

RECONSTRUCTION OF THE EARLY PLEISTOCENE PALEOSHORE AND PALEORELIEF OF SW PELOPONNESUS AREA

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ABSTRACT

Based on (i) the distribution of the Pleistocene marine deposits around the Kyparissia and Pylos mountains, (ii) the absolute altitude of the boundaries between the pleistocene marine deposits and the alpine formations and (iii) the deformation of the study area during and after its uplifting (last 0.8 Ma), the paleo-relief and paleo-shore configuration was reconstructed. Additionally, the comparison between the present day relief and that of Early Pleistocene.

1. INTRODUCTION

The SW Peloponnesus (Messinia) is one of the most active areas in the Hellenic Arc, as it lays at a very short distance (about 60km) from the Ionian trench, where the collision between the African and Eurasian plate occurs (Fig. 1).

By the end of the thrust movements (Middle Miocene), the largest part of the area is land and the morphogenic procedures begin. Therefore the biggest part of the study area remains land until the Late Pliocene. During Early-Pleistocene, when the sea transgression reaches its biggest extent, from the geotectonic point of view, the mountains of Kyparissia and Pylos belong to the island arc (MARCOPOULOU - DIACANTONI et al., 1989, 1991). By the end of Early-Pleistocene the area starts uplifting a new.

This paper attempts (i) a reconstruction of the figure of the paleo-relief and paleo-shore at Kyparissia and Pylos areas during Early-Pleistocene, (ii) the comparison between today's relief and that of Early-Pleistocene.

For the reconstruction of the map of paleo-shores and paleo-relief the following elements were taken into account:

- i. the distribution of the Pleistocene marine deposits around the Kyparissia and Pylos mountains
- ii. the absolute altitude of the boundaries between the Pleistocene marine deposits and the alpine formations
- iii. the deformation of the study area during and after its uplifting.

2. GEOLOGY

2.1 The post alpine deposits

The post-alpine deposits are distinguished into marine and terrestrial deposits.

The marine deposits

The marine sediments lie unconformably, over a well formed paleo-relief

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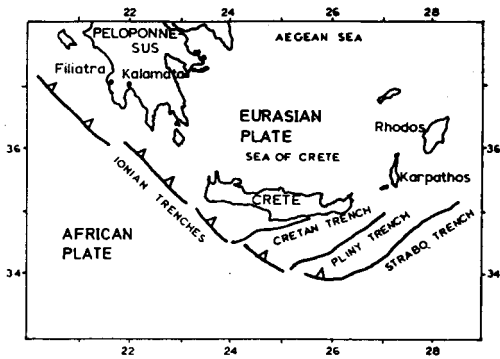


Fig.1: Location map

of the alpine formations and represent deposits of shallow marine phase (MARCOPOULOU-DIACANTONI et al., 1989, 1991). They consist of calcitic sandstones, marly sandstones, marls and conglomerates of different thickness from place to place. The age of these deposits should be considered mainly of Early-Pleistocene, although at some positions e.g. Ano Amphia, the Upper-Pleiocene has been confirmed (PSONIS, 1986, PERRIER 1980).

The terrestrial deposits

They consist mainly of conglomerates, red-coloured siliceous sands and sandstones. The age of the red-coloured siliceous sands, which overlay unconformably the marine post-alpine deposits, is most likely of Middle and Upper Pleistocene. Holocene is being represented by loose and cohesive talus slope screes.

2.2 Alpine formations

The Alpine formations can be distinguished to the following geotectonic units:

- i. Gavrovo - Pylos and Tripolis Units, consisting of neritic carbonates and clastic sediments of flysch.
- ii. Pindos Unit, consisting mainly of multifolded thinbedded pelagic limestones, radiolarites and clastic sediments of flysch.

From the geotectonic point of view, Pindos Unit is the upper tectonic nappe of the area, overthrusting Tripolis Unit.

