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NEOTECTONIC BLOCKS AND PLANATION SURFACES IN IRAKLION BASIN, CRETE, GREECE

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ABSTRACT

Detailed neotectonic analysis with special emphasis on the distribution and character of the planation surfaces was carried out in Iraklion Basin, Crete. The resulted neotectonic map showes the major and minor neotectonic blocks of the basin as well as their overall kinematic character such as uplift, subsidence and/or tilt. The basin was distinguished in 7 neotectonic units on the basis of the above neotectonic blocks and other unifying elements, such as the nature of the geological basement and the geomorphology. The planation surfaces were analysed according to their erosional or depositional and their horizontal or tilt character. The conclusion is that the planation surfaces are depended upon the evolution of the relevant neotectonic blocks over which they have been developed.

KEY WORDS: Neotectonics, Morphotectonics, block tectonics, planation surfaces, Iraklion, Crete, Greece.

1. INTRODUCTION

The neotectonic basin of Iraklion has been developed over the alpine basement of Crete since Middle Miocene times. The present day submarine basin of Iraklion Gulf constitutes its prologation to the north, with their tectonic boundary lying along the E-W coastline, result of the recent Quaternary tectonism. During Miocene times the Iraklion Basin was extended to the south, as far as the Asteroussia Mts, forming a continuous neotectonic graben with Messara Basin.

The alpine basement comprises several tectonic units (CREUTZBURG et al, 1977, FYTROLAKIS, 1980; SEIDEL et al, 1982; PAPANIKOLAOU, 1988) such as: i) the relative Autochthon unit of Mani, comprising crystalline limestones, ii) the metamorphic unit of Arna, comprising blueschists, iii) the Tripolis Unit, comprising a shallow water carbonate platform, iv) the Pindos-Ethia Unit, comprising pelagic carbonates and v) the topmost ophiolite bearing unit of Asteroussia. The above alpine units have been tectonised mainly within Early Tertiary-Early Miocene times. The postalpine cover sediments are distinguished in (MEULENKAMP, 1979; IGME Geological Maps): i) Middle Miocene (Mm) clastics, including coarse breccias and conglomerates of continental facies, ii) Upper Miocene (Ms) marine sediments, comprising marly limestones and evaporites, iii) Pliocene (Pl) marine sediments, comprising marls and iv) Quaternary sediments (Q), comprising marine shallow water sediments and terraces as well as allouvial and fluvial deposits. The extension of the above formations is given in the simplified geological map of Iraklion Basin (Fig.1).

2. NEOTECTONIC STRUCTURE

Some informations about the neotectonic structure and the geomorphological characteristics of Iraklion Basin have been given by ANGELIER (1979), BONNEFONT (1977), FYTROLAKIS (1980) and FYTROLAKIS in DRAKOPOULOS et al (1983). The actual geometry of Iraklion Basin is characterized by a general dip to the north. This is illustrated by: i) the distribution and geometry of the hydrographic

