

FIRST ORDER CORRELATIONS OF SOME MEDITERRANEAN UPPER MIOCENE SECTIONS

M. Dermitzakis* and M. Triantaphyllou*

INTRODUCTION

The biostratigraphy of the Miocene deposits of the Mediterranean region has been based mainly on land sections with usually short biostratigraphic range.

The fragmentation of the geological record, together with the scarcity of a typical form and even total absence of many index species, does not allow easily the application to this region of zonations which have been based on materials from areas outside the Mediterranean.

In the present paper we try to compile all the available biostratigraphic data derived from land sections located at Eastern Mediterranean. The results led to the correlations of microfauna (calcareous nannofossils, planktonic foraminifera) and macrofauna biostratigraphic data, which might be useful to determine the position of the Mediterranean Upper Miocene deposits.

MATERIAL OF THE STUDY

For the purpose of the present study the biostratigraphic data of the following sections have been used.

Giammoia 3 (Sicily).

Vassiliki 1, Vassiliki 2 (E. Crete).

Skouloudhiana (W. Crete).

Kastelli (central Crete).

Kokkino Rema (Kassos island, Southern Sporades).

Potamos, Metochia (Gavdos island, Crete).

Aghios Sostis (Zakynthos island).

Limin Keri (Zakynthos island).

Giammoia 3

The uppermost part of the Giammoia section (Sicily), which consists of homogeneous brownish grey marls with thin intercalations of laminated brown clays, is represented by the section Giammoia 3. This section consists of 88m of marls alternating with closely spaced laminated brown clays. The planktonic foraminifera of the section have been studied by Zachariasse & Spaak (1983), and the calcareous nannofossils by Theodoridis (1984). The section ranges from *E. kugleri* Subzone to the *C. pelagicus* Zone (Theodoridis, 1984), which correlate to NN7 - NN11 (Martini, 1971) and CN5b - CN9a (Okada & Bukry, 1980) biozones. The biostratigraphic data point to an Upper Serravalian to Upper Tortonian time span.

Vassiliki 1

This section is located in the northeast outskirts of the village Vassiliki

* Dep. of Hist. Geology - Paleontology, Subfaculty of Earth Sciences,
University of Thessaloniki, 55501 Thessaloniki, Greece

in the Ierapetra province (E. Crete). It consists of 21m of grey, silty clays with a few thin sand intercalations. The calcareous nannofossils of the section have been studied by Theodoridis (1984). According to this author the section ranges through *E. bellus* and *E. hamatus* Subzones, which correspond to NN8 - NN9 (Martini, 1971) and CN6 - CN7a (Okada & Bukry, 1980) biozones.

The biostratigraphic data point to an Uppermost Serravalian to Lowermost Tortonian time span.

Vassiliki 2

Section Vassiliki 2 is exposed in the southeast outskirts of the village Vassiliki in the province of Ierapetra (E. Crete). It consists of a 31m thick succession of beds which has been subdivided into three units (Dermitzakis & Theodoridis, 1984). The lowermost unit with a thickness of 7.5m represents bluish homogeneous sandy marls. The next higher unit consists of a 16m thick succession of blue - gray marls with thin intercalations of marly limestones, and finally the topmost lithological unit of the section has a thickness of 7.5m and consists of graded sands alternating with sandy marls and sandy bioclastic limestones.

The planktonic foraminifera and the calcareous nannofossils of the section have been studied by Dermitzakis & Theodoridis (1984). The section - concerning calcareous nannofossils - ranges through *E. hamatus* Subzone /*E. calcaris* Zone (Theodoridis, 1984), which correspond to NN9 (Martini, 1971) and CN7a (Okada & Bukry, 1980) biozone. Concerning planktonic foraminifera, the section ranges through N15 and N16 biozones (Blow, 1969), which correspond to *N. continuosa* and *N. acostaensis* (Zachariasse 1975, Dermitzakis 1978) biozones.

The macrofossil assemblages point to the presence of *Chlamys solarium* Assemblage Zone and *Gryphaea (Crassostrea) gryphoides crassisima* Assemblage Zone (Dermitzakis & Georgiades - Dikeoulia, 1987).

The biostratigraphic data point to a Lower Tortonian time span.

Skoloudhiana

This section is located in W. Crete near the village Skoloudhiana, and consists of 42m thick blue - gray homogeneous clays with several ferruginous layers. The planktonic foraminifera of this section have been studied by Langereis et al (1984), and the calcareous nannofossils by Theodoridis (1984). The section - concerning calcareous nannofossils - ranges through *C. pelagicus* and *A. primus* Zones (Theodoridis, 1984), which correspond to NN11 (Martini, 1971) and CN9a - CN9b (Okada & Bukry, 1980) biozones. Concerning planktonic foraminifera, the section ranges through N16 (Blow, 1969) biozone, which corresponds to *N. acostaensis* zone (Zachariasse, 1975).

