Paleogeographic Reconstructions in the Methoni Embayment in Greece

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Surface and subsurface geologic reconstructions of coastal change may be clearly correlated with the historical and archaeological records. However, paleogeographic reconstructions of coastal geographies in prehistoric times have long been in doubt. This paper presents a technique for interdisciplinary research linking the archaeological record with the geological record and geological processes. The combination results in fairly precise paleogeographic determinations in the SW Peloponnese of Greece.

Introduction

In the extreme SW corner of the Greek Peloponnese on the peninsula of Messenia lies the ancient fortress of Methoni and a deep-water embayment of the Ionian Sea. Here is preserved a record of man's occupancy dating from sometime in the Middle Bronze Age (Middle Helladic or MH: ca. 2100-1580 B.C.) to the present. The highly strategic location of the Methoni embayment led to construction of important fortification and harbor facilities in use from Classical times (480-323 B.C.) to the present (FIGS. 1-2). Until the development of modern shipping techniques in the 19th century, this coastal fortification and harbor facility was extremely important in servicing commerce and other traffic between the western and eastern Mediterranean. Confrontations and the interfacing of many civilizations and countries occurred here. At present, however, the Methoni area has become of less importance in world trade, and the area is occupied by a small, rural village.

The embayment of Methoni has rapidly evolved in geomorphic form throughout the Holocene Epoch (10,000 B.P. to present). A new hypothesis is developed in the following pages that geomorphic change has been an important factor in the nature of human occupation of the Methoni embayment. Coastal changes continue in the Methoni embayment and it is possible to make useful projections of future change. The changes in geomorphology are normal, ongoing coastal processes. Intrusion of man, from Graeco-Roman times onward, has led to major modifications of the NW corner of the embayment. Elsewhere around the northern and eastern shores, natural, physical processes of coastal change have continually altered the geomorphic setting. Accordingly man has been forced to shift his loci of occupation and adapt to rapidly migrating and physiographic elements. Thus the area is one of long-term settlement and resulting archaeological remains, and one of rapid alteration of physiographic setting.

The authors studied the Methoni area in some detail in an attempt to show the usefulness of an interdisciplinary approach to the understanding of certain problems in the inhabitation of a coastal zone setting over a long period of time.

Settlement History (see TABLE 1)

Our paleogeographic reconstructions of the Methoni embayment result from an intimate cooperation between the natural and the social sciences. The reason the authors undertook such a cooperative effort, is that because of human settlement in the area we possess both archaeological and historical "markers" in terms of which the coastal changes can be estimated (FIG. 3). Without relatively long and intensive human settlement at Methoni, we would not have references by ancient historians, descriptions by travelers, graphic representations in drawings and coinage, nor the unintended history of human settlement left in the archaeological record.

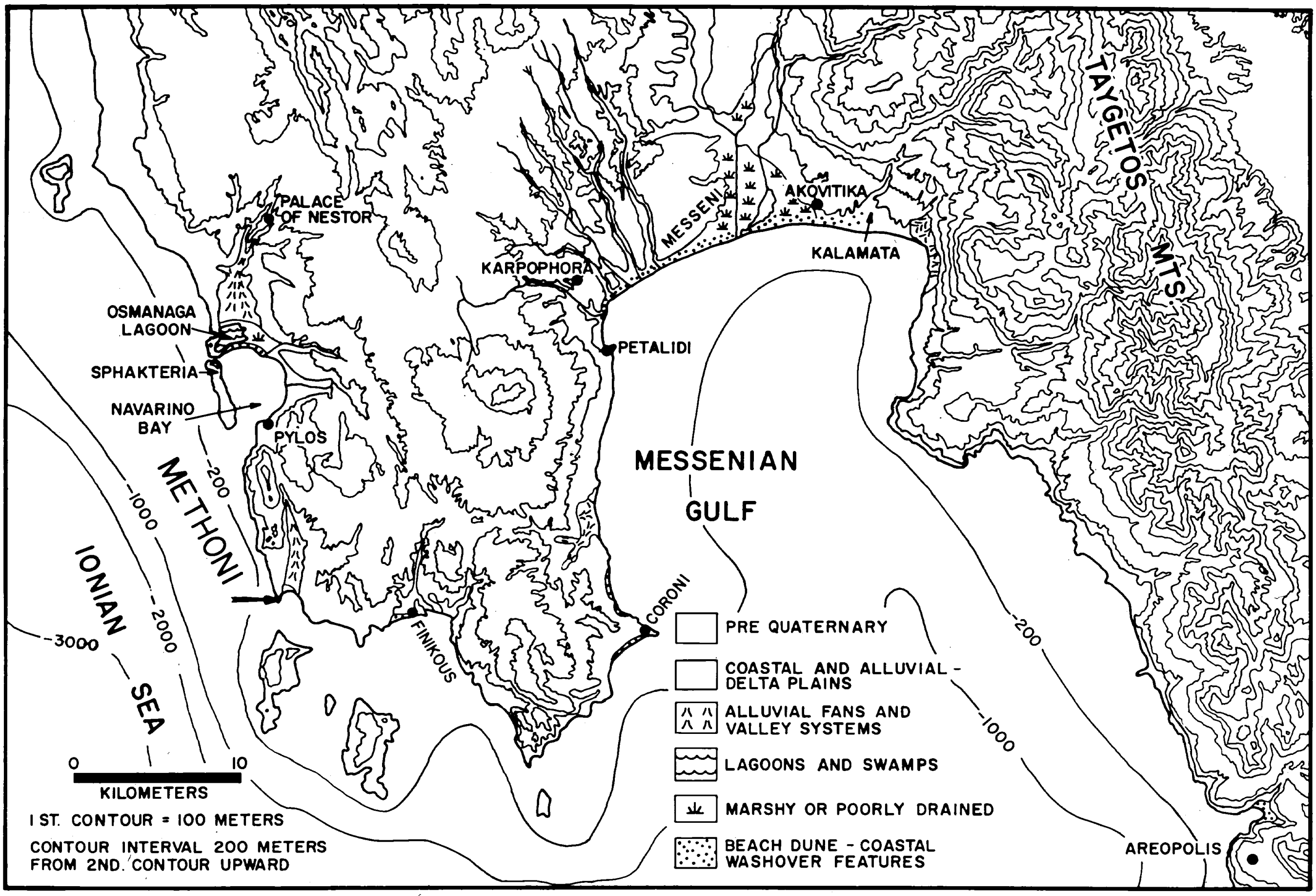


Figure 1. Regional geomorphology of southwestern Peloponnese, showing the relationships of the Methoni embayment to other coastal embayments, the Messenian peninsula, and the mountainous ridges of Peloponnese.

The earliest positive evidence of occupation comes from near the end of the Middle Bronze Age, ca. 1700 B.C. In some portions of this long span from the 17th century B.C. to present, data are so fragmentary that it is difficult to comment on the nature of the settlements. But it is significant that when data are relatively rich, the character of Methoni has nearly always been that of a port, independent town, or administrative center, all of which contrast greatly with its character and role in the contemporary scene, where it is a quiet, charming little agricultural town with a few fishing boats.

The remains of MH occupation are known only on the tiny island called Nisakouli which is about 1.5 km. SE of modern Methoni, near the east shore of the embayment (FIG. 3). From the succeeding period, the Late Bronze Age (Late Helladic or LH: ca. 1580-1100 B.C.), the remains are scanty in the extreme: only one steatite spindle whorl from a disturbed context in the fortress area and a very few sherds on Nisakouli. This probably should not deter us from assuming substantial LH occupation at such an attractive location, since later occupation of the fortress area has covered and disrupted earlier remains.

From sub-Mycenaean through Protogeometric and Geometric times, which cover the span ca. 1100-750 B.C., no positive evidence of settlement exists. For the Archaic period, ca. 750-480 B.C., there are only some cist graves, but now we receive aid from historical evidence. The long sequence of struggles between the Messenians and the Spartans begins. In the 2nd Messenian War (670-650 B.C.) Methoni apparently still enjoyed some independence, for it comes to the aid of the Messenians.[1] By about 600 B.C. all of Messenia comes under Spartan control, and the people of Nauplia, expelled by the Argives, are settled at

1. For a fuller treatment of the relevant Messenian history, see J. F. Lazenby and R. Hope Simpson, "Greco-Roman Times: Literary Tradition and Topographical Commentary," in ***The Minnesota-Messenia Expedition: Reconstructing a Bronze Age Regional Environment,*** W. A. McDonald and G. Rapp, eds. (Minneapolis 1972) 81-99.

Figure 2. Aerial photograph of the Methoni embayment. A) Ionian Sea; B) Venetian-Turkish fortifications; C) moles and harbor; D) low lying (swampy) plain, formerly extension of marine embayment and site of Venetian Salt pans; E) area of rapidly eroding sea cliffs; F) Isle of Nisakouli; G) wave patterns. Photo courtesy of the University of Minnesota Messenia Expedition.

