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**MID CRETACEOUS (APTIAN – TURONIAN) PLANKTIC AND
BENTHIC FORAMINIFERA FROM ISRAEL:
ZONATION AND MARKERS**

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Table of contents

1. ABSTRACT	1
2. INTRODUCTION	1
3. PLANKTIC FORAMINIFERA	2
4. BENTHIC FORAMINIFERA	6
5. CONCLUSION	12
6. ACKNOWLEDGEMENTS	13
7. REFERENCES	14
8. TABLES 1-4	

ABSTRACT

The use of local Aptian to Turonian planktic and benthic foraminifera as stratigraphic tools is discussed. A dual model, consisting of "standard" planktic foraminiferal zonation and retrozonation, is applied to the study of surface and subsurface sections respectively. The two zonations are compared in term of their respective resolutions. Twenty datum levels based on first and last occurrences of benthic foraminifera (including 4 zonal markers) are proposed for the Aptian to Cenomanian stage subdivision. Aptian and Albian benthic foraminiferal zones in use for subsurface biostratigraphy are calibrated with stratigraphically important planktic species. However, additional taxonomic and biostratigraphic work (especially on the *Orbitolina* group) is required in order to update and refine the existing shelf biostratigraphy. The age of the Cenomanian *Gavelinella aumalensis* zone needs to be re-considered. The long-range Turonian species do not lend themselves to biostratigraphy.

INTRODUCTION

Local Cretaceous rocks consist mainly of fossiliferous (macro- and microfauna) carbonates. Their foraminiferal content has been the subject of ongoing studies since the 50's. The description of their foraminiferal content was initiated by Reiss (see references in Reiss et al., 1985) followed by Hamaoui (from 1961 onwards) Ecker (1962) and more recently by Bachmann and Hirsch (2006). Subsurface assemblages were studied by Derin and his co-workers in reports of the Israel Institute of Petroleum and Energy. Subsequently, informal biostratigraphic units were proposed (Derin and Gerry, 1965). Further, analyses of the benthic foraminiferal content of the Talme Yafe Formation led to the description of a sequence of discrete assemblages that could provide a good basis for the biostratigraphy of this mostly Albian formation (Derin, in prep.).

Additionally, analyses of sediments retrieved from offshore boreholes contributed to the knowledge of Aptian–Albian pelagic sequences and their Tethyan assemblages that, until then, were not found in outcrops sediments. They are described and illustrated in Lipson–Benitah and Almogi–Labin, 2000 and 2003.

Previous Cretaceous biostratigraphic works focused on the younger (Late Turonian to Maastrichtian) interval. A Late Cretaceous multiple chrono- and biostratigraphic framework of Israel using, among other fossils, planktic and benthic foraminifera was proposed by Reiss et al. (1985). A biostratigraphic chart based on Globotruncanidae species was presented by Almogi-Labin et al., 1986. They proposed to use *Globotruncana rosetta* as a Late Campanian zonal species in place of the retained but sporadically occurring marker *Globotruncana ventricosa* (cf. Robaszynski and Caron, 1995). Using a multi-disciplinary approach, also based on planktic and benthic foraminiferal bioevents, Gvirtzman et al. (1989) correlated Coniacian to Maastrichtian shelf to slope sediments deposited in central Israel. In addition, ostracodes and calcareous nannofossils were used as Late Cretaceous biostratigraphic tools (Honigstein, 1983; Moshkovitz, 1984 and Eshet and Moshkovitz, 1995 respectively). Therefore, the present study concerns only the Aptian to Turonian biostratigraphy.

Cretaceous biostratigraphic tables established for the Tethyan Realm and based on planktic foraminifera are well-established and continually updated (Sigal, 1977; Caron, 1985; Robaszynski and Caron, 1995). They, however, are applicable only to the study of surface sections and cores (Lipson-Benitah et al., 1988; Lipson-Benitah et al., 1997), while an alternative provided by the retrozonation approach was proposed for the study of sediments originating in cuttings (Lipson-Benitah, 1991)

The purpose of this report is to present an updated version of the published Aptian to Turonian retrozonation and discuss the value of Aptian to Turonian benthic foraminifera as stratigraphic and zonal markers.