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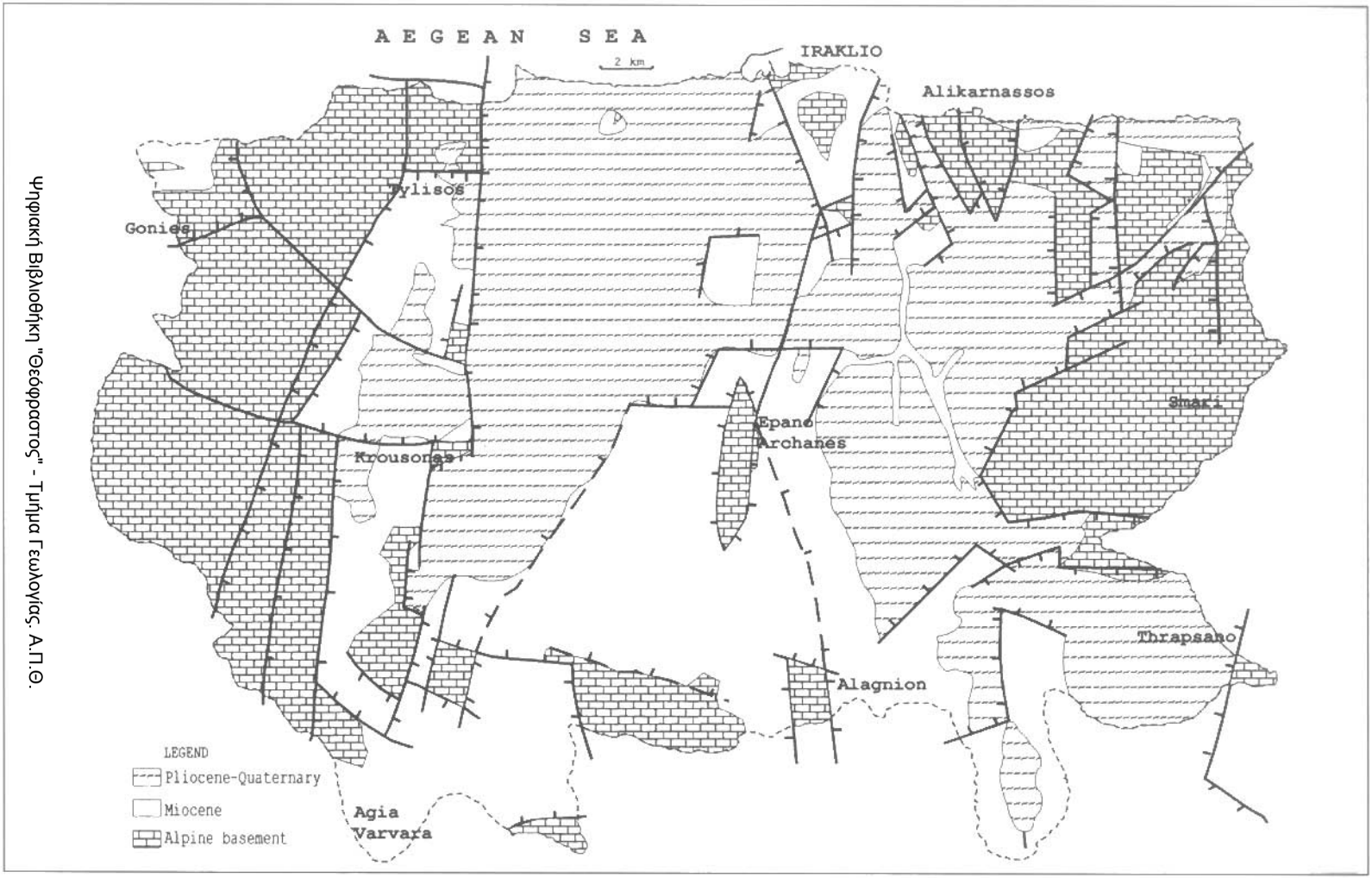

Fig. 1: Simplified Geological map of Iraklion Basin

networks, which are mostly draining from south to north, ii) the general dip of the geological strata and especially of the Pliocene deposits and iii) the distribution of the planation surfaces and more especially their systematic plunge to the north along the E-W coastal area of Iraklion.

Within the Iraklion Basin there is, approximately in the middle, a N-S oriented mountain, named Youchtas, which is made of alpine basement rocks uplifted within the post-alpine sediments of the basin, constituting a neotectonic horst. This Youchtas Horst subdivides the Iraklion Basin in a western and an eastern subbasin, where maximum subsidence throughout the Neogene period has occured. In the two marginal areas of the basin there is a pronounced uplift with much higher rates in Idi Mountain to the west than in the eastern margin. It is remarkable that in the western margin and at very high altitude of more than 1400 m., we observe extended outcrops of the Lower tectonic unit of Crete (Mani Unit). On the contrary, within the western subbasin of Iraklion at 100-300 m. of altitude the post alpine sediments, of about 1 Km thickness, are lying over the topmost ophiolite bearing alpine unit. These vertical neotectonic movements of kilometric scale have been effected through the activation of numerous faults, as shown on the simplified map of Fig. 2, which delineate the neotectonic blocks of the area. The amount of their relative movement, estimated by the fault throw and by the level of the post-alpine formations and/or the outcroping alpine units, permit their distinction in major or minor uplift and major or minor subsidence. In some areas a clear tilt character may co-exist as this is usually confirmed by the general dip of the post-alpine sediments. The similar kinematic character of adjacent blocks enables their attribution to one of the seven neotectonic units distinguished within the basin (Fig.3).