Methoni. During the Classical period Methoni was attacked by the Athenian fleet under Tolmides (454 B.C.) and during the Peloponnesian War later in the century the town was besieged by the Athenians. The story that can be told of the Methoni settlement through Hellenistic times (to 146 B.C.) is equally scanty. It is one of the towns of Messenia and seems to enjoy, like others, some autonomy, even to the point of joining the Achaean League as a separate entity.[2]

2. Ibid., 60-62.

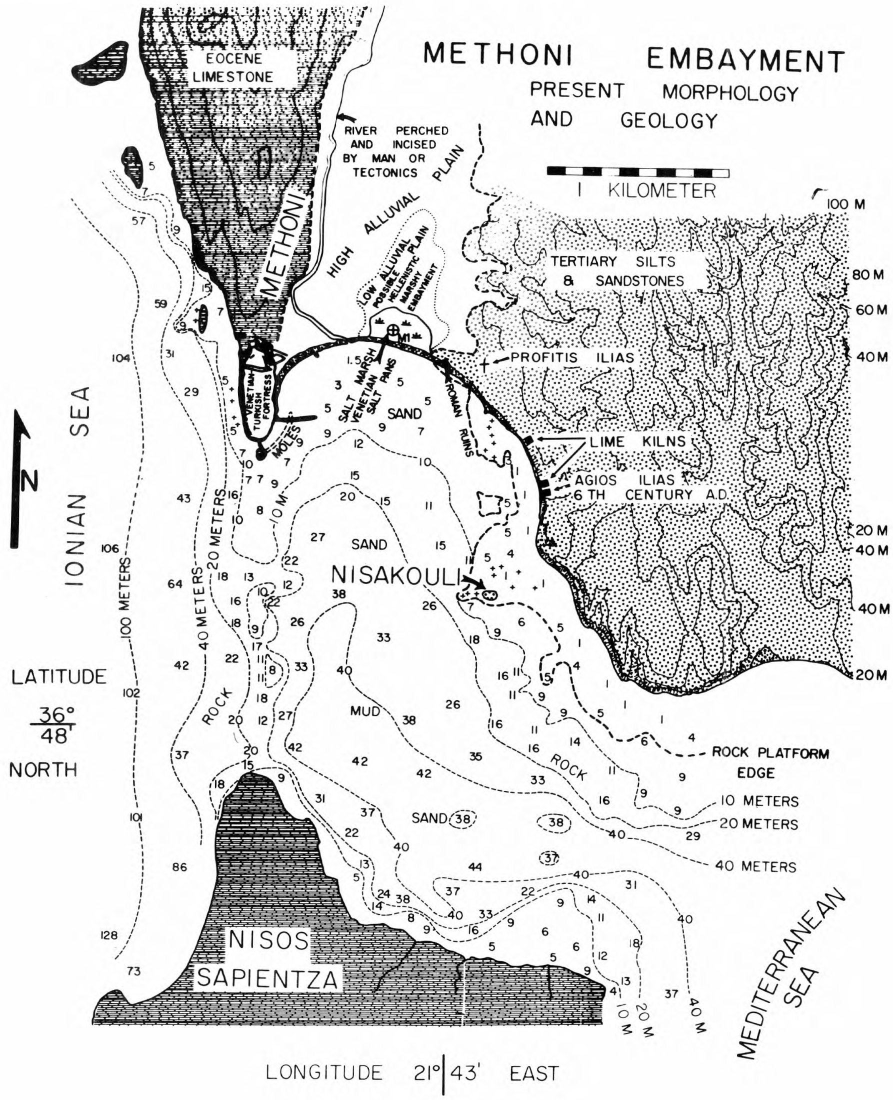


Figure 3. The topography and geology of the Methoni embayment and vicinity showing topographic and submarine contours. This plan is based on air photograph studies, U.S. Naval and British Admiralty charts and Greek contour map sources.

In the period after 146 B.C., when all of Greece came under increasing Roman control, the status of towns like Methoni is not clear, though it is thought to have been "free" as a reward for not having taken an active part against Rome. Just before the Battle of Actium in 31 B.C., Methoni was attacked by Agrippa, the lieutenant of Octavian (later Augustus) Caesar.[3] Later we hear of Trajan's (reigned from 98-117 A.C.) granting it "freedom."[4] Though without specific, positive evidence, historians assume the towns of Messenia like Methoni existed and shared in the prosperity which resulted in the 2nd century from the cessation of civil wars and from the efficiency of Roman Imperial administration. That assumption receives some support from archaeology: there are the Roman remains that McDonald and Hope-Simpson[5] note 2 km. NNE of Methoni (possibly of a villa), and the ancient sickle-shaped mole, the ruins of which may still be seen. The earliest parts of the fortress wall that are still in place date from the 2nd century and attest to the town's importance. In addition, we have observed a Roman brick wall, pottery kiln, drain, and extensive sherd deposits in an eroding sea cliff 0.9 km. east of the fortress (FIG. 3).

For a period as long as the succeeding Byzantine era

3. Strabo viii. 4, 3.

4. Pausanias iv. 35.3 and Lazenby and Hope-Simpson, op.cit. (in note 1) 93.

5. W. A. McDonald and R. Hope-Simpson, "Prehistoric Habitation in Southwestern Peloponnese," *AJA* 65 (1961) 254, note 5, cites M.N. Valmin, *Études Topographiques sur la Messenie Ancienne* (Lund 1930) 135.

Table 1. Summary of settlement chronology and major historical events.

Period		*Event or Remark*
(Late) Middle Helladic	1700-1580 B.C.	Settlement begins on Nisakouli.
Late Helladic	1580-1100 B.C.	Scanty evidence of settlement.
Sub-Mycenaean, Protogeometric, and Geometric	1100-750 B.C.	No evidence of settlement.
Archaic	750-480 B.C.	Historical evidence of settlement begins. Spartan control begins ca. 600 B.C. Nauplians settled, Methoni becomes semi-free town.
Classical	480-323 B.C.	Attacked by Athenian fleet in 454 B.C. Athenians besiege in Peloponnesian War, 431 B.C. Removal of Spartan control in 370 B.C.
Hellenistic	323-146 B.C.	Methoni is semi-autonomous; joins Achaean League.
Roman	146 B.C.-330 A.C.	Roman control begins. Agrippa attacks in 31 B.C. Trajan (98-117 A.C.) grants "freedom." Construction of mole and fortress ca. 200 A.C. Roman construction in NE corner of bay.
Byzantine	330-1204 A.C.	Chapel Agios Ilias built on east side of bay, 6th century. Slavs settle, 7th and 8th centuries. Venice razes pirates' nest 1125. Byzantium grants Venice free trade at Methoni.
Frankish	1204-1206 A.C.	Villehardouin captures Methoni and uses it as base to conquer Peloponnese. By treaty, Methoni becomes Venetian possession. Called Modon.
1st Venetian Occupation	1206-1500 A.C.	Quickly becomes major port, mole remodeled, present fortress built, moat begun. Usual stop for Pilgrims and travelers. First mention of salt pans in 1447.
1st Turkish Occupation	1500-1685 A.C.	Captured by Bajazet II in 1500. 1st evidence of harbor filling in 1671.
2nd Venetian Occupation	1685-1715 A.C.	Venice initiates extensive repairs, revives economy.
2nd Turkish Occupation	1715-1828 A.C.	Long period of decline and depopulation.
Independent Greece	1828-present	Ca. 1890 new mole built, half of Chapel Agios Ilias falls into sea.

(ca. 330 to 1204 A.C., when the Franks arrived) there is less historical data available to us on settlement at Methoni than we might expect. From general historical knowledge of Greece and the western Peloponnese some impression of what may apply to Methoni may be garnered. These areas had "gradually declined since the second century owing to the excessive fiscal demands of the imperial governments and the cumulative effects of earthquakes (522 A.C.), pestilence (bubonic plague 541-608 A.C.) and barbarian inroads."[6] Methoni first

6. Peter Topping, "The Post-Classical Documents," in McDonald and Rapp, op. cit. (in note 1) 64-65.

appears as a Byzantine city in 533 A.C.[7] In the 7th and 8th centuries a large number of Slavs entered and settled. Methoni became a Suffragan See of the Metropolis of Patras in the 9th century (about 2 km. NE of modern Methoni are the ruins of a settlement of this period).[8] By 1125, Methoni had become a pirate nest, and Venice razed it to the ground to protect her sea commerce passing by this important point.[9] Methoni must have been rebuilt, for by 1199 A.C. it figured in a trade treaty between Venice and Byzantium that granted Venetians free trade here. This was a foreshadowing of the role and kind of settlement that Methoni was to become.