The biostratigraphic data allow the chronostratigraphic correlation of the section to the Upper Tortonian.

Kastelli

The section is located near Kastelli village in central Crete, and consists of 53m of grey clays with several ferruginous layers. The planktonic foraminifera of this section have been studied by Langereis et al (1984) and the calcareous nannofossils by Theodoridis (1984). The section - concerning calcareous nannofossils - ranges from *C. pelagicus* Zone to *R. rotaria* Zone (Theodoridis, 1984), which correspond to NN11 (Martini, 1971) and CN9a - CN9b (Okada & Bukry, 1980) biozones. Concerning planktonic foraminifera, the section ranges through N16 - N17 (Blow, 1969), which correspond to *N. acostaensis* - *Gl. conomiozea* (Zachariasse, 1975) biozones.

The biostratigraphic data point to an Uppermost Tortonian to a Lowermost Messinian time span.

Limin Keri

The section is exposed along a coastal cliff to the southwest of the small harbour of Limin Keri, on the southern coast of Zakynthos island. Dermitzakis (1978) has studied the planktonic foraminifera of the section, and Theodoridis (1984) has studied the calcareous nannofossils from a 6.5m thick part of the section consisted of bluish to greenish - grey clays. The section - concerning calcareous nannofossils- contains *E. hamatus* and *E. pseudovariabilis* Subzones (Theodoridis, 1984), which correspond to NN9 (Martini, 1971) and CN7a (Okada & Bukry, 1980) biozones. Concerning planktonic foraminifera, the section ranges through N16 zone (Blow, 1969), which correlates with *N. acostaensis* (Zachariasse 1975, Dermitzakis 1978) biozone.

The biostratigraphic data point to an Early Tortonian Age.

Aghios Sostis

Dermitzakis (1978) has described a thick, monoclinial succession of silty clays and sands, which is discontinuously exposed in coastal cliffs between Kastello Keri and Ag. Sostis (S. Zakynthos). According to the major sedimentary features the same author subdivided the succession into three parts. The lower part shows alternations of brownish sandstones, greyish marls and silty clays. The middle part shows a similar alternation of sandy and finer - grained intervals, but the amount of sand intercalations seems to be higher. The third part of the succession includes the transition from the clastic sequence into evaporitic beds (laminated gypsum, gypsum arenites, balatino, gypsum conglomerates), which are overlain by "trubi" limestones and calcareous marls. Dermitzakis (1978) has studied the planktonic foraminifera of the section and identified the presence of *Globorotalia conomiozea*.

The section ranges through N17 biozone (Blow, 1969), which corresponds to the *Globorotalia conomiozea* Zone (Zachariasse 1975, Dermitzakis 1978), and from a chronostratigraphically point of view points to a Lower Messinian time span.

Kokkino Rema

This section is located at the southern part of Kassos island, along the Kokkino Rema torrent to which it owes its name. It consists of more than 80m of sediments, and has been subdivided into the following four lithological units (Dermitzakis & Triantaphyllou, 1992): reddish conglomerates devoid of fossil remains, 16m thick sands and sandstones, 60m thick sandy - marly limestones, and unfossiliferous greyish marly limestones unconformably overlying the previous unit. The planktonic foraminifera and the calcareous nannofossils as also the macrofauna assemblages, have been studied by Dermitzakis & Triantaphyllou (1992). The section - concerning calcareous nannofossils - is assigned to the *Calcidiscus leptoporus* Zone / Subzone A (Theodoridis, 1984), which corresponds to NN11 (Martini, 1971) and CN9b (Okada & Bukry, 1980). Concerning planktonic foraminifera, the section is assigned to the *Globorotalia conomiozea* Zone (Zachariasse 1975, Dermitzakis 1978), which corresponds to N17 (Blow, 1969) biozone. The macrofossil assemblages point to the presence of the lower part of *Neopycnodonta navicularis* Zone (Dermitzakis & Georgiades-Dikeoulia, 1987).

The available biostratigraphic data point to a Late Messinian Age.

Potamos

The section is located at the northern part of Gavdos island, and represents

a 200m thick succession, consisting of coral limestones, macrofossil limestones, and calcareous shales with sandy intercalations. Planktonic foraminifera, calcareous nannofossils and macrofossil assemblages of this section have been studied by Anastasakis, Dermitzakis & Triantaphyllou (in press). The section - concerning calcareous nannofossils - ranges from *E. exilis* Zone / *H. intermedia* Subzone to *E. calcaris* Zone / *E. hamatus* Subzone (Theodoridis, 1984), which corresponds to NN6 - NN9 (Martini, 1971) and CN5a - CN7a (Okada & Bukry, 1980) biozones. Concerning planktonic foraminifera, the section is assigned to N14 - N16 (Blow, 1969) biozones, which correspond to *N. mayeri* - *N. acostaensis* Zones (Zachariasse 1975, Dermitzakis 1978). The macrofossil assemblages of Potamos section indicate the presence of *Gryphaea (Crassostrea) gryphoides crassissima* Assemblage Zone (Dermitzakis & Georgiades-Dikeoulia, 1987).