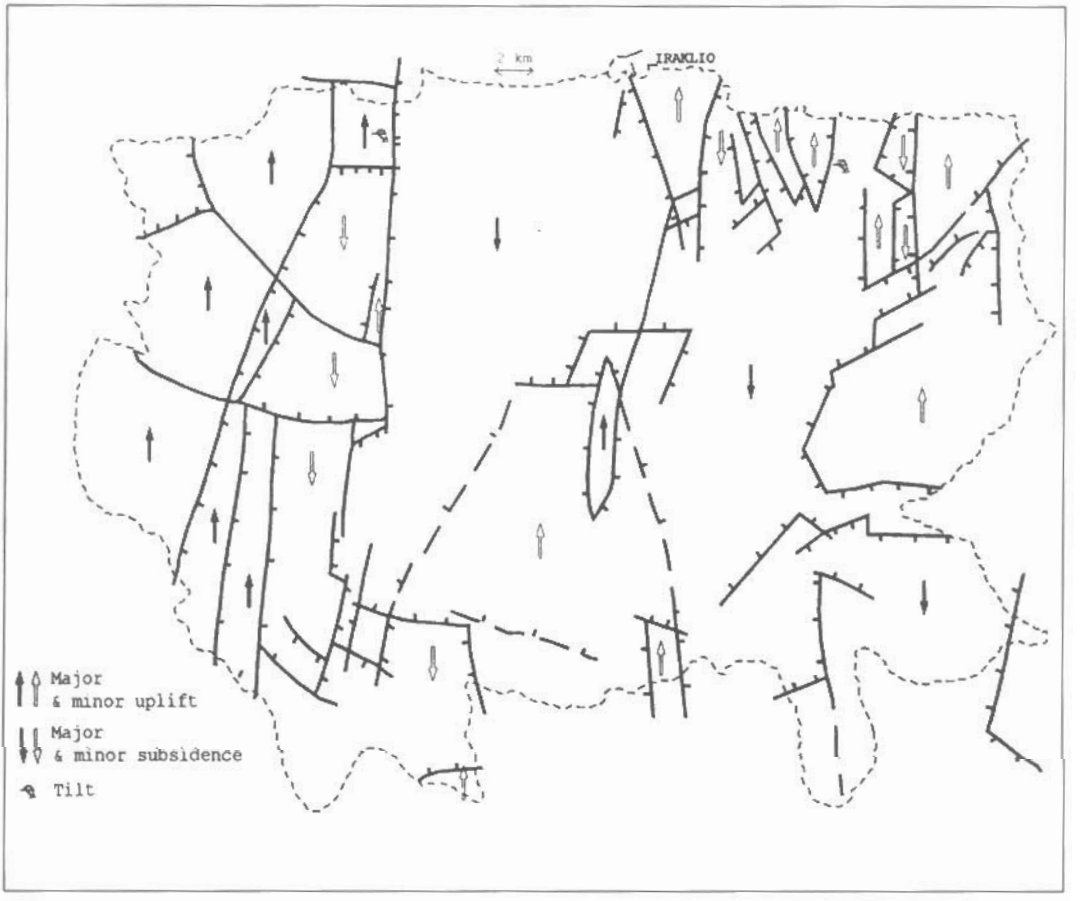

Fig. 2: Neotectonic Blo[illegible]