In 1204 A.C. Constantinople was sacked by Crusaders and Byzantine territory was divided among the conquerors. Among others, the district of Methoni went to Venice, though she did not gain possession of it for another two years, since Geoffroy de Villehardouin used it for the base of the Frankish conquest of the Peloponnese. From 1206 A.C. until 1500 A.C., Methoni was a territorial possession of the Venetians. And:

> "as the Eastern trade of the Most Serene Republic increased, Modon, in particular assumed a great importance in Venetian commercial supremacy. Situated at the tip end of the westernmost of the three capes of the Peloponnese with a fair natural haven protected from the severe westerly winds, harbor works were undertaken, a mole built, and the town supplied with walls, the thickness and strength of which were the admiration of all travelers to and from the East. All the commercial convoys stopped at this point for supplies to refit, to repair damages from wind or weather, and to take on fresh pilots."[10]

In addition to the functions mentioned above, Methoni was also the export point for agricultural produce, and a salt works was built with pans at the north end of the bay. During this period many travelers, most of them on pilgrimages to the Holy Land, stopped at Methoni, which happily they then described.

In 1500 the Turks under Sultan Bajazet II besieged Methoni unsuccessfully for a month when, ironically, the arrival of Venetian reinforcements distracted the local garrison momentarily and the Turks were able to swarm in and to kill most of the defenders and inhabitants.[11] Methoni was quickly repaired and repopulated by the Turks who retained it until 1686 when the Venetians under Morosini retook it.[12]

The second Venetian occupation lasted only until 1715. But during this time the Venetians set about with vigor to restore and to improve the conditions in their newly rewon districts.[13] At Methoni this meant not only strengthening the fortress walls and resumption of work on the never-completed task of cutting a moat through the bedrock north of the fortress, but also reviving the silk industry that had been allowed to die and at least planning to reopen the salt works.

In 1715 the threat of a Turkish attack and the mutiny of the Venetian garrison led to the second Turkish occupation, which continued until Greek independence was won over a century later. Initially Methoni retained an economic importance both as the seat of the French consulate and because raw products, especially olive oil, from the SW Peloponnese were exported from it.[14] Near the end of this period, several travelers visited and gave accounts of Methoni: Poucqueville in about 1818 [15] and Leake in 1805.[16] It seems to have been a miserable place: the fortifications were in disrepair, there was poverty and idleness, the silk culture had again been abandoned. Finally, in 1828 Methoni surrendered to the French expeditionary force that had come to the aid of the Greeks in their freedom struggle. From that time until the present it has been simply a small agricultural community.

Archaeological and Historical Features

Located around the arc of the embayment are seven features which testify to changes in its geography. The time period spanned by these features is from the late Middle Helladic period (ca. 1700 B.C.) to the present, or ca. 3600 years. Not even for a single one of these features, however, does archaeology provide a stratigraphic sequence for successive periods. Nor does history provide us with evidence in a continuous sequence for the more recent periods.

7. Kevin Andrews, *Castles of the Morea* (Princeton 1953) 58.

8. M. N. Tod, "Notes and Inscriptions from Southwestern Messenia," *JHS* 25 (1905) 32-55.

9. S. B. Luce, "Modon — A Venetian Station in Medieval Greece," in *Classical and Medieval Studies in Honor of Edward Kennard Rand,* Leslie W. Jones, ed. (New York 1938) 195-208.

10. Ibid., 197.

11. W. Miller, *Latins in the Levant: A History of Frankish Greece 1204-1566* (London 1908) 495.

12. Luce, op. cit. (in note 9) 203-204.

13. Topping, op. cit. (in note 6) 71-78.

14. V. Kremmydas, *"To Emporio tes Peloponnesou sto 18 Aiona (1718-1792)* (Me vase ta gallika archeia)," (The Trade of the Peloponnese in the 18th century [1718-1792] [Based on the French Archives]) (Athens 1792) 42-43.

15. F. Poucqueville, C.H.L., *Voyage de la Grèce* VI (Paris 1826-27) 63-67.

16. W. Leake, *Travels in the Morea* I (London 1830) 428-434.

The reasons for lacunae of historical evidence are both expectable and familiar: 1) not much information was ever recorded about a small place like Methoni, especially in the pre-Venetian period, and 2) descriptive data for geographical and man-made features on a landscape, especially with details of locational relationships, are usually not of such great interest as to insure their recording. There are three basic causes of the deficiency of archaeological data: 1) the Methoni region has had virtually no systematic excavations, so there may be considerable potential data that only await uncovering; 2) major portions of the embayment area are subject to erosion rather than to deposition, and the latter is required to form the archaeological record, and 3) in some areas, e.g. the fortress, later occupation has either destroyed or deeply buried the archaeological record of earlier occupation.

The paragraphs that follow describe the seven features, but by no means in a complete fashion. The characteristics relevant to our task of reconstructing the paleogeography chiefly comprise the presentations. Despite this deliberate limitation to achieve brevity, it has been necessary, we feel, to include prolonged discussions in those cases that allow alternative interpretations.

Nisakouli Island

On the east side of the embayment and only some 325 m. west of the eroding siltstone cliff is the tiny island of Nisakouli (also referred to as Kouloura on some charts). It is 50 m. N-S by 70 m. E-W and rises with rather steep and eroding scarps to an elevation of 13.2 m. (FIG. 4). The surrounding water is 1.3 m. and less in depth. The rapidly eroding sides of the island and of the mainland scarp to the east indicate that considerable topographic change has occurred.

Figure 4. The island of Nisakouli viewed from the south. Note the relatively flat-lying, thin-to-medium bedded resistant sandstone layers. The southern end of fortress Methoni can be seen in the distance to the left of the island.

Although the surface of the island is being severely eroded and much archaeological information has already been lost, enough is preserved to permit some positive conclusions. From the late Middle Helladic period (ca. 1700 B.C.) there are recently excavated remains of an altar.[17] There are also pottery sherds, of which the majority date to MH, but a few LH sherds and even a piece of Roman combed ware (6th century A.C.) have been noted. In the main, however, these levels of occupation seem to have been stripped off by erosion.

The data from Nisakouli suggest that it was once much larger than at present and was linked to the mainland. Other data indicate that by Medieval times changes because of various processes (rising sea level, erosion, etc.) had proceeded sufficiently that Nisakouli was indeed an island with something of its present shape. First, McDonald and Hope-Simpson observed that ". . . on the exposed west side there are remains of badly eroded fortification walls that probably date from Medieval or later times."[18] Second, these ruins may be related to the castle or fortifications on a small island that frequently appears in the foreground of the Medieval drawings of Methoni. An example is the drawing by the artist Reuwich who accompanied the German traveler Bernhard von Breydenbach on his pilgrimage to the Holy Land in 1483.[19] Many other travel accounts in the following years are illustrated with copies of Reuwich's drawing (these range from rather faithful copies to those with apparent alterations by omissions or embellishments). One example believed to be derived from Reuwich is the drawing appearing in Braun and Hohenberg, *Theatres des villes* (FIG. 5).[20] In both, the structure shown on the island is, significantly, on the west side. The question remains as to the identification of the islands shown; the authors speculate that Nisakouli is shown on the left while the island on the right has eroded away. Historians disagree and suggest the island to the right is Nisakouli. Finally there is the observation by Bernard Randolph in 1689, "in port is a small island on which a battery might be raised

17. A. K. Choremis, "M.H. Altar on Nisakouli at Methoni," *AAA* (1969) (in Greek) 10-14; W.A. McDonald and R. Hope-Simpson, "Further Explorations in Southwestern Peloponnese; 1964-1968," *AJA* 73 (1969) 153-154.

18. MacDonald and Hope-Simpson, op. cit. (in note 17).

19. Bernhard von Breydenbach, *Peregrinations in Terram Sanctam* (Mainz 1486).

20. Braun and Hohenberg, *Theatres des villes* II (1574) 52 (as cited in Soulis 1959 and from Kraft's copy of the illustration).

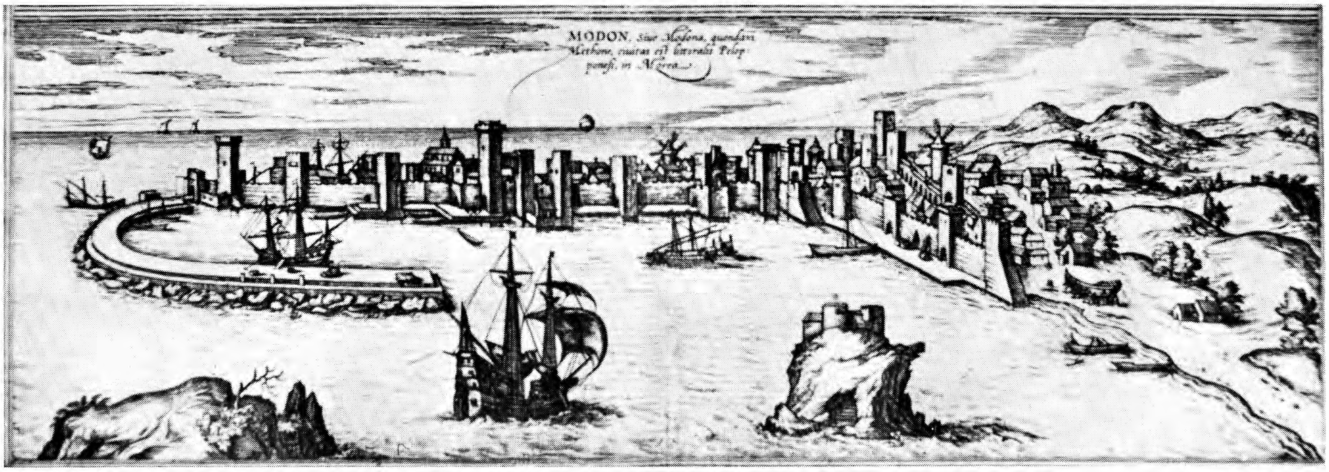


Figure 5. A schematic panorama of Fortress Methoni viewed from the cliffs on the east side of the embayment. By Hohenberg (Braun and Hohenberg, 1574).

and do much harm to the castle, it being as high as the walls."[21] This last item suggests that Nisakouli still appeared an appropriate site for a structure, but it also suggests that the structures apparently there two centuries earlier were no longer even conspicuous ruins; otherwise, it seems likely that Randolph would have remarked on them.

