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Geomorphology and Archeology, Northwest Peloponnesos, Greece.

Constantine Nicholas Raphael

Louisiana State University and Agricultural & Mechanical College

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Louisiana State University and Agricultural and Mechanical College, Ph.D., 1968
Geography

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1969
Geomorphology and Archeology, Northwest Peloponnesos, Greece

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Geography and Anthropology

by

Constantine Nicholas Raphael
B.A., Wayne State University, 1961
M.A., Eastern Michigan University, 1962
August, 1968
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ABSTRACT

The low-lying coastal area of the northwest Peloponnese, Greece is characterized by beach ridge, levee, dune and upland topography. Superimposed on this diverse physical landscape is man's occupancy. Archeological evidence suggests that man has occupied the northwest Peloponnese continuously since prehistoric times.

The primary emphasis of this paper is to illustrate that there is an intimate association between man and the land which he has inhabited.

The geomorphic features are first discussed. This is followed by a discussion of the archeology of the area. With the aid of archeology, aerial photographs, old maps, and historical accounts, the geomorphic features are dated and the relative sequence of geomorphic events established. Within this area, one episode of coastal accretion and alluviation is established. Progradation of the shoreline was greatest during the Roman period at a rate of approximately 170 meters per century. Since that time the shoreline has retreated as evidenced by physical and cultural features.

The writings of the ancient geographers suggested that the Peneus, the major river of the area, debouched into the
sea 18.4 kilometers north of its present outlet. Ancestral levee systems and the archeology have confirmed this view. The Peneus flowed north of its present course during Roman and Turkish times but diverted to its present course in the past 160 years.
INTRODUCTION

Relationships between Quaternary geomorphology and archeology have been well illustrated by several writers such as McIntire (1958) and Säucier (1963). The primary purpose of such studies is to use settlement patterns and archeological data as keys to unravelling the geomorphic and geologic history of the immediate past.

In the Old World, there have been very few studies which examine cultural remains in the light of coastal development, in spite of the vast amount of archeological data, maps, and accounts of ancient geographers and travelers. Although detailed geomorphic studies such as those of Russell (1941, 1954) and Butzer (1960, 1962) have been conducted in the Mediterranean, they do not emphasize the interrelation of man and geomorphology.

The purpose of the present study is to examine the association of prehistorical and historical remains and the geomorphology of a relatively small coastal plain of the northwest Peloponnesos, Greece (Fig. 1). Here, abundant archeological sites related to various cultures are intimately associated with beach ridge, levee, dune, and upland topography of the narrow coastal plain. In southwest Peloponnesos, a line of demarkation has been tentatively
Figure 1. Location and approximate limits of the study area.
established between the prehistoric sites and the physical setting by archeologists (McDonald and Hope Simpson, 1964). Field work conducted in 1965 and 1966 under the sponsorship of the Earth Sciences Division of the National Research Council of the National Academy of Sciences, indicates that similar relationships are present through prehistoric as well as historic times in the northwest Peloponnesos.

Field work was begun in May, 1965, and continued for a period of one year. The coastal plain was mapped with the use of air photographs supplied by the Royal Hellenic Air Force. Because of the several military installations, this aerial photography was restricted and had to be supplemented with older photos supplied by the Geography Branch of the Office of Naval Research, Washington, D.C.

The study was undertaken in four steps: (1) fluvial and coastal landforms of the coastal plain in the study area were mapped; (2) all archeological sites discovered were mapped and collections were made for the purpose of determining their absolute age; sites of previous investigators were also noted for the purpose of confirmation; (3) maps and early accounts were researched at the Library of Congress, Washington, D.C., and the British Museum Library, London, England. An earnest attempt was also made to obtain additional data in Greece. Monasteries in and around the study area were visited as was the National Library of Greece. Unfortunately, the German occupation and the civil war left little data which were pertinent to this study; (4) the final step was the interpretation of relationships
between coastal morphology and archeology with the aim of testing the hypothesis that man's occupation was intimately related with the development of this coastal area.

The difficulties in working in the area were many. All-weather roads are few and flooding common. Therefore, in winter, much of the area was traversed on foot. Maps on a scale of greater than 1:250,000 are generally restricted and their accuracy questionable. Due to the efforts of A. Philippson and others, a geologic map of Greece has been compiled at a scale of 1:500,000 (1954). This is the only geologic map presently available of the study area. Additional information concerning the problems of undertaking field work in Greece is presented by Higgins (1966).
CHAPTER I

Geographical Setting

Location and General Character

In his Geography, Strabo (8.2.1) described the Peloponnesus or Morea as having the shape of a leaf of a plane tree with each of its five peninsulas corresponding to a point of the leaf. Coastal plains in Peloponnesos are largely absent or of restricted area. The largest is the plain of Ellis at the most western margin of the Peloponnesos. The area is located between 37° 40' and 38° 14' North Latitude and between 21° 05' and 21° 24' East Longitude. The airline distance from north to south is approximately 60 kilometers.

The area is bounded on the west and north by the Ionian Sea and the Gulf of Patras respectively (Fig. 2). On the east and south the plain is limited by uplifted Pliocene sediments.¹

Two prominent headlands rise abruptly above the low plain. The Chlemutsi Headland is 241 meters in elevation and is composed of well dissected Pliocene sands and clays. The rocky headland of Kounoupeli is 47 meters above sea level and composed of older deformed limestones.

¹Geologic names are based on the 1:500,000 Geologic Map of Greece, Institute of Geology and Subsurface Research, Athens, Greece, 1954.
Figure 2. Landforms of the study area.
Between the sea and the foothills is a higher depositional surface which parallels the coast. This surface varies in width from 1 to 8 kilometers and extends from Mavron Oros southwestward. South of the summer resort of Korouta it is truncated by the Ionian Sea. This feature, composed of well-oxidized coarse sands and gravels, has been dissected and subsequently alluviated by streams. Its terrain is relatively flat, however it is particularly well dissected at its seaward margin by intermittent streams. A well defined scarp, between this older surface and the more recent coastal plain, is especially well marked north of the Peneus River. (Photo 1a). Judging from data obtained from artesian wells on the modern coastal plain, it does not appear that the strata of the older terrain dips beneath the coastal plain. Thus it appears that the surface was exposed to the sea and eroded to its present position. An alternative possibility is that the surface was faulted parallel to the coast and occurs at great depths. However, this alternative is not likely, since Tertiary strata dip beneath the plain (Food and Agriculture Organization of the United Nations, Vol. II, p. 8). A similar surface is also present between the Ohlemutsi Headland and the modern plain. This older terrain is primarily used for herding as well as the cultivation of potatoes, wheat and other haycrops.

The modern plain, of presumably Recent age, in general is less than 15 meters in elevation. It is composed of unoxidized gravels, sands, and silts. The geomorphic units composing this plain will be discussed elsewhere. This
prosperous lowland is intensively cultivated and has been in the past. Anacharsis (Barthelemy, 1794, Vol. 3, p. 413) noted in 450 B.C. that:

Elis is the most plentiful and best peopled district of Peloponnesos. Its plains, which are generally fertile are covered with laborious slaves and agriculture flourishes...

Also (Vol. 4, p. 2):

Within and without the sacred grounds are woods distributed in the plain or on the mountain which are the retreats of roe-bucks, stags, and wild boars...

Pausanias described this region as being fruitful, especially suited for the cultivation of fine flax and hemp, (Pausanias, 6.16.6.).

Randolph (p. 47) in 1689 stated that the town of Gastouni

...stands in a large plain...There are several large woods about it. The land is most plowed and pasture land having few olive or fruit trees...

In 1814 Pouqueville (p. 113) noted in the northern part of the region that:

The country...is agreeable varied by arable, pasture and woodland...

And (p. 115):

Leaving Gastouni, the route enters on a plain sown with annual cotton...

These and other accounts indicate that the prosperous plain has been cultivated for the past 2400 years.

Today the plain is intensively irrigated by water from the Peneus River and artesian wells. The primary crops are
cotton, grapes, and a variety of truck crops such as melons, tomatoes, and cucumbers. South of Gastouni is a noteworthy currant growing region discussed by De Vooys (1960).

The main road between Pyrgos and Patras generally follows the scarp of the higher surface. Prior to the early 1950's this was a gravel road. However, with the increased tourism to the archeological sites at Olympia and Pylos, this road has been surfaced. Tourists are utilizing many of the beaches along the coast and the mineral baths of the area. Recently a French tourist club has constructed a resort in the vicinity of Metochi.

The towns located on this road function as service, social, and religious centers to the entire surrounding area. Many of the place names are suggestive of medieval and Turkish occupancy, e.g., Gastouni, Andravida, Bondieka, and Sambanaga.

Geology

The coastal plain of Elis is restricted on the east by the Erimanthos Mountains and Tertiary hills (Fig. 3). The Erimanthos range which attains elevations of over 2200 meters is a continuation of the Dinaric orogenic belt which borders the west coast of Albania and Yugoslavia and can be traced through Crete into southern Turkey.

These mountains are predominately composed of folded limestone, dolomites, shales, and cherts, ranging in age from Triassic to Cretaceous. The folds are isoclinal with the strike in the NE-SW direction and the dip to the SE,
Figure 5. Geology of western Peloponnesos.
Flysch deposits of lower Tertiary age commonly occur on the flanks of the Mesozoic deposits. On the western side of the Erimanthos Mountains an extensive flysch deposit occurs. It has been termed the "Adriatic ionian [sic] Flysch", (Institute of Geology and Subsurface Research, [I.G.S.R.], 1954) and is described as follows:

a very thick complex of fine-bedded sandstones, rarely thick and sometimes very thick, alternating with fine beds of argillaceous shales. In the lower parts intercalated limestone beds. Sometimes [containing]...conglomerates...Beginning from middle Eocene to the base of Miocene; shallow sea deposits.

The strike of the flysch is generally N-S. The dip varies considerably, however, to the west the dip is to the west, (Foldyna, p. 287).

Following the deposition of the lower Tertiary flysch the Alpine orogeny took place and the Erimanthos Mountains were formed. Subsequent sedimentation followed and additional late Tertiary deposits were laid down. These deposits consist mainly of poorly consolidated sandstones, clays, marls, and conglomerates, and are mostly fresh-water deposits, however, some are brackish and marine. (I.G.S.R., 1954). Sedimentation continued through the Quaternary period. Quaternary sediments were deposited in a basin to the west. The thickness of these sediments is not known. However, a test well bored southwest of Amalias remained in Quaternary sediments to a depth of approximately 315 meters.

Tectonic activity has continued, if on a more subdued
scale, since the Alpine orogeny. The west and north coasts of the Peloponnese and the adjacent Ionian Islands have had the highest incidence of earthquake activity in Greece, (British Geographical Handbook Series, p. 8). From 1893 to 1930 Elis has experienced 327 earthquakes with several epicenters in the study area (Galanopulos, p. 105). The catastrophic earthquakes on the adjacent islands in the past decade are still discussed by the local populace. The post-flysch deposits of upper Tertiary age are faulted at the southern margin of the plain south of Amalias. Also extreme tilting is evident wherever the post-flysch deposits occur. The frequent occurrence of earthquakes and tremors is also indicative of the present tectonic instability of the region.

The Quaternary sediments are subdivided into two distinct surfaces. The older and higher surface consists of well-oxidized sands and gravels. For the purpose of this report it will be referred to as the Amalias surface. The Sachia River, which passes through the town of Amalias, has dissected this surface and several sections of the oxidized sand and gravel are exposed on its banks. Thus Amalias is a suitable type locality for this surface.

The age of the surface is questionable. The Institute for Geology and Subsurface Research (1954) has mapped it as Quaternary. Archeological artifacts of Paleolithic age, found in sites on this surface, suggest that it is not Recent, but at least Pleistocene in age. The Recent coastal plain generally consists of unoxidized sediments which reflect its relatively young age. The study is primarily
focused on this area.

Climate

The climate of the west coast of the Peloponnese is typically Mediterranean (Csa, Koppen), with hot dry summers and mild wet winters (Fig. 4). Precipitation in this region is orographic and frontal in nature. The coastal plain is situated in the belt of prevailing westerly winds, consequently the weather and climate approach from the west. A local comment which is often heard is that whatever the weather is in Italy today, will be the weather in Greece in two or three days.

Precipitation

The west coast of Peloponnese is often considered as the "wet-side" of Greece (Philipsson, 1947). In a sense, the eastside of the peninsula is in a rainshadow. The moist air passing over the coastal areas releases its moisture as it crosses the Erimanthos Mountains. It then descends on to the east coast of the Peloponneseos as relatively cool, dry air. The average annual precipitation at Amalias is 815.7mm. In contrast, Nauplia (Fig. 1), near the Aegean coast, averages 503mm. yearly, although the altitude and latitude are approximately the same.

The modern coastal plain of Elis receives about 714.6mm. of precipitation each year, predominately in the form of rain. The south coast of the Gulf of Patras however receives a smaller amount of precipitation (Mariolopoulos, 1955). A comparison of the two stations in Figure 4 substantiates
Figure 4. Temperature and precipitation of the plain of Elis.
this view. Small amounts of hail occur, particularly in the spring. Snow has never been recorded on the modern coastal plain but does occasionally occur in higher areas such as Amalias (elevation 50 meters). The city of Pyrgos, (elevation 62 meters), has recorded a light snowfall twice since 1940. During the winter, it often rains continuously for 3 or 4 days and then ceases for 4 or 5 days before raining again.

