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Some remarks on the Kinematic Evolution of Messinia Province (SW Peloponnesus, Greece) during the Pleistocene based on Neotectonic, Stratigraphic and Palaeoecological Observations

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Kurzfassung: Die Provinz von Messinia (SW-Peloponnes) ist eines der tektonisch und seismisch aktivsten Gebiete in Griechenland (Hellenischer Bogen), ursächlich durch die Nähe zum Hellenischen Graben, der als die Kollisionszone der Afrikanischen und Europäischen Platte angesehen wird. Die neotektonische Struktur des SW-Peloponnes wird durch eine große Zahl von Gräben und Horsten charakterisiert, die durch weite N-S streichende Verwerfungszonen verbunden sind. An den Rändern und innerhalb dieser neotektonischen Megastrukturen 1. Ordnung ist eine große Zahl kleinerer, untergeordneter Strukturen ausgebildet.

Detaillierte stratigraphische und paläontologische Untersuchungen der postalpinen Sedimente (Mergel, mergelige Kalksteine, Sandsteine und Konglomerate) der Sektionen von Filiatrino Rema (westlich der Kyparissia-Berge) und Thouria-Ano Amfia (Messinia-Graben) brachten folgendes Ergebnis:

- Die Sedimente sind reich an planktonischen und benthonischen Foraminiferen und anderen Fossilien.
- Das Auftreten der Index-Foraminiferen *Globorotalia truncatulinoides* und *Hyalinea balthica* zeigt pleistozänes Alter an.
- Mindestens seit dem Ende des Pliozäns sollte die gesamte Messinia-Provinz im Absinken begriffen sein.
- Während des älteren Pliozäns fand die Sedimentation in Tiefen von 80 bis 100 m statt (Vorkommen von *Pyrgo depressa, Bigerina nodosaria* etc.), wogegen für das frühe Pleistozän Tiefen von 50 bis 80 m anzunehmen sind. Dies ist ein Hinweis auf die Abnahme der Subsidenz während des frühen Pleistozäns.
- Die mittlere Absenkungsrate liegt im Bereich von 0.2-0.3 mm/Jahr, wogegen die mittlere Hebungsrate zwischen 0.625 und 0.375 mm/Jahr variiert.
- Die neotektonische Morphostruktur der Kyparissia-Berge, zusammen mit dem westlichen Teil des Kato (unterer) Messinia-Sub-Graben, und der Taygetos Mt.-Horst verhalten sich, vom kinematischen Standpunkt her, als tektonische Dipole, die um eine NNW-SSE streichende Rotationsachse nach Osten rotieren.

Abstract: The province of Messinia (SW Peloponnesus) is one of the tectonically and seismically most active areas in Greece (Hellenic Arc) due to its neighbouring with the Hellenic Trench, considered as the collision boundary between the African and European Plates. The neotectonic structure of SW Peloponnesus is characterized by the presence of large grabens and horsts bounded by wide fault zones, trending N-S. At the margins or inside these 1st order neotectonic megastructures a great number of smaller order structures are present.

Detailed stratigraphic and palaeoecological studies of the postalpine sediments (marls, marly limestones, sandstones and conglomerates) of sections from Filiatrino Rema (west of the Kyparissia Mt.) and Thouria-Ano Amfia (Messinia graben) showed the following:

- They are rich in planktonic and benthic Foraminifera and other fossils.
- The presence of the index Foraminifera *Globorotalia truncatulinoides* and *Hyalinea balthica* is indicating a pleistocene age.
- Since at least the end of Pliocene the whole Messinia province should be under subsidence.
- During the Late Pliocene the sedimentation took place in depths up to 80-100 m (presence of *Pyrgo depressa, Bigerina nodosaria* etc.), whereas during the Early Pleistocene at depths about

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50-80 m. This is an indication of the decreasing of the subsidence during the Early Pleistocene.
- The mean subsidence rates are in the order of 0,2-0,3 mm/y whereas the mean uplifting rates range from 0,625 to 0,375 mm/y.
- The Kyparissia Mt. neotectonic morphostructure together with the western part of Kato (Lower) Messinia Sub-graben and the Taygetos Mt. horst behave, from kinematic point of view, as tectonic dipoles, rotating towards east, around a rotational axis trending NNW-SSE.

1. Introduction

The province of Messinia (SW Peloponnesus) is one of the tectonically and seismically most active areas in Greece. This is due to its neighbouring with the Hellenic Trench, which is considered as the collision boundary between the African and European plates (Fig. 1).

From geotectonic point of view, the western part of the study area has belonged to the Hellenic Island Arc from Late Pliocene to Early Pleistocene, although nowadays is a part of the Peloponnesus peninsula.