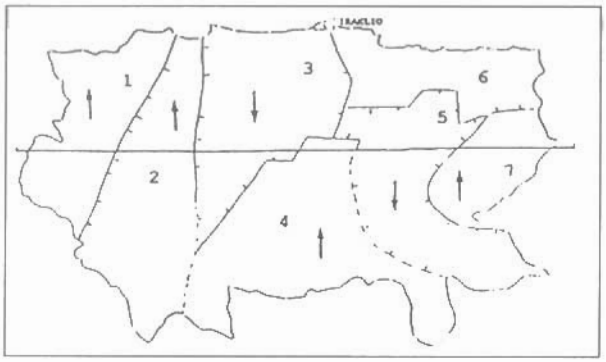

Fig. 3: Neotectonic Units of Iraklion Basin

Neotectonic Unit 1 is characterized as a tectonic horst and extends along the western margin of Iraklion Basin, comprising the higher mountainous areas with exclusive occurrence of the alpine basement rocks. This unit is characterized by a major uplift.

Neotectonic Unit 2 lies parallel to the previous zone with smaller average altitudes and with blocks composed of alpine basement and of relics of Miocene sediments.

Neotectonic Unit 3 is characterized as a tectonic graben and corresponds to the western Iraklion Subbasin with dominance of Pliocene sediments and low altitudes.

Neotectonic Unit 4 includes the Youchtas Horst and its neighboring moderate relief areas, with outcrops mainly of the alpine basement and of Middle Miocene sediments.

Neotectonic Unit 5 is characterized as a tectonic graben and corresponds to the eastern Iraklion Subbasin, including mainly the Pliocene sediments with low altitudes.

Neotectonic Unit 6 comprises a sequence of neotectonic blocks with minor uplift along the coastal area to the east of Iraklion, with outcrops of thin Upper Miocene-Pliocene sediments over the alpine basement.

Neotectonic Unit 7 is characterized as a tectonic horst and corresponds to the eastern margin of Iraklion Basin with moderate uplift and with extended outcrops of alpine basement.

This general neotectonic structure is illustrated in the schematic transverse E-W geological section of the Iraklion Basin given in Fig. 4.

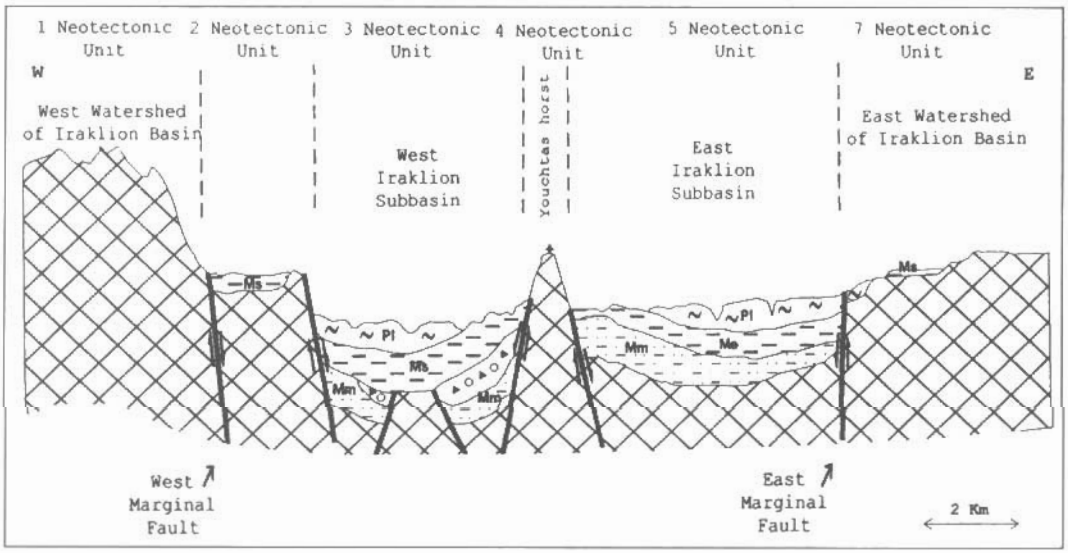

Fig. 4: Schematic geological Section across Iraklion Basin (its position is indicated in Fig. 3).