Since the rainfall is concentrated in the winter months, the probability of flooding is increased. Although flood control projects have been initiated winter floods commonly occur on the plain. In contrast to winter, the summer months receive little rainfall. Often no precipitation is recorded for July or August.

Temperature

The average annual temperature on this region is 18°C. In summer, due to the low humidity and clear skies, the diurnal range is higher than in winter. Also, because of the relatively high temperatures year around, frosts do not occur.

Winds

The variable winds in the eastern Mediterranean have been noted since classical times. Theophrastus, in his section, Enquiry into Plants (36.), remarked that the northeast and southwest winds were the wettest and the south, the west, and the southeast winds were the driest.

Two dominant winds are mainly responsible for the
winter precipitation. These are the bora and the garbi. The bora is a cold north wind which blows across the Adriatic Sea on to the west coast of Greece. It is normally accompanied by heavy precipitation. The garbi is a rain-bearing wind usually associated with warm and humid weather. It blows from the southwest or from the "corner," as the peasants refer to it. The local inhabitants do not consider this wind as violent as the bora because of the more agreeable temperatures associated with it.

Another winter wind associated with inclement weather is the ostria. This wind is warm and moist and blows out of the south.

The livano, sirocco, and the maestro occur in the summer months. The livano is a south or southeast wind which is normally hot and dry. Occasionally however, as a livano passes over the relatively warm Mediterranean, it gathers moisture and orographic precipitation occurs in the mountains.

Although the term "sirocco" is used frequently in Greece it does not necessarily connote a desert origin. It has been noted that, "The 'sirocco di levante' of the Gulf of Kyparissia [Fig. 3] is nothing but an east foehn" (Biel, 1944, p. 18-19). The term sirocco is used by the farmers and shepherds in this area for a wind from the southeast or east which is cool and dry. The maestro is also a cool summer wind. The wind direction normally is from the north or northwest. In essence it is a summer etesian wind (Ibid., p. 65).
The meltemi occurs locally. It is a fair weather breeze from the northwest and characterized by calm seas. Although the peasants refer to the meltemi as an onshore wind, it is generally considered as an etesian wind because of its constant northwest direction (Ibid., p. 13).

The winds are well known to the coastal plain inhabitants and are associated with precipitation rather than with temperature. In early September, during the currant harvest, unexpected precipitation can have disastrous consequences on the industry. Thus, the peasants are inclined to think that the success of a harvest depends on the winds and not on the soil or precipitation.

Hydrology

Due to the contrasting summer and winter climatic conditions, there is a great variation in the flow of the rivers and the presence and size of the lagoons. In winter with the maximum rainfall and relatively humid conditions, the rivers of the coastal plain reach a bankfull stage and flooding commonly occurs. Prior to the construction of major drainage ditches the plain was traversed with great difficulty. Pouqueville (1822, p. 114) noted:

This [Verge River] and some other streams...carrying their waters into the bay of Clarentza...in winter...by stagnation render the plain next to impassable even in June.

Rivers

The Peneus River which drains an area of 917 square kilometers is the largest stream flowing in the region and
the second largest in the Peloponnese. It is fed by two major tributaries (Fig. 3). The northern tributary, originates in the flysch deposits flanking the western side of the Erimanthos Mountains. It flows southward between two folded ranges of the mountains onto late Tertiary conglomerate deposits and flows westward and then northward over late Tertiary sediments. The two tributaries join on the Tertiary beds. The Peneus then flows upon its modern alluvial valley to the Ionian Sea.

The Peneus is the only perennial river in the study area. This depends primarily on its relatively large drainage basin; its source in high mountains where summer rainfall is more frequent and snow lingers in the spring.

Many torrents such as the Sachia and Verga (Fig. 2) originate on the late Tertiary surface and flow directly on to the coastal plain. When they reach the modern plain their courses meander and ultimately flow into lagoons. The Sachia is an exception as it flows directly to the sea. To prevent flooding many of the rivers have been dredged and straightened, and artificial levees have been constructed. However, periodic inundation frequently occurs. In January 1966, the Peneus breached its man-made levee twice causing considerable damage.

Unnamed streams flowing from lagoons into the sea obliquely traverse beach ridges. These streams are stagnant in the summer since they do not have sufficient flow to traverse the river mouth bar developed at their mouths. The beach ridges in the north are more subdued and the
streams flowing out of lagoons in this area take advantage of this depression to reach the sea.

Lagoons

Lagoons, like low-lying plains, are an exceptional phenomenon on the coasts of Greece. The lagoons in this area and those south of Pyrgos form one of the largest expanses of brackish water in Greece. Although they are by nature perennial, their seasonal extent varies greatly. The size and extent of the water bodies were often noted by 18th and 19th century travelers (Pouqueville, 1822, and Leake, 1830). Although these extensive water bodies are visible from the Amalias surface, they were not discussed by anyone, including Strabo, before the 1750's.

The salinity of these brackish water bodies is not known. However, the salinity of lagoons south of Pyrgos ranges from 15.6 0/00 to 16 0/00 in September. The salt content appears to vary considerably throughout the year since in summer the water is almost fresh (F.A.O., Vol. 3, p. 209-210).

Other lagoons are present, however they are intermittent. During the winter they accumulate about 0.5 to 0.75 meters of water. In the summer, the water bodies dry up, exposing the flat lagoonal bottom. These intermittent lagoons are also brackish as evidenced by the presence of Batis maritima and accumulations of salt in small depressions which indicate that they are intruded by salt water.
The tidal range on the west coast of Peloponnesos is small. It does not appear to be over 8 inches in the vicinity of Korouta (Fig. 2). The nearest station with tide data is Patras, on the Gulf of Patras. The mean range (difference in height between mean high water and mean low water), is 1.5 feet (U.S. Dept. of Commerce, 1964, p. 168). However, this figure is not representative of the Ionian Sea because of the confinement of the tide station in a relatively narrow gulf.

The circulation of the surface currents in the Mediterranean is counter-clockwise. On a reduced scale the surface currents of smaller water bodies such as the Aegean and Ionian Seas also circulate in a counter-clockwise direction (Sverdrup et al., 1954, p. 648-649). Consequently, the currents on the west coast of Peloponnesos flow from south to north.

Local longshore currents and littoral transport are northward on both sides of the Chlemutsi Headland. This is evidenced by the following observations: (1) Large accumulation of mobile sand and wide beaches on the south side of the Chlemutsi Headland and on the south side of Mavron Oros. (2) The Sachia River has breached its foredune. It flows northward, parallel to the beach, severely eroding approximately 120 meters of the foredune. Other rivers, such as those draining smaller lagoons landward of the beach ridges are also diverted to the north. (3) The inlet of a lagoon between Kounoupeli and Chlemutsi Headlands also
confirms the direction of littoral transport. The inlet of the lagoon is artificial and a groin has been constructed there. The groin has trapped sediments southwest of the inlet. As a result, an "offset" has developed. The barrier southwest of the inlet has prograded seaward whereas on the northeast it has remained stationary. (4) Along the beaches from Chlemutsi Headland northward, wave-worn sherds occur. At the north end of Chlemutsi Headland extensive archeological remains are present on the clffy coast. Since this is the only archeological site in this vicinity, it may be reasonably assumed that the sherds were transported northeastward and deposited on the beach. (5) The orientation of the beach ridges suggests that the littoral transport has also been northeastward in the past. The beach ridges fan out in a northerly direction. Moreover, Kounoupeli Headland has trapped a considerable amount of sediment southwest of the rocky promontory.

Vegetation

Because of the intensive cultivation of the lowland, the natural vegetation of the plain has been disturbed. It has been generally stated that most of the Balkan Peninsula was much more wooded in the past. However, as early as classical times, many of the forests had been exploited. Aristotle in his Politics (6.5.4., 7.11.4.) mentions commissioners of woods and forests who were appointed to see to the proper administration of the woodlands.

The pines of Elis have been known since the time of
Theophrastus, (3.9.4.). On the plain of Elis, the principal reasons for exploitation of the forests were for timber for shipbuilding, the tanning industry, and charcoal production, in addition to numerous domestic uses.

The dominant vegetation in the late 17th century also appears to have been pine (Spon, Vol. II, p. 6). R. Walpole noted in 1818 that the *Pinus pinea* was used for the construction of ships. He stated (p. 46):

...the *Pinus maritima* or true pine of the neo Greeks abounds in Attica... but never here obtains the same bulk as it does in the forest of Elis where trees may be seen fit for the largest ships of war and where the soil is everywhere sandy. The seeds of the stone pine (*Pinus pinea*) are collected with great industry in Elis...

Another industry related to this forest was recorded by W.G. Clark (1858, p. 278):

The wood through which we rode consisted of scattered oaks, of the kind which produces the Vallonia, one of the principal articles of the export of the district,

The oak he was referring to was the Valona oak, *Quercus suber*, which was used in the tanning industry. The use of cork in Elis goes back to at least the Roman period. During this time, the bark of the Valona oak was used for ropes on ships, floats for fishing nets, soles for women's shoes and for wainwright's carpentry (Pliny, 16.12.34).

In 1832, the most extensive forest on the coastal plain belonged to Ali Tchelebe, a Turkish landowner. This forest, colonized by pine, paralleled the Ionian Sea from the Gulf of Patras southward to the Verga River. The forest was about 23 kilometers in length and approximately 6 kilometers wide.
Since that time it has been restricted to a narrow zone of beach ridges.

This pine forest is presently under the strict control of the local government. No lumbering is tolerated in the area. However, under the supervision of the government, the tapping of the parasol pine (*Pinus pinea*) is permitted. The sap collected from this area is used in the production of the resinated wine known as "restina" which is popular throughout Greece.

Because of the lack of natural fuels such as lignite and coal, charcoal was an invaluable source of fuel. By 1907 a large oak forest composed chiefly of *Quercus conferta* near Kapeleto was almost entirely exploited, for charcoal, and was being replaced by maquis and other plant communities (Turrill, 1929, p. 199-200). Philippson in 1947 also reports the destruction of oak forests near Manolas (p. 159).

Other vegetation noted by early travelers included the acacia, *Acacia* sp., and the oleander, *Nerium oleander*, which colonized torrent beds and river banks (Walpole, 1817, p. 46). Also noted along river banks and marshy areas were laurels, *Laurus nobilis*, plane trees, *Platanus orientalis* (Blouet, 1838, Vol. 3, p. 45), willows, *Salix* sp., and alders, *Alnus* sp. (Clark, 1858, p. 278). To this can be added *Arundo donax* and *Agave* sp.

At the present time two distinct species of pine occur on the beach-ridge crests. The seaward beach ridges are predominately colonized with Aleppo pine, *Pinus halepensis*. The more landward set of beach-ridge crests are vegetated
with parasol or stone pine, *Pinus pinea* (Photo 1b). Since *Pinus halepensis* was not mentioned by early travelers it would be reasonable to assume that *Pinus pinea* was the dominant vegetation on both sets of beach-ridge crests. This may be further substantiated by the occasional occurrence of older, isolated *Pinus pinea* surrounded by younger *Pinus halepensis* on the more seaward set of beach ridges.

The dominant vegetation occurring in the beach-ridge swales may also be subdivided into two genera. The swales of the seaward beach-ridges are colonized with the Mediterranean heath, *Erica verticilata*, *Ephedra dietachya*, and other maquis scrub. The swales of the landward set of beach ridges are dominated by *Juncus maritimus*. Occasionally the lower swales are colonized with *Batie maritima*.

A reconnaissance of the phytogeography of the beach and foredune of the west coast of the Peloponnesos is presented by Lavrentiades (1964). With the exception of the coast near Glifa (Fig. 2), his observations are primarily restricted to the shore south of Cape Katakolon. Therefore a brief description of the coastal vegetation in the plain of Elis is of value.

The foredune bordering the beaches of Elis is sparsely vegetated. The dominant grass is marram, *Ammophila arenaria*, which occurs in tussocks. Other plants occurring to a lesser extent are *Diotis maritima* and *Euphorbia eschscholz*. The foredune on the coast at Glifa is colonized by *Agropyrum junceum* ssp. *mediterraneum*, *Galilea mucronata*, and *Diotis maritima* (Ibid., p. 264.).
Photograph 1a. Contact between flood basin and Amalias surface south of Metochi.

Photograph 1b. Beachridge surface and associated Pinus pinea and Juncus sp. communities.

Photograph 1c. Shingle berms east of Glifa.
A large series of parabolic and transverse dunes are situated along the coast from Korouta northwestward to Glifa. Both types of dunes are active and hence poorly vegetated. The parabolic dunes are aligned in three sets approximately parallel to the shoreline. Enclosed depressions occur between the sets, which are well vegetated with low grasses. The dominant plants associated with the hollows are *Juncus acutus*, *Erianthus ravennae*, *Arundo donax*, *Ephedra distachya*, and *Eryngium*, sp. The dunes are poorly colonized with tussocks of *Ammophila arenaria*, *Echium hispidum*, *Vaccinium*, and *Panicum*.