The erosion on the west side seems to have advanced notably in just the past five years. In the fall of 1973 the junior author swam out to Nisakouli and was unable to detect any Medieval walls whatsoever on the west side where McDonald and Hope-Simpson had found them in 1968. Fragments of terra cotta roof tiles were apparent in the beach wash of the protected east side. Two fragments of roof tiles and one stone were found with some of the lime-rich mortar, so characteristic of Medieval construction, still adhering.

Agios Ilias Chapel

Perched on the very edge of the sea cliff that forms the eastern side of the embayment are the ruins of a 6th century church, Agios Ilias (FIG. 3). As Higgins concluded from his careful description of the church's location, this feature is especially significant for understanding how the area is changing.[22] The ruins consist of the eastern apsidal end of a chapel having a basilica plan. The walls are preserved on the SE to nearly 2 m. above the mosaic floor, for which Peter Megaw was able to furnish a 6th century date (on stylistic grounds) to Higgins. The entire western part of the chapel has fallen away and utterly disappeared into the sea some 12.2 m. below as the sheer cliff has receded towards the east (FIG. 6). This gradual destruction continues today.

A minimal estimate for how much the sea cliff has eroded since the 6th century is derived by Higgins through consideration of dimensions of the ruins in comparison to comparable basilica plans. The full interior width of Agios Ilias is preserved: 5.3 m. The usual interior length associated with such a width is more than 8 m. Thus, to the preserved length of 3 m., there must be added more than 5 m. to reach the western wall. But since the west wall opposite the apse customarily has a door, several more meters are implied for sufficient space outside the door.[23] Fortunately, we know a bit about the history of the sea cliff erosion here. In 1905, M.N. Tod published his description of the state of several antiquities around the Methoni Bay. Of Agios Ilias, he writes: ". . . about 15 years ago the encroachment of the sea caused a landslip which carried away half the chapel, the remainder of which lies wholly in ruins."[24] Thus, we have evidence that 5 m. or more of the cliff recession occurred within the past century.

There is possible further evidence for the rate of sea encroachment here but it is difficult to interpret. Tod was led to visit the area of Agios Ilias by the account of the famous French Scientific Expedition which states that in the late 1820s there were Roman antiquities 2 km. east of Methoni: "There had been in this place baths and factories of coarse pottery, likewise on a

21. Bernhard Randolph, *The Present State of the Morea* (London 1689) 6.

22. C. G. Higgins, "Possible Disappearance of Mycenaean Coastal Settlements of the Messenian Peninsula," *AJA* 70 (1966) 23-29.

23. Ibid., 27.

24. Tod, op. cit. (in note 8).

small hill above the sea was a temple."[25] Yet Tod says: "Here I failed to find traces of antiquity"; instead, he seems to have come upon the ruins of the chapel, which is indeed 2 km. by road from Methoni.[26]

There are several possible interpretations. First, the same landslip that sent the west end of Agios Ilias down to the sea might also have destroyed the Roman ruins. Thus, by implication, such ruins were located somewhere along the presumably relatively narrow strip of cliff on which stood the missing part of the chapel. The Roman ruins may have been north or south of the chapel, but in either case they were not very far west of the chapel. Although this intepretation may seem plausible at first, it does not explain why Tod learned nothing of the former existence of such ruins from the same local sources who informed him that half of Agios Ilias had fallen away 15 years earlier and who gave him other data on recent change. A second interpretation is that the Roman ruins were destroyed earlier, say, between 1830 and 1880, and that they were many meters west of the missing part of Agios Ilias. Although this theory implies rather rapid erosion of the cliff in the last 140 years, the depositional evidence near the fortress on the west side of the bay suggests that during this same period increasing amounts of material were in fact put into the long-shore coastal currents. This second interpretation seems more plausible to us. However, a third possibility is that the distance of 2 km. given by the French Expedition account was somewhat in error. Instead the distance should have been merely 1.5 km., and hence the spot referred to is about where the new chapel of Profitis Ilias stands. Here indeed are coarse sherds in abundance along with some Roman materials, and a British Admiralty chart annotates the area with the phrase "Ruined Pillars." The obstacle to accepting this account is that it compels us to presume yet another error, namely, that Tod, who had to pass right by this area to reach the old, ruined Agios Ilias, failed to observe the very items he was seeking. We are thus inclined to believe the second interpretation, namely, that Roman ruins were considerably west of Agios Ilias and that they were eroded away not long after being observed by the French Expedition team. That Tod did not see the Roman materials at Profitis Ilias is explained by the fact that in both places where they are now visible (road cut and eroding sea cliff) they are covered by colluvium. In Tod's time this cover had not yet been disrupted by road cutting nor had the erosion advanced to the archaeological remains.

25. E. P. Boblaye, ***Recherches Géographiques sur les Ruines de la Morèe*** (Paris 1835) 11-13.

26. Tod, op. cit. (in note 8) 34.

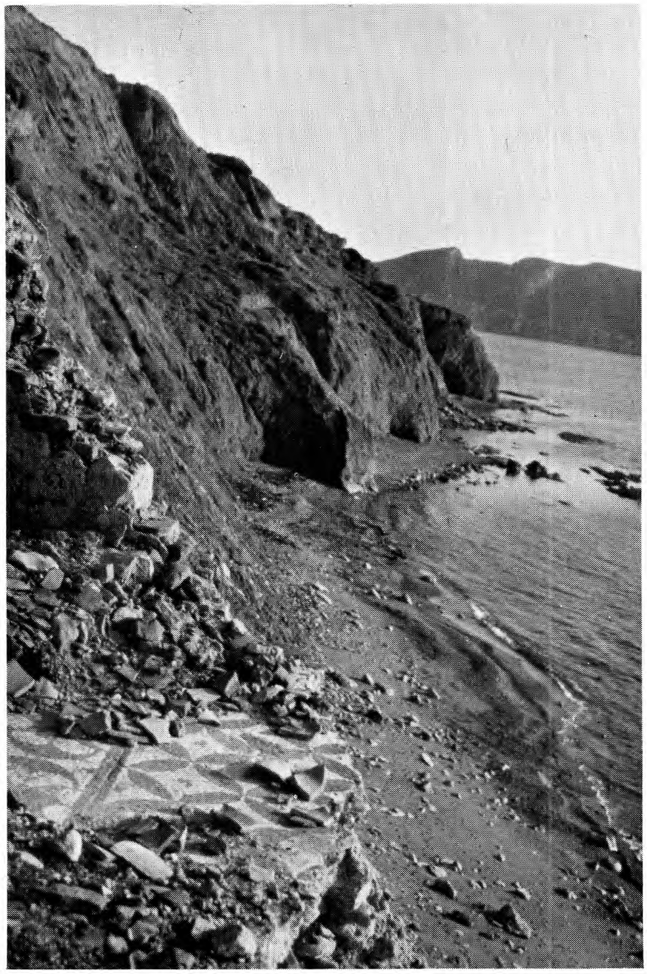


Figure 6. The mosaic floor of the chapel Agios Ilias at the edge of the eroding sea cliff, approximately 12 meters above sea level.

Agios Ilias probably was constructed when the shoreline lay several hundred meters to the west. The builders probably had as little concern about coastal erosion as the builders of the new chapel, Profitis Ilias, a short distance to the north and again several hundred meters from the present shoreline. Applying the principle "the present is the key to the past," then the new chapel will go the way of the old.

Lime Kilns

Proceeding north of Agios Ilias along the east side of the bay, we encounter two abandoned kilns formerly used to roast limestones for making hot lime (FIG. 3). These kilns likewise testify to recent changes in the beach line, as Higgins noted.[27] The southern kiln stands less than 50 m. north of Agios Ilias on the side of a

27. Higgins, op. cit. (in note 22) 27.

small gulley. Originally the cylindrical shaft of the kiln must have been dug into the siltstone of the gulley slope. Now the advance of the eroding sea cliff has exposed and cut away the western part of the kiln wall. The kiln floor is 1.5 m. above sea level. Just as with the Agios Ilias chapel above it, the kiln must have been constructed much more distant from the beach than it is now. No local resident could recall when the kiln was built, though there was some consensus that its use ceased before World War II.