3. TECTONICS - NEOTECTONICS

The Neotectonic structure of the greater area of SW Peloponnese is characterised by the presence of tectonic grabens and tectonic horsts (1st order structures) striking NNW-SSE and E-W (MARIOLAKOS et al. 1987). Such 1st order neotectonic macro-structures are e.g. the Kalamata - Kyparissia graben, the Vlachopoulos graben, the Gargaliani - Filiatra horst, the complex morphotectonic unit of Kyparissia Mts. the complex tectonic horst of Lycodimon Mt. (Fig. 2). At the margins or inside the 1st order neotectonic macrostructures, neotectonic structures of minor order (2nd, 3rd, ...) exist, the strike of which is perpendicular or parallel to the trends of the 1st order ones. All these macrostructures are connected together dynamically, as they are the result of the same stress field, whereas from the kinematic point of view, there are differences which appears either at the primary stage of their creation or during their evolution (MARIOLAKOS et al., 1989).

Such 2nd order neotectonic macro-structures inside the major Kalamata - Kyparissia graben are the following : (Fig. 2)

1. Kato Messinia graben
2. Meligalas horst
3. Ano Messinia graben
4. Dorion basin

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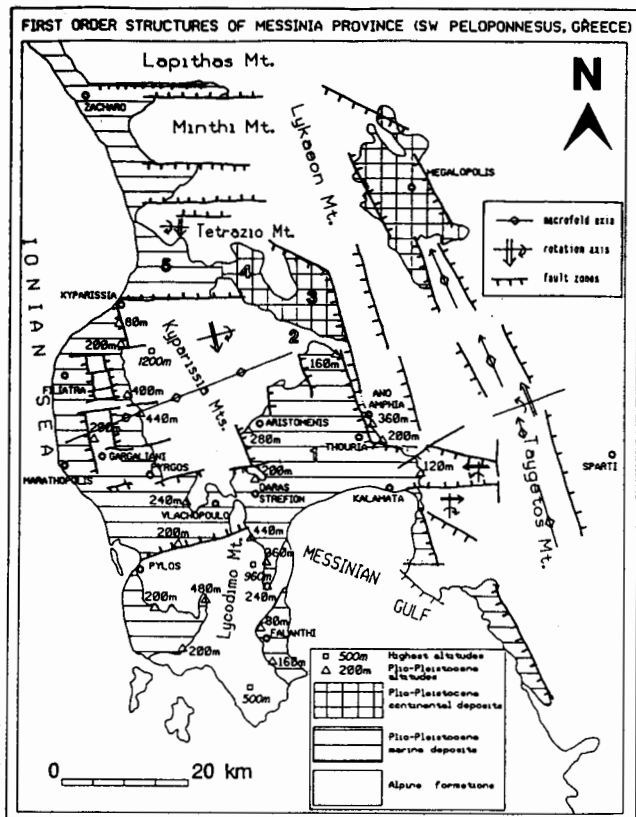


Fig. 2: 1st and 2nd order neotectonic macrostructures. The 2nd order neotectonic macrostructure of Kalamata-Kyparissia graben are : 1: Kato Messinia graben, 2: Meligala horst, 3: Ano Messinia graben, 4: Dorion basin, 5: Kyparissia-Kalo Nero graben.

The **Taygetos Mt.** is a horst whereas the **Kyparissia Mts.**, although topographically is a high area from the tectonical point of view, in its greater part is a graben (MARIOLAKOS & FOUNTOULIS, 1991).

A more detailed study on the neotectonic deformation of the area of Taygetos Mt., Kyparissia Mts. and Filiatra horst, has shown that the deformation is not simply of brittle but of brittle-ductile type, as there have been created folds of big curvature radius (MARIOLAKOS & FOUNTOULIS 1991). Consequently, the Taygetos Mt. must be considered as a neotectonic anticlinal multifaulted mega horst, based among others on the fact that the carbonates of the Tripolis Unit dip towards East at the eastern margins of the horst and towards west on the western margins respectively. The Kyparissia Mts. is more complicated compared to the Taygetos Mt.

The Pleistocene marine deposits distribution at various levels to the south, makes the three dimensional kinematic interpretation more complicated.

We consider that the morphogenetic procedures should have started after the end of the thrust movements. The greater part of the study area remained land

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5. Kyparissia - Kalo Nero graben

MARIOLAKOS et al. (1994) interpret the kinematic evolution of the Messinian peninsula after the end of Early Pleistocene, taking into account :

- i. the phase, and the thickness of the post alpine deposits
- ii. the present day outcropping altitude of the post alpine marine sediments.