The transverse dunes were devoid of vegetation until 1952. At this time the government began a project to vegetate these dunes in order to stabilize and perhaps develop the area as a tourist resort. The vegetation includes several species of *Pinus*. These are: *Pinus halepensis*, *Pinus maritime*, *Pinus brutia*, and *Pinus pinea*. The cypress, *Cupressus sempervirens* has also been introduced. This species is often grouped into two forms (Davis, 1965, p. 78), *pyramidalis* and *horizontalis*, both of which occur in this area. Broadleaf vegetation includes eucalyptus, *Eucalyptus* sp., false acacia, *Robinia pseudoacacia*, acacia, *Acacia cyanophylla*, and necklace poplar, *Populus canadensis*. 
CHAPTER II

Landforms

Geomorphic field studies in the northwest Peloponnese are few. In 1834, Bory de Saint Vincent briefly described the beach ridges and the lagoons, the latter which he referred to as étangs. A theory he proposed for the formation of the beach ridges was related to erosion of the Tertiary surface associated with successive stages of sea level (Vol. II, p. 354). He also discussed the dunes north of Korouta. Philippson's work (1959) on the coastal plain is topographical in nature and only few data are pertinent.

The landforms of the plain of Elis are a product of fluvial, marine, and aeolian processes. The features in this area, as on many coastal plains, are primarily depositional in nature. The geomorphic units of the plain are divided into the following subheadings: (1) Beaches, (2) Barriers, (3) Lagoons, (4) Levee systems, and (5) Recent gravel plain. These features are in part illustrated in Figure 2. However, more detailed illustrations are present in this chapter (Fig. 5 and 6).

Beaches

The beaches of the northwest Peloponnese are crescentic in shape and joined to the headlands. They are relatively narrow, the maximum width being 60 meters just south
of Mavron Oros. Based on composition, two types of beach occur on this coast. These are shingle and sand beaches.

**Shingle Beach**

A beach composed of gravel extends from the mouth of the Peneus River northwestward to Chlemutsi Headland, a distance of 9 kilometers. The width of the beach is 25 meters. The gravels, which are poorly sorted, measure up to 4.75 centimeters in length. The source of the gravel is probably the Peneus River which is capable of transporting coarse material to the sea in winter.

In summer, the shingle is deposited in a "staircase" manner with the highest "step," or berm, farthest from the strandline (Photo 10). As one proceeds from the river mouth toward Glifa, the gravel berms increase in number. This suggests that the wave energy increases in a westerly direction and the source of the shingle is the Peneus River. The maximum of three berms was encountered. Also, the thickness of the deposit increases toward Glifa. According to reports the shingle at Glifa, which is devoid of sand, attains a thickness of 2 meters. Also, the contact between the shingle and the mixture of sand and gravel beneath is quite distinct.

In winter, when high energy conditions prevail, the beach is modified. During this time much of the shingle is removed and a mixture of sand and gravel is exposed. On this shoreline the cycle of removal and deposition of the shingle is a seasonal occurrence and not ephemeral. Also,
the accumulation of shingle does not appear to be associated with wave energy since the coarsest deposit occurs with minimum wave energy.

Sand Beach

The sand beach deposits are located south of the Peneus River to approximately Korouta. A similar beach deposit occurs north of Ohlemutsi Headland to Mavron Oros, however it is interrupted by the hard-rock headland of Kounoupeli. This beach is composed of medium size, subangular quartz sand intermixed with small amounts of shell hash and gravels. On the beach, particularly south of Kounoupeli Headland, pumice cobbles up to 25 centimeters in length are often encountered. The width of the beach varies considerably. North of Cape Katokolon and Ohlemutsi Headland, the deposit is 13 to 16 meters in width. The beach is also steeper in these areas and a berm is poorly developed. As one proceeds northward, the beach widens, the profile flattens, and a berm is clearly evident.

Barriers

On the northwest coast of the Peloponnesos 3 types of barriers occur. These are: (1) single foredune, (2) beach ridges, and (3) sand dunes.

Single Foredune

The single foredune is well developed from the Sachia River to Glifa and from Killini to Mavron Oros. It is composed of moderately well sorted quartz sand. The foredune
varies in height and width. Behind the active shingle beach, it is 8 meters in height and is 47 meters wide, whereas at Myrsini, where more sediment is available, it is 2 meters high and 97 meters wide. The foredune is vegetated with low grasses and is hummocky in appearance. The velocity of the wind appears to be great as evident from the large accumulations of pumice cobbles which are concentrated in low depressions on the depositional feature. The thickness of the barrier is not known. However sediment in a spoil heap on the coast indicates that the feature is approximately 2.5 to 3.0 meters in thickness and overlies gray clays similar to the adjacent lagoonal deposits. This suggests that the foredune is encroaching over the lagoon surface and may be evidenced as coastal retreat.

The foredune is active, primarily because of the lack of a vegetative cover, which is in part induced by man. In winter, the foredune is often used for sheep grazing when the low pastures are inundated. Many of the young plant shoots on the barrier are grazed upon by sheep, exposing areas of sand to the wind. Also, farmers extract sand from the barrier in places. During storms, these areas may be breached by the sea, causing washover fans extending 16 to 20 meters on to the lagoonal surface.

Beach Ridges

Beach ridges define the location of a former shoreline. Their development is in part dependent upon an excess sediment supply. As long as sediment supply exceeds sediment
removal the beach ridge system will prograde. However, if sedimentation cannot predominate over the forces of erosion, the shoreline will recede. Many beach-ridge complexes are thought to have developed since the Recent stillstand of sea level. Therefore most systems were initiated about 3500 B.P.²

The beach-ridge system (Fig. 5) in northwest Peloponnesos is the largest accretionary ridge feature on the entire west coast of the peninsula and perhaps one of the largest in Greece. It lies immediately between the beach and a series of intermittent lagoons. When the beach ridges were first initiated the trend was northeast-southwest. As the body of sediment accreted seaward the ridges joined the island of Kounoupoli to the mainland. This initial union undoubtedly was a fine example of a tombolo enclosing a small lagoon. The ridges have a subparallel lineation to the shore (Photo. 1b). However, at the northeastern margin of Kotychi Lagoon, they swing seaward and in this vicinity are truncated by the Ionian Sea (Photo. 2a). In winter, when the beach is cut back, exposures of white silty sand containing rootlets occur. The exposures are aligned with the swales behind the foredune in each case.

The breadth of the feature varies considerably. The system is approximately 1.2 kilometers wide at the north

²McIntire and Morgan (1963) have concluded that the present stillstand of sea level was reached 3375 B.P., whereas Coleman and Smith (1964) indicate that the present sea level was attained 3650 B.P. For the purpose of this report the approximate mean of 3500 B.P. will be used.
Figure 5. Landforms north of Kotychi Lagoon.
end of Kotycki Lagoon and progressively widens to 2.5 kilometers north of Manolas. The ridges are abruptly truncated by the rocky headland at Mavron Oros.

The landward set of ridges stand somewhat higher in elevation than those more seaward. This set is between 4 and 5 meters above the sea, whereas those closer to the sea are between 2 and 4 meters above sea level. The spacing of the crests is a rather consistent figure of 35-40 meters. The height of the crests above the swales is 0.75 meters. However, there are crests which stand as much as 2.5 meters above their adjacent swale.

A relationship exists between the height of a beach ridge and the length of time the shoreline is in a fixed position (Thom, 1965). An application of this hypothesis indicates, with few exceptions, that the time required to form each ridge was approximately the same. The irregularity of the higher crests may be accounted for by a comparatively longer period of time the shoreline remained established in one position. The establishment of higher beach-ridge crests is related to the duration the shoreline remained stationary in one position and not to eustatic changes of the sea.

A seaward decrease in elevation of beach ridges, suggested by some writers, resulted from a gradual lowering of sea level from a higher stillstand in Recent time (Davis, 1961). However, a gradual decrease in the availability of the sediment supply during the progradation of the shoreline may also be an important factor regarding the seaward
slope of beach ridges. Such a hypothesis can not be shown with any validity on this coast because of the gradual decrease in elevation of the beach ridge system to the north. Several reasons may be cited for the northward dipping slope. Subsidence may have occurred after the development of the barrier. It may be associated with the tectonic instability of the area. Also, the source area must be considered. It has been illustrated that narrowing and thinning of the beach ridges becomes more evident as the distance from the source increases (Vann, 1959). The littoral drift on this coast is northward which would account for the decrease in height of the beach ridges. Thus, any one of these, or a combination of these factors may account for the difference in elevation at the north and south margins of the beach ridges.

The crests of the beach ridges remain permanently dry throughout the year and many are cultivated year around. During the winter, the swales are inundated. This is particularly the case in the broad swales of the more landward beach ridges to the north where the complex is lower. Inundation is due directly to the increased water level in Kotychi Lagoon and not to precipitation.

The beach ridges are composed of well to moderately well sorted sand, 1.00-0.35 based on the classification of Folk and Ward (1957). No borings have been made on the system, however data from artesian wells indicate the feature is 10 meters thick and rests on alternating layers of sand and clay to a depth of at least 60 meters.
The younger beach ridges are devoid of any soil profile, which is indicative of their young age. The oldest ridges do however have a poorly consolidated humate zone of 18 centimeters. The humate decreases in depth seaward and is present in only 6 or 7 of the older ridges.

Sandpits reveal that the beach ridges are not characterized by any dominant microstructure. However in one sandpit some structure was observed 1 meter beneath the crest. At 1 meter, a top set unit, 25 centimeters in thickness occurs. Below this deposit, a fore set unit 36 centimeters thick is encountered. These units dip landward 4 and 8 degrees respectively. The difference in dip is related to wave energy (Psuty, 1965). The low angle strata were probably deposited under calm wave conditions whereas the high angle strata were laid down under stormy conditions.

The calcium carbonate content of the beach ridges is relatively high. Cementation occurs in thin laminations of the deposit. Also cementation around roots is common. The concentration of calcium carbonate is not continuous but occurs in an interrupted manner. Also, cementation occurs well above the water table which suggest that it was formed through percolation of rain water and not by the fluctuation of the ground water table.

Dunes

On the northwest coast of the Peloponnesos three types of dune features are recognized. These are (1) Parabolics,
(2) Transverse, and (3) Dune Ridges.

Parabolic or U-dunes (Fig. 2) occur adjacent to the coast from Korouta to 1.6 kilometers northwest of the mouth of the Peneus River. From here to Glifa the Aeolian deposit is transformed into an area of transverse dunes. The change in dune morphology is probably related to the orientation of the coast and wind.

The parabolic dunes, occurring in three sets, extend over an area of approximately 6 square kilometers and are separated by well vegetated enclosed depressions (Photo. 2b). They are composed of moderately well sorted sand ranging from 0.50-1.00, however pumice pebbles occur in the blowouts. The axis of each dune is due north but a maximum deviation of 18° east of north was observed.

The U-dunes south of the Sachia River are distinguished by long, well vegetated lateral walls and a relatively confined blowout zone which is active. The length of the lateral walls is longer on the most landward set of dunes which indicates that they were the first to be initiated. A maximum length recorded was 250 meters.

The second parabolic type occurs north of the Sachia River. This U-dune is characterized by short semicircular poorly vegetated lateral walls. The maximum length of the lateral walls is 190 meters. The blowout zone of this dune is more extensive than the first parabolic type. Also the orientation of the axis is more variable.

The transverse dunes (Fig. 2), east of Glifa, occur in sub-parallel ridges extending over an area of 11 square
Photograph 2a. Beachridge swales exposed on beach north of Kotychi Lagoon.

Photograph 2b. Enclosed depression between two sets of parabolic dunes near Korouta.

Photograph 2c. Poorly vegetated transverse dunes near Glifa.
kilometers. The ridges are discontinuous and the tips of the dunes extend in a leeward direction (Photo. 2c). The dunes are separated by low troughs which are devoid of any natural vegetation which suggests that these dunes are more mobile. The slip slope is over 30° in most cases. The transverse dunes attain elevations of 135 feet.

In the early 1950's the Greek government introduced conservation measures to stabilize this extensive dune field. The program included the planting of trees and shrubs which could withstand the abrasion by sand and summer drought. Also fences constructed of *Arundo donax* 31 to 46 centimeters in height were erected in a rectangular pattern on the mobile sand to prevent landward migration. The dune fields were also fenced off to prevent sheep from grazing on the planted vegetation.

A comparison of 1945 and 1963 aerial photos and local inquiries indicate that the conservation measures have been partially effective. However, migration is still active. In the past 10 to 12 years, the sand has migrated 50 meters covering cultivated fields. Also, a fence line, 1.25 meters in height, on the leeside of the dunes south of the Sachia River has been buried since it was erected in 1961. As on the foredune, shepherders violate the fences to feed and water their stock on the hollows of the dune field during the winter.

Dune ridges occur on the northwest coast of Peloponnesos from Kotychi Lagoon to Mavron Oros (Fig. 5). They are exceptionally well developed north of the Kounoupeli
Headland where blow-outs frequently occur. The dune ridges are poorly vegetated with low maquis shrub. They average about 200 meters in breadth; south of Mavron Oros a maximum breadth of 300 meters is attained. The feature is up to 4 meters in height and the orientation of the axis of the dune ridges is N 50° W to N 55° W.