Ca. 300 m. north is a second kiln, again on the south side of a coastal gulley. This kiln, with its floor elevation of ca. 2 m., is being constantly eroded by storm waves. The NW wall disappeared and the interior was filled with beach cobbles several years ago. Erosion over the past two years has removed an additional 0.5 m. of kiln and shoreline. Residents say it was built 50-60 years ago and was in use until ten years ago.[28] Even if we were to suppose that this kiln continued in use after the advancing beach made its location far less suitable than when it was built, we still must postulate a rapid rate of advance, since within the past 10 years its use has become impossible.

Profitis Ilias

Moving somewhat NE around the bay we pass more of the severely eroding sea cliff and arrive at a point just below the low hill on which stands the chapel of Profitis Ilias (the successor to Agios Ilias). Here again is a feature that helps us date coastal change. The road passes along the very edge of the sea cliff, which is about 4 m. high. The entire road is in danger of being undercut, and in two places where this has already occurred, the first efforts at conservation, in the form of concrete retaining walls, lie in fragments on the beach among pieces of the native sandstone that erode out from the soft siltstone cliff.

In this area there was some occupation in Roman times: numerous fragments of coarse pottery and roof tiles, including diagnostic pieces of combed ware (6th century A.C.), are visible in the north scarp of the road cut. Furthermore, just below the road the erosion of the beach scarp has now revealed a section of wall, probably of Roman date, with several brick courses laid on a foundation of sandstone (FIG. 3). The bottom of the wall is 1.60 m. above sea level. On either side of this wall there is a very dense deposit of coarse pottery, including occasional pieces of combed ware, from about 2.00 to 2.40 m. above sea level. During a storm in 1974-1975, a Roman pottery and tile kiln, a terracotta drain, and a larger deposit of pottery debris were exposed in the sea cliff.

Venetian Salt Pans

We come now to one of the features that first excited our interest in this exercise in paleogeographic reconstruction. We are pleased to acknowledge our debt to Professor Peter Topping through whom we became aware of the salt pans of Venetian Methoni. And it is through his diligent search of the archives in Venice and his kind cooperation that we have much of the data presented below.

There are a number of references to the production and sale of salt at Methoni (and Koroni: these "twin" ports are often mentioned together in the sources) in Venetian times, but unfortunately the location of the pans is not clearly given (FIG. 3). Hence part of our task here is to make the best possible inference concerning their location. During the initial Venetian occupation of 1206-1500 there were pans in existence; for example, a document of 1290 mentions them[29] as does one of 1447.[30] Several references pertain to the second Venetian period of 1685-1715. In a letter of 1686 sent from Methoni, a German mercenary soldier in Venetian service writes that there is "a salt pan near the sea, having a gluey soil and being one musket shot distant from Modon."[31] This must have been located to the east of the fortress at the north end of the bay where today there is a very low marshy meadow which floods with salt water during winter storms. Again, a Venetian official reports in 1691 that "the salt pans of Methone were only partly exploited."[32] Finally, there is a plan of the salt pans of ca. 1692 which Topping found in the archives of Venice (FIG. 7).[33] Comparison of this diagram with air photo interpretations of the area suggest that the northern perimeter of the salt pan is still extant in the swamp at the northern end of the Methoni embayment. The coastal erosion at the northern shoreline of the Methoni embayment is estimated to be 30 m. from the 17th century to present.

28. See also T. Demodos, "Toponyms of Methoni," *Onomata, Revue Onomastique* 4 (1972) 3-6. (In Greek).

29. F. Thiriet, *Déliberations des Assembleés Venitiennes concernant la Romanie* 1 (Paris 1966) 61.

30. Idem, *Regestes des Déliberations du Senat de Vince concernant la Romanie* 3 (Paris 1959) 137.

31. Anonymous, *Grundlicher und Genauer Bericht Aller Mercckwurdigen Sachen Welche bei Belager — und Eroberund der Bestungen in Morea Navarino und Modon Taglich Vorgelauffen: Bestehend in Zwein Send-Schreilien* (1686).

32. Cited in Topping, op. cit. (in note 6) 76.

33. Ibid., 77.

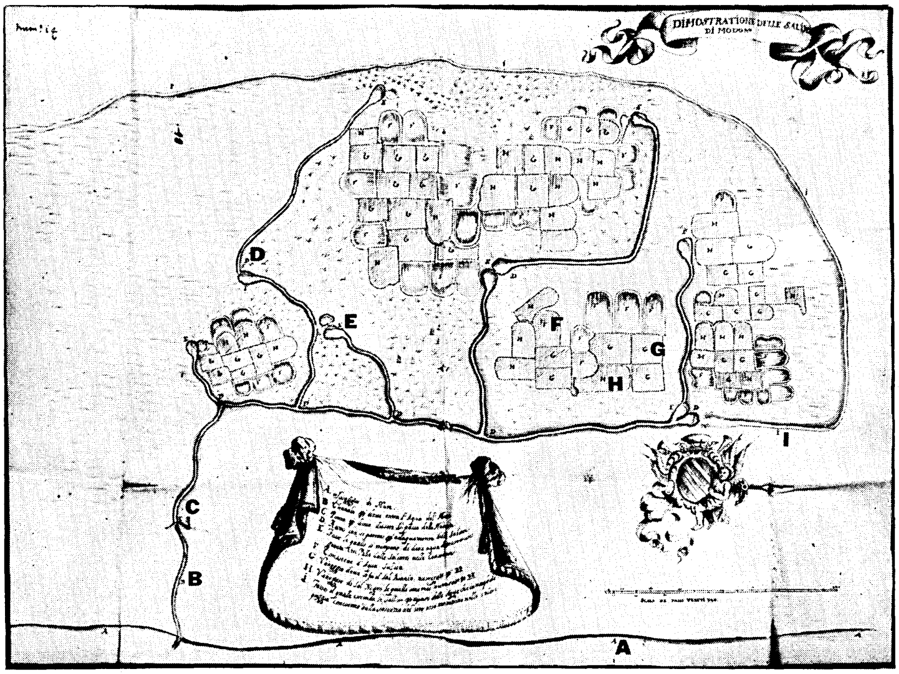


Figure 7. A Venetian drawing of the "salt pans of Methoni." A) Shoreline ca. 1692; B) channel to admit sea water; C) bridge; D) branches of channel; E) cavities filled with sea water; F) pans for storing sea water; G) white salt pans; H) black salt pans; I) ditch to keep out rain water.

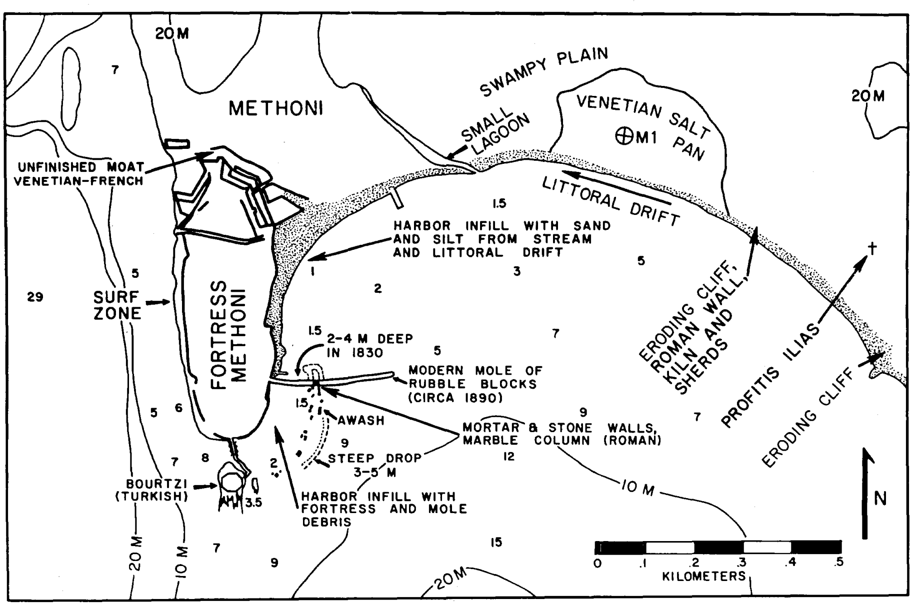


Figure 8. Ancient and modern elements of Fortress Methoni, its harbor, and its moat. Depths in meters. Fortress area in part after Flemming and others, 1973.

It is likely that the salt pans portrayed in the 1692 plan were located in the low marsh at the north end of the bay, for that is the only location that fits the description "one musket shot distant from Modon" in the German's letter of 1686. In addition, stereoscopic study of modern air photos of this marsh revealed part of the northern outline of the 1692 pans. Because of this fit it has been possible to superimpose a rescaled form of the 1692 plan on the base map of the Methoni bay. Analysis shows that the shoreline has migrated northward approximately 30 m. in the intervening 270 years.