3. PLANATION SURFACES

The morphotectonic analysis of the area was focused mainly on the planation surfaces, which are observed all over the basin from the highest mountain areas in the west to the lowest coastal marine terraces to the N and NE. The planation surfaces have been distinguished in: a) erosional, b) depositional and also in horizontal and tilted (Fig. 5). The depositional planation surfaces occupied the coastal area of Iraklion Basin (pl.s. no 60,77,79,85) the SE part of the basin in average altitude 300-400 m. where the alluvial basin has succeeded the marine Pl-Q sediments (pl.s. no 112,113,114,115) and also in the central-southern part of the basin (pl.s. no 40) to the SW of Youchtas which is developed over the Middle Miocene sediments.

All the rest planation surfaces are erosional horizontal or tilted with most characteristic case, the planation surfaces Neotectonic Unit of 6 along the coastal area of the Iraklion Basin, which are tilted to the north with altitudes between 0 and 200 m. and the planation surfaces of Neotectonic Unit 2 which are tilted to the East.On the contrary, the erosional planation surfaces in the other neotectonic units, are either horizontal or tilted in various directions. Nevertheless, one can distinguish some groups of planation surfaces either on the basis of their average altitude (as shown on Fig.5) or on the basis of their plunge direction. These groups of planation surfaces are correlated to the neotectonic blocks of the area as the comparison of figures 2 and 5 indicates.

Another important element is the nature of the geological basement over which the planation surfaces have been developed. These data have been summarized in the diagrams of Fig.6 corresponding to each of the 7 neotectonic units of Iraklion. These diagrams demonstrate that each neotectonic unit is characterized by a number of planation surfaces of a certain average altitude and of certain plunge direction and/or nature of geological basement. Thus, Neotectonic Unit 3 comprises planation surfaces of ±100 m. of altitude with plunge towards the north, developed over Pliocene sediments. Neotectonic Unit 6 comprises planation surfaces between 100-200 m. of altitude plunging to the north, developed over alpine formations and/or Pliocene formations. On the contrary, Neotectonic Unit 1 comprises planation surfaces plunging to various directions, developed over the alpine basement, mainly grouped in altitudes ±500 m. (planation surfaces No 1-11)and ±1000m (planation surfaces No 15,16,17,20,21,23,26).

4.CONCLUSIVE REMARKS

The previously described neotectonic structure of Iraklion Basin comprises a number of neotectonic units, characterised by a certain kinematic character of the neotectonic blocks accompanied by a certain type of planation surfaces and a certain type of geological basement. More presicely, the overall neotectonic evolution of each neotectonic block defines, by its kinematic character, the following elements: (i)In the case of uplift, there is a horst structure on which pronounced erosion of the alpine units has occured with outcrops of the lower units, without post-alpine sedimentation and with erosional planation surfaces at high altitudes (e.g. Neotectonic unit 1). (ii)In the case of subsidence, there is a graben structure, in which thick post-alpine sediments over the upper alpine tectonic units are observed with depositional planation surfaces at low altitudes (e.g. neotectonic units 3 and 5). (iii)In the case of co-existence of tilt, the planation surfaces are plunging to a pronounced direction (e.g. neotectonic unit 6). In the case of intermediate kinematic situations, the thickness of the post-alpine sediments is diminished in the graben and so is the eroded part of the alpine basement rocks in the horst areas (e.g. neotectonic unit 2). Finally, the main period of subsidence or uplift can be deduced by the absence or presence of the post-alpine formations of a certain period. Thus, the area of neotectonic unit 4 of the Youchtas Horst, has been highly uplifted in Late Miocene-Quaternary times(absence of sedimentation), after the deposition of the thick Middle Miocene sediments observed over the alpine basement rocks (Fig 1 and 3).

The general conclusion is that the neotectonic structure and evolution of Iraklion Basin is not simple and uniform all over its extension but very complex with differentiations on each neotectonic block. The geomorphological characteristics and especially the planation surfaces vary according to the dominant kinematic character of each block.