Because of the poor vegetation cover and the direct exposure to the sea, the dune ridges are mobile. They are presently encroaching over the beach ridges at a rapid rate, asphyxiating the Pinus sp. in their path (Photo. 3a). The beach ridges adjacent to the shore have been buried and subsequently exhumed. Their lineation, however is still evident. They appear as low hummocky ridges, poorly colonized with tussocks of Ammophila arenaria, and wind sheared Pinus halepensis. Remnants of tree trunks (Pinus sp.) have been exhumed on the beach ridges indicating that the beach ridges adjacent to the sea were relatively well colonized in the past.

The wind velocity on this coast is high. This is evident from the wind sheared pines and also from the pumice cobbles which occur in the blowout zone of the dune ridges. It has been illustrated that an onshore wind with a Beaufort Scale of about 4 knots is required to move sand and form dune ridges (Jennings, 1957).

The parabolic and transverse dunes are high in calcium carbonate content which is evident from the cementation which has taken place well above the water table. Eolianite normally occurs in vertical or horizontal forms. Where
crossbedding is evident, cementation is often present on the bedding planes. However, crossbedding is not a common feature of these dunes. Conspicuous bedding of coastal dunes in the Mediterranean appears to be associated with the plant cover and is not possible under the modern vegetative conditions (Butzer, 1963). Occasionally cementation 7 to 10 centimeters in length occurs around roots. Under these circumstances the cementation encases roots which gives a cylindrical shape to the eolianite. No cementation is present on the dune ridges or foredune suggesting that these aeolian features are of a more recent origin and possibly more active than the transverse and parabolic dunes.

Fluvial Features

Fluvial features of the coastal plain include the modern Peneus River and smaller rivers known as torrents, and their active and abandoned levee systems and floodbasins.

As levee systems stand above the surrounding floodbasin, cultural activity accentuates their occurrence and extent. For example, in south Louisiana, levee systems, active and abandoned, form the main arteries of transportation, settlement, and agricultural activity. In the northwest Peloponnesos, levee systems with their coarser sediments are generally areas of intensive and relatively prosperous viticulture or cotton farming. Thus, vegetation whether it be natural or artificial, is often significant in distinguishing landforms on coastal plains.

The Peneus River, meandering to the sea, has undoubtedly
been significant to the well-being of the peoples occupying its banks since antiquity. Ancient Elis was founded on its left bank during the Perisan Wars (Strabo, Geography, 8.3.2.). With the hot dry summers, water was important for the inhabitants of the plain. Springs, although common in many areas of Greece, do not appear on the floodplain. Small torrents can not be relied upon because of their intermittent nature.

The Peneus River flows out of its valley onto the coastal plain. Its channel, choosing the steepest gradient, flows west southwest for a distance of approximately 15 air-line kilometers. Between Vartholomio and Kardiakafti it impinges on the Amalias surface and is diverted to the south (Fig. 6). The slope of the Peneus is sufficient to allow the transportation of coarse sands and gravels to its mouth. The coarse sediment transported to the sea is the probable source for the shingle of the beach previously discussed.

During summer an anastomotic fluvial pattern occurs. The scoured channels, which result from the previous flooding, are generally 30 to 60 centimeters in depth. At the bends of the channels, point bars frequently occur which are composed of coarse sandy sediments. Gravels of varying size often overlie the sand in narrow linear patterns which are deposited as flooding subsides.

Tectonic forces coupled with the lateral activity of the unstable channel of the Peneus have developed fluvial terraces up the valley. On the south side of the valley
Figure 6. Landforms south of Kotychi Lagoon.
8 river terraces have been noted (Food and Agricultural Organization, Vol. II, p. 23). Philippson has also noted a cut terrace on the north valley wall (1947, p. 323). On the valley floor southeast of Tragano, unpaired terraces were observed cut into the alluvium 2 meters above the present flood basin.

The crests of the terraces are often utilized as irrigation ditches. Water from the Peneus is pumped up to the terrace and allowed, by gravity flow, to be transported down valley to the adjacent fields. As the water descends, the ditch is breached at several places and the water guided to the crops. These irrigation ditches support a luxuriant growth of *Arundo donax* which makes their identification relatively easy.

Cut-offs become more numerous south of Vartholomio. Meander scars enclosing the ridge and swale point-bar topography are evident. During winter rains, some become reoccupied by the river; others accumulate water and become ephemeral lakes. Point bars support several vineyards and truck crops. Abandoned channels are also utilized in summer for truck crops. This is possible because of the lack of saline soils, even near the mouth of the river, where the elevation is less than 1 meter above sea level.

In recent years the Peneus has been dredged, and artificial levees have been constructed from Sambanaga to the sea to prevent flooding. However, these levees are discontinuous and irregular in height. Consequently, when flood conditions are reached, overflow and flooding occur in concentrated
areas. During January, 1966, serious flooding occurred on the banks opposite Kardiakafti and Sambanaga. The break opposite Kardiakafti was so violent it undermined the asphalt road from Gastouni to Vartholim approximately 2 kilometers to the south (Photo. 3b). The velocity of the water displaced sections of the gravel roadbed, and cut several tens of feet into the adjacent vineyards. The wide, irregular and distinct contact of the natural levee and adjacent flood basin suggests that the levee was developed by crevasses rather than uniform overflows. Crevasses on rivers with steep gradients have also been reported in Turkey (Russell, 1954). There, as in Elis, crevasse topography is created suddenly in unpredictable localities.

Premodern Levees

Meandering rivers flowing to the sea, seek a steeper gradient as their declivities decrease and their channels accumulate more and more sediment, thus setting the stage for diversion. In the past, the Peneus emptied into the Ionian Sea north of the Chlemutsi Headland. Strabo in his Geography mentioned that, "It is between Chelonatas [Chlemutsi] and Cyllene [Kounoupeli Headland] that the River Peneus empties." (8.3.5.). Ptolemy located its mouth, with reference to latitude and longitude, in the same general vicinity (Ptolemy, [trans. by Stevenson] 1932). Maps of medieval times also depict the river flowing north of the Chlemutsi Headland (Mercator, 1568, Randolph, 1689, et al.). The map of Santini, published in 1778, is the most recent
map showing the Peneus flowing north. Maps of the late 1700's to the present depict the Peneus River flowing south (Bocage, 1786, Rochette and Faden, 1791, Ministrie La Guerre, France, 1832). Therefore, the diversion appears to have taken place between 1778 and 1786, during the Turkish occupation. Reclus (1892) suggests that the diversion may have been partly induced by man, however natural diversion is not to be excluded.

Some writers suggest that the Peneus never flowed to the north of Chlemutsi Headland (Partsch, 1897, Philippson, 1893). Others however speculated that a premodern channel existed in the vicinity of Lechenia (Walter, 1928).

Two abandoned levee systems occur north of Chlemutsi Headland (Fig. 6) and can be traced from the sea to northwest of Tragano. Both sets of levees stand 1.75 to 2 meters above the adjacent flood basin west of Tragano and decrease in elevation seaward. No data are available on the thickness of the levees, however artesian wells located on these relict features obtain water from subsurface gravels at a depth of 5 meters. Immediately south of Kotychi Lagoon deposits of a fluvial system are exposed in the sea cliff composed of oxidized fine sand and silt (Photo 3c). Toward the flood basin the silt content increases and manganese nodules and root fragments occur. The channel, which is partly exposed at the base of the scarp, contains fine unoxidized gravel and sand. The width of the natural levee between the channel gravels and the lower flat of the flood basin is approximately 665 meters.
Photograph 3a. Migrating dune ridges asphyxiating beach-ridge vegetation.

Photograph 3b. Displacement of roadbed due to flooding of the Peneus River west of Gastouni.

Photograph 3c. Truncation of a premodern levee 2 kilometers south of Kotychi Lagoon.
A second channel system debouched into the sea 5 kilometers south of Kotychi Lagoon. Remnants of a discontinuous channel can be traced from the sea (Photo. 4a), north of Lechenia into Andravida Air Base. Within one half kilometer of the sea, the channel accumulates water in winter which is brackish, as evidenced by the presence of salt tolerant Batis maritima. The width of the levee (channel to flood basin) is 100 meters. It is composed of brownish silt. Point bars have accumulated coarse sands to depths of at least 2 meters.

Local Torrents

Two main rivers, the Verga and Larrisos (Fig. 5), having their headwaters on the Neogene surface, contribute sediment to the coastal plain.

These intermittent torrents drain a total area of approximately 680 square kilometers. Alluviation in the past is indicated by the relatively flat-lying surface in the valley bottoms. Subsequent down cutting by streams has resulted in entrenchment of the torrents which attests to the instability of the area. Their gradients permit them to carry coarse sediments onto the modern plain. Levee systems have developed on the coastal plain which stand above the flood basin. The natural levee of the Verga River, composed of sands and silts, stands 2.75 meters above the adjacent flood basin and attains a width of 700 meters. As on the Peneus, natural levees of the Verga River vary in width. Prior to the construction of
artificial levees, flooding occurred in selected locales. Inundations were common until the channel was dredged in 1947. In 1917, a large flood occurred on this river, which inundated Manolas leading to resettlement of the town of Nea Manolas on the scarp of the Amalias surface.

Crevasse deposits, composed of coarser sediments, are evidenced by braided patterns some distance below the levee crests and, on the modern plain, extend along the length of the channel. Not only are the levees of the Verga higher and steeper but the channel is narrower than that of the Peneus. Such an association between channel width and levee characteristics has been noted in other regions (Russell, 1939).

Lagoons

The lagoons (Fig. 6) on this coast occupy a significant part of the study area. Some travelers believed that these features were initiated in the immediate historical past as they were not mentioned by Strabo (Pouqueville, 1822). No enclosed water bodies appear on maps until the 1700's. D'Anville's map was the first to depict Kotychi Lagoon (1756). However, many cartographers since that time have also omitted the lagoons suggesting that the feature was present but neglected (Hérisson, 1828).

The omission of lagoons on early maps may be associated with the aridity of the summer climate; a time when travel was most convenient. The areal extent of all lagoons is highly variable. Lamia Lagoon (Fig. 5) ranges in surface
Photograph 4a. Remnant channel of Peneus River west of Lechenia.

Photograph 4b. Contact of the gravel plain and adjacent flood basin south of Gastouni.

Photograph 4c. Sachia River exposing Amalias surface dipping beneath the gravel surface.
area from 9.41 square kilometers in winter to 4.00 square kilometers in summer. Prokopos Lagoon varies from 7.84 to 1.69 square kilometers.

The largest intermittent lagoon is located northwest of Mirsin (Fig. 6). In winter the surface area of this unnamed lagoon covers approximately 7.50 square kilometers. A similar feature occurs landward of Kounoupeli Headland, however its area is less than 0.06 square kilometers in extent.

Northwest of Lechenia is the commercial salt pan of Aliki or Aligarouli. This feature appears to have been a natural lagoon on older maps and charts (Smyth, W.H., 1825). Since that time however, it has been artificially modified into a salt pan. The only other lagoons of commercial importance are Kotychi and Prokopos Lagoons. These two brackish water bodies are utilized as fisheries. The more important fish are eels, Anguilla anguilla, and gray mullets, Mugil cephalus.

The lagoons are ovate in shape with the long axis parallel to the coastline. Narrow sandy beaches occur on the perimeter of Kotychi Lagoon. However, the lagoon floors are clay.

Kotychi Lagoon is bounded on the seaward side by a foredune approximately 40 meters in width which is artificially breached. On the south, the water body is confined by a natural levee of the premodern Peneus River. A beach-ridge system restricts the lagoon on the north. Kotychi Lagoon is filling. Figure 7 illustrates the changes which have taken
Figure 7. Changes occurring in Kotychi Lagoon: 1832-1963.
place since 1832.

In 1832 the barrier extending across the seaward side of the lagoon was continuous and a main road between Lechenia and Metochi was located on it. The Verga River emptied into a bay east of the beach ridges. The configuration of the southeast shore of the lagoon was regular. Also the island at the southern part of the lagoon was an elongate peninsula joined to the mainland.

By 1914, the bay in the north was diminished to one half its previous size. At this time it had evolved into a lake communicating with Kotychi Lagoon through a narrow inlet. The barrier was breached, perhaps artificially, and the peninsula at the southern margin of the lagoon was truncated and stood as an island. The irregularity of the shoreline in the southeastern parts of the lagoon suggests that progradation was taking place in these areas.

By 1945, the bay, east of the beach ridges, was completely silted and the Verga River flowed directly into Kotychi Lagoon.

Air photos flown in 1960 indicate that the north shore of the lagoon had prograded seaward several tens of feet. Also small deltas which had developed are now extending into the lagoon.

Lamia and Prokopos Lagoons (Fig. 5) are bordered on the seaward side by the beach ridge complex and on the landward side by the Amalias surface. The cravasse topography of the Verga River prohibits this lagoonal complex to communicate with Kotychi Lagoon, and consequently the drainage is
northward. Lamia and Prokopos Lagoons may have communicated
with Kotychi Lagoon at one time, but were subsequently iso-
lated by the prograding levee of the Verga River. A church
located 0.5 kilometers east of Manolas on the levee was be-
lieved to have been constructed between 1000-1200 A.D. This
suggests that the lagoons, north of Manolas did not communi-
cate with Kotychi Lagoon for the last 900 to 700 years.