In this paper we try to interpret the kinematic evolution of Messinia province during the last stages of the neotectonic period taking into account: (i) the facies, (ii) the thickness and (iii) the present-day altitude of the post-alpine marine sediments. Cross sections in two localities were studied, three at **Filiatrino Rema** (west) and two at **Thouria-Ano Amfia** (east) (Fig. 1).

The area has been studied from the stratigraphic point of view by MARCOPOULOU-DIACANTONI et al. (1989, 1990), whereas the neighbouring areas by HAGEMAN 1977, KELLETAT et al. 1978, KOWALCZYK & WINTER 1979, KOUTSOUVELI 1987, KAMBERIS 1987, ZELILIDIS et al. 1988, FRYDAS 1990.

2. Geology
2.1. Alpine formations

In the major area of Messinia two alpine geotectonic units occur. The **Tripolis Unit** in the east and its equivalent Gavrovo-Pylos Unit in the west, which consists of neritic limestones - dolomits and flysch (Upper Eocene - Lower Miocene(?)), and the **Pindos Unit**, consisting of thinbedded multifoldet limestones, radiolarites and flysch. From geotectonic point of view, the Pindos Unit overthrusts the Tripolis Unit.

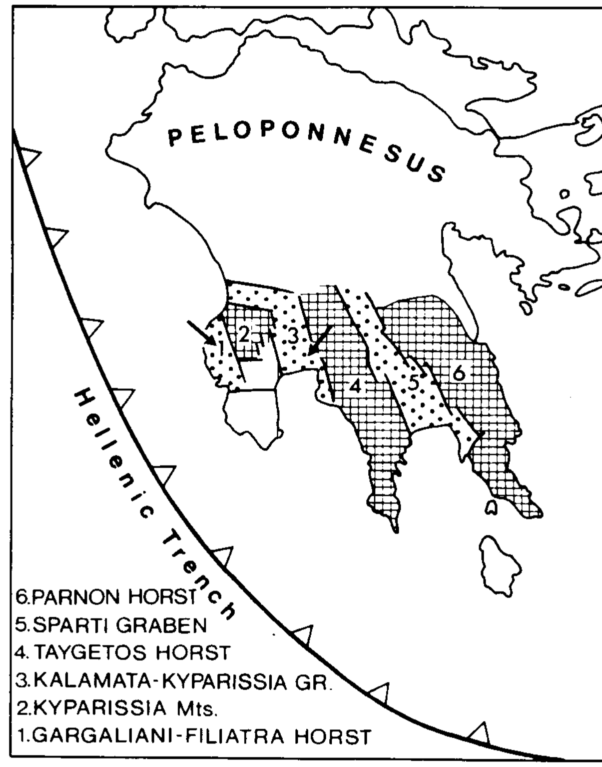

Fig. 1: Location map of the 1st order Neotectonic mega-structures.

2.2. Post-alpine formations

The post-alpine formations overlie unconformably the above mentioned alpine units and consist of marine and continental deposits.

The post-alpine marine sediments consist of marls, sandstones and conglomerates, the total thickness of which differs from place to place. The thickness of these sediments has been estimated, based on geophysical and geological data, to be more than 500 m near the city of Kalamata.

The overlying continental deposits consist mainly of red-coloured siliceous sands, sandstones and conglomerates which should be of Middle and Late Pleistocene age. The Holocene is represented by unconsolidated and consolidated alluvial deposits, clastic material and talus cones.

3. Lithostratigraphy
3.1. Western Messinia - The Filiatrino Rema Section

The Filiatra area is located about 80 km western of Kalamata (Fig. 4). The post-alpine sequences of the area consist of marl, marly sandstone, marly limestone, sandstone and conglomerate. These deposits feature a small inclination towards SW.

The lithological columns of 3 sections from different places along the Filiatrino Rema are given at Fig. 2. A great number of micro- and macrofossils, collected from these sediments, has been determined.

The sediments of the **Filiatra Formation** are rich in fossils. They contain planktonic and numerous benthic Foraminifera, numerous Bryozoans, infrequent Brachiopods, Bivalves, Gastropods, Scaphopods, tubes of Worms, Radiolaria, Ostracods, Echinoids, Porifera, Corals and Algae. Foraminifera and Mollusca dominate the fauna.

As also supported by sedimentological study, the whole faunal assemblage confirms a very shallow, high to low energy (conglomerate - sandstone - marl) inner shelf environment for this formation.

The rich micro- and macrofauna as well as the Algae collected from Filiatrino Rema confirm a Pleistocene age for the fossil bearing strata, particulary for the Low Head Member (Fig. 2: section horizons A_1, B_2, C: 1, 2, 4).

The Pleistocene age is based on the presence of the index Foraminifera *Globorotalia truncatulinoides* and *Hyalinea balthica* at the sections A, B and C of Fig. 2. *Gl. truncatulinoides* is collected from the sections: A, horizon 1; B, horizon 2; C, horizon 1, 2, 4. *Hyalinea balthica* comes from the section B, horizon 2.

