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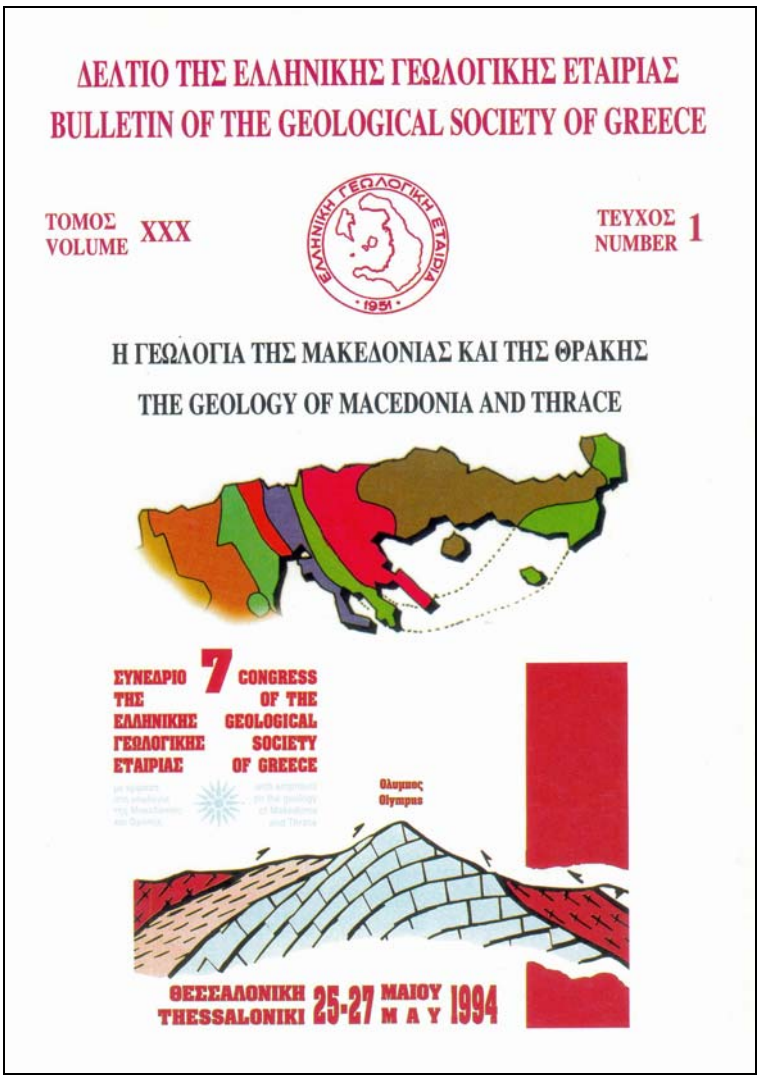

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RECONSTRUCTION OF THE EARLY PLEISTOCENE PALEOSHORE AND PALEORELIEF OF SW PELOPONNESUS AREA

By
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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 Mα), 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 Ear1y-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 a1., 1989,1991). By the end of Ear1y-Pleistocene the area starts uplifting a new .

This paper attempts (i) a recostruction of the figure of the paleo-relief and paleo-shore at Kyparissia and Pylos areas during Ear1y-Pleistocene, (ii) the comparison between today's relief and that of Ear1y-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 Pyloss 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.

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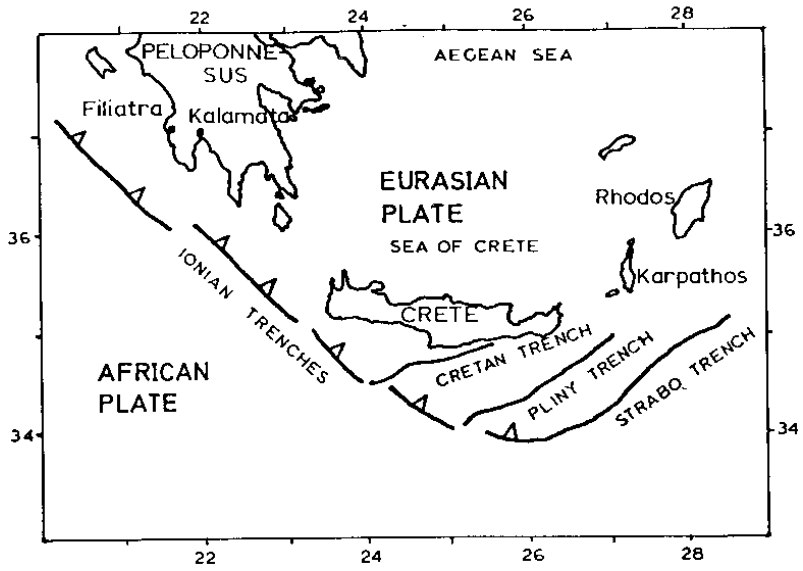