In 1822 Pouqueville (p. 113-114) noted:

Before the sun went down I had time to
survey, but at a distance, the salt-lakes
which line the shore for seven miles to-
gether [Prokopos and Lamia Lagoons ] and
which still are accessible by fishing
boats. These lakes are in progressive
diminution, much more probably by the
accumulation of substances from the land
than from any depression or retreat of
the sea,...

Today no boats are used in the fishing industry in any
lagoons in this coastal area.

A continuous foredune restricted Aliki Lagoon (Fig. 6)
from communicating with the sea. On the north and south it
is restricted by the two sets of abandoned levee systems of
the Peneus River. In a sense Aliki Lagoon is an inter-levee
basin. An unnamed intermittent lagoon occurs to the south
of Aliki Lagoon which is confined on the north by the pre-
modern Peneus levee and on the south by the higher terrain
of the Amalias surface.

Gravel Plain

South of Gastouni, the physical and cultural landscape
is of a different nature. The soils are sandier and well
drained. Town names, such as Ambelokambos, suggest the main
economic crop of the area is the grape. The gravel plain (Fig. 2) is one of the largest producers of grapes and currants in the Peloponnesos which gives the landscape a relatively prosperous appearance.

A well defined scarp, 2 meters in elevation, delineates the modern plain from the sandier upland terrain (Photo. 4b). The scarp, forming the northern boundary of the gravel plain, can be traced from the Amalias surface, seaward to the mouth of Sachia River. On the east and south, this surface is delimited by the Amalias surface. On the coast, it is represented by a sea cliff. At Korouta, the cliff is approximately 4 meters above the adjacent beach and dips northward until it eventually fades at the mouth of the Sachia River. From Korouta to the Sachia River the feature is capped by parabolic dunes.

The seaward slope of the gravel plain is 6.7 meters per kilometer which is considerably more than the 2.5 meter per kilometer slope of the modern plain. The Sachia River has deeply entrenched the gravel plain, exposing large sections of subsurface deposits plunging beneath a more recent surface (Photo. 4c).

The components of the surface are coarse unconsolidated sands and gravels. Several gravel pits and exposures on the Sachia River indicate that the deposit is of considerable thickness and has a seaward dip (Fig. 8). East of Amalias, a section exposes 12 meters of gravels. West of Amalias, the river has incised the plain exposing vertical sections of gravel 7 meters in height. As one proceeds seaward
unconsolidated coarse sands overlie the gravels. Within the sands, gravel lenses occur, suggesting the sands are of a fluvial origin. The sand layer above the gravels thickens seaward attaining a maximum thickness of 2 meters. However, artesian wells near Korouta indicate that the sands are 5 meters in thickness and overlie the gravels. The gravel outcrops on this coast are locally termed "kaliko porri," meaning gravel passes. The kaliko porri have been planed under the hoofs of sheep and form a readily accessible route from the plain to the sea.

The oxidized terrain of the Amalias surface dips beneath the gravel plain. The contact is well exposed in the banks of the Sachia River for a distance of 585 meters. The stratigraphic association is similar to that noted on the Gulf Coast of the United States. There, the Pleistocene coastwise terraces underlie the seaward thickening wedge of Recent sediments of the Gulf Coastal Plain.

The valley of the Sachia River, east of Amalias, is morphologically similar to the valleys confining the local torrents, except for scale. Here, the Sachia eroded a valley in the oxidized sediments 475 meters in width. The valley was subsequently alluviated with sands and gravels. As alluviation progressed seaward it buried the sloping oxidized sands and gravels west of Amalias. The surface was then dissected by intermittent torrents, exposing vertical sections of the recently deposited alluvium.

A generally accepted theory is that much erosion has occurred in the Classical Lands during historic times which
Figure 8. Geomorphic relationships of the Amalias surface and the Recent gravel plain.
has been largely attributed to deforestation (Darby, 1965). The archeological evidence suggests that the gravel plain was, at least in part, deposited in the historic past as a direct natural response to the erosion of the adjacent higher terrain.

Coastal Retreat

The coastline of the northwest Peloponnesos is retreating. This is evident from Korouta to the mouth of the Sachia River and north of Chlemutsi Headland.

The gravel plain, which is truncated by the Ionian Sea, has been retreating in the past decades. At Korouta a fence on the sea cliff has been replaced three times since 1950. The second row of posts had been replaced in 1963. Concrete foundations indicating where the posts had been previously located are still evident on the face of the scarp. In winter the surf often reaches the scarp, which causes undercutting and slumping. A calculated seaward projection of the gravel plain suggests that this surface intersected the level of the sea at least 500 meters from the present shore. This calculation does not take into account any tectonic instability of the plain, which may alter the figure.

South of Korouta a fossiliferous limestone outcrop occurs. At the base an undercut notch has developed 12 meters from the fair-weather strandline. Similar undercut notches occur elsewhere. Approximately 5 kilometers north of Cape Katakolon wave-cut notches occur 3 meters above sea
level. The feature, which is discontinuous over a distance of 30 meters, dips southward and appears to be joint controlled. Other discontinuous notches, in similar limestone bedrock occur at Glifa approximately one meter above sea level (Photo. 5a).

The notches occurring at Glifa may result from storm conditions. However, the discontinuity, and poor correlation and tilted notch at Cape Katakolon, and the absence of notches at Kounoupeli reflect the local instability of the coastal area. Thus, it is highly probable that these features indicate a relative and not a eustatic change in sea level.

North of Kotychi Lagoon, the truncation and the exposure of beach ridge swales on the beach is indicative of coastal retreat. At the northern margin of Kotychi Lagoon the lineation of the beach ridges indicates that the coastline extended farther seaward in the past. But because of a decrease of sediment supply the shoreline has retreated.

The barrier separating Kotychi Lagoon and the sea has narrowed since 1832. At that time, a road traversed the length of the lagoon (Fig. 7). Today however, no evidence of the road remains. Breaching and inland migration of the barrier and washover fans suggest that the road was destroyed by the sea.

The abandoned levee system immediately south of Kotychi Lagoon stands as a low sea cliff. Undoubtedly it attained a level close to the present sea level. As sea level in the past 3500 years was relatively stable, it is apparent that
the coast was truncated since the formation of this levee system. Farmers in the area reported that the sea cliff has retreated 7 meters in the last ten years. This is partly confirmed by evidence of a former fence line constructed in 1962. Remnants of the fence occur 2.75 meters seaward of the scarp, which is indicative of rapid coastal retreat.

The fluvial system 5 kilometers south of Kotychi Lagoon also has a levee system which stands above the adjacent plain at the present shoreline. Normally, levees decrease in width and elevation above sea level and are scarcely discernable on the shore (Russell, 1936, p. 26). However, both premodern levees may be traced and clearly identified at the shoreline indicating that they were eroded by the retreating shoreline.

If the scarp of the levee adjacent to Kotychi Lagoon is projected seaward, it intersects the level of the sea approximately 1.2 kilometers off shore. However, this is a minimum value which does not take into account subsidence of the levee, tectonic activity, or the possibility that the river debouched into a lagoon. According to several reports, foundations of an archeological site 4 by 1.75 meters occur beneath 4 meters of water about 100 meters seaward of this levee system. Also in this area several potsherds of Roman age have been washed ashore which tend to substantiate the report of the local inhabitants.

Active dune ridges which are migrating over the beach ridges, exposing unvegetated ridges on the shore, also
indicate coastal retreat. In extreme cases, the dune ridges have penetrated 150 meters inland, burying the woody vegetation in their path.

At Cape Katakolon beach rock occurs near sea level. Several potsherds of Roman age and cut limestone foundations have been incorporated in the beach rock. Also extensive archeological foundations occur in the immediate offshore zone. This evidence indicates the headlands of the northwest Peloponnesos have also retreated since Roman time. Shoreline recession is active on the cliffy coast of southern Greece. Higgins suggests that the shoreline south of Pylos, composed of Tertiary flysch, has retreated 800 meters since the last rise of sea level (1966).
CHAPTER III

Archeology

Archeological studies in Greece are numerous. With few exceptions, these studies have been approached topically rather than regionally. Consequently most of the archeologists in Greece have concentrated on certain cultural periods such as the Bronze or Classical Age. This is exemplified by the Bronze Age excavations at Mycenae and more recently at Pylos (Fig. 1), the focus of Nestor's kingdom. Field work by archeologists in the study area has been approached with similar methods. Records of the historic past are known mainly from the excavations at Olympia and the ancient town of Elis.

Travelers and topographers passing through the northwest Peloponnesos were primarily impressed with the agricultural wealth of the landscape at that time and not with the monotony of the relatively flat terrain. Ancient Elis and a castle on Chlemutsi Headland were recorded in most travel accounts. Most other sites were generally ignored. Gell, who traversed the study area in 1817, was the only topographer in the past century who noted smaller sites. However, he made no attempt to describe these sites. Consequently, his log is too brief to be of significant value.

Undoubtedly the journals of many early travelers discouraged archeological investigations in the area. In
1830 William Leake (Vol. II, p. 219-220) wrote:

...if the traveler is disappointed at the little of antiquity that remains either here or at Olympia or indeed upon any of the Hellenic sites of this province [Elis] it may be of some consolation to him to consider that a soil, subject like that of the Eleia, to alluvial changes was the best adapted speedily to conceal, and may still therefore preserve some of the works of art which survived the fury of the persecutors of idolatory...and that if there is less above ground in the Eleia, than in any of the provinces of Greece, there may be more below the surface.

The first formal excavations in the study region were undertaken by Austrians at the ancient city of Elis. Their findings were published in 1911 in Die Jahresheft des Österreichischen Archäologischen Institue, Band, XIV. Excavations were revived at this site by the Greek Archaeological Service, in the last few years.

Sperling (1942) was the first archeologist to approach this area regionally. In 1939, he established a basic framework for the regional archeology of Elis but primarily confined his field work to an area south of the Peneus River. He concluded that the early inhabitants of Elis occupied the more fertile low lying regions of the province.

The presence of prehistoric settlement in the northwest Peloponnesos was not established until the early part of the current decade. In 1961, Servais published on the Paleolithic artifacts he discovered on the Chlemutsi Headland. In the same year, McDonald and Hope Simpson, reconnoitered the area to the immediate south, and confirmed the presence of a prehistoric occupation at Cape Katakolon (1961).
Additional sites were established by a team of archeologists in 1963 (Leroi-Gourhan, Chavaillon, N., and Chavaillon, J.). According to their report (p. 324):

De Patras à Pyrgos et tout particulièrement dans les régions de Kato Achaia, de Kastron, de Neochóri, de Amalias et du Cap Katakolon, nous avons découvert, en place, dans des formations pléistocènes continentales, les vestiges d'industries appartenant à trois périodes du Paléolithique grec,...

Although the record of early man was only established in the past few years, it does indicate that the northwest Peloponnesos has been occupied since prehistoric time. Also the archeological record is based on the cultural remnants preserved in the landscape; the ancients left their cities, the Franks their castles, and the Turks their wells. Today on the plain of Elis most towns have non-Hellenic names illustrating centuries of foreign domination. Gastouni was named after Gaston, a Frank, and Andravida in honor of Andreville (Leake, 1830).

The chronology of the northwest Peloponnesos is based on the artifacts which were found in the study area. As any preliminary chronology, it will undoubtedly be refined in the future. Based on the artifacts, the following periods are recognized in the northwest Peloponnesos:

- Turkish . . . . . . . . . . 1354-1821
- Byzantine/Frankish . . . 328-1354
- Roman . . . . . . . . . . 196 B.C.-285 A.D.
- Hellenistic . . . . . . . . 338 B.C.-146 B.C.
- Classical . . . . . . . . . 550 B.C.-338 B.C.
Archaic . . . . . . . . . . . . 1110 B.C.-800 B.C.
Helladic . . . . . . . . . . . 3000 B.C.-1100 B.C.
Prehistoric Neolithic Paleolithic . . before 4000 B.C.

The dates indicated above are used with little chronologic precision. Historically they may be somewhat inaccurate. However the objective of presenting these dates is to give a perspective to the human and physical history of the area.

Some artifacts of two cultural periods are grouped under one heading. This grouping however does not detract from the pattern of settlement for a particular time. The prehistoric sites are one such group. "Stone Age" artifacts have been categorized as "Prehistoric." This includes artifacts of Paleolithic and Neolithic age.

Prehistoric Sites

The earliest inhabitants in the light of the present evidence were the prehistoric peoples. The sites are of Paleolithic and Neolithic Age, which terminated with the introduction of metals about 4000 B.C.

The prehistoric sites occupy the oxidized sands and gravels of the Amalias surface and the older and higher geologic units (Fig. 9). In the northwest Peloponnnesos, the sites occur on the Pliocene of the Chlemutsi Headland and Cape Katakolon, and the Quaternary oxidized sands and gravel paralleling the sea.

Artifacts consist of white and reddish-brown flakes of chert which is not indigenous to the area. Many of them have been worked around the edges and fashioned into blades
Figure 9. Prehistoric sites.
up to 5 centimeters in length (Photo. 5b). Some of the blades, which are up to 2.5 centimeters in width, exhibit serrated edges. Varying degrees of patination occur. This form of chemical weathering probably accounts for the variable discoloration.

Most chert artifacts were found in place (Servais, 1963). However, others were noted on the surface of local stream beds and not in situ. Surface collections were made in the vicinity of Cape Katakolon and Glifa. A characteristic common to many of the sites is that they overlook the sea. This relationship is evident at Cape Katakolon, Glifa, Retuni, and Limnohori.