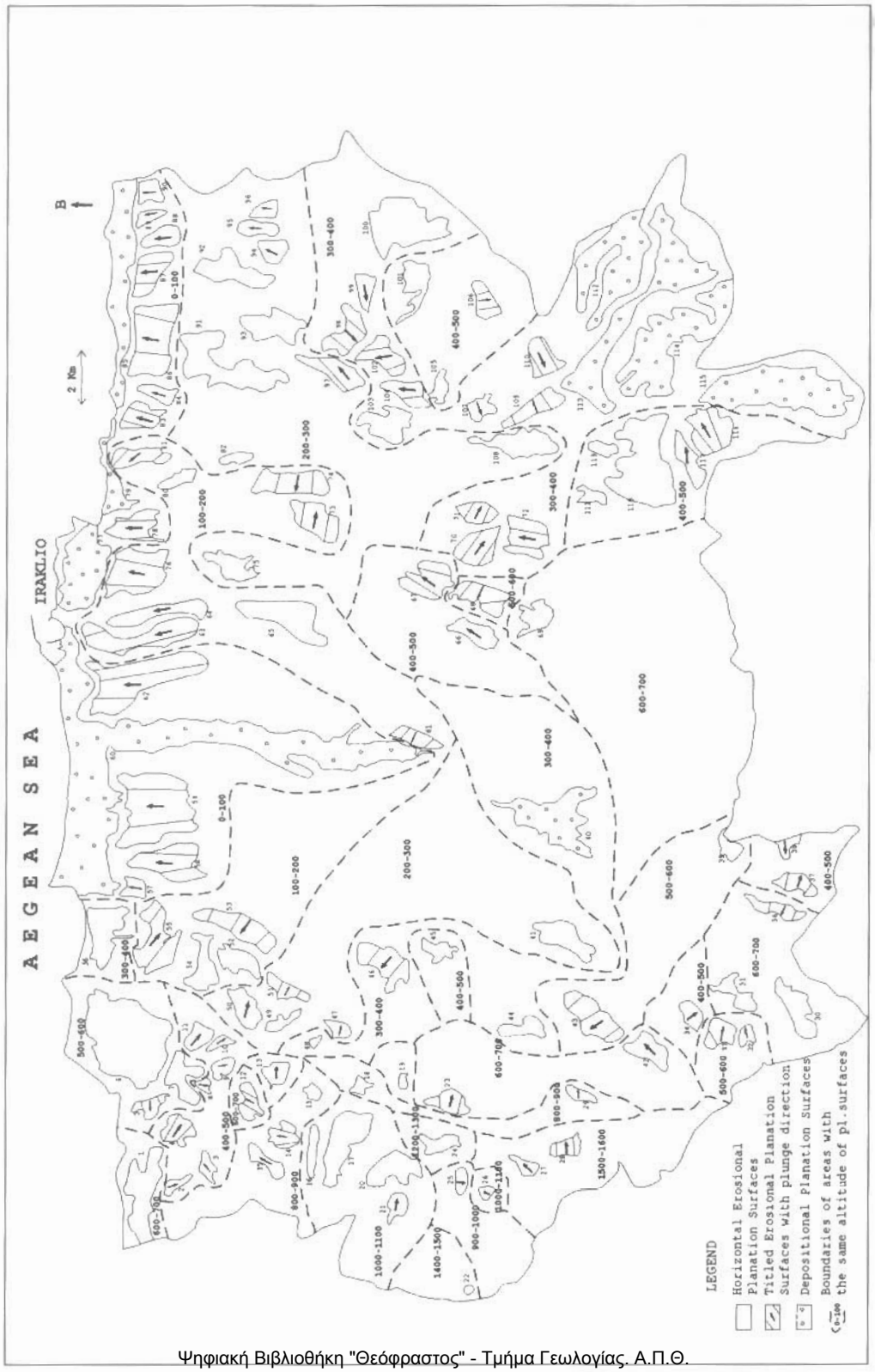

Fig. 5: Planation Surfaces in Iraklion Basin

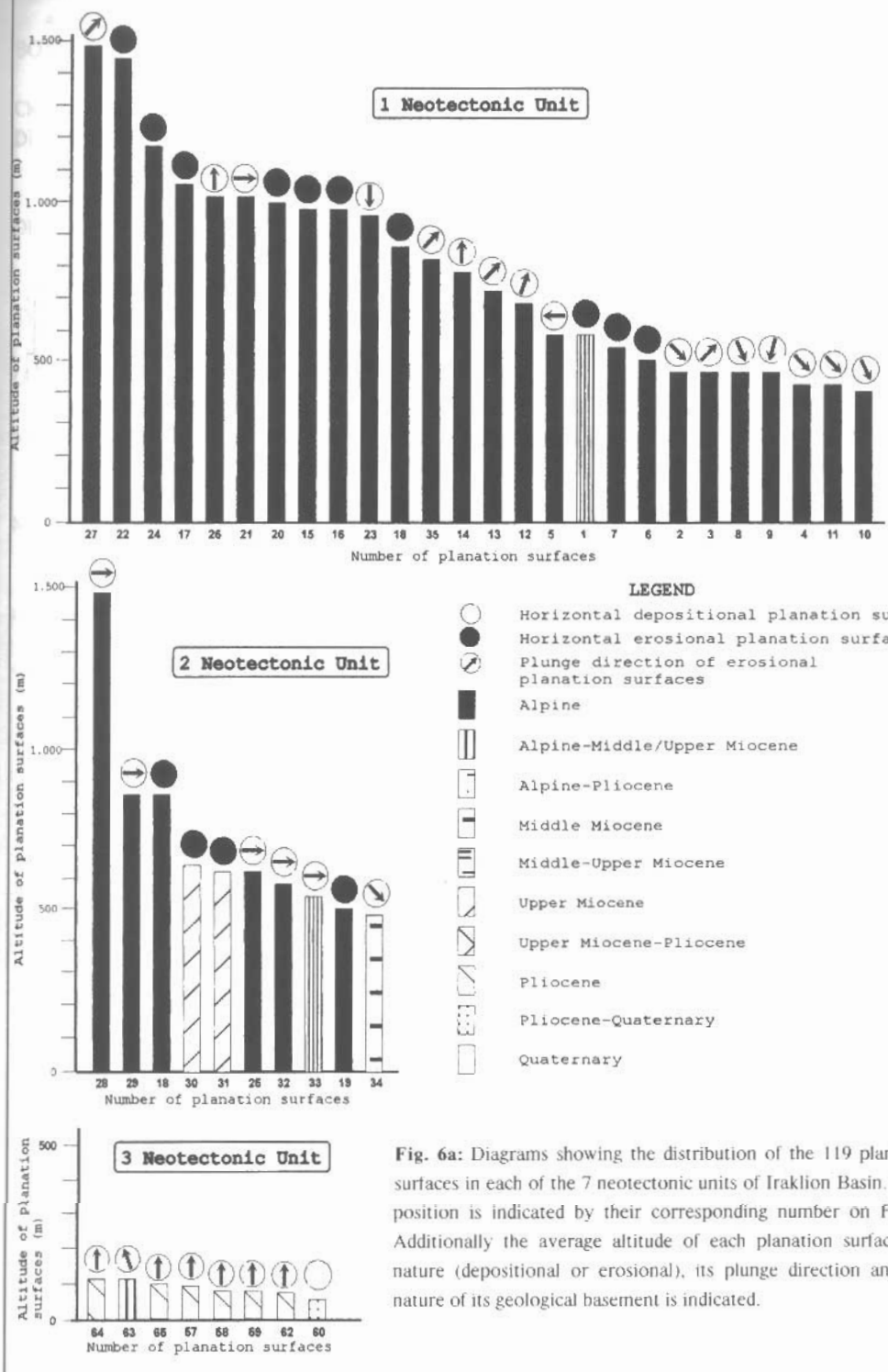

Fig. 6a: Diagrams showing the distribution of the 119 planation surfaces in each of the 7 neotectonic units of Iraklion Basin. Their position is indicated by their corresponding number on Fig. 5. Additionally the average altitude of each planation surface, its nature (depositional or erosional), its plunge direction and the nature of its geological basement is indicated.