It should be stressed here that the sequences of this area have been considered to belong to Late Pliocene. This consideration cannot be accepted now, because of the occurence of the species *Gl. truncatulinoides* and *H. balthica* which after BIZON & BIOZON (1984) appear for the first time at the Lower Pleistocene.

The majority of the taxa shows very wide stratigraphical ranges. A great part of the fauna is characteristic for Tertiary - Quaternary.

From the fossil assemblage, and especially from the characteristic Foraminifera, it is evident that, from the palaeogeographical point of view, the study areabecame gradually shallower from the lower members of the formation to the upper ones. This is based on the presence of *Hyalinea balthica* at the lower members of this formation and the frequent

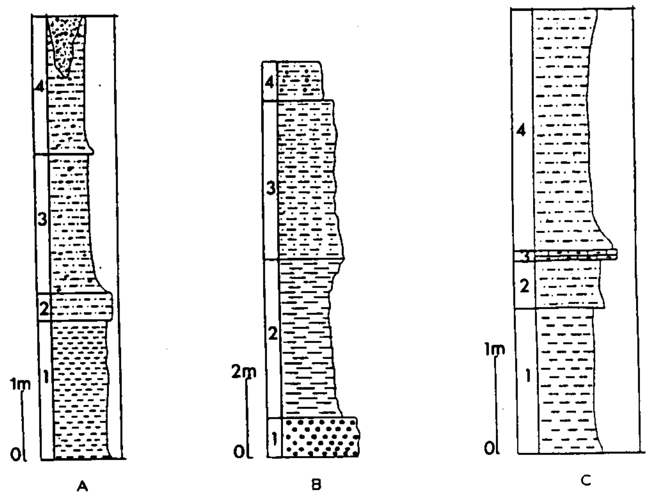

Fig. 2: Filiatrino Rema lithological sections.
A: 1: marl, 2: marly sandstone, 3: conglomerate-sandstone, 4: conglomerate.
B: 1: conglomerate, 2: yellow marl, 3: red sandstone, 4: porous sandstone.
C: 1: marl, 2 & 4: marly sandstone, 3: marly limestone.

presence of the Algae *Lithophyllum racemus* in the deposits of the upper members of the sequence (section A, horizons 1, 2, 4).

As it is known *H. balthica* flourishes in depths between 80 and 250 m (BIZON & BIOZON, 1984) whereas *L. racemus* prefers very shallow water. Concerning the palaeoclimatic conditions during the deposition of the above mentioned sequences, the fossil assemblages (colonial Corals, Bryozoans, Sponges, Molluscs) and bioactivity traces are indicative of temperate palaeoclimatic conditions.

Based on the above mentioned, the palaeogeographic conditions at Filiatra area during the Lower Pleistocene could be summarized as follows: (i) marine environment, (ii) relatively low sedimentation rates and (iii) shallow and temperate water.

3.2. Eastern Messinia, Thouria - Ano Amphia sections

The areas of Thouria and Ano Amphia are located at the eastern margin of the Kalamata - Kyparissia neotectonic megagraben, around 10 km north of Kalamata.

a. Thouria Section

It consists mainly of marls with intercalations of sands and sandstones. The sediments are rich in fossils, containing planktonic and numerous benthic Foraminifera, Bryozoans, Bivalves, Gastropods, Scaphopods, tubes of Worms, Ostracods, Echinoids, Porifera. The total thickness of the section measures 13 m (Fig. 3), and the beds dip about 15°-20° towards SW. The detailed analysis of the faunal assemblages of the section results in the following:

i. 2 m above the road, the Late Pliocene sediments outcrop (presence of *Globorotalia inflata* and characteristic macrofossils).

ii. 4 m above the road, the base of the Early Pleistocene (presence of *Hyalinea balthica*) is located.

The above mentioned indicate that:
- the sedimentation was continuous from Late Pliocene to Early Pleistocene.
- the environment was a shallow marine, low energy one. The latter indicates that the sedimentation should have taken place at a palaeo-bay area, open to the larger Kato (Lower) Messinia palaeo-gulf, but it was protected from the currents.

b. Ano Amphia section

It consists of sandstones and sandy marls with a total thickness of about 25 m (Fig. 3). The beds dip about 15°-20° towards SE. The sediments (mainly the upper members) are rich in fossils, with benthic Foraminifera being dominant. The designated fossils belong to macro- and microfauna: tubes of Worms, Radiolaria, Brachiopods, Bryozoans, infrequent Gastropods, Bivalves, Echinoids, Holothourians, Ostracods, Scaphopods, Porifera, Foraminifera (planktonic and benthic) and Algae.