**Helladic Sites**

Prior to 1966, the only Helladic site which has been confirmed in the study area, was that of Servais. Servais' site, located at the crest of Chlemutsi Headland, was established in 1964 (Fig. 10). Thus, intensive archeological field work is relatively recent in this area.

Most Helladic artifacts occur in mounds, locally termed "magoula" or "magoulaka" meaning cheeks or little cheeks (Photo. 5c). They are conical in shape and vary in height and diameter. The largest mound noted is located in Boudieka. It stands 4.2 meters above its surrounding terrain and has a diameter of 115 meters.

All the magoula noted in the study area were composed of locally derived oxidized sand and gravel. It has been stated that "probably all the 'tholos' tombs of the Late
Figure 10. Helladic sites.
Bronze Age, whether sunk in the ground or built above it, were surmounted by a mound of some kind" (Hood, 1960, p. 281). The sherds from mounds, in northwest Peloponnesos, have been dated 1800 to 1500 B.C. (Photo. 6a), and are therefore Late Helladic in age. It may be possible that some of the larger mounds are tombs and the lower mounds habitation sites. Up to the present however, no excavations have been undertaken in this area to determine the precise function of the mounds.

Some magoula are situated on a scarp overlooking the coastal plain. Others occur on valley crests overlooking intermittent streams which have dissected the Amalias surface. No sites have been observed on the modern plain. Other than their occurrence in the oxidized terrain, no general distribution appears evident. Similar relationships between Prehistoric and Helladic sites and the geomorphic environment have been noted in other coastal areas of the Peloponnesos.

The relative sparsity of sites in the highlands of southern Peloponnesos has been attributed to rough topography, isolation, and poorly watered and infertile soils. Also the modern plain did not attract settlement because of its marshy condition (McDonald and Hope Simpson, 1964). Thus, settlement was concentrated on or close to the contact of the Pliocene sediments and the modern plain. Sites seaward of this contact have not been established. Also, sites above the bedrock contact are rare.

The physical environment of Elis resembles that of
Photograph 5a. Wave-cut notch at Glifa.

Photograph 5b. Artifacts of prehistoric age.

Photograph 5c. A Mid-Helladic "magouli" near Boudieka.
southern Greece. The modern plain was probably marshy 3500 years ago. Also Pliocene foothills were probably no more habitable in Elis than in southern Peloponnesos. The Amalia surface therefore appears to have been the most hospitable area to settle during Helladic and Pre-Helladic times.

In the Pamasos Valley of southern Peloponnesos (Fig. 3), the contact between the modern alluvial valley and the Tertiary outcrops is distinct. All Prehistoric and Helladic sites occur on the bedrock surface; no sites of these early cultures have been identified and mapped on the modern valley. McDonald and Hope Simpson (Ibid., p. 240) concluded:

The lowest sites so far identified seem to be set precisely at the line of demarcation between the slightly sloping Pliocene sediments and the recent alluvium.

No Helladic sites were established on the coastal plain of Elis. The absence of such sites may be explained by subsequent burial by Recent alluvium. Since sea level reached its present stillstand about 3500 years B.P., the coastal plain was marshier and subsidence active. Therefore it may be possible that the sites, if they occur on the marshy plain, subsided beneath the surface. Moreover, as subsidence was active, alluviation of the plain by rivers may have aided in concealing the sites. In south Louisiana, where subsidence is active, mounds have been known to disappear beneath the unconsolidated surface over a period of 20 years (McIntire, 1958, p. 27). Helladic sherds located beneath lagoons near Pylos by McDonald and Hope Simpson do
suggest that the lowlands may have been occupied (1964). However no geomorphic relationship has been established. In addition due to concealment by subsidence and alluviation, sites on the premodern shoreline may have been destroyed by the rising sea.

The economy of the Myceneans was based primarily on agriculture. If the lowland was not marshy, it was undoubtedly subjected to flooding as it is today. Thus the Amalias surface was more favorable for the agrarian economy. Under these circumstances, it may be possible that no Helladic sites were located on the modern plain because of flooding and possible salt-water intrusion which hindered the agricultural economy.

Archaic Sites

Chronologically the Archaic period followed the Helladic. New migrations of peoples entering Greece rapidly destroyed the relatively peaceful Mycenaean kingdoms. The Dorian invaders with superior weapons of iron deposed the Helladic inhabitants and destroyed their strongholds. This movement was long and the unsettled conditions of the times were not particularly favorable to civilization. Essentially then, Greece entered a "Dark Age" which was to be revived centuries later.

This period of upheaval may have attributed to the scarcity of sites not only in Elis but also in south Peloponnesos. The oldest sites in the Rhône delta date from the fifth or sixth century, B.C. (Russell, 1942, p. 243) which
Photograph 6a. Helladic sherds.

Photograph 6b. Recent excavations at Elis.

Photograph 6c. Well preserved Hellenistic sherds.
correspond to late Archaic or early Classical time. McIntire noted in south Louisiana that the oldest cultures are less likely to survive unless they are associated with geomorphically stable areas (Ibid., p. 54). The Helladic period in Elis is well represented on the upland terrain which is not seriously affected by subsidence. The poor representation of Archaic sites in Elis (Fig. 11) may be associated with the geomorphic instability of the modern plain. Perhaps the Archaic peoples occupied the modern plain which was swampy and therefore actively subsiding. If this environment prevailed during Archaic time, any evidence of their culture may indeed have subsided beneath the plain.

Only one Archaic site was established during this study which was associated with more stable terrain. Several sherds of Archaic age were noted at Glifa on the Pliocene surface overlooking the Ionian Sea. Although, only one site was recorded, it does suggest that the higher, more stable terrain of Elis was inhabited by Archaic peoples. It does not necessarily mean that the Recent plain was not occupied.

Classical Sites

The oldest sites located on the modern plain of Elis are of Classical Age (Fig. 11). The ancient city of Elis which was established after the Persian Wars (490 B.C.) was situated on the alluvial valley of the Peneus River (Photo. 6b). An accurate topographical description was recorded by Pausanias who was impressed by this elaborate city.

It is believed that the Eleans organized and managed the
Figure 11. Archaic and Classical sites.
Olympic games. Within the town a gymnasium and other training areas were constructed for the athletes who "are wont to go through the training through which they must pass before going to Olympia" (Pausanias 2.23). Alluvium has buried the town and only recently have archeologists begun excavations. To the present only the theater has been uncovered. In 450 B.C., Anarcharsis was impressed with the plain which was "...covered with laborious slaves and agriculture flourish [ed] ..." (Barthelemy, Vol. 3, p. 413). His observations suggests that a relatively dense population pattern was established by this time.

Hellenistic Sites

Occupation by Hellenistic peoples is well represented in the study area (Fig. 12). The archeological evidence suggests that this culture was the first to occupy the beach ridges and the flood basin. However, Hellenistic occupation is also evidenced on the Amalias surface and the undifferentiated bedrock.

A site of Hellenistic Age occurs northwest of Metochi, situated on the most landward beach ridge. Several sherds 6 to 18 centimeters below the crest of the ridge were noted. Many of the pottery fragments were decorated with black paint and were well preserved (Photo. 6c). Since the sherds were not corraded, the movement of sand was minimal. This implies that the beach ridge was adequately and consistently vegetated since Hellenistic time. An alternative explanation for the preservation of the paint is that the sherds
Figure 12. Hellenistic sites.
were buried rapidly by an artificial or natural process. However, since no Hellenistic tomb was associated with this site, the latter explanation is probably less valid.

Other sites of Hellenistic Age have been established on the flood basin. Southwest of Gastouni a site contains several Hellenistic sherds which were dated between 250 and 200 B.C. The sherds were noted in a spoil bank of a drain which was 2 meters in depth. It is difficult to estimate the precise depth at which the sherds occurred. However, spoil heaps of shallower drains 0.5 meters in depth leading to the main drain contain sherds of the same culture. This implies that the sherds exhumed in the main drain were located at approximately the same depth.

A site in a similar flood basin environment was located 3 kilometers north of the Peneus River. This site, located between the two abandoned levee systems, contained sherds in a spoil bank removed from a drainage ditch 0.3 meters in depth.

On the northern abandoned levee system, an additional site was established. The sherds were approximately 0.3 meters beneath the surface suggesting that the pottery was buried by the premodern Peneus River when it was active. Also Roman sherds were associated with this levee site.

The Sachia River has cut a gorge exposing the oxidized Amalias surface plunging beneath the gravel plain. Two sites occur at the contact which have been buried by the gravel and subsequently exposed in the steep walls of the river (Fig. 13).
Figure 13. Relationship of Hellenistic and Roman sites and the gravel plain.
The first site was located 0.7 kilometers down river from Amalias. The artifacts are buried 1.75 meters beneath the gravel plain and occur only at the contact of the two surfaces. The sherds, which are found on both walls of the river, can be traced over a horizontal distance of 16.5 meters.

The second site, with the same stratigraphic position, is located less than 1000 meters down river from the site above. The sherds occur beneath 3 to 4 meters of unoxidized sand and gravel. The lateral extent of this site is approximately 7 meters.

The pottery of these two sites is in situ. Decorative painting on several of the pieces is well preserved and no excessive abrasion appears evident. In addition, fragments of charcoal are dispersed through the site up river which also suggests that the sherds were not transported.

Roman Sites

Perhaps the most abundant sites in the northwest Peloponnnesos are of Roman Age. These sites are associated with dune, gravel plain, beach ridge, and levee surfaces (Fig. 14). The widespread occurrence of these sites suggests that the settlement on the coast was relatively well distributed.

Several sites have been identified on both, parabolic and transverse dunes. Most of the sites encountered occur in the enclosed depressions of the transverse dunes and the blow-out zone of the parabolic dunes. The sherds have a coarse texture because of the abrasive effect caused by the
Figure 14. Roman sites.
sand. Some sites, particularly just northwest of Korouta, often have chestnut shaped fragments of pitch associated with them, which may have been used for caulking of ships. Often the sites on the dunes have sherds which are scattered over an area of approximately 16 to 20 meters.

North of Korouta, the dunes are perched on the truncated scarp of the gravel plain. A Roman site is located on a sandy hummock overlooking the sea (Photo. 7a). The sand of this low hummock has a coffee-brown stain to a depth of approximately 10 centimeters. Associated with the site are pitch, cinders, and a few scattered clumps of red clay.

Roman tombs occur at shallow depths of the gravel plain several kilometers west of Amalias (Fig. 13). The body was covered by an inverted V-shaped series of red clay tiles, and was buried 0.75 - 1 meter beneath the surface. In a gravel pit where Roman tombs are exposed, the gravel is generally overlain by 0.6 meter of dark brown sand. Immediately above the tombs, gravel mixed with sand occur which indicate that the surface was disturbed. Apparently the grave was dug, the tomb placed in the ground and covered with the mixture of sand and gravel.

A Roman tomb was located on the oldest beach ridge north of Metochi. The tomb was constructed in the same manner as the tombs described on the gravel plain. Other Roman sites were situated northwest of the Verga River and on several beach ridges near Kounoupeli.

Several sherds have been exposed on the surface of cultivated landward beach ridges. Also, sherds have been
located in the bank of a water pond, above the water table, which was excavated in a swale. The depth of the pond is approximately 1.3 meters. Roman sherds are relatively abundant in the spoilheap of the pond. The sherds are incorporated in the beach-ridge complex, suggesting that the ridges may have been active when they were occupied.

Several ridges with sherds of Roman age occur behind the hard-rock headland of Kounoupeli. Most of the sherds were located on the ridge crests, however, some were dispersed in the swales. Several limestone cobbles littered the area. These were probably quarried from the adjacent headland. The Roman artifacts located on these beach ridges were well preserved. The surfaces of the sherds were smooth and not abraded by the sand as those of the dunes. In photograph 7b sherds which are not abraded can be readily distinguished from those exposed to the wind. As in the instance of the Hellenistic site, it appears that these beach ridges were stabilized by vegetation during the occupation by the Romans. References have been cited which substantiate the presence of abundant vegetation at this time, which may account for the absence of abraded sherds.

The beach ridges were well vegetated in 1675 (Spon, ibid., p. 45). However, the type and condition of the vegetation cover between Roman and the Mid-Turkish occupation can only be speculated upon. If the vegetation was removed during this 1400-year interval it would appear that the Roman and Hellenistic artifacts would have been exposed to the wind and abraded.
Photograph 7a. A Roman site north of Korouta.

Photograph 7b. Roman sherds from beach ridges and dunes.

Photograph 7c. Roman sherds incorporated in a truncated levee, 2 kilometers south of Kotychi Lagoon.
Roman sites occur on the premodern levee system immediately south of Kotychi Lagoon. Pottery is exposed in the sea cliff at the coast (Photo. 7c). Roman sherds occur in the silted channel and on the flanks of the levee 0.7 meters beneath the surface. Other Roman sites occur 2.2 kilometers northwest of Lechenia, 0.3 meters beneath the crest of the levee. The occurrence of the Roman sherds incorporated with the levee suggests that the channel was active at that time.

A Roman tomb was located on the levee, west of Tragano, situated above the point of bifurcation. Other tombs, probably of Roman age, are associated with the more northern levee system of the Peneus River. North and northwest of Lechenia farmers who cultivate vineyards on this levee system have described tombs which are similar to those described above.