According to these researchers, the area is dominated by two big neotectonic units, the Kyparissia Mts and the Taygetos Mts, which from the kinematic point of view, they function as "tectonic dipoles" having undergone a very complicated rotation around more or less E-W and NNW-SSE trending axes, that is:

- i. The **Taygetos Mt.** has been rotated towards NNW and in the same time towards E.
- ii. the **Kyparissia Mts.** have been rotated towards SSE and in the same time towards E.

until Late Pliocene, when gradually started to sink. Hence, the margins of the mountainous area have started to submerge partially in Early Pleistocene. So that during this period great parts of the Messinian peninsula was submerged under the sea level.

The marine sedimentation continued during Lower Pleistocene which is the period that the sea transgression reached its greatest extent. Lower Pleistocene has been designated in many positions of the Messinia peninsula by the presence mainly of *Hyalinea balthica* (KOUTSOVELI 1987, MARKOPOULOU - DIACANTONI et al., 1989, 1991, FRYDAS 1990).

From Middle - Pleistocene on, the regime of subsidence turns to regime of uplifting, thus the area becomes again land. There is no evidence if this change was gradual or abrupt. It is possible that there was a period of relative constancy during which, the basins filled up with sediments gradually resulting in the lowering of their depth. The palaeo-ecologic data show that the marine sedimentation was carried out in shallow and warm waters. The sedimentation was continuous during the period between the Late Pliocene and the Latest Early Pleistocene (MARKOPOULOU-DIACANTONI et al. 1989).

4. DESCRIPTION OF THE METHODOLOGY

This paper is an attempt of reconstruction of the palaeo-shore of the Messinian gulf, as well as of the palaeo-morphology of the Kyparissia and Pylos Mts; therefore its precision can not be high. The precision problems which arise are two and related to each other: The first one is the mapscale (1/100.000) and the second one is the reconstruction of the countouring of the deformation.

The map scale is very small, but it could not be bigger, (a) because of the dimensions of the study area, and (b) the fact that the study and mapping of the Plio-Pleistocene marine deposits is not yet completed at big scale. Therefore, the biggest scale of geologic maps that could be used for collecting information was that of 1/50.000 (geological maps of I.G.M.E.). As a result of that scale was the construction of curves of equal quantity of deformation every 100m and not less.

The method for the construction of the paleogeomorphological map follows the next steps:

1. The topographic map of the study area was made at the scale 1/100.000 with contour intervals 200 m. based on the topographic maps scale 1/100.000 of: a) Filiatra sheet, b) Pylos sheet, and c) Kalamata sheet.

2. The geological map of the study area at the scale 1/100.000 was made based on: a) the Neotectonic map of Greece, Filiatra sheet (1/100.000, EPPO), b) the geological maps of Greece, Koroni-Pylos-Schiza and Kalamata sheets (scale 1/50.000, IGME),

3. On a transparency of the topographic relief of the study area which overlay the geological map, all intersection points of the boundaries between the Lower Pleistocene marine sediments - alpine formations marked. Based on this map contour lines were traced.

4. The "curve 0" represents the paleoshore of Messinia area during the Early Pleistocene by taking into account the erosion that has taken place since then, that is the period since theretrat of this area.

5. After the reconstruction of the palaeo-shorelines, all points of the same uplift amount were joined together by contour curve lines. By this way the contour lines of the same vertical movements have been constructed ignoring the local erosion, that has taken place since the regression of the Uppermost