Fig. 1 Location map

The marine deposits

The marine sediments lie unconformable, over a well formed paleo-relief of the alpine formations and represent deposits of shallow marine phase (MARCOPOULOU-DIACANTONI et a1., 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 Ear1y-Pleistocene, although at some positions e.g. Ano Amphia, the Upper-Pliocene 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 unconformable the marine post-alpine deposits, is most likely of Middle and Upper Pleistocene. Loose and cohesive talus slope scree are representing Holocene.

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 Peloponnesus is characterised by the presence of tectonic grabens and tectonic horsts (1st order structures) striking NNW-SSE and E-W (MARIOLAKOS et a1. 1987). Such 1st order neotectonic macro-structures are e.g. the Kalamata - Kyparissia graben, the Vlachopoulo graben, the Gargaliani - Filiatra horst, the complex morphotectonic unit of Kyparissia Mts. the complex tectonic horst of Lycodimon Mt. *(**Fig.** **2**)*. Aı 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 ροίηI ofview, 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. Dorioη basin
5. Kyparissia - Kalo Nero graben

MARIOLAKOS et a1. {1994) interpreted the kinematic evolution ofthe Messinian peninsula after the end of Early Pleistocene, taking into account :

i. the facie, and the thickness of the post alpine deposits
ii. the present day outcroping altitude of the post alpine maήne 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 ίη the same time towards E.
ii. the **Kyparissia Mts.** have been rotated towards SSE and ίη the same time towards E.

The **Taygetos Mt**. is a horst whereas the Kyparissia Mts., although topographically is a high area from the tectonic 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). Consequent1y, the Taygetos Mt. must be considered as a neotectonic anticlinal multifaulted mega horst, based among others oη the fact that the carbonates of the TήPOIís Unit dip towards East at the eastem marginS ofthe horst and towards west on the westem 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 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* (KOUTSOUVELI 1987, MARKOPOULOU - DIACANTONI et a1., 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 Ear1y Pleistocene (MARKOPOULOU-DIACANTONI et al. 1989).

4. DESCRIPTION OF THE METHODOLOGY

This paper is an attempt of reconstructioη of the palaeo-shore of the Messinian gulf, as weII as of the palaeo-morphology of the Kyparissia and Pylos Mts; therefore its precision cannot be high. The

precision problems which aήse are two and related to each other: The first one is the map scale *(1/1*00.000) and the second one is the reconStruction of the couŋtouήŋg 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 100 m and not less.