All the available biostratigraphic data are suggesting a Middle Seravallian to Early Tortonian Age.

Metochia

This section is exposed at the east coast of Gavdos island. It consists of 50m thick sequence composed - from bottom to the top - of a basal conglomerate, a whitish-yellowish strongly fossiliferous cemented carbonaceous sandstone, and calcareous marls with laminated marly intercalations. Calcareous nannofossils, planktonic foraminifera and macrofossil assemblages of the section have been studied by Anastasakis, Dermitzakis & Triantaphyllou (in press). The section - concerning calcareous nannofossils - is assigned to *E. calcaris* Zone / *E. hamatus* Subzone (Theodoridis, 1984), which corresponds to NN9 (Martini, 1971) and CN7a (Okada & Bukry, 1980) biozones. Concerning planktonic foraminifera, the section is assigned to the lower middle part of N16 Zone (Blow, 1969), which corresponds to the lower middle part of *N. acostaensis* biozone (Zachariasse 1975, Dermitzakis 1978). The macrofossil assemblages are indicating the correspondence of the studied interval to the *Gryphaea (Crassostrea) gryphoides crassissima* Assemblage Zone (Dermitzakis & Georgiades-Dikeoulia, 1987).

Subsequently, all the available biostratigraphic data are suggesting an Early- Middle Tortonian Age.

DISCUSSION - CONCLUSIONS

Observing the biostratigraphic correlations that have been achieved, we can remark that the represented dotted lines are due rather to taxonomic than biostratigraphic problems. The determination of isolated specimens instead of species assemblages represents an often mistake causing taxonomic problems.

By this way intermediate types of the species *N. continua* and *N. acostaensis*, which can show 4, 4.5 and 5 chambers in the last coiling, may cause confusion concerning the recognition of the boundary between *N. continua* and *N. acostaensis* biozones. The several morphological differences between the two species are due to the position and the shape of the aperture as also to the shape of the outer equatorial line. More specifically the species *N. continua* is characterised by a less lobate equatorial outline, when *N. acostaensis* has a more arched aperture.

In case when the species *Globorotalia conomiozea* is not present, similar problems can be observed at the boundary of *N. acostaensis*/*Globorotalia conomiozea* biozones. Therefore the presence of *Neogloboquadrina humerosa* is imperative. However intermediate types with 5-6 chambers, similar to *N. humerosa* can be observed and can be taken for the species *N. acostaensis*.

Finally, another feature concerning the species *N. humerosa*, in order to

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CHRONOSTRATIGRAPHY		BIOSTRATIGRAPHY						SECTIONS	
		NANNOFOSSIL ZONES			PLANKTONIC FORAMINIFERA ZONES		MOLLUSCAN ZONES		
SERIES	STAGES	MARTINI, 1971	OKADA & BUKRY, 1980	THEODORIDIS, 1984	BLOW, 1969	ZACHARIASSE, 1975 DERMITZAKIS, 1978	DERMITZAKIS & GEORGIADIS - DIKEOULIA, 1987		
MIOCENE	UPPER	MESSINIAN	NN11	CN9b	NI7	<i>Globorotalia conomiozea</i>	<i>Neopycnodonta navicularis</i> Assemblage Zone	Olimnioia 3	
				<i>C. leptoporus</i>					
				<i>R. rotaria</i>					
				<i>A. primus</i>					
				<i>C. pelagicus</i>					
	TORTONIAN	CN9a	NI6	<i>N. acostaensis</i>	<i>Gryphaea (Crassostrea) gryphoides crassissima</i> Assemblage Zone				
		CN8b							
		CN8a							
		CN7b							
		CN7a							
MIDDLE	SERRAVALIAN	NN9	CN7a	<i>E. calcaris</i>	NI5	<i>N. continuaosa</i>	<i>Chlamys solarium</i> Assemblage Zone		
				NN8				CN6	
				NN7				CN5b	<i>E. exilis</i>
				NN6				CN5a	
				NN5				CN4	
NI4	<i>N. mayeri</i>								

Biostratigraphic correlation of the selected sections

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determine more accurately the exact level of the biozone, is the type of the coiling, as it is certified that at the upper part of this zone the coiling changes from mainly sinistral to mainly dextral.

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