Harbour Works or Moles

There are two moles that have been built at Methoni about which we have positive evidence. Both are of particular interest since they are man-made features that appear to have been significant in altering the erosional-depositional processes at play in the embayment.

The remains of the earlier mole, which has the shape of a fish-hook or sickle curved about the east side of the fortress, are still clearly visible in some places above the sea and in others barely submerged (FIGS. 2, 3). The 5-meter-wide wall of the mole enclosed an area roughly

200 m. E-W and 330 m. N-S; the western side of the enclosure is formed by the fortress wall. The second and newer mole (built in 1890) is simply a rude jetty consisting of large boulders piled up in a line running east from the fortress, passing over the north end of the ancient mole, and extending on eastward for another 100 m. (FIG. 8).

Assigning a date to the construction of the ancient mole involves some difficulty. It evidently was built before 1483, for a mole of this shape with a road on top of it appears in the Reuwich drawing of Methoni. It is noteworthy that neither this nor any other drawing of the first Venetian occupation 1206-1500 shows the octagonal tower called Bourtzi that now stands on the SW corner of the ancient mole. This agrees with Andrews' inference that the tower was built by the Turks after 1500. There is a scholarly consensus that the date of the construction of the mole vastly predates the Venetians. The task then becomes one of reconciling this position with the apparently contrary statement by Luce, who, in describing the great importance Methoni assumed in Venetian commerce soon after 1206, says "harbour works were undertaken, a mole built, and the town supplied with walls."[34] Luce, however, does not cite a source or any evidence for the assertion that a mole was built, and our research has not uncovered such evidence. The most reasonable interpretation is not that the Venetians built a new mole where there had been none, but rather that they rebuilt a previous one that had fallen into disrepair. Evidence consistent with this is that the north end of the ancient mole, where it lies partially covered by the boulders of the new mole, has distinctly different upper courses. These courses are likely attributable to Venetian activity, since a document of 7 March, 1400, refers to the continual repairs of the cover stones of the mole because of storm damage, and it records an order that another boat be sent for this work.[35] Furthermore, the lower part of the ancient mole is composed of large, squared sandstone blocks, and these bear a close resemblance to similar blocks of the Roman period at the base of the SW fortress wall.

There is more positive evidence for crediting the mole to the Romans. As Lehman-Hartleben noted, there is a mole represented on a coin from Methoni minted under Caracalla (who reigned 211-217 A.C.).[36] Some scholars have dated the mole even to the Classical Period.[37] Lehman-Hartleben, however, argues that the mole could not have existed in Pausanias' time (2nd century A.C.), or else he would have described it in his discussion of the Methoni harbor.[38] In addition, two general observations by Shaw may be applied to Methoni to argue against a pre-Roman date: 1) in the post-Classical period more and larger ships came to be used, and larger harbor and docking facilities gradually developed, and 2) more careful examination of harbor works has generally tended to indicate later dates.[39] We therefore interpret the ancient mole to have been built in the late 2nd or early 3rd century A.C..

The harbor of Methoni and, in particular, the area associated with the two moles has for a considerable time become increasingly shallow. The silting up of the harbor along the entire length of the eastern fortress wall is one of the most conspicuous features of the changes occurring in the embayment. The innermost, southern portion of the ancient harbor is filled with construction debris and is clear of silt and sand. The open, northern portion is filled with sand and silt from the westerly littoral drift stream of the Methoni embayment and sediment from the stream entering the harbor. Possibly man's activities and/or westerly storms account for the eastward deflection of the lagoon (counter to dominant littoral drift). Reuwich's drawing of 1483 (FIG. 5) portrays the harbor enclosed by the sickle-shaped mole, the fortress, and the beach to the east as seen from the SE. Along its entire length water laps against the fortress wall. Cargo and traffic appear on the broad road atop the mole. By 1671 Bernard Randolph reports that Methoni "hath a small mole to contain 2 or 3 galleys."[40] This suggestion of change is made explicit in Foscarini's statement in 1722 that Methoni is a "small port once capable of holding 7 or 8 galleys but now through long neglect barely sufficient for a few small craft."[41] A century later the French Scientific Expedition found that only small boats and launches could moor inside the mole because there was hardly more than 1 or 2 fathoms of water. When Tod visited

34. Luce, op. cit. (in note 9) 197.

35. Venetian State Archives, "Cancellarias Secretae Pars Altera (Deliberationi Miste) (Reg. °45, 1400-1401, c. 2)" in *Documents Inedits Relatifs à l'Histoire de la Grèce au Moyen Age* 2, C. N. Sathas, ed. (Paris 1400).

36. K. Lehman-Hartleben, "Die Antiken Hafenanlagen des Mittelmeeres," *Klio* 14 (1923) 209. For publication of the coin see F. Imhoof-Blumer and P. Gardner, *Numismatic Commentary on Pausanias* (Chicago 1964), a reprint of *JHS* 6-8 (1885-87).

37. Tod, op. cit. (in note 8) and A. Blouet, *Expédition Scientifique de Morée* 1 (Paris, 1831) 9-18.

38. Lehman-Hartleben, op. cit. (in note 36) 208-209.

39. J. W. Shaw, "Greek and Roman Harbourworks," in *A History of Seafaring: Based on Underwater Archaeology,* George F. Bass, ed. (London 1972) 87-112.

40. Randolph, op. cit. (in note 21) 6.

41. As cited in Andrews, op. cit. (in note 7) 62.

here in 1905, the new mole had been built and completely cut off access to the old mole. Obviously the new mole was to provide a usable substitute for the useless old one. But as elderly local informants point out, the new mole only accelerated the silting process. Tod seems to record this when he writes: "to the north of this mole sailing boats can approach close to the fortress but the coasting steamers which call at Methone in the summer season have to land out in the bay."[42]

Fortress and Moat

On the west side of the bay stands the vast fortress, impressive and awesome even in its decay (FIGS. 2, 3). Separated from the mainland by an incomplete moat 20 m. wide, the fortress stretches south for 700 m. to the octagonal tower of Bourtzi at its tip. Some 175 m. separate its west and east walls.

The earliest positive evidence of fortification at Methoni comes from the SW wall where late Roman pottery has been found in association with a section of rectangular poros blocks forming the foundation for the Venetian construction above.[43] But the remainder of the fortress and its extent at this time are not known. The fact that Methoni was unsuccessfully besieged by the Athenians in 431 B.C.[44] and besieged and occupied by Agrippa just before the Battle of Actium in 31 B.C.[45] may suggest earlier fortification by virtue of the premise that siege implies fortification. No remains of any pre-Roman fortification, however, have been found, nor is there evidence of the fortification in Byzantine times or in the brief Frankish occupation of 1204-6. Luce is convinced, though, on admittedly "superficial examination," that no part of the structure remaining today is assignable to the Franks.[46] In its main form the fortification to be seen today dates from the first Venetian period of 1206-1500,[47] so that the drawing made by Reuwich in 1483[48] can be related readily to the still-visible features.

The salient aspect of the fortress for this study is that the entire eastern wall was in contact with the bay and formed an artificial land barrier there. This was true even at the very northern end where the tiny rocky peninsula covered by this structure joins the mainland. Here in the last years of the 15th century and just before losing Methoni to the Turks, the Venetians began to cut a moat through the Eocene limestone bedrock. The Venetians recommenced this ambitious task during their second occupation of 1686-1715 and again left it uncompleted when the Turks retook Methoni. Work on the moat was started once more in the early 19th century after Greek independence and as a part of the efforts of the French General Maison to reconstruct the fortress.[49] Although never completed (as finally abandoned, the cut has proceeded from the bay on the east side to nearly three-quarters the distance across the peninsula), the moat is a particularly clear testimony to where the sea was at the time. The fact that in 1828-9 it still seemed feasible to pursue cutting the moat channel and that the bridge across it from the town to the north was rebuilt (also by General Maison) both suggest how rapidly this NW corner of the bay has silted up. Today the sea does not come nearer than 70 m. to the east entry of the moat, and the fine sand has filled the moat to a height of over a meter above sea level.

Physiographic and Geologic Setting of the Methoni Embayment

The Messenian peninsula is comprised mainly of Mesozoic and Tertiary sedimentary rocks. Studies of the geology of the peninsula by the Institute of Geology and Subsurface Research (IGSR) of Athens, now National Institute of Geology and Mining Research (NIGMIR), show SSE-trending, structurally-deformed Mesozoic and Tertiary sediments. Intense folding of these early Tertiary sediments is evident at Methoni. The eastern flank of the Messenian peninsula is bounded by the deep Gulf of Messenia, a graben-like structure. The western flank of the peninsula, along the edge of the Ionian Sea, is probably also a tectonic feature. Much of the SW shoreline is comprised of intensely deformed, early Tertiary flysch and Eocene limestone. The eastern portion of the peninsula is comprised of Mesozoic and Pliocene sediments.

