AGE DETERMINATION AND PALAEOGEOGRAPHIC RECONSTRUCTION OF DIAPONDIA ISLANDS IN NW GREECE, BASED ON CALCAREOUS NANNOFOSSILS

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Abstract

Diapondia islands - Ereikoussa, Othonoi and Mathraki – extended in the north-western area of Greece, are part of the external Ionian zone of the Hellenides. The exposed sedimentary succession of the three islands consists of up to 74m thick submarine fans, interpreted as inner fan deposits. The determination of the sediment ages is based on the study of calcareous nannofossils, which came from almost 63 samples covering geological cross sections across the coast line of the three islands. The recorded nannofossil associations are assigned to the biozones of Martini’s (1971) standard scheme. According to the age determination clastic sedimentation in the studied area started during the Late Oligocene and finished during the Early Miocene time. Moreover, the age determination and in accordance with the previous results, indicate that also the Ionian thrust activity started during Late Oligocene.

Key words: Diapondia islands, Erioussa, Othonoi, Mathraki, calcareous nannofossils, turbidites, external Ionian zone, Ionian thrust.

1. Introduction

The Ionian zone has been studied in detail during the last century and is subdivided by internal thrusting into three sub-basins (internal, middle and external) (Aubouin, 1959; I.G.S.R. & I.F.P, 1966). The studied area (North-western Greece) is a part of the external Ionian zone. Clastic sedimentation in the Ionian zone took place from middle Eocene to late Miocene in a foreland basin, the Pindos foreland (Avramidis et al., 2002; Vakalas et al., 2001) which was subdivided due to internal thrusting and changed to a complex type foreland basin. It belongs to the external Ionian zone and thus to the western part of the Pindos foreland, bounded eastwards by the middle Ionian internal thrust and westwards by the Ionian thrust. The presence of strike-slip faults, with ENE-WSW direction, internal to the foreland basin, influenced the depositional conditions in the studied area. Internal thrust activity together with the sedimentation, has influenced transportation and grain-size distribution, whereas strike-slip faults many times acting as pathways to deliver coarse-grained sediments in more distal parts (Avramidis & Zelilidis, 2002; Vakalas et al., 2001). Many times the continuous uplift due to internal thrusting produced large slumps horizons of the uncondensed sediments, deposited over the uplifted area (Avramidis et al., 2002).
The aim of this work is to determine the depositional age of the submarine fans, accumulated in the studied area. This age is based on the study of calcareous nannofossil content of the sediments. The nannofossil associations from each sample are revealed by paleontological determination of characteristic species. They are interpreted biostratigraphically using Martini’s (1971) standard zonal scheme. All palaeontological determination of nannofossils, as well as biostratigraphic interpretation and conclusions are implemented by K. Stoykova.

2. Geological setting

The studied area is a part of the Pindos foreland. It belongs to the external Ionian zone of the Hellenides, and comprises the three Diapondia islands – Othonoi, Mathraki and Erikoussa (NW Greece). To the north it is bounded by the Borsh-Khardhiqit strike slip fault, to the south by the Corfu margin, to the east by the Middle Ionian thrust, and to the west by the Ionian thrust. Therefore the studied area is situated backward of the Ionian thrust and corresponds to a piggy back basin, where sedimentation is continuous (Fig. 1).

The sedimentation in this basin (Fig. 2) is characterized by fine-grained sediments with channelized sandstone intercalations. These deposits are interpreted as inner fan deposits (Makrodimitras and Zelilidis, 2009) accumulated in the external Pindos foreland, resulted from the segmentation of the Pindos foreland basin due to internal thrusting during Oligocene, which migrated in a westward direction (Underhill 1985; 1989, Clews 1989, Alexander et al. 1990, Avramidis 1999).

According to Makrodimitras and Zelilidis (2009) the sedimentation of submarine fans was continuous in the studied part of the foreland basin, before the Ionian thrust activity. Due to the Ionian thrust activity the western part of the area was uplifted and the deformation of turbiditic sequence was started. Especially, in Mathraki Island the whole sedimentary sequence has strongly deformed, whereas in Erikoussa Island two slump horizons were produced, the lower one up to 5m thick and 70m long, and the upper one, up to 10m thick and more than 100m long. Both slump horizons show an eastward thinning trend, and consist of thick sandstone clasts. In Mathraki Island the strongly deformed sedimentary sequence is in contact with Triassic evaporates, which came up due to Ionian thrust activity, whereas in Othoni Island Mesozoic limestones outcropped.
Fig. 2: Geological maps of Erikoussa, Othonoi and Mathraki Islands.
Paleocurrent analysis shows both N-S and an E-W trend, indicating the Ionian thrust activity influence on depositional conditions.

3. Methodology

The determination of the sediment ages is based on the study of calcareous nannofossils, originating from 63 samples, distributed across the geological sections along the coastline of the three islands. All samples were processed and smear-slides were prepared using Canada Balsam as a fixative. Each slide was observed under cross-polarized and normal light using a Zeiss Axioskop 40 Pol microscope at 1250x magnification.

Plate I & II: nannofossil species from Othonoi Island


Plates III & IV: nannofossil species from Erikoussa Island


Biostratigraphic interpretations are based on the first and last occurrence of stratigraphically important nannofossil taxa. In order to achieve accurate age, standard biozonation of Martini (1971) is employed.
4. Results

4.1 Erikoussa stratigraphy

In Erikoussa 41 samples have been studied in order to form the island stratigraphy. These samples have been chosen according to their position in the stratigraphic column to cover the entire succession. The results of the biostratigraphical analysis are shown in the table 1, whereas the selected samples and studied sections are shown in table 2.