Traces of a possible Roman site occur 2.2 kilometers east of Killini. The sherds were situated on the Amalias surface overlooking the sea. Also several Roman sherds and a limestone foundation were noted north of Cape Katakolon incorporated in a beach rock outcrop near sea level. Reports confirm that there are remains of foundations in the immediate off-shore zone. This may be the location of ancient Pheia, described by Strabo in his Geography (8.3.12).

Byzantine and Frankish Sites

Sites of post-Roman to pre-Turkish occupancy predominantly occur on headlands overlooking the sea (Fig. 15).
During this time foreign domination of the Peloponnese passed from the Romans to feudal landlords. Thus settlements were established which could be easily defended and easily accessible to the sea.

Only one Byzantine site was noted, however, its authenticity is questionable. On the coast, 4.8 kilometers east-northeast of Killini, a mound which is situated adjacent to the shore has been truncated by the sea. The mound is composed of discarded undatable tiles intermixed with Byzantine sherds. Since the Byzantine sherds are haphazardly scattered among the tiles the certitude of this site is questionable.

Anyone travelling through the Peloponnese is soon aware of the numerous medieval fortresses on the landscape (Photo. 8a). Such fortresses, known as "Paleokastra," in local parlance, command the headlands of Katakolon, Chlemutsi, and Kounoupeli.

Perhaps the most imposing structure in Elis is Chlemutsi or Clairmont Castle (Castel Tornese). The castle derived its name from the Romaic word chlemos meaning hills with regular form (Clarke, ibid., p. 276). This hexagonal fortress was built in 1223 by Geoffrey de Villehardouin. The architecture of Chlemutsi is discussed by Andrews (1953, p. 146-158).

It was believed that William Villehardouin established a mint at this site and issued coins which were common in France at the time. The coins were stamped with the church of St. Martin of Tours and the currency became known as
Figure 15. Byzantine and Frankish sites.
"tournois" in the Peloponnese from 1250 to 1333. The Venetians, in the 16th century, who assumed that the mint was located at the fortress, named the fortress Castel Tornese.

Andravida was the capital of the Frankish principality. Within the town, all that remains is part of the Gothic cathedral of St. Sophia. Ruins of a small castle, Pondiko Castro, remain at Cape Katakolon. However, it and a small fortress on Kounoupeli Headland are delapidated and overgrown by vegetation.

Turkish Sites

The Ottoman Turks occupied Greece for approximately 500 years. Several sites of the era have been identified (Fig. 16).

At Andravida (Fig. 6), the Turks attempted to transform the Gothic cathedral into a mosque. However, whenever a minaret was constructed, it was destroyed by earthquakes. Although minarets are common in several areas of Greece, none exists on the coast of Elis today. The Greeks believe that archeological remains are good indicators of the tectonic activity. It is often pointed out that Athens is a relatively stable area because the Parthenon has not been destroyed by earthquakes. Conversely, the western Peloponnesos is less stable as indicated by the many toppled columns at Olympia.

Much of the land in Elis belonged to Turkish landlords such as Ali Tchelebi whose estate was centered near Metochi.
Natural Levees
Flood Basin
Meander Scars
Amalias Surface

Figure 16. Turkish sites.
Towns ending in "aga," meaning "the great one," in Turkish, also suggest that the Turks had estates in several places. This is implied by the names of Sambanaga and Suleiimanaga, the former name of Mirsini.

Turkish sites occur on the abandoned levee system 5 kilometers south of Kotychi Lagoon. Several sites with sherds were found on the levee of the last meander before the Peneus debouches into the sea. Pottery is so plentiful in this area, that local residents refer to it as Turkopolis.

Three wells were also located on the levee in the same area. The wells are constructed of narrow shafts 0.8 meters in diameter and lined with limestone cobbles (Photo. 8b). Above ground, a semi-circular limestone wall about 1 meter high was constructed. The present depth of the wells is 2.5 to 3 meters. These wells have not been used since the Turks evacuated Greece and are partly filled with litter. Although they can be utilized, the inhabitants prefer to construct their own wells. Many of the peasants feel that the old wells are too contaminated to be of any use.

Reports suggest that Lechenia was located at the mouth of the old Peneus River approximately 5 kilometers south of Kotychi Lagoon. The town was relocated at its present site, 4 kilometers inland, because of the constant threat of pirates. Piracy was common on the west coast of Greece from Epidamnos (Durrës) to Messenia throughout ancient and medieval times (Semple, p. 648). It is not known when the town was relocated. However, relatively accurate maps (Smyth, 1825) indicate that the site must have been moved before
Photograph 8a. A medieval fortress on Chlemutsi Headland.

Photograph 8b. A Turkish well on levee crest 5 kilometers south of Kotychi Lagoon.
Another Turkish site is located 0.62 kilometers west of Tragano. This site is on the levee system above the point of bifurcation.

In summary, Table I illustrates that the Helladic and prehistoric settlement was primarily established on the higher and older geologic units. From the evidence, it is apparent that the earliest settlements on the modern plain were of Classical Age. Settlement on the modern plain subsequently increased through historic time.
**TABLE I**

<table>
<thead>
<tr>
<th>AGE</th>
<th>FREQUENCY</th>
<th>LANDFORM ASSOCIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkish</td>
<td>5</td>
<td>Abandoned levee 5 kilometers south of Kotychi Lagoon</td>
</tr>
<tr>
<td>Byzantine/Frankish</td>
<td>5</td>
<td>Headlands, one possible site on flood basin</td>
</tr>
<tr>
<td>Roman</td>
<td>14</td>
<td>Dunes, beach ridges, gravel plain, levee one kilometer south of Kotychi Lagoon, offshore (beach rock), bedrock</td>
</tr>
<tr>
<td>Hellenistic</td>
<td>7</td>
<td>Most landward beach ridge, flood basin, abandoned levee one kilometer south of Kotychi Lagoon, Amalias surface</td>
</tr>
<tr>
<td>Classical</td>
<td>3</td>
<td>Peneus Valley, bedrock</td>
</tr>
<tr>
<td>Archaic</td>
<td>1</td>
<td>Amalias surface</td>
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<tr>
<td>Helladic</td>
<td>14</td>
<td>Amalias surface and bedrock</td>
</tr>
<tr>
<td>Prehistoric</td>
<td>12</td>
<td>Amalias surface and bedrock</td>
</tr>
</tbody>
</table>
CHAPTER IV

Correlation of Landforms and Archeology

Archeological artifacts are useful for the relative dating of landforms. The oldest site on a landform is indicative of the minimum age of that feature. Obviously the landform must be present before it can be occupied.

In the northwest Peloponnesos, a distinct association is evident between the landforms and archeological sites. Man has established sites which are best suited to his bent. He does not occupy the land in a haphazard fashion. Levee systems afford high well drained locales which are annually revitalized by floods. Adjacent to such landforms, there is an ample and reliable fresh-water supply for his needs. In a Mediterranean climate, the perennial streams may be utilized in the dry summer months to irrigate fields, which have in turn been naturally fertilized by the winter floods. Perennial streams are also important for domestic uses such as washing and bathing.

Although much of the coastline has receded in the range of historic time, causing the possible destruction of archeological sites, the seashore does not appear to have had the importance of the levee sites. The tidal range is small, consequently, the possibility of obtaining food from a normally rich intertidal zone is not great. Also, the near-shore is not abundant in sea life as evidenced by the
scarcity of shell washed up, on the beach. In addition, the shallow offshore is not suitable for ports. The only ports in this coastal area recorded through historical time were Killini and Kounoupeli. Today Killini, the only active port, services the adjacent Ionian Islands via flat bottom ferry.

The coastal areas, however were occupied. The beach ridges, as the levees, afforded high, dry ground for occupancy. The forests of the beach ridges, which have been noted since Classical time, were exploited for shipbuilding and resin for wine. Also the cones of the pine have been collected for their edible seeds, known as "kokonaria," since Roman time (Pliny, 15.9.36).

The land of Elis has been in agriculture or herding since Mycenean time. Nestor of Messenia made annual raids to Elis to obtain cattle for his kingdom. Homer (11.756) mentions the wheat fields of Buprasium, which are believed to have been located north of Nea Manolas. Pausanias (1.5.2) contends that the flax of Elis is as fine as that of the Hebrews. Before the establishment of the town of Elis, the inhabitants lived in villages which dotted the countryside (Strabo, 8.3.2).

The classical authorities never have favorably mentioned the fishing industry in this region. However, Strabo (8.3.19) does comment on lagoons immediately south of Pyrgos:

The greater part of the water is received by the Anigrus, a river so deep and so sluggish that it forms a marsh; and since
the region is muddy, it emits an offensive odor for a distance of twenty stadia, and makes the fish unfit to eat. Thus the inhabitants of the plain of Elis depended upon agriculture and herding for their primary subsistence since fishing was a minor product of their economy.

Man has occupied the northwest Peloponnesos since prehistoric time. His earliest sites have been identified on the older and higher geologic units. Occupational sites may occur beneath the modern plain which were subsequently buried or destroyed by the Flandrian transgression. On the Nile, all prehistoric sites thus far established occur on scarps, several feet above the adjacent floodplain (Butzer, 1966). A similar geographic distribution has also been noted in the Pamasos Valley of southern Peloponnesos. On the Recent alluvium of the Lower Mississippi Valley, no pre-pottery sites occur which suggests that the surface is less than 5000 years old (Haag, 1961).

The Prehistoric sites, some of which are Levalloisian and Mousterian in age, are without exception located on the oxidized sand and gravel of the Amalias surface. This indicates that the Amalias depositional surface is at least Pleistocene in age. Thus, this surface was formed prior to Recent time which was introduced with the last major rise in sea level some 20,000 or more years ago.

The Helladic sites are a dominant archeological feature on the physical landscape. The conspicuous absence of magoula on the modern plain suggests that the lowland was not suitable for habitation at this time. Whether it was
easier to cultivate the upland rather than the coastal plain is open to question.

Although the coastal plain may have had a luxuriant vegetative cover, it would not have been difficult to clear and prepare the area for planting. In summer, during long periods of drought, the coastal plain could be cleared rapidly and effectively with fire. Thus, the vegetative cover would not hinder the occupation of the more fertile coastal plain.

Malaria has existed in Greece since antiquity. This, as a factor in prohibiting the Mycenaeans to settle in the lowlands, does not appear significant in the light of later settlement. The name "Kounoupeli," referring to mosquitoes, is indicative that this pest inhabited the lowlands. The area was infested with malaria until the 1950's. However the coastal plain was continuously inhabited at least since Classical times which clearly indicates that malaria was not a deterrent to settlement.

Sea level reached its present stand approximately 3500 years B.P., and the shoreline prograded seaward somewhat later. Thus the Helladic Age existed during this continuous rise of the sea. If the early Helladic sites were located on the shore they certainly would have been drowned. Further inland, on the coastal plain, sites may also have been destroyed by the advancing sea level.

In addition to the rise in sea level, subsidence and alluviation may have obliterated these sites from the present surface. When sea level reached its present stillstand,
alluviation resulted in seaward progradation. If any settlement was established on the plain, it probably would have been situated on the higher ground, such as levee systems or beach ridges, and not on the flood basin. However no Helladic sites were found on the levee systems or the beach ridges. If any sites were located on the marshy plain they may have subsided beneath the unstable surface in the past 3000 years.

From the present archeological evidence and the site distribution maps of Sperling (1941) and McDonald and Hope Simpson (1964), it is apparent that the modern plain was not inhabited during Helladic time. The Mycenaean had an agriculture and herding economy. The Pylos tablets which date back to about 1200 B.C. list flax, olives, figs, wine, and grain and a variety of livestock as the dominant items of their economy (Samuel, 1966). Produce and cattle, which are presently the main items of the modern plain, appear to have been less significant to the Helladic economy. Sheep and goats and comparatively few pigs were the most important animals. The inscriptions of the Helladic people suggest that bulls, oxen and cows were uncommon and primarily used in offerings (Palmer, 1965, p. 108). Today the above mentioned crops are primarily cultivated on the higher surfaces. Undoubtedly the oxidized sands and gravels and higher surfaces were more suitable for agriculture during Helladic time. Moreover, the absence of Archaic sites on the surface of the modern plain appears to substantiate the fact that the region was not inhabited until a later date.
Beach Ridges and Archeology

Archeological sites occurring on the beach-ridge complex connote the fact that settlement was established on lowland in the proximity of the sea by Hellenistic time. The well-wooded beach ridges in Elis had been exploited for shipbuilding and other industries at least by Roman times. The smooth surfaced potsherds with the original paint intact, indicate the beach ridges were continuously vegetated since Hellenistic time.

The beach-ridge system was initiated some time after the stillstand of sea level was reached. Archeological evidence indicates that the oldest site established on the ridges is of Hellenistic Age. Although only one site was found, on the most landward ridge, it does imply the minimum age for the initiation of the beach ridges is 2300 B.P.

Roman sites were established on the beach-ridge system from the leeward margin of the dune ridges to the most landward beach ridge. Their occurrence is mainly on the ridge crests, however one site was established in a swale. Since neither Strabo nor Pausanias mentioned any islands in the immediate offshore, it is believed that the high rocky promontory of Kounoupeli, visible above the forest, served to anchor the beach-ridge system by Roman times. This is confirmed by the occurrence of Roman sherds on the beach ridges which tie into the headland at the present time.