The western flank of the Messenian peninsula is a high limestone ridge, quite resistant to erosion (FIG. 1). This ridge forms a spine-like western flank of the Bay of Navarino in the north. Southward the ridge of Eocene limestone forms the peninsula of Methoni, which projects into the submarine area with a continuation onto Sapientza, a large island lying offshore at the extreme SW corner of the Peloponnese (FIG. 3). This westernmost spine of Eocene limestone has proven to be strongly

42. Tod, op. cit. (in note 8) 33.

43. G. P. Papathanasopoulos, "Yearly Report" (Chronika) *ArchDelt* 17 (1962) 93-94 (in Greek).

44. Thucydides ii. 2.5.

45. Dio Cassius i. 11.3 and Strabo viii. 4.3.

46. Luce, op. cit. (in note 9) 196.

47. Andrews, op. cit. (in note 7) 77-78.

48. von Breydenbach, op. cit. (in note 19).

49. Andrews, op. cit. (in note 7) 64-65.

resistant to erosion and, accordingly, the shoreline of the Ionian Sea has changed little throughout recent time from Navarino southward. That shoreline is rocky and cliff-like, and drops to depths greater than 100 m. less than 0.5 km. offshore. Small rocky projections, islands, and an extremely irregular shape have resulted along the western shoreline of the Messenian Peninsula. Erosion of this Eocene limestone spine has produced gaps or embayments leading into the Bay of Navarino and the embayment at Methoni. As the Eocene limestone spine continues from the Methoni fortress underneath the narrow straits and on to the island of Sapientza, it is logical to assume that, at some time in the past, the westernmost spine of this resistant limestone was continuous as a boundary of the western flank of the peninsula.

At Methoni, a narrow low-lying alluvial valley runs north from the Gulf of Methoni parallel to the westernmost Eocene limestone ridge. This valley is covered with late Holocene alluvium and is occupied at present by a small stream. The flow of alluvium southward along this valley has tended to fill in the head of the Gulf of Methoni.

The eastern shoreline of this gulf is also rocky and cliff-like. However, in contrast to the hard and resistant Eocene limestone ridge under fortress Methoni, the eastern shoreline is one of rapidly eroding, soft Tertiary silts and sands interbedded with more resistant, thin-to-medium, bedded sandstone layers. The embayment of Methoni is a relatively deep (up to 44 m.) extension of the Ionian Sea bounded on the south by the island of Sapientza and on the SE by the Mediterranean Sea (FIG. 3). The embayment is a geological extension of a pre-Holocene Epoch valley eroded into the soft Neogene silts. This valley was ultimately drowned by the post-Würm glaciation and resultant sea-level rise.

Observation of the rocky shoreline facing the Ionian Sea shows that present coastal processes are causing little coastal erosion. The walls of the fortress directly face and are in contact with the sea. The submarine area immediately west of the Eocene limestone outcrop appears to drop off fairly rapidly to depths of greater than 10 m. The spine of limestone continues south of the fortress in a jagged ridge into the submarine area; the latter was occupied by the Turks when they built the small, outlying, defensive structure (the Bourtzi) to head the mole which had been previously constructed to the east around the fortress and into Methoni harbor. According to Admiralty charts the ridge continuing southward from the fortress of Methoni is barren and rocky at depths of 7 to 20 m.

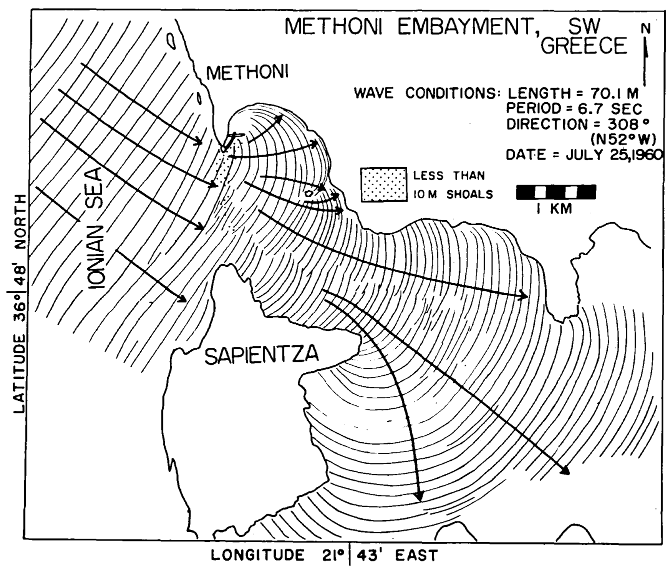
The bottom of the embayment itself is covered with sand and mud in the deeper areas. As one approaches the slightly eroding shoreline of the northerly arcuate strand, the sand-gravel content increases sharply. Behind the washover barrier at the shoreline, the area is swampy. However, the present barrier ridge is in part artificial and has been built up as a narrow roadway. The alluvial valley which extends northward approximately a third of the way to Pylos (ca. 5 km.) is covered by a thin veneer of late Holocene sand, gravels, and silty clay.

Coastal Processes and Geomorphic Change in the Methoni Embayment

The major elements of geomorphic change in the Methoni embayment are controlled by wave action. The average long-term wave approach direction is from the NW across the Ionian Sea. In view of the geography of the area and the large island lying offshore to the south (Sapientza), wave approaches in the Methoni embayment must come from the west or to a lesser degree through the channel from the SE. Waves enter the embayment, strongly refracting around the limestone ridge and fortress and to a lesser degree around the limestone ridge at the northern end of Sapientza. These waves are somewhat modified by the relatively shallow submarine ridge that lies between Methoni and Sapientza (see FIGS. 2, 3).

Figure 9 is a wave refraction diagram based on interpretations of air photographs. The wave pattern shown is, of course, only one variant. Westerly waves are dominant, whereas, southeasterly waves occur as the exception. The more westerly-southwesterly the wave

Figure 9. Wave refraction plan in the Methoni embayment based on air photographic interpretation.



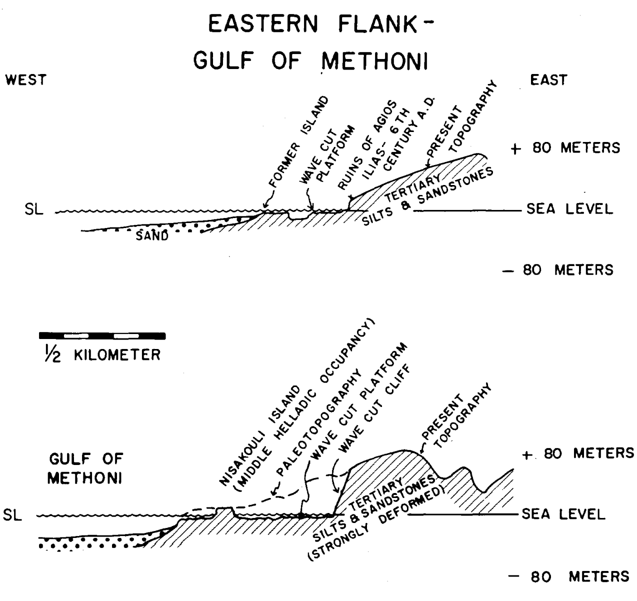
approach component, the stronger the northwesterly littoral drift. Relatively strong wave convergence and erosion occurs around the island of Nisakouli on the eastern side and against the wave-cut cliffs farther to the east. This erosion continues around the embayment to the northerly shore and shifts to a strongly depositional area in the harbor of Methoni at the mole. A dominant littoral drift to the north and west is set up along the eroding shorelines of the eastern side of the embayment to the north of Nisakouli Island, and to the SE of Nisakouli Island. However, this littoral drift direction can and does reverse from time to time. The net result is deposition in the NW quadrant of the embayment and strong erosion and coastal retreat of wave-cut scarps along the NE and east shoreline. Strong deposition also results in the minor embayments to the SE towards the area of Finikous. The western shoreline of the Methoni peninsula and the island of Sapientza is less affected by wave attack, in view of the resistant nature of the hard Eocene limestones, and there is no evidence of sand bypass in the offshore submarine area from "sandy Pylos," over 20 km. to the north, the only source of Ionian Sea shoreline sands. In addition, the Eocene resistant spine and fortress form a "breakwater-wave shadow" effect that also emphasizes deposition in Methoni harbor.

Coastal Retreat: Nisakouli Island and the Wave-Cut Cliffs

Higgins[50] noted that the lack of Mycenaen settlements along this coast might be attributed to the fact that coastal erosion has been occurring at a relatively rapid rate. He projected the possibility of up to 800 m. of coastal erosion in the SW corner of the Messenian peninsula. Based on the work of McDonald and Hope-Simpson,[51] Higgins pointed out that Bronze Age occupation at Finikous on the south shore of the Messenia peninsula was probably larger in extent than is indicated at present, and the area is rapidly undergoing coastal erosion.