Though the rich invertebrated fossils, and among them the *Flabellipecten flabelliformis*, *Terebratula ampulla*, *Cadulus* cf. *gadus* etc., are indicative of the Pliocene age, the presence of the benthic Foraminifera *Bulimina basispinosa* and *Marginulina cherensis* is an evidence for a Pleistocene age of the sequence. The occurrence of a great number of benthic Foraminifera as well as that of the Algae *Lithophyllum racemus* in the upper member of the sequence indicate more shallow, temperate sea water and low energy sedimentation. A detailed account of occurrence and palaeoclimatic significance has been presented by MARCOPOULOU-DIACANTONI et al. (1989, 1990).

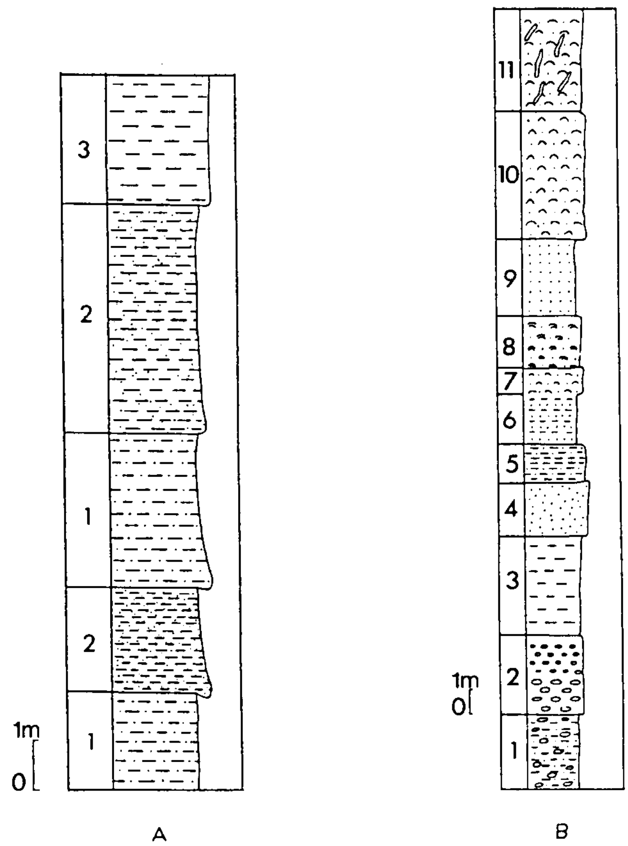

Fig. 3: Thouria - Ano Amphia lithological sections.
A: 1: marl, 2: marly sandstone, 3: compact marly sandstone.
B: 1: sandstone-conglomerate, 2: conglomerate with pebbles of yarying size, 3: marl, 4: marly sandstone, 5 & 6: compact marly sandstone, 7 & 10: sandy marl, 8: compact sandy marl, 9: sandy marl-sand, 11: sandy marl with calcite concrete.

4. Neotectonic Structure of Messina Area

The neotectonic structure of SW Peloponnesus is characterized by the presence of large grabens and horsts bounded by wide fault zones. Such big structures are the **Taygetos Mt.** megahorst, **Kalamata - Kyparissia** megagraben, **Gargaliani - Filiatra** megahorst and **Kyparissia Mts.** which represent a complex morphotectonic structure (Fig. 4).

At the margins and/or inside these 1st order neotectonic megastructures a great number of 2nd and 3rd order smaller structures (smaller horsts and grabens) are present, which trend either parallel or roughly perpendicular to these 1st order neotectonic megastructures.