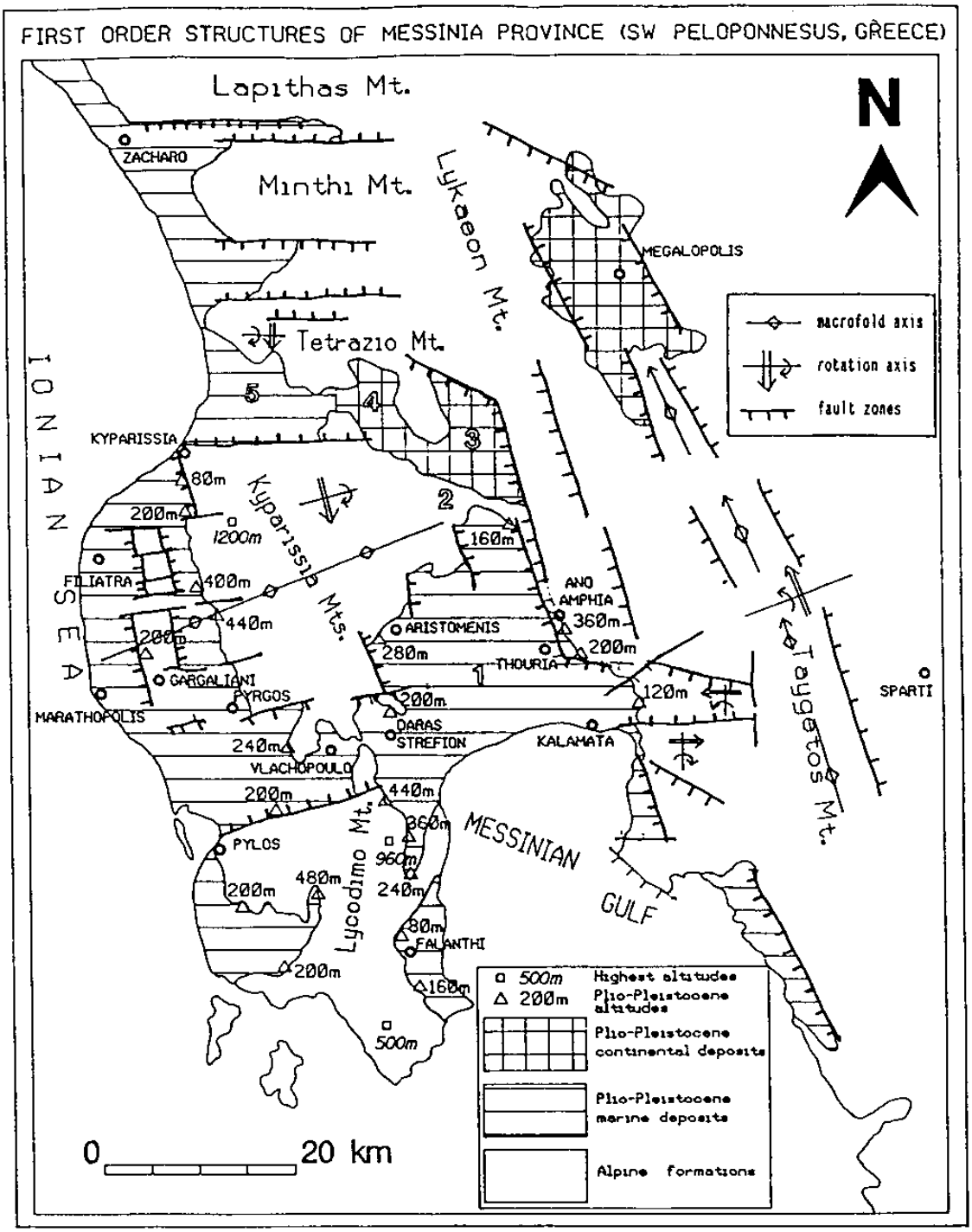

Fig. 2. 1st and 2nd order neotectonic macrostructures. The 2nd order neotectonic macrostructure of Kalamata-Kyparissia graben are : 1: Kαto Messinia graben, 2: Meligala horst, 3: Ano Messinia graben, 4: Dorion basin, 5: Kyparissia-Kalo Nero graben.

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 rn 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 ignoringiŋg the local erosion, that has taken place since the regression of the Uppermost Ear1y(?) 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 Ear1y Pleistocene are 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 Ear1y Pleistocene. In this way the last stage 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 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 some mountains as well as large areas of low relief dominate Messinia. *(**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 lIow; 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 appeaήŋg 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 bu1k of the area. The altitude of Mavrovouni Mt. is about 500m.

Around the mountains, areas of low altitude are developed. The most characteristic ήone is the basin of Kalamata-Kyparissia tectonic graben. It is narrow strip of land of average altitude less than l00m, which connects the Messinian gulf to the Kyparissia gulf.

The Vlachopoulo graben is developed southem of the Kyparissia Mts, with an average altitude

about 200m. Westem of the Kyparissia Mts., the Marathopoli-Agia 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 altitude is about 200m.