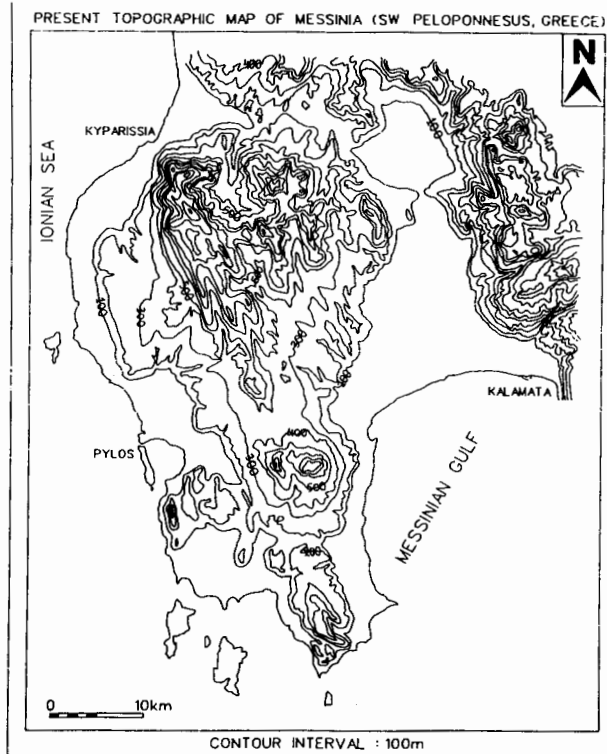


Fig. 3: Present topographic map of Messinia

by faulting have not taken into account. In this way the paleo-shoreline as well as the paleorelief of the western Messinia area is restored.

5. DISCUSSION - CONCLUSIONS

A. The Present day relief

Observing the relief of the topographic map, we see that Messinia is dominated by some mountains as well as large areas of low relief. (Fig. 3). The most important mountains are the Kyparissia Mts., the Kalamata Mts. and Pylos Mts. The Kyparissia Mts are a complex neotectonic structure which has a triangular shape at its development. The distribution of the altitudes is indicative of their neotectonic deformation. Their highest altitude appears at the NW part (1200m), while at the NE the altitude is reduced gradually to almost 1000m. At the SW part their altitude is 600m while at the SE their altitude is very low: 200m. The greatest vertical displacement is related to the hinge line of the anticlinal macrofold at the Filiatra - Gargaliani area, which has been described by MARIOLAKOS & FOUNTOULIS, 1991 (Fig. 2).

The " Kalamata " Mts. (highlands E and NE of Kalamata) are developed at the margin of Kalamata-Kyparissia tectonic graben and they form the intermediate structures to the Taygetos tectonic horst. The highest altitude appearing at the area is 1200m.

The Pylos Mts (Lycodimo Mt. & Mavrovouni Mt.) are the only exceptions at the generally smooth relief of the peninsula. The Lycodimon Mt. (960 m) is the biggest mountainous bulk of the area. The altitude of Mavrovouni Mt. is about 500m.

Early(?) Pleistocene.

6. On a transparency the intersection points between the contour lines of the same vertical movements and the topographic contours were marked. The altitudes of these points during the transgression period of the Early Pleistocene is estimated by subtracting the amount of the vertical displacement from the topographic contours. By this way a map full of such points is produced.

7. The last step is to join all points of the same altitude, that means we produce the paleo-contours of the transgression period of the Early Pleistocene. In this way the last stage of of the neotectonic deformation which is expressed by vertical displacement is subtracted. At this point, it is worth to note that we consider the deformation as continuous, that means that abrupt displacements caused

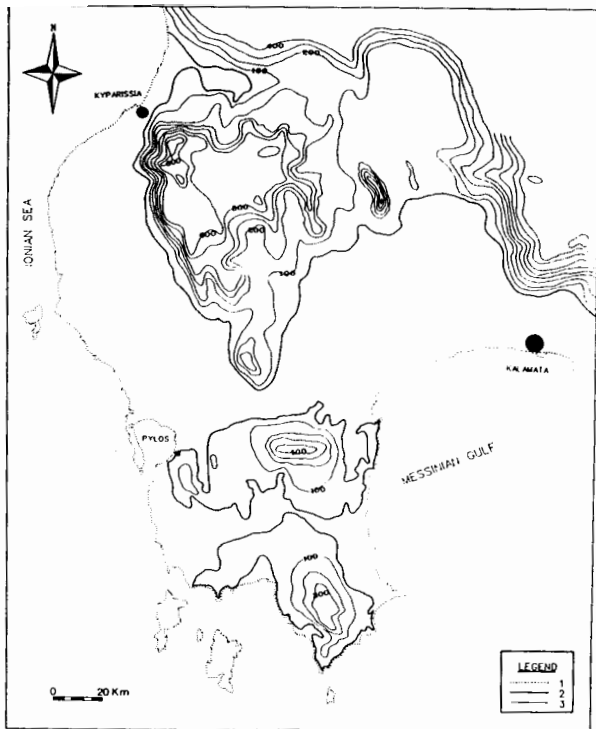


Fig. 4: The early Pleistocene shorelines and morphology of Messinia. 1: Present-day shore -line, 2: Pleistocene shore-line, 3: Pleistocene contour.

altitude is about 200m.