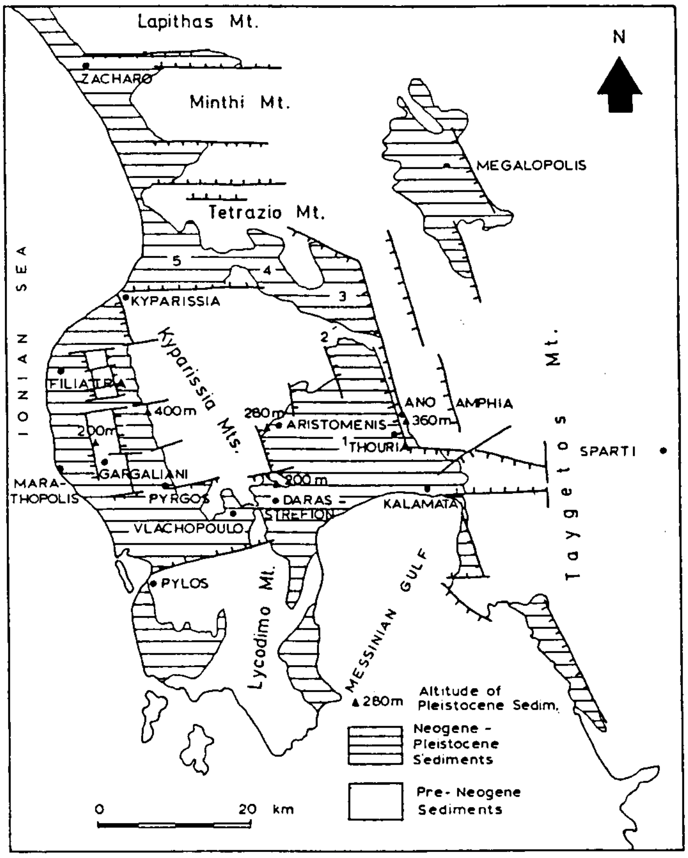

Fig. 4: 1st and 2nd order neotectonic macrostructures. The 2nd order neotectonic macrostructure of Kalamata - Kyparissia megagraben, 1: Kato (Lower) Messinia graben, 2: Meligala horst, 3: Ano Messinia graben, 4: Dorion basin, 5: Kyparissia - Kato Nero graben.

Inside the Kyparissa - Kalamata megagraben for example, the following 2nd order neotectonic macrostructures are distinguished (Fig. 4): (1) the Kato(Lower) Messinia graben, (2): the Meligalas horst, (3): the Ano Messinia graben, (4): Dorion basin and (5) Kyparissia - Kalo Nero graben.

The smaller order neotectonic macrostructures, from the dynamic point of view, are connected to each other, as they are located between two 1st order neotectonic macrostructures, one positive (horst) and one negative (graben) which resulted from the same stress field. On the contrary, from the kinematic point of view, they differ. This differentiation has appeared either very early, that is from the very first stages of their creation, or later, during their evolution (MARIOLAKOS et al., 1989).

The study area mainly deals with an E-W trending section crossing the following 1st order neotectonic macrostructures from W to E (Fig. 5):

(I) the Gargaliani - Filiatra megahorst,
(II) the Kyparissia Mts., which we consider as a synclinic graben structure,
(III) the Kyparissia - Kalamata megagraben.

5. Neotectonic - Kinematic Interpretation

As already mentioned, the **Filiatrino Rema** section belongs to the Gargaliani - Filiatra megahorst whereas the **Thouria - Ano Amphia** section to the eastern margin of Kato (Lower) Messinia graben. When the thrust movements terminated (Middle Miocene) the Messinia province emerged and the morphogenetic processes started. Thus, the area eastern of Kyparissia Mts. should have remained as a land up to the Middle Pliocene, while the area directly western of Kyparissia Mts. remainded as land until the Late Pliocene. This is concluded from the occurrence of Upper Pliocene marine deposits at the Thouria - Ano Amphia section while at the Filiatrino Rema section deposits of this age are absent. The area western of Kyparissia Mts. (Gargaliani - Filiatra megahorst) should possibly have been submerged during the Late Pliocene, but the Upper Pliocene sediments are in deeper points and therefore are not visible.

Therefore, since at least the end of Pliocene the whole Messinia province (Gargaliani -Filiatra megahorst, Kyparissia Mts., Kalamata - Kyparissia megagraben) should be under subsidence. This regime may have started earlier. That means that during the Late Pliocene the margins of Kato (Lower) Messinia graben were gradually subsiding below the sea level, whereas at the same time the Gargaliani - Filiatra megahorst continued to be above the sea level.

Marine sediments, mainly of coastal facies, were deposited on a well-formed palaeorelief in the Kato (Lower) Messinia graben. We believe that, in this graben, the sedimentation was continuous from Late Pliocene up to the end of Early Pleistocene, while in the Gargaliani - Filiatra megahorst it was continuous at least during the Early Pleistocene. For this area it is difficult to be proved if the transition from Pliocene to Pleistocene was continuous, as the upper limits of the Pliocene sequences do not outcrop here.

The palaeoecologic data (based on the fossil assemblages) of Kato (Lower) Messinia graben indicate that during the Late Pliocene the sedimentation took place in depth up to 80-100 m (presence of *Pyrgo depressa, Bigenerina nodosaria, etc.*).