PLANKTIC FORAMINIFERA

Local Cretaceous (Aptian–Turonian) planktic foraminiferal biostratigraphy is mostly based on the study of cutting sediments retrieved from boreholes and to a lesser extent on surface sections analyses. These two sources of information have, in turn, required different approaches to biozonation. Most of the zones used in biostratigraphy are interval-zones defined by first occurrences events (Robaszynski and Caron, 1995). However, this method is inapplicable to the study of cuttings. There, to avoid caving contamination, last occurrences levels are used to define retrozones (Lipson-Benitah, 1991). In order to stress their stratigraphic importance and wide distribution, markers selected for the published low to middle latitudes zonations are also used in retrozonation. The comparative tables between the

two stratigraphic frameworks show that the resolution provided by the retrozonation is nearly as good as the resolution provided by the 1995 "standard" scheme of Robaszynsky and Caron, (see Tables 1, 2).

Following is an updated version of the proposed retrozonation for the Aptian–Turonian stratigraphic interval based mainly on Lipson–Benitah and Almogi–Labin, 2000 and 2003).

APTIAN

Blowiella blowi (= *Globigerinelloides blowi*) retrozone.

Definition: partial range of the nominal species between the last occurrences of *Epistomina caracolla* and *Favusella hoterivica*.

Age: Late Barremian to Early Aptian.

Remark: In absence of planktic species the lower boundary of the zone is defined by means of the benthic *Epistomina caracolla*. *E. caracolla* is known to occur from the Late Jurassic (Reiss, 1964). In the offshore wells (Derin et al., 1989, 1990) its last occurrence is taken as indicating a Barremian-Aptian transition zone. However, in Northern Europe this species has a shorter range, disappearing within the Barremian (Arnaud-Vanneau, 1998). Therefore, the last occurrence of *E. caracolla* is tentatively dated as Late Barremian.

Leopoldina cabri retrozone.

Definition: between the last occurrences of *F. hoterivica* (which is close to the emergence of *L. cabri*) and the nominal species.

Age: Early Aptian (upper part) to Late Aptian (lower part).

Remark: *L. cabri* was not found in the studied wells. Nonetheless this interval is recognizable by its association of stellate forms. Moreover, the presence of *Claviblowiella saundersi* seems to be restricted to this zone.

Globigerinelloides algerianus retrozone.

Definition: between the last occurrences of *L. cabri* and the nominal species.

Age: Late Aptian.

Pseudoplanomalina cheniourensis (= *Planomalina cheniourensis*) retrozone.

Definition: between the last occurrences of *G. algerianus* and the nominal species.

Age: Late Aptian.

Paraticinella eubejaouaensis (= *Ticinella bejaouaensis*) retrozone.

Definition: between the last occurrences of *P. cheniourensis* and the nominal species.

Age: Late Aptian to lower part of Early Albian (see remark about the age of this zone in Robaszynsky and Caron, 1995).

Remark: the species *Ticinella bejaouaensis* Sigal renamed *T. eubejaouaensis* by Randrianasolo and Anglada 1998 is now attributed to the genus *Paraticinella* by Premoli Silva et al., 2009.

The extension of the range of *P. eubejaouaensis* into Early Albian is not unanimously accepted despite its calibration with ammonites (Premoli Silva et al., 2009; Sigal, 1977 respectively).

ALBIAN

The evolution of Albian planktic foraminifera records two short phases of accelerated speciation at the Aptian-Albian boundary and in latest Albian separated by a much longer period of stasis that encompasses most of this stage. Accordingly, the duration of the biozones varies from 1 to 9–10 Ma.

Hedbergella – *Ticinella primula* retrozone.