Plate V: nannofossil species from Erikoussa island

Table 1. Erikoussa samples age determination.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age (NP and NN zones of Martini, 1971)</th>
<th>Nannofossil species in the association in situ</th>
</tr>
</thead>
<tbody>
<tr>
<td>E102-E104 Late Oligocene to Earliest Miocene, NP24-NN1</td>
<td></td>
<td>Coccolithus pelagicus, C. eopelagicus, Cyclicargolithus floridanus, Cy. abisectus, Sphenolithus moriformis, Dictyococcites bisectus, D. scrippsae, Helicosphaera compacta, H. intermedia, H. euphratis, Pontosphaera multipora, Reticulofenestra retiformis, Helicosphaera kamptneri, Discoaster deflandrei, Discoaster cf. calculosus, Transversopontis sp. indet.</td>
</tr>
<tr>
<td>E25, E10 Early Miocene, NN1-NN2</td>
<td></td>
<td>Discoaster calculosus, D. deflandrei, Sphenolithus moriformis, S. dissimilis, S. compactus, Coccolithus pelagicus, C. miopelagicus, Cy. floridanus, Cy. abisectus, Helicosphaera kamptneri, H. euphratis, Reticulofenestra minuta, Dictyococcites scrippsae.</td>
</tr>
</tbody>
</table>
4.2 Othonoi stratigraphy

In Othonoi outcrop B, 4 samples have been studied. The sample O1 is from the contact of submarine fan deposits with the Pre-submarine fan deposits to the west (Cretaceous limestones). The results of the analysis are shown in the table 3:

Table 3. Othonoi outcrop B age determination.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age (NP and NN zones of Martini, 1971)</th>
<th>Nannofossil species in the association in situ</th>
<th>Depositional environment/ reworking/ remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>O3</td>
<td>Early Miocene, NN1-2</td>
<td><em>Sphenolithus conicus, S. disbelenmos, Sphenolithus moriformis, Coccolithus pelagicus, Cyclicargolithus floridanus, Cy. abissectus, Helicosphaera compacta, H. scissura, H. sp. aff. elongata, H. perch-nielseniae, Dictyococctes scrippae, Discoaster deflandrei, Pontosphaera multipora, Reticulofenestra retiformis.</em></td>
<td>Recovery of the abundant and diverse nannofloral association, with very good to excellent preservation. It is indicative of favourable conditions for blooming of the nannoflora.</td>
</tr>
<tr>
<td>O4</td>
<td>Latest Oligocene to Early Miocene, NP25-NN1</td>
<td><em>Coccolithus pelagicus, C. eopelagicus, Cyclicargolithus floridanus, Cy. abissectus, Dictyococctes scrippae, D. biceptus, Sphenolithus moriformis, Discoaster adamanatus.</em></td>
<td>Impoverishment of the association – poor preservation with signs of overgrowth and recrystalization.</td>
</tr>
</tbody>
</table>
4.3 Mathraki results

In Mathraki the thrust activity has destroyed every old turbiditic sequences. Nevertheless, we choose 3 samples from the west coastline destroyed sequences, and one sample (M1) from the contact of submarine fan deposits with the thrust. The results of the analysis are shown in the table 4:

Table 4. Mathraki samples age determination.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age (NP and NN zones of Martini, 1971)</th>
<th>Nannofossil species in the association in situ</th>
<th>Depositional environment/ reworking/ remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2</td>
<td>Latest Oligocene to Early Miocene, NP25-NN1</td>
<td>Coccolithus pelagicus, Cyclicargolithus floridanus, Cy. abisectus, Dictyococites scrippsei, Sphenolithus moriformis, Discoaster deflandrei.</td>
<td>Impoverishment of the association – poor preservation. Large amount of Si-skeletons of microplankton: a lot of spicules of Si-sponges, diatoms, radiolarians are observed.</td>
</tr>
<tr>
<td>M4</td>
<td>Early Miocene, NN1-2</td>
<td>Discoaster calculosus, D. deflandrei, Sphenolithus compactus, Sphenolithus moriformis, Coccolithus pelagicus, Coccolithus miopelagicus, Cyclicargolithus floridanus, Cy. abisectus, Helicosphaera kamptneri, H. intermedia, H. euphratis, Dictyococites scrippsei, Pontosphaera multipora, Reticulofenestra reiformis.</td>
<td>Diverse nannofloral association; again abundant Si-skeletons of microplankton observed.</td>
</tr>
</tbody>
</table>

5. Conclusions

Considering the age determination results of the studied sections we can conclude that:

1. The sedimentation in the studied area occurred during the Late Oligocene to Early Miocene time.
2. The age of the sediments in studied area (external part of Pindos foreland), is younger than the
other parts situated eastwards, either in the middle or in the internal parts of the Pindos foreland, showing the internal thrusting activity influence on the depositional conditions.

3. The presence of slump horizons in Erikoussa island (Late Oligocene-Early Miocene) and the highly deformed deposits in Mathraki island, overthrusting Triassic evaporites, indicate that Ionian thrust activity started at the end of Oligocene and caused deformation and slumping of the turbiditic sequences.

4. Taking into account that Ionian thrust activity in Zakynthos Island took place during early Pliocene, the different time activities of the different parts of the Ionian thrust could be indicated. These parts are bounded by strike-slip faults and the oldest activity is manifested northwards whereas the younger is shifted southwards.

5. The studied area, with the three islands, changed from a foreland basin that formed in response to the middle Ionian thrust activity, to a piggy back basin, as it is situated on the hangingwall of the active Ionian thrust, after Late Miocene, and when tectonic activity migrated westwards. This piggy-back basin remains unchanged in now days, whereas the new foreland basin, the Ionian foreland, is situated in the footwall of the Ionian thrust.

6. References