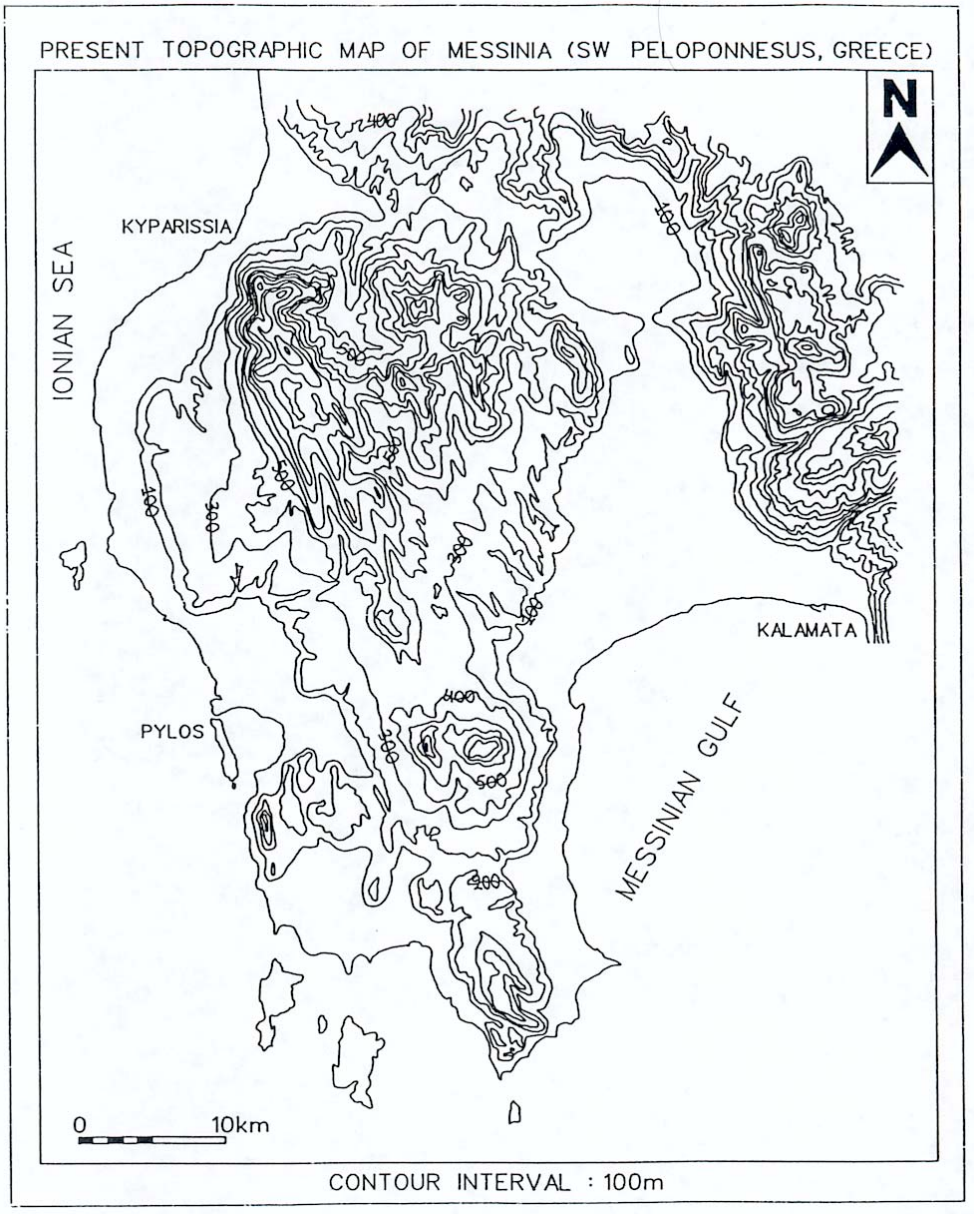

Fig. 3. Present topographic map of Messiania

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 Ear1y Pleistocene. The lack of more detailed geological maps reduces the accuracy of the paleoshore configuration.

The present day convex shape of the shoreline, from Kyparissia to Pylos should not be existed in Ear1y Pleistocene times. This shape is probably connected to the deformation of the uplifting period.