Definition: between the last occurrence of *P. eubejaouaensis* and the level at which the low species diversity that characterizes this interval is replaced by a remarkable increase in their diversity and abundance.

Age: Early to Middle Albian.

Ticinella praeticinensis retrozone.

Definition: between the rather poorly defined upper boundary of the *Hedbergella*–*T. primula* retrozone and the last occurrence of the nominal species.

Age: Late Albian.

Biticinella breggiensis retrozone.

Definition: between the last occurrences of *T. praeticinensis* and the nominal species.

Age: Late Albian.

Planomalina buxtorfi retrozone.

Definition: between the last occurrences of *B. breggiensis* and the nominal species.

Age: Late Albian.

CENOMANIAN

The local Cenomanian biostratigraphy is mainly based on the study of cutting samples. Nonetheless, the study of three Carmel cores provided the possibility to recognize the "standard" *Rotalipora*-based zonation (Robaszynski and Caron, 1995) and for the first time the opportunity to retrieve the distinctive and stratigraphically important *Thalmaninella* (*Rotalipora*) *reicheli* (Lipson–Benitah et al., 1997). However this very rare species has yet to be recognized in cuttings where a two- rather than a tripartite Cenomanian retrozonation is presently available.

Thalmaninella brotzeni retrozone.

Definition: between the last occurrences of *P. buxtorfi* and the nominal species.

Age: uppermost part of Late Albian to lower part of Late Cenomanian.

Remark: the Early Cenomanian part of this interval is often attributed to the *R. globotruncanoides* zone since *T. brotzeni* was thought to be the junior synonym of *Thalmaninella* (*Rotalipora*) *globotruncanoides*. Despite similar morphologies and almost identical stratigraphic ranges, they however are separate species. (Lipson-Benitah et al., 1997; Caron and Premoli Silva, 2007).

Rotalipora cushmani retrozone.

Definition: between the last occurrences of *T. brotzeni* and the nominal species.

Age: Late Cenomanian.

TURONIAN

Helvetoglobotrucana helvetica retrozone.

Definition: between the last occurrences of *Rotalipora cushmani* and the nominal species.

Age: Late Cenomanian to Middle Turonian.

Remark: the Turonian stage (especially the Early and Middle Turonian) records a single datum useful for retrozonation, namely the last occurrence of *Helvetoglobotrucana helvetica*. This in turn, implies that only one retrozone is identified between the disappearances of *R. cushmani* and *H. helvetica* as opposed to the two intervals defined by Robaszynsky and Caron (1995), the *Whiteinella archaeocretacea* and *H. helvetica* zones. The Cenomanian/Turonian boundary falls within the short-lived *W. archaeocretacea* Zone (less than 0.5 Ma, represented by 6-8 meters thick interval of sediments), hence its importance. However, the latter interval is difficult to recognize in cuttings since its upper boundary, as opposed to its lower boundary (above the disappearance of *R. cushmani*), is defined by the first occurrence of *H. helvetica*, a datum of no value to retrozonation. Nevertheless, in the presence of complete, undisturbed sequences, the existence of the *Whiteinella archaeocretacea* Zone can be suggested by a relative increase of non-keeled species that, otherwise, constitute the major component in assemblages retrieved from surface samples.

BENTHIC FORAMINIFERA

The geographic distribution of benthic foraminifera is ecologically controlled, leading to the establishment of zones that depend on the regional setting. In addition, their stratigraphic range is only rarely calibrated with ammonites or planktic foraminifera (Abdallah et al., 1995; Castro et al., 2001). Therefore, the value of the following biostratigraphy is limited to the studied area. The proposed stratigraphic and zonal markers are based on ranges compiled from outcrops studies (G.S.I. reports, Hamaoui, from 1961 onwards) and published studies of Northern Sinai (Egypt) and Northern Israel exposures by Bachmann et al., 2003 and Bachmann and Hirsch, 2006 (Tables 3, 4). Therefore, interval-zones, rather than retrozonation, were mostly used.