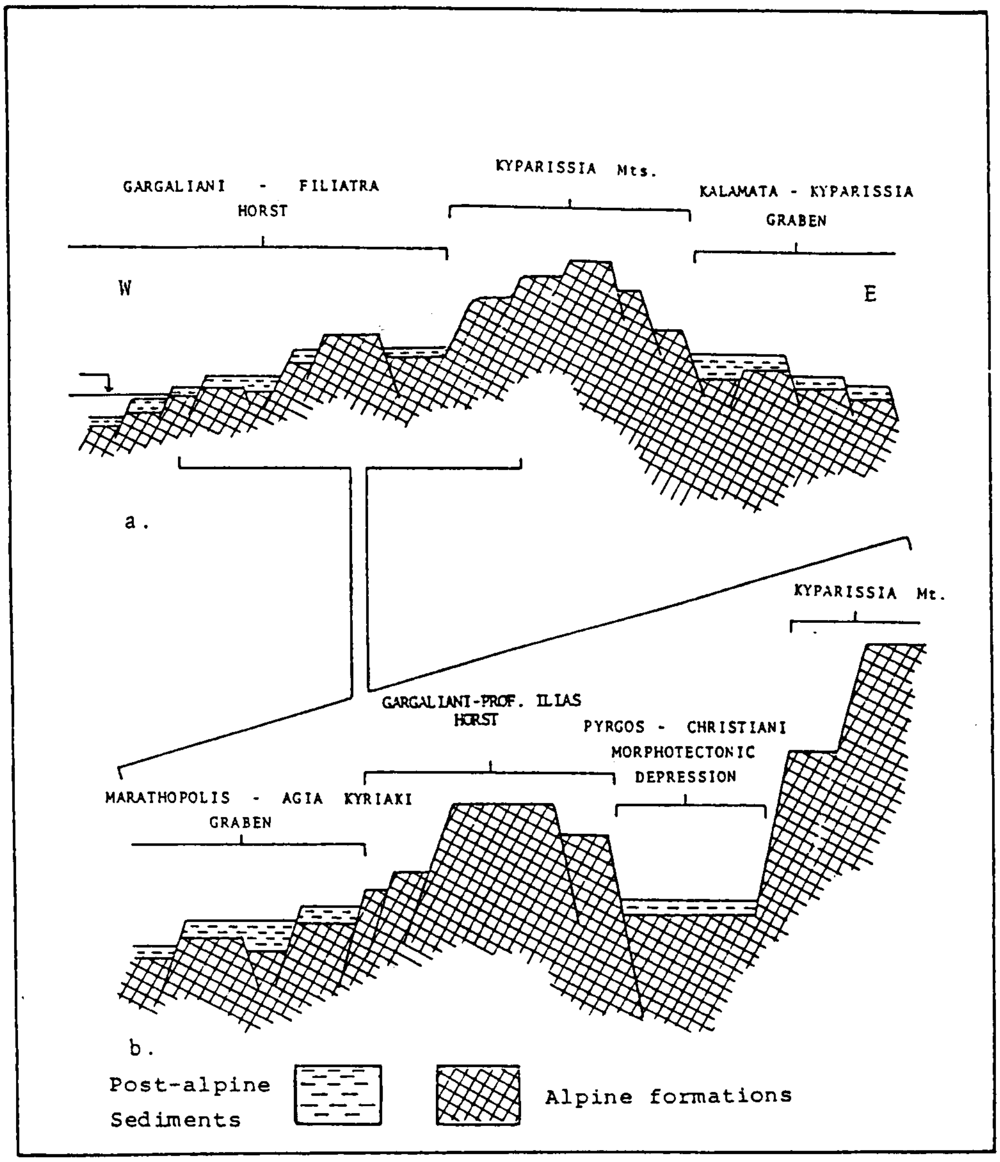

Abb. 5: Schematic cross sections.
a. 1st order Neotectonic megastructures. b. 2nd order Neotectonic macrostructures.

At the first stages of the sedimentation during the Early Pleistocene, the sedimentation should have taken place at depths of about 50-80 m (presence of *G. truncatulinoides* and *H. balthica*), while the presence of the algae *Lithophyllum racemus* in the upper horizons of the sediments indicates that the sedimentation should have taken place at shallower-depths, namely at 10 - 60 m in both areas. This is an indication that somewhere in the middle of the deposition time the subsidence at the depositional area was decreasing, becoming progressively more stable until the filling up of the basin with sediments.

The subsidence regime, therefore, did not change abruptly to an uplifting one, but this shift passed through a phase of relative constancy.

The uplifting regime was followed by the regression of the sea that resulted in the occurrence of the Lower Pleistocene marine deposits at the present-day altitude of 400 m, at the western slopes of Kyparissia Mts., whereas at the eastern slopes of the same mountains they occur at an altitude between 200 m and 280 m. In the area of Thouria-Ano Amphia (eastern margin of Kato (Lower) Messinia graben) they occur at an altitude of 360 m (Fig. 4).

The above mentioned data allow the estimation of the order of the mean subsidence rate during the sedimentation (Lower Pleistocene) and the mean uplift rate during the phase of uplift. To calculate the mean rates of subsidence and uplift, the following must be taken into account in addition to the above mentioned:

(I) the visible thickness of the Lower Pleistocene marine sediments which is 150 m in both sections.

(II) we have ascertained, in the area of Messinia, that at least 100 m thickness of Lower Pleistocene marine deposits have been eroded (Ano Amphia). In order to estimate the mean subsidence rate, therefore, we have to take into account that the whole thickness of the Lower Pleistocene marine deposits is more than 150 m at the western area (Gargaliani - Filiatra megahorst) and 250 m at the eastern area (Kato (Lower) Messinia).