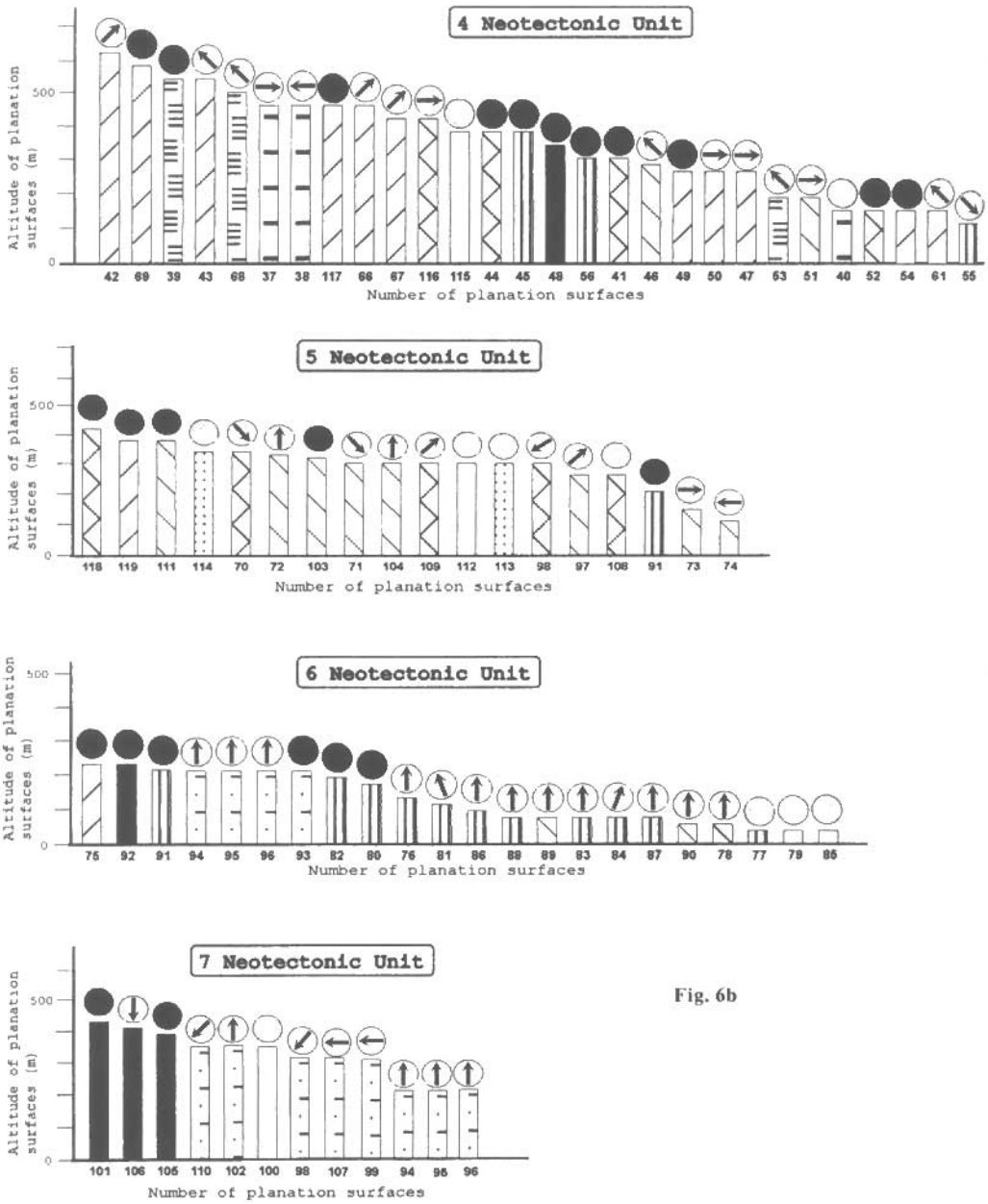

Fig. 6b

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