APTIAN

1- Markers:

The list of first and last occurrences appearing below is organized in chronological order.

Praechrysalidina infracretacea.

The presence of *Praechrysalidina infracretacea* indicates an Early Aptian age according to Bachmann and Hirsch, 2006. In Northern and Central Israel, the presence of the dasycladacean algae *Salpingoporella* (= *Hensonella*) *dinarica* also indicates a similar age (Reiss, 1961; Derin and Gerry, 1983; Raviv and Lorch, 1992).

Praeorbitolina cormyi.

The first occurrence of *Praeorbitolina cormyi* is of an Early Aptian age.

Orbitolina (Mesorbitolina) parva.

The first occurrence of *Orbitolina (Mesorbitolina) parva* is at the Early-Late Aptian boundary.

Orbitolina (Mesorbitolina) texana.

The first *Orbitolina (Mesorbitolina) texana* appears in Late Aptian (lower part).

Praeorbitolina cormyi, Palorbitolina lenticularis and *Orbitolina (Mesorbitolina) lotzei.*

In Northern Israel, the last recorded *Praeorbitolina cormyi* and *Palorbitolina lenticularis* occur below and slightly above the Early-Late Aptian boundary respectively. Moreover, the last occurrence of *Orbitolina (Mesorbitolina) lotzei* could be an indication for the Early-Late Aptian boundary.

Choffatella decipiens.

The disappearance of *Choffatella decipiens* occurs just above the Early-Late Aptian boundary. The latter datum is useful for subsurface biostratigraphy.

2- Zonation:

In Northern Israel four benthic foraminiferal interval-zones were recognized by Bachmann and Hirsch, 2006.

Palorbitolina lenticularis interval-zone.

Definition: between the first occurrences of *Praechrysalidina infracretacea* and *Praeorbitolina cormyi*.

Age: Early Aptian (lower part).

Praeorbitolina cormyi- *Orbitolina (Mesorbitolina) lotzei* interval-zone.

Definition: between the first occurrences of *P. cormyi* and *Orbitolina (Mesorbitolina) parva*.

Age: Early Aptian (upper part).

Orbitolina (Mesorbitolina) parva interval-zone.

Definition: between the first occurrences of *O. (M.) parva* and *Orbitolina (Mesorbitolina) texana*.

Age: Late Aptian (lowermost part).

Orbitolina (Mesorbitolina) texana-*Orbitolina (Mesorbitolina) parva* interval-zone.

Definition: the lower boundary of the zone is defined by the first occurrences of *O. (M.) texana*. Its upper boundary was not defined by Bachmann and Hirsch, 2006.

Age: Late Aptian.

Their proposed biostratigraphy was based on the study of a transect across the inner platform and its applicability to the entire platform remains to be tested.

In offshore Israel, an association of *Orbitolina*, *Choffatella decipiens* and *Lenticulina nodosa* occurs below *Paraticinella eubejaouaensis* while the *Gavelinella barremiana* acme zone occurs below *Globigerinelloides algerianus*, two Late Aptian foraminiferal planktic species (Derin et al., 1988a and 1990 and Lipson–Benitah and Almogi–Labin, 2000). Therefore, the two benthic zones are here considered as being of a similar age, Early to the lower part of the

Late Aptian. In addition to *L. nodosa* and *G. barremiana*, local Aptian assemblages include other boreal components, *L. ouachensis* and *Conorotalites aptiensis*.

ALBIAN

The Albian (especially the Early to Middle Albian) planktic foraminiferal biostratigraphy is characterized by low resolution. Likewise, the Albian benthic foraminifera provide a limited number of markers for the subdivision of the stage. The following are mainly deduced from Northern Sinai sections (Bachman et al., 2003). Subsurface biostratigraphy is discussed below.

1- Markers:

Pleurostomella subnodosa.

The first occurrence of *Pleurostomella subnodosa* was proposed by Sigal (1977) as indicating the Aptian–Albian boundary in the Tethyan realm.

Orbitolina (Mesorbitolina) parva.