(III) we accept that these deposits have been uplifted up to around 500 m of altitude at the western slopes of Kyparissia Mts. and around 250 m at its eastern slopes, whereas at the eastern margin of Kato (Lower) Messinia graben (Ano Amphia) the marine Pleistocene deposits have been uplifted up to an altitude of around 450 m.

(IV) the disagreements about the timing of the Pliocene - Pleistocene boundary are well known. Some of the researchers accept that it is 2.4 Ma and others 1.6 Ma or in some intermediate timings. For our calculations we have accepted the Pliocene - Pleistocene boundary to be at 1.6 Ma.

(V) the global climatic changes are well known during the transition from Pliocene to Pleistocene. Therefore, the decrease of the sea depth could be attributed to eustatic movements, but (1) as the fossil assemblage indicates that they could live in sub-tropic climatic conditions, and (2) as we observed a widespread transgression of the lower pleistocene sea, we believe that the changing of the sedimentation conditions was due mainly to tectonic activity.

Taking into account the above mentioned, we tried to calculate the **mean subsidence rates** Vs for the western and eastern areas of Kyparissia Mts., which are the following:

(Filiatra area)

$$Vs1 = \frac{150.000 \text{ mm}}{800.000 \text{ y}} = 0.19 \text{ mm/y}$$

(Ano Amphia area)

$$Vs2 = \frac{250.000 \text{ mm}}{800.000 \text{ y}} = 0.3125 \text{ mm/y}$$

Therefore, the mean subsidence rates are in the order of 0,2 mm/y and 0,3 mm/y for the Filiatra and Ano Amphia areas respectively.

The **mean uplift rates Vu** for the areas western and eastern of Kyparissia Mts. and the area of Ano Amphia are:

(Filiatra area)

$$Vu1 = \frac{500.000 \text{ mm}}{800.000 \text{ y}} = 0.625 \text{ mm/y}$$

(Aristomenis area)

$$Vu2 = \frac{380.000 \text{ mm}}{800.000 \text{ y}} = 0.475 \text{ mm/y}$$

(Daras - Strefion area)

$$Vu3 = \frac{300.000 \text{ mm}}{800.000 \text{ y}} = 0.375 \text{ mm/y}$$

(Ano Amphia area)

$$Vu4 = \frac{450.000 \text{ mm}}{800.000 \text{ y}} = 0.56 \text{ mm/y}$$

Thus, the western edge of Kyparissia Mts. was under uplifting regime since the end of Early Pleistocene (0.8 Ma) with a 0,6 mm/y mean rate, while the eastern edge was uplifted with a mean rate of about 0,425 mm/y. In other words, the western edge of Kyparissia Mts. was uplifted with 0,2 mm/y higher rate than the eastern one (Fig. 6).

The eastern margin of Kato (Lower) Messinia graben was uplifted with a mean rate of 0,55 mm/y. That means 0,07 mm/y lower rate than the western edge of Kyparissia Mts..

Taking into account in addition that the Upper Pliocene (?) marine deposits occur at altitudes of not more than 300 m in the Sparti (Evrotas River) megagraben (eastern of Taygetos Mt.), the following can be suggested:

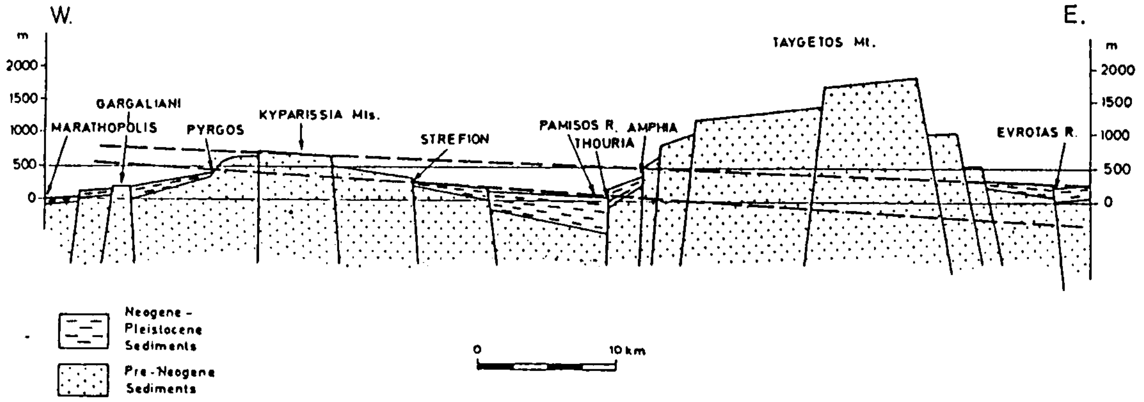

Fig. 6: Schematic cross sections of the two main neotectonic units.
Dashed lines: Theoretical lines connecting the upper limits of the L. Pleistocene marine deposits at Taygetos Mt. (1) and Kyparissia Mts. (2).