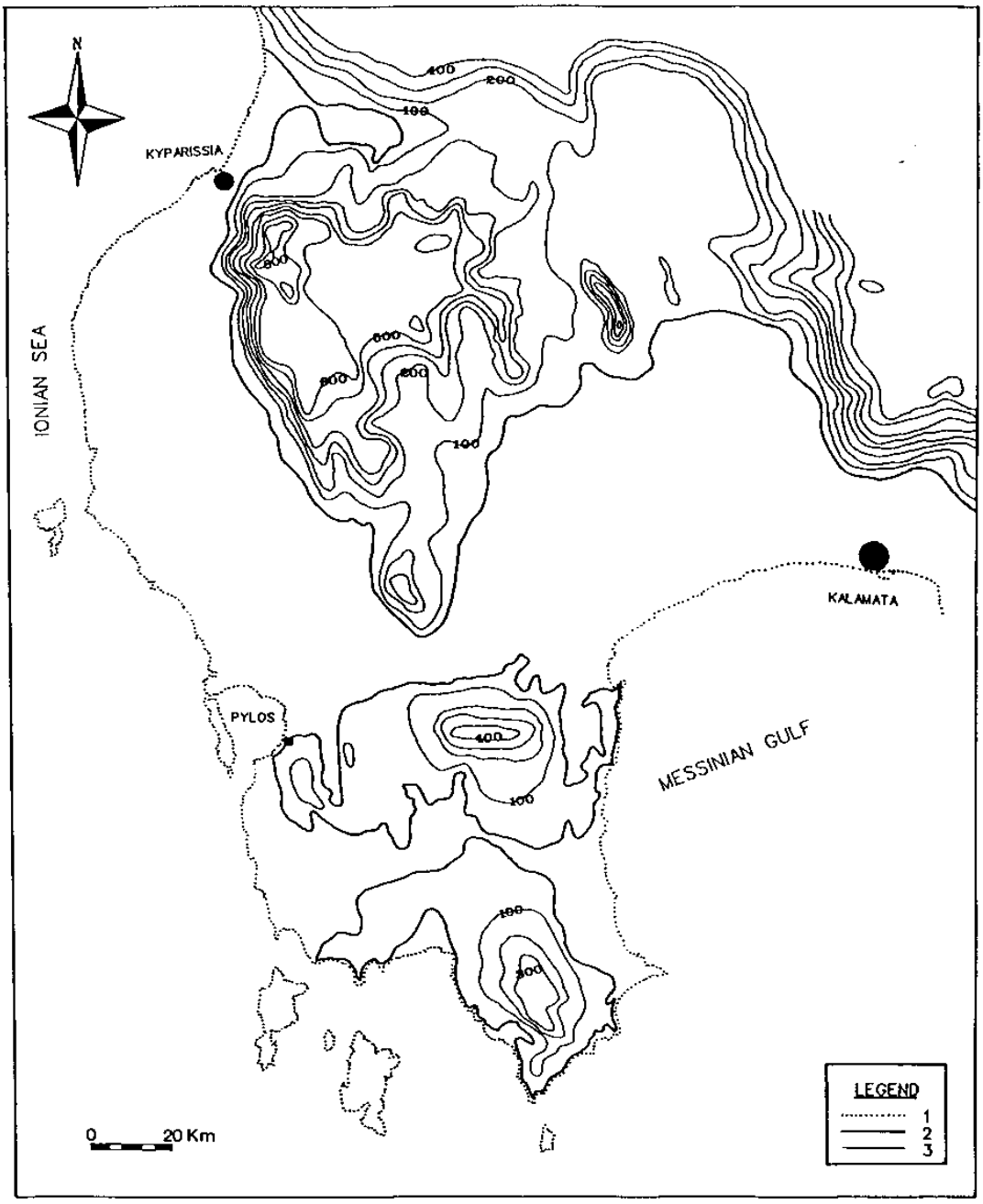

Fig. 4. The Early Pleistocene shorelines and morphology of Messinia. 1: Present day shoreline, 2: Pleistocene shoreline, 3: Pleistocene contour line

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 Ear1y 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 ηο 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 were 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 todays, 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 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 up1ifting is about 400m, as it follows from the distribution of the Plio- Pleistocene sediments. The altitude of Mavrovouni Mt. - island was about 300m. That means that the altitude difference between Lycodimo Mt. and Mavrovouni Mt. duήηg Lower Pleistocene was very Iitt1e, 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 1200rn. 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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