The last occurrence of *Orbitolina (Mesorbitolina) parva* is a marker for the Middle–Late Albian boundary.

Orbitolina (Mesorbitolina) texana.

The last occurrences of *Orbitolina (Mesorbitolina) texana* and *Orbitolina (Mesorbitolina) subconca* are close to the Albian–Cenomanian boundary.

2- Zonation:

No zonal scheme was proposed by Bachmann et al. (2003) in their study of the Northern Sinai outcrop sections.

Subsurface biostratigraphy consists of only one zone, the *Orbitolina–Nezzazata* sp. A assemblage zone also featuring long ranging species of *Hedbergella*. Its position above the last occurrence of *Paraticinella eubejaouensis* and below the occurrences of the Late Albian planktic forms *Biticinella breggiensis* and *Planomalina buxtorfi* in offshore sections indicates

an Early to Middle Albian age (Derin et al., 1976; Derin et al., 1988 a, b, and Lipson– Benitah and Almogi– Labin, 2000).

CENOMANIAN

The Cenomanian foraminiferal markers and zonation are mainly derived from outcrop sections examined by Hamaoui, 1961, 1965 a, b, c; 1966, 1967; Hamaoui and Saint - Marc, 1970 and Bachmann et al., 2003. Their age assignments are here updated according to Lewy, 1996.

The Cenomanian assemblages are characterized by addition of new genera, *Biconcava*, *Cisalveolina*, *Merlingina*, *Praealveolina*, *Sellialveolina* (= *Pseudedomia*), *Pseudorhapidionina*, *Reissella* and *Trochospira* whose exact ranges require additional work .

1- Markers:

Hemicyclammina evoluta.

The first occurrence of *Hemicyclammina evoluta* is given as indicating an Early Cenomanian age (Hamaoui, 1965 b, 1979).

Merlingina cretacea.

The first local occurrence of *Merlingina cretacea* seems earlier than reported in other Mediterranean sections (middle part of Early Cenomanian in Hamaoui, 1966 versus Middle Cenomanian in Schroeder and Neumann, 1985).

Sellialveolina drorimensis.

The first occurrence of *Sellialveolina drorimensis* is recorded within the Early Cenomanian (Hamaoui, 1965 a ; Bachmann et al., 2003). Co-occurrence of *Biconcava bentori*, *Trochospira avnimelchi* and *S. drorimensis* characterizes Northern Sinai Middle to Late Cenomanian assemblages.

Pteramma israelensis.

The Cenomanian *Pteramma israelensis* seems to have a short range, within the Middle part of this stage (Hamaoui, 1965 b, 1966).

Ammobaculites (= *Haplophragmoides*) *difformis* is also appearing within Middle Cenomanian with a range probably extending to Late Cenomanian (Hamaoui, 1966).

Thomasinella.

The last occurrence of this distinctive Cenomanian genus is recorded in Middle Cenomanian by Hamaoui (1965 a, 1966) and in Late Cenomanian by Abdallah et al., 1995. However, the ammonites associated to this younger occurrence of *Thomasinella* could indicate a Middle/Late Cenomanian boundary age rather than a Late Cenomanian age (Lewy, pers. communication). Therefore, the last occurrence of *Thomasinella* is given as indicating Middle Cenomanian. This genus consists, so far, of one valid species, *T. punica* (Weidich and Al Harithi, 1989). An association of *Thomasinella*, *Orbitolina* and *Praealveolina cretacea* indicates an Early (upper part) to Middle Cenomanian age (Saint-Marc, 1977).

Cisalveolina fallax.

The range of *Cisalveolina fallax* is given as Late Cenomanian to Early Turonian by Saint-Marc (1979) and Hamaoui (1979). According to Schroeder and Neumann (1985) the range of the genus also starts in Late Cenomanian but does not extend into the Turonian. Therefore, the only data retained here is its Late Cenomanian first occurrence.

Reissella ramonensis.