Thus, the archeology indicates the beach-ridge complex, which is at least Hellenistic in age, prograded seaward through Roman times to at least its present position.
The rate of accretion was on the order of 170 meters per century.

The calculated rate of accretion of the beach ridges is of a minimum magnitude. Roman sherds washed on the beach and reports of offshore sites suggest that the coastline was farther seaward in the historical past. The sediment source for the beach ridges was the ancestral rivers of the Peneus. The projected levee scarp, south of Kotychi Lagoon indicates the shoreline was at least 1.2 kilometers more seaward in this vicinity. Since the littoral transport is northward, the shoreline adjacent to the beach ridges was also situated seaward of its present position in the past.

Premodern Peneus River Levees and Archeology

The ancestral channels of the Peneus River flowed north of the Chlemutsi Headland. Their location, north of the headland, has been recorded in the works of Strabo and Ptolemy. Also maps, up to the latter part of the 18th century, depict the river flowing to the north. Maps of the 19th and 20th century illustrate the river flowing south of the headland. Thus, the diversion took place in the late 1700's or early 1800's.

Roman sherds occur in the levee system immediately south of Kotychi Lagoon. The sherds were located to a depth of 30 centimeters beneath the crest of the levee. Since the pottery was buried in the levee, the channel must have been active during and after Roman times. The volume of
water was, at times, greater than the channel was capable of transporting. Flooding occurred, which increased the thickness of the levee and consequently buried the Roman artifacts. Reports of Roman pottery on the surface suggest the levee was occupied when flooding ceased and therefore when the channel was nearly or completely silted.

The channel 5 kilometers south of Kotychi Lagoon is in the final process of filling. In winter, meandering channels near the sea occasionally collect water for short periods. The channel is well differentiated from the adjacent levee by its land use. In summer the channel is sown in wheat. In winter, when the channel is occasionally inundated, the land is leased out to shepherds who graze their flocks on the wheat stubble and grasses. The levee can easily be distinguished by the ever present cypress, *Cypresus sempervirens*, vineyards, and linear settlement on its crests (Photo. 8b).

The artifacts on this levee are of Turkish Age. Therefore the minimum age of the levee is 186 years. Maps of the past centuries are too generalized to note the shift of the river from the Roman to the Turkish channel. The occurrence of channel remnants can be traced several kilometers inland which attests to the relatively young age of this fluvial system.

As both levee systems stand above the adjacent flood basin on the coast, their mouths during Roman and Turkish times were respectively situated farther seaward. Also, as the litteral drift is northward, both systems aided in
the development of the beach ridges.

How much farther seaward the beach ridges prograded is not known. However in 1675 at the headland of Kounoupeli a port was established suggesting the beach ridges did not encompass this headland (Spon, *ibid.*, p. 6). Therefore, if a period of coastal recession occurred after Roman and before Turkish times, an older set of dune ridges or other evidences of coastal retreat should occur. Only one episode of post-Roman recession is evident which is still active. Indeed the height of the premodern levee north of Killini and the questionable Byzantine site on the present shore suggest coastal retreat occurred after Turkish time.

The coastal retreat which is presently active, occurred after the Peneus River channel of Turkish Age shifted south of the Ohlemutsi Headland. The channel during that time was graded to existing sea level. When the shift took place, the sediment source for the beach ridges was discontinued and the shoreline began retreating. As the coast receded, it truncated the two former levee systems; also the dune ridges developed and encroached upon the beach ridges.

East of the bifurcation of the two premodern levee systems, a Roman grave site was noted 60 centimeters beneath the surface. This suggests that flooding, in the past as today, does not often occur in this vicinity. Also several Turkish and pre-Roman sherds littered the cottonfields. The occurrence of the latter findings suggests a channel of the Peneus was established north of the Ohlemutsi
Headland before Roman time. Indeed, Hellenistic sites on the levee verify this conclusion.

No artifacts were found on the modern levee system. Gastouni, as the name suggests, was probably established during the Frankish occupation. A church believed to have been founded in 1580 lies at the western margin of the town. If the channel flowed in its present course during the middle ages, it would have been more appropriate to locate the town on the levee. Many travelers of the later centuries traversed Elis mainly on the Amalias surface, and crossed the Peneus River up valley at ancient Elis. Quite possibly they may not have been aware of the changes which had occurred on the plain. Therefore, the only reliable source for dating the river diversion to its present channel are maps and artifacts which indicate the change took place about 180 years ago.

Dunes and Archeology

Dunes on the coasts of Greece are a rare phenomena. It seems quite unusual that the dunes on this coast were noted by few early travelers (Gell, 1817, Bory De Saint-Vincent, 1834). Neither Strabo nor Pausanius commented on the aeolian features.

The transverse and parabolic dunes of this coastal area do not appear to be associated with the diversion of the Peneus River. The occurrence of Roman sites on these dunes clearly indicates that they were initiated at least 1500 years ago.
The precise function of the Roman sites occurring on the dunes is open to speculation. Although most sites occur in close proximity to the sea, others have been established one kilometer or more from the sea. Moreover, the geographical distribution along the coast is poor. In winter, the enclosed depressions accumulate rainwater for a month at a time and vegetation is abundant. The dunes may have been utilized as winter pastures as they are today. Also, by grazing sheep in the dune hollows during winter months, the possible loss of livestock, due to flooding of the plain, might have been avoided.

Gravel Plain and Archeology

The vine covered gravel plain, standing above the Peneus flood basin, predates the initial development of the dunes. Therefore the sand and gravel sediments on the coast were deposited before Roman times. The alluvium, primarily deposited by the Sachia River, thickens in a seaward direction and the transition from coarse gravels to fine gravels and sand is rapid.

At the contact of the Amalias surface and the gravel plain Hellenistic sherds occur in situ indicating alluviation was active near the apex of the plain during Late Hellenistic or Roman time.

Since the time of the Romans, little, if any deposition has occurred. In a gravel pit, located one kilometer west of the Hellenistic sites, Roman grave sites and pottery occur approximately one meter beneath the surface. The
disturbed bedding above the gravels indicates the graves were artificially, not naturally buried. Therefore the surface of the gravel plain is at the same approximate elevation as it was during Roman times. Stratigraphically, the Roman sites occur above the Hellenistic artifacts. Hence, it is evident that deposition continued up to and possibly through Roman time.

The Sachia River is presently an eroding stream. After the interval of deposition, the torrent incised its alluvial fill from the Pliocene hills to the sea. Today, its channel follows a relatively direct course to the Ionian Sea.

The erosion occurring on the coast may suggest that the gravel plain was developed at a lower stand of sea level. Such a theory would agree that the alluviation was initiated before Hellenistic time. However, it would not account for the dissection of the fill which occurred after Hellenistic time.

An alternative hypothesis suggests erosion of the coast took place after Hellenistic time. Consequently, the gradient of the Sachia River was increased and entrenchment occurred. Undoubtedly the tectonic instability is an important factor to consider. If the area has been uplifted since Roman times, the coast would recede and entrenchment of older channels would occur.

The geomorphic changes of the Sachia River and the associated gravel plain is similar to that of other channels such as that of the Verga River. Both streams have eroded valleys in the Amalias surface which were subsequently
filled. The alluvial fill, which occurred not later than Roman times on the Sachia River, was followed by a period of erosion which is presently active. Similar alluviation occurring during Roman times has been noted elsewhere in the Mediterranean (Vita-Finzi, 1964).

All Helladic magoula have been established on the Amalias surface overlooking the modern plain or up valleys situated on older geologic units above the modern fill. None has been noted on the modern plain or on the gravel plain.

Summary and Conclusions

From the archeological evidence available, it is apparent that the modern coastal plain of Elis was not occupied until post-Helladic time. The initial occupancy of this coast was established on the oxidized sands and gravels of the Amalias surface and on the older geologic units. The primary reason for the settlement appears to be associated with the agriculture economy of the early inhabitants and the higher well-drained terrain. However, by Classical time, settlement on the modern plain was well established.

The primary sequence of events leading to the development of the Recent coastal plain of Elis is illustrated in Table II. Progradation of the shoreline north of the Chlemutsi Headland was continuous through Hellenistic and Roman times. Also, deposition of the gravel plain, which was initiated before or during Hellenistic time, was active through the time of Roman settlement.
The gravel plain has been dissected and its seaward margin eroded after Roman settlement. At what period the dune ridges began to encroach over the beach ridges, is not clear. However, it was well after Roman time. A ruined fortress on top of Kounoupeli Headland and the establishment of a port in 1675 suggest that the beach-ridge system did not prograde beyond the headland. Thus, it appears that recession of this coastal area has not been of a great magnitude.

The correlation of the archeology and levee systems of the premodern Peneus River, indicates this river flowed to the sea north of the Chlemutsi Headland during Hellenistic, Roman and Turkish times, but diverted to the south in the past 180 years.

From the evidence available it is apparent that progradation and subsequent recession of the coastal plain are confined to definite cultural periods. The episode of deposition and hence coastal progradation in northwest Peloponneseos was initiated during or just prior to Hellenistic time. However, the greatest deposition appears to have occurred during the time of Roman occupation.

To expand the concept of coastal deposition during Roman times to the entire Mediterranean basin would imply universal erosion of adjacent uplands which may be associated with climatic changes in the historical past. This does not appear to be the case. In the Küçük Menderes delta in the vicinity of Ephesus, Turkey, it is believed that sediment accumulation was greatest during Hellenistic


<table>
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<th>PERIOD</th>
<th>EVENT</th>
<th>EVIDENCE</th>
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<tr>
<td>Turkish</td>
<td>Peneus River occupied channel 5 kilometers south of Kotychi Lagoon; Peneus diverted southward late 1700's; coastal retreat</td>
<td>Turkish sherds and wells on relict levee; map data and literature; dune ridges, exposed beach-ridge swales, truncation of gravel plain</td>
</tr>
<tr>
<td>Byzantine/Frankish</td>
<td>Coastal progradation (?)</td>
<td>Questionable Byzantine site exposed on present shoreline</td>
</tr>
<tr>
<td>Roman</td>
<td>Coastal progradation of beach ridges; deposition of gravel plain completed</td>
<td>Roman occupance of beach ridges, and levee one kilometer south of Kotychi Lagoon; offshore sites; Roman grave sites on surface of gravel plain</td>
</tr>
<tr>
<td>Hellenistic</td>
<td>Peneus River flowing north of Chlemutsi Headland; beach ridges established; initiation of gravel plain</td>
<td>Sherds on premodern levee one kilometer south of Kotychi Lagoon and oldest beach ridge; also at contact of gravel plain and Amalias surface</td>
</tr>
</tbody>
</table>
time and associated with the diffusion of the Hellenic culture to Anatolia (Eisma, 1964). In north Africa deposition was initiated after Roman times (Ibid., 1061). In east-central Sicily the greatest alluviation occurred between post-eighteenth century B.C., and 325 B.C. (Judson, 1963). On the coast of southern France, deposition was primarily confined to Byzantine times (R.J. Russell, personal communication). Thus, it is evident that erosion and subsequent coast deposition did not occur in the Mediterranean at any specific cultural period.

Vita-Finze (Ibid., p. 1324) has suggested "that a period of stream deposition occurred after Roman times throughout the Mediterranean area..." Any Byzantine/Frankish deposition and subsequent progradation cannot be established with absolute certainty on this coast. The questionable Byzantine site, partly exposed on a sea cliff on the present shore, does confirm that the shoreline was more seaward at one time. However the archeology only suggests a minimum date for this coastal segment. The site may be situated on sediments deposited during Roman times. Thus the only conclusion, which is based on questionable evidence, indicates that this segment of the coast was eroded after the Byzantine/Frankish period. The deposition which has occurred may be Roman or post-Roman in age.

The beach-ridge system and the gravel plain which has alluviated the Sachia Valley and spread over at least part of the Amalias surface, were initiated at least by
Hellenistic time and deposition continued through the Roman occupation (Table II). The process required for the synchronous deposition of these landforms conflicts.

Progradation of beach ridges is most likely to occur during a period of relative stability of the sea or a slowly dropping level. Such a concept has been implied by Coleman (1966, p. 62). Many beach-ridge complexes were initiated and prograded seaward after the present stability of the sea some 3500 years B.P. Conversely optimum conditions for valley filling is a rising sea level or a level which has been stable over a long period.

As evidenced by poorly correlated wave-cut notches and the past and present tectonic record, it is concluded that the coast of Elis is not stable. Thus the beach ridges prograded during a relative drop of sea level and the alluviation of the Sachia Valley and the adjacent plain occurred during a relative rise of the sea. Although the beach ridges are approximately 20 kilometers north of the gravel plain, tectonic activity, acting in opposite vertical directions, has had a profound influence in the development of these two depositional features.

The geomorphic evidence from various areas of the Mediterranean implies that if any climatic change had occurred, altering the precipitation regime, it was not significant enough to modify the entire physical landscape. Man is a great modifier of the landscape. It appears that his diffusion and technology may be more closely associated.
with the destruction of the vegetation and subsequent soil erosion of the uplands and deposition on the coastal areas of the Mediterranean.
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Title of Thesis: Geomorphology and Archaeology of the Northwest Peloponnesus, Greece

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