McDonald and Hope-Simpson noted that it would be highly unlikely to have a Middle-Late Helladic settlement on a small island such as Nisakouli. In view of this, they speculated that Nisakouli might once have been a promontory or peninsula extending westward from the present cliff area along the eastern side of the Methoni embayment. The island of Nisakouli lies along the direct extension of the contact between the valley alluvium and Tertiary flysch at the northern end of the Methoni embayment (FIG. 3). This extension may be traced as the submarine edge of a rock platform having depths of less than 5 m.; both British Admiralty charts and air photos clearly show the platform. Massive cliff retreat has definitely occurred in this area throughout the past four millennia. Projection of present surface slopes of the mainland east of the island of Nisakouli towards the island shows a logical reconstruction of the ancient land surface extending to the island and thence downwards under the Methoni embayment. Figure 10 shows profiles of the rocky wave-cut cliff that has retreated eastward. It also shows the present topography of the mainland and a submarine platform with an "island-like" areal extent, lying to the north of Nisakouli. The northerly profile shown is drawn through the area of the ruins of Agios Ilias, a 6th century church which, as we have seen, is at present nearly entirely eroded away and falling into the sea (FIG. 6). It is interesting to speculate that the isolated wave-cut platform shown in Figure 10 to the west of the position of Agios Ilias may have been an island in historical times. It is possible that this is the island shown on the 1574 A.C. panorama by Hohenberg (FIG. 5). Many authorities have noted that the island shown in Figure 5 bears ruins which suggest that it is Nisakouli. However, the island to the left in the diagram (FIG. 5) might equally well have been Nisakouli. There is then, a strong probability that an island formerly existed as

Figure 10. Topographic profiles along the eastern flank of the Gulf of Methoni. Topographic detail is shown in a section running east-west through the ruins of the chapel, Agios Ilias, and a line of profile through Nisakouli Island. The wave-cut cliffs are well developed. It is hypothesized that a former island existed to the west of the ruins of Agios Ilias.



50. Higgins, op. cit. (in note 22) 23-24.

51. McDonald and Hope-Simpson, loc. cit. (in note 5).

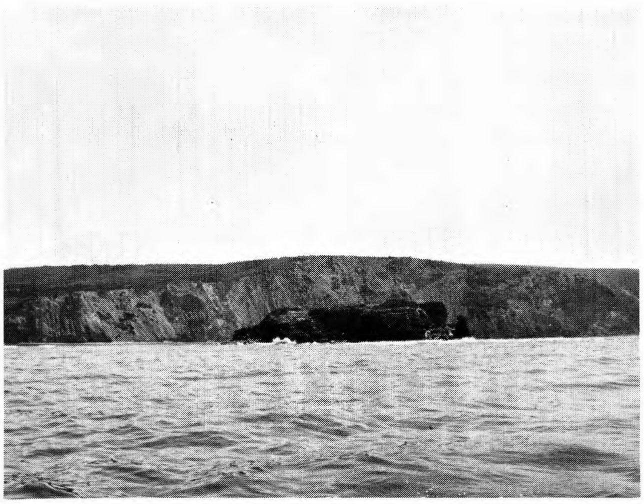


Figure 11. The island of Nisakouli showing the currently eroding Tertiary silt and sandstone cliffs.

positioned in Figure 10 and Figure 2. The view of Nisakouli from the sea (FIG. 11), shows the immediate potential of an extension of the surface of the island to the highlands to the east, thus suggesting that Nisakouli may have been a promontory in the past.

Nisakouli Island (FIG. 11) is formed of a sequence of relatively horizontal, thick layers of well-cemented sandstone. Similar hard sandstone beds up to 12 cm. thick occur in the mainland scarp, but there the sandstone beds are surrounded by much less well-indurated silt beds. The thick, hard beds of fine sandstone in Nisakouli Island are interbedded with thin (1-3 cm.) silts, whereas the well-cemented sandstones occur in beds up to 0.5 m. in thickness. While the bedding on Nisakouli is relatively horizontal, that of the eroding cliff on the mainland to the east consists of strongly distorted and deformed beds, frequently standing on edge. The outcrop extending into the embayment to the north of Nisakouli includes thicker, more resistant sandstones which form a small spine or extension southward towards Nisakouli (FIG. 3).

The eroding sea cliff along the eastern side of the embayment is mainly comprised of thinly interbedded (approximately 1-2 cm. in thickness) sequences of very soft, bright yellow-brown silt with very fine sand. Thin, hard brown sandstone layers, 10 cm. thick, highly fractured, but more resistant to erosion, are interbedded in the silt-sand sequence. Erosion of the Tertiary layers results in the distribution of silt and sand into the littoral drift stream and their being moved away from the area.

Waves converge around Nisakouli, with a concentration of their wave energy behind the island and against the rapidly-retreating, relatively high cliff. The eroded, thicker, more resistant, highly fractured sandstone beds concentrate at the foot of the cliff in the shore area and are rounded into pebbles, cobbles, and boulders. These form a "ball mill" effect during stormy periods and add to the erosive nature of the shoreline during times of high wave activity (FIG. 12). Some of this coarse sediment is transported in the littoral drift system around the embayment to the beaches lying along the edge of the alluvial valley in the north.

As the erosion encounters higher and higher cliffs and as relative sea level continues to rise, the amount of sediment per linear meter of coastal erosion significantly increases. This may be one of the most important causes of increasing silting of the harbor at Methoni.

The NE Corner of the Embayment: Low-lying Wave-cut Cliffs

Along the NE flank of the Methoni embayment, coastal erosion is the dominant process: littoral drift moves sand and gravel from the area in a constant stream towards the harbor of Methoni to the west and in more exceptional cases to the south and out of the embayment area. Some of the sand-size sediment is removed to the near-shore marine area of the embayment. This shoreline is characterized by relatively low-lying wave-cut cliffs undergoing retreat to the north and east. In some areas, bedrock Tertiary silts and sandstones are undergoing erosion just as in the higher cliffs lying to the south. Younger colluvial units are also being eroded. This colluvium covers brick walls and masses of associated Roman pottery and tiles (see FIG. 3). This is an area of low-lying gulleys, trending westward into the embayment, along which boulders and cobbles are transported from the highlands down to the beach area and then redistributed.

The Alluvial Plain at the North End of the Methoni Embayment

An alluvial plain at the northern end of the embayment (FIGS. 2, 3) is part of a relatively deeply incised, pre-Holocene valley that ran between the Eocene limestone ridge to the west and the highlands comprised of Tertiary silts and sandstones to the east. This valley ran southward under the present alluvial plain through the embayment and exited into the Mediterranean Sea to the SE. The modern plain may be subdivided into high and low alluvial plains. The small river which runs across the plain is now located along the western flank and is not in the lowest part. In view of the fact that the river is perched at a higher level than the central plain and runs toward the fortress of Methoni before exiting

Figure 12. Cliff retreat along the eastern side of the Methoni embayment.

into the Gulf of Methoni, it is assumed that the river was put into its present position by earlier occupants of the Methoni area who desired a well-drained alluvial plain for agricultural purposes. In addition, they may have developed a water supply to the fortress and town area by shifting the river. What is more, one should note that westerly storm winds and resultant minor currents could in part account for the easterly projection of the river mouth (FIG. 8). Sediment from the river itself contributes to the filling-in of Methoni harbor and the man-made shift of the river to the west would tend to accelerate sediment flow via the river into the harbor area. Thus, the shift of river position to the west flank of the valley might account for the easterly deflection of the river lagoon mouth, counter to the dominant littoral drift.

The Venetians established a salt pan in the lower part of the alluvial plain. Here again, they may have diverted the river away from the lower part of the alluvial plain so that they could form evaporation pans based on successive flooding by salt water and restriction of flooding by fresh water of the stream itself. Now the lower alluvial plain includes a very low-lying salt marsh bounded seaward by a relatively high sand and gravel shoreline ridge. This barrier is formed by littoral drift of materials from the eroding cliff areas to the SE. In addition, a component of sand, gravel, and other debris is injected into the shoreline area from the stream flowing along the west side of the alluvial plain. Because of the dominant littoral drift flow from the SE to the NW, one might expect a sorting mechanism to be in action and thus a diminishing of grain size towards the NW. However, sediment of all sizes flowing into the Methoni embayment via the stream acts to diminish size sorting on the beach.

Study of the 1692 drawing of the Venetian salt pans, located by Professor Peter Topping in the Archivio di Stato, Venice (FIG. 7) has enabled us to locate a portion of the salt pans by stereo-photographic studies. It appears that the Venetians constructed drainage ditches around the salt marsh area to remove fresh water, and formed channels to allow salt water to flow into the excavated salt-pan areas. These channels were dug through the existing sand-gravel barrier at the head of the Methoni embayment. Based on the Venetian document it appears that approximately 30 m. of erosion has occurred at the northern shoreline of the Methoni embayment. The