The range of *Reissella ramonensis* was given as Late Cenomanian by its author (Hamaoui, 1963). Subsequently, Hamaoui (1965 a) recorded *R. ramonensis* together with the planktic foraminifera *Helvetoglobotruncana helvetica*, indicating a possible Middle Turonian age for its last occurrence.

2- Zonation:

Gavelinella aumalensis zone.

Hamaoui (in Arkin and Hamaoui, 1967) established an Early Cenomanian zone based on the total range of *Gavelinella aumalensis* for Central and Southern Israel. However, its range was extended to the base of the Middle Cenomanian (Hamaoui, 1979) and, in a later study, to Early Turonian of southern France (Tronchetti and Grosheny, 1991). Therefore the age of this local, albeit important zone for correlation needs further study.

TURONIAN

Turonian foraminiferal assemblages were often defined only at genus level (Hamaoui and Raab, 1965). They mainly consist of long ranging genera (*Nezzazata*, *Cuneolina*, *Pseudolituonella*) and species inherited from the Late Cenomanian that became extinct in the Early Turonian (*Merlingina cretacea*, *Cisalveolina fallax*, *Reissella ramonensis* (Hamaoui, 1965 a ; Saint - Marc, 1977). Consequently the Cenomanian-Turonian boundary is not easily recognized either by means of benthos or even plankton (see the above discussion on the *Whiteinella archaeocretacea* Zone). Nonetheless, the boundary could be placed between the *Taberina-Edomia*=*Taberina-Sellialveolina drorimensis* and the *Hedbergella-Heterohelix* assemblage zones as proposed by Ecker (1962), a suggestion reinforced by the associated ammonites (Lewy, pers. communication) and by the range of *S. drorimensis* (Arnaud-Vanneau, 1998). The positions of the lower boundary of the *Taberina-Edomia* and of the upper boundary of the *Hedbergellas-Heterohelix* assemblage zones were not discussed by Ecker (1962).

CONCLUSION

The planktic foraminiferal zonation established for the Tethyan Realm, was used only for the study of the Carmel Cenomanian cores and Turonian outcrops. The Aptian to Turonian retrozonation applied to the study of cuttings from offshore boreholes is re-described and updated. The Aptian and Albian benthic foraminiferal zonation in use for subsurface zonation is calibrated with stratigraphically important planktic species. Taxonomic work (especially on the *Orbitolina* group) is required to test the applicability of the Aptian and Albian

foraminiferal data provided by Bachmann et al. (2003) and Bachmann and Hirsch (2006) to additional platform deposits. Cenomanian bioevents (first and last occurrences of selected benthic species) seem to be more useful for the subdivision of the stage than the available zonation. The long-range Turonian species do not lend themselves to biostratigraphy.

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Table1. Local Aptian to Albian surface and subsurface planktic foraminiferal zonations. Bioevents compiled from several authors (see text). Geological time after Gradstein et al., 2005.

Age Ma	STAGE	Surface Zonation	Bioevents	Subsurface Zonation		
100	ALBIAN	Late	<i>T. globotruncanoides</i>	<i>P. buxtorfi</i>	<i>P. buxtorfi</i>	
			<i>P. appenninica</i>	<i>B. breggiensis</i>	<i>B. breggiensis</i>	
			<i>P. ticinensis</i>	<i>T. praeticinensis</i>	<i>T. praeticinensis</i>	
			<i>T. subticinensis</i>	<i>T. subticinensis</i>		
	<i>T. praeticinensis</i>	<i>T. praeticinensis</i>	top of planktic foraminifera low - diversity interval	<i>T. primula</i> / <i>H. planispira</i> (planktic foraminifera low - diversity interval)		
	Middle	<i>T. primula</i>	<i>T. primula</i>		<i>H. planispira</i>	
						Early
	APTIAN	Late	<i>P. eubejaouaensis</i> (2)		<i>P. eubejaouaensis</i> (1)	
			<i>P. eubejaouaensis</i>		<i>P. chenourensensis</i>	<i>P. chenourensensis</i>
			<i>P. chenourensensis</i>		<i>G. algerianus</i>	<i>G. algerianus</i>
<i>G. algerianus</i>			<i>L. cabri</i>	<i>L. cabri</i>		
<i>G. ferreolensis</i>			<i>L. cabri</i>	<i>F. hoterivica</i>		
<i>L. cabri</i>			<i>L. cabri</i>			
125	APTIAN	Early	<i>B. blowi</i> (part)	<i>B. blowi</i> (part)		
			<i>B. blowi</i> (part)	<i>B. blowi</i> (part)		