I. That two main neotectonic units, Kyparissia Mts. and Taygetos Mt., behave from the kinematic point of view as tectonic dipoles rotating towards east around a rotational axis trending NNW-SSE.
II. Based on other evidences, as morphological (MARIOLAKOS, 1986), geological and tectonical (MARIOLAKOS et al., unpublished papers), the rotational axis of the Kyparissia Mts. neotectonic unit plunges towards SSE, whereas that one of Taygetos Mt. neotectonic unit plunges toward NNW.III. The rotation along the cross section depected on Fig. 6 is more intensive at Kyparissia Mts. compared to the rotation of Taygetos Mt. (compare line (1) and line (2) of Fig. 6).

In this point, we would like to underline that the upper limit of the marine Pleistocene deposits outcrop at different levels at the eastern margin of the Kato (Lower) Messinia graben and especially that the altitude of the upper limits becomes gradually lower towards North. Therefore, the three-dimensional kinematic is more complicated than the above described as the neotectonic deformation is not only of brittle type but it is of brittle - ductile type (MARIOLAKOS & FOUNTOULIS, 1990).

6. References

BIZON, G. & BIOZON, J.J., (1984): Ecologie des microorganismes en Mediterranne occidentale "ECOMED".- Assoc. Fr. Techn. Petr.; Paris.

FRYDAS, D. (1990): Plankton-Stratigraphie des Pliozäns und unteren Pleistozäns der SW-Peloponnes, Griechenland.- Newsl. Stratigr., **23** (2): 91 - 108; Berlin - Stuttgart.

HAGEMANN, J. (1977): Stratigraphy and sedimentary history of the Upper Cenozoic of Pyrgos area (Western Peloponnesus, Greece.). - Ann. Geol. Pays Hellen., **28**: 299-333; Athens.

KAMBERIS, E. (1987): Geological and Oil-geological study of NW Peloponnesus.- Ph. D. thesis, Technical Univ.; Athens (In Greek).

KELLETAT, D., KOWALCZYK, G., SCHRÖDER, B. & WINTER, K.-P. (1978): Neotectonics in the Peloponnesian coastal regions.- Alps, Apennines, Hellenides. Inter-Union Commission on Geodynamics, **38**: 512-518; Stuttgart.

KOUTSOUVELI, A. (1987): Etude stratigraphique des formations Pliocenes et Pleistocenes en Messenie occidentale (Peloponnese, Grece).- These Univ. d' Aix - Marseille, II, 162 p.; Luminy.

KOWALCZYK, G. & WINTER, K.-P. (1979): Neotectonic and structural development of the southern Peloponnesus.- Ann. Geol. Pays Hellen., Tome hors ser. **1979**, fasc. II, p. 637-646; Athens.

MARCOPOULOU-DIACANTONI, A., MIRKOU, M.-R., MAIOLAKOS, I., LOGOS, E., LOZIOS, S. & FOUNTOULIS, I. (1989): Stratigraphic observations at the post-alpine sediments of Thouria - Ano Amphia area (SW Peloponnesus, Greece) and their neotectonic interpretation.- Bull. Geol. Soc. Greece, **23** (3): 275-295; Athens (In Greek).

MARCOPOULOU-DIACANTONI, A., MIRKOU, M.-R., MARIOLAKOS, I. & FOUNTOULIS, I. (1990): Stratigraphic and paleogeographic observations at the post-alpine sediments of the Filiatra area (SW Peloponnesus, Greece), and their neotectonic interpretation.- 5th Congr. of the Geol. Soc. Greece, May 1990, Abstracts p. 78.

MARIOLAKOS, I. (1986): Beitrag zur morphotektonischen Entwicklung der Becken von Ano Messinia, Dorion und Kyparissia (Peloponnes). - Salzburger Exkursionsber., **10**: 159-184.

MARIOLAKOS, I., FOUNTOULIS, I., LOGOS, E. & LOZIOS, S. (1989): Surface faulting caused by the Kalamata (Greece) earthquakes (13-9-1986).- Tectonophysics, **163** (1989): 197-203, Amsterdam.

MARIOLAKOS, I. & FOUNTOULIS, I. (1990): Neotectonic macrofolds at the Filiatra area (SW Peloponnesus, Greece).- 5th Congr. of the Geol. Soc. Greece, May 1990, Abstracts p. 53.

ZELILIDIS, A., KONTOPOULOS, N. & DOUTSOS, TH. (1988): Geological cross section at the neogene and quaternary deposits of SW Peloponnesus.- Bull. Geol. Soc. Greece, **20** (2): 149-166; Athens (In Greek).