B. The relief of the Early Pleistocene geomorphology

From the map of Fig. 4, on which the present shorelines and that of the Early Pleistocene are depicted it follows that the present day Pylos Peninsula was a separate island and most probably more than one during the Early Pleistocene. The lack of more detailed geological maps reduce the accuracy of the paleoshore configuration.

The present day convex shape of the shoreline, from Kyparissia to Pylos should not be existed in Early Pleistocene times. This shape is probably connected to the deformation of the uplifting period.

An important difference appears also at the relief, which is more intense at the Kyparissia Mts. and the Lycodimon Mt. The differentiations between the relief of Early Pleistocene and that of today's are due to the deformation of the area after the Middle Pleistocene, during which the tectonic regime changed.

The highest altitudes of the Kyparissia Mts. occur at their NW part. The highest present day altitude is about 1200m., whereas during Lower Pleistocene their altitude was no more than 800 m. The uplifting of that part is at least 400m. The same uplifting occurs also at the NE part of the mountains where the altitude was 600m, while that of the present day is about 1.000 m.

The uplifting of the SW part is relatively smaller, it is about 300m. The relief of the western part was sharper than that of today's, whereas that one of the eastern part was smoother.

At Pylos peninsula the relief was smooth just like that of today. **Lycodimo Mt.** and **Mavrovouni Mt.** might probably have been two separate islands. At this

Around the mountains, areas of low altitude are developed. The most characteristic one is the basin of Kalamata-Kyparissia tectonic graben. It is narrow strip of land of average altitude less than 100m, which connects the Messinian gulf to the Kyparissia bay.

The Vlachopoulo graben is developed southern of the Kyparissia Mts, with an average altitude about 200m. Western of the Kyparissia Mts., the Marathopoli-Ag. Kyriaki basin with altitudes less than 200m; and the Pyrgos-Christiani basin with altitudes varying from 200 to 400 m are developed.

Around the Pylos Mts. the basins of eastern & western Pylos are developed. The relief of western Pylos basin is very smooth and its average altitude is about 100m. The relief of the eastern Pylos basin is more intense than the western one and its average

point it should be stated that FYTROLAKIS 1971 has observed many remnants of Pleistocene (?) marine deposits around the Lykodimo and Mavrovouni mountains. **Lycodimo Mt. - island** was a low mountain of an altitude just above 400m, while the today's one is 960m. Its exact altitude can not be estimated. Its uplifting is about 400m, as it follows from the distribution of the Pleio- Pleistocene sediments. The altitude of **Mavrovouni Mt. - island** was about 300m. That means, that the altitude difference between Lycodimo Mt. and Mavrovouni Mt. during Lower Pleistocene was very little, whereas the today's difference is about 400m. That means, that the period since Middle Pleistocene, Lycodimo Mt. has been uplifted much more than Mavrovouni Mt.

The mountains east of Kalamata have undergone deformation of different type in comparison with that of the Kyparissia Mts. Their highest altitude was about 900m, for the study area, whereas the today's one is 1200m. The uplifting of the area is about 400m at least, but its distribution, though not the same from area to area, has taken place in a different way than that of the Kyparissia Mts.

This is connected with the complicated faults kinematic of the Kyparissia graben.

From the map of Fig. 4 it is inferred that the palaeo-gulf of Messinia was connected to the paleo-gulf of Kyparissia with a narrow land strip of an altitude of about 100 m; in other words during the Early Pleistocene a palaeoisthmus existed in the area between the village of Kato Kopanaki and Meligalas, connecting the Kyparissia Mts. and the rest Peloponnesus. The Kyparissia Mts during that time was a narrow peninsula totally separated from Lykodimon Mt. and Pylos Mts.

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