Bollmann, J., Herrle, J. O., Mutterlose, J., & Young, J. R. (1999). Calibration of the random settling technique for calculation of absolute abundances of calcareous nannoplankton. Micropaleontology, 45, 437–442.
- Gradstein, F., Ogg, J., Smith, A., 2004. A Geological Timescale 2004. Cambridge University Press, Cambridge.
- Guex, J., Morard, A., Bartolini, A., Morettini, E., 2001. Découverte d'une importante lacune Stratigraphique à la limite Domérien-Toarcien: implications paléo-océanographiques. Bull. Soc. Vaudoise Sci. Nat. 345, 277–284.
- Jenkyns, H.C., Jones, C.E., Gröcke, D.R., Hesselbo, S.P., Parkinson, D.N., 2002. Chemostratigraphy of the Jurassic System: applications, limitations and implications for palaeoceanography. J. Geol. Soc. 159, 351–378.
- Kemp, D.B., Coe, A.L., Cohen, A.S., Schwark, L., 2005. Astronomical pacing of methane release in the Early Jurassic period. Nature 437, 396–399.
- Littler, K., Hesselbo, S.P., Jenkyns, H.C., 2010. A carbon-isotope perturbation at the Pliensbachian–Toarcian boundary: evidence from the Lias Group, NE England Geological Magazine 147, 181-192.
- Mattioli, E., Erba, E., 1999. Synthesis of calcareous nannofossils events in Tethyan Lower and Middle Jurassic successions. Riv. Ital. Paleontol. Stratigr. 105, 343–376.
- Mattioli, E., Pittet, B., Young, J.R., Bown, P.R., 2004. Biometric analysis of Pliensbachian–Toarcian (Lower Jurassic) coccoliths of the family Biscutaceae: intra- and interspecific variability versus paleoenvironmental influence. Mar. Micropaleontology 52, 5–27.
- McArthur, J.M., Donovan, D.T., Thirlwall, M.F., Fouke, B.W., Mattey, D., 2000. Strontium isotope profile of the early Toarcian (Jurassic) oceanic anoxic event, the duration of ammonite biozones, and belemnite palaeotemperatures. Earth Planet. Sci. Lett. 179, 269–285.
- Morard, A., Guex, J., Bartolini, A., Morettini, E., Wever, P. de, 2003. A new scenario for the Domerian-Toarcian transition. Bulletin de la Société géologique de France 174(4), 351-356.

- Röhl, H.J. Schmid-Röhl, A., Oschmann, W., Frimmel, A., Schwark, L., 2001. The Posidonia Shale (Lower Toarcian) of SW-Germany: an oxygen-depleted ecosystem controlled by sea level and palaeoclimate. Palaeogeogr. Palaeoclimatol. Palaeoecol. 165, 27–52.
- Rosales, I., Quesada, S., Robles, S., 2004. Paleotemperature variations of Early Jurassic seawater recorded in geochemical trends of belemnites from the Basque– Cantabrian basin, northern Spain. Palaeogeogr. Palaeoclimatol. Palaeoecol. 203, 253–275.
- Schouten, S., Kaam-Peters, M.E., Rijpstra, I., Schoell, M., Sinnighe Damste, J.S., 2000. Effects of an oceanic anoxic event on the stable carbon isotopic composition of early Toarcian carbon. Am. J. Sci. 300, 1–22.
- Suan, G., Mattioli, E., Pittet, B., Mailliot, S., Lécuyer, C., 2008a. Evidence for major environmental perturbation prior to and during the Toarcian (Early Jurassic) oceanic anoxic event from the Lusitanian Basin. Paleoceanography 23, PA1202.
- Suan, G., Pittet, B., Bour, I., Mattioli, E., Duarte, L.V., Mailliot, S., 2008b. Duration of the Early Toarcian carbon isotope excursion deduced fromspectral analysis: consequence for its possible causes. Earth Planet. Sci. Lett. 267, 666–679.
- Suan, G., Mattioli, E., Pittet, B., Lécuyer, C., Suchéras-Marx, B., Duarte, L. V., Philippe, M., Reggiani, L., Martineau, F., 2010. Secular environmental precursors to Early Toarcian (Jurassic) extreme climate changes. Earth and Planetary Science Letters 290 (2010) 448–458.
- Tremolada, F., Schootbrugge, B. van de, Erba, E., 2005. Early Jurassic Schizosphaerellid crisis in Cantabria, Spain: Implications for calcification rates and phytoplankton evolution across the Toarcian oceanic anoxic event. Paleoceanography 20, PA2011, doi: 10.1029/2004PA01120.
- Ziegler, P.A.. 1988. Post-Hercynian plate reorganization in the Tethys and Arctic-North Atlantic domains. Chapter.30. In: Manspeizer, W.(End.), Triassic- Jurassic Rifting. Continental breakup and origin of the Atlantic Ocean and Passive Margin. Part B.Elsevier, Amsterdam, pp. 711-755.