Table 2. Local Cenomanian to Turonian surface and subsurface planktic foraminiferal zonation. For complete legend, see Table 1.

Age Ma	STAGE	Surface Zonation	Bioevents	Subsurface Zonation	
90	TURONIAN	89.3 ± 1.0			
		Late			
		Middle		<i>H. helvetica</i> ▼	
		Early	<i>H. helvetica</i>		<i>H. helvetica</i>
95	CENOMANIAN	93.5 ± 0.8			
		Late	<i>W. archaeocretacea</i>	▼ <i>H. helvetica</i> ▼ <i>R. cushmani</i>	<i>W. archaeocretacea</i> <i>R. cushmani</i>
		Middle	<i>R. cushmani</i>	▼ <i>T. globotruncanoides</i> ▼ <i>T. brotzeni</i>	
		Early	<i>T. reicheli</i>	▼ <i>T. reicheli</i>	
		Early	<i>T. globotruncanoides</i>		<i>T. brotzeni</i>
		Late ALBIAN		▼ <i>T. globotruncanoides</i> ▼ <i>P. buxtorfi</i>	

Table 3. Local Aptian to Albian surface and subsurface benthic foraminiferal zonation.
For complete legend, see Table 1.

Age Ma	STAGE	Surface Zonation	Bioevents	Subsurface Zonation
100	ALBIAN		<i>O. (M.) subconcava</i> <i>O. (M.) texana</i>	<i>Orbitolina /</i> <i>Nezzazata</i> sp. A
		Late		
		Middle		
105			<i>O. (M.) parva</i>	
	Early			
110				
		---	?	
			<i>P. subnodosa</i>	
112.0 ± 1.0				
	APTIAN		<i>O. (M.) texana</i> <i>O. (M.) parva</i>	<i>Gavelinella</i> <i>barremiana</i>
		Late		
115			<i>O. (M.) texana</i>	
			<i>O. (M.) parva</i>	
			<i>O. (M.) parva</i>	
			<i>C. decipiens</i> <i>P. lenticularis</i> <i>O. (M.) lotzei</i>	
120			<i>P. cormyi</i>	
	Early		<i>O. (M.) lotzei</i>	
			<i>P. cormyi</i>	
			<i>P. cormyi</i>	<i>Orbitolina</i> <i>L. nodosa</i> <i>C. decipiens</i>
			<i>P. lenticularis</i>	
125			<i>P. infracretacea</i>	
125.0 ± 1.0				

Table 4. Local Cenomanian to Turonian surface benthic foraminiferal zonation.
For complete legend, see Table 1.

Age Ma	STAGE	Surface Zonation	Bioevents
90	TURONIAN	89.3 ± 1.0	
		Late	
		Middle	<i>Reissella ramonensis</i> †
95	CENOMANIAN	93.5 ± 0.8	
		Late	<i>Taberina-Sellialveolina drorimensis</i> † <i>Cisalveolina fallax</i>
		Middle	----- ? ----- † <i>Thomassinella</i> † † <i>Pterammina israelensis</i> † <i>Ammobaculites difformis</i>
	CENOMANIAN		
		Early	<i>Gavelinella aumalensis</i> † ----- ? ----- † <i>Sellialveolina drorimensis</i> † <i>Merlingina cretacea</i>
		99.6 ± 0.9	† <i>Hemicyclammina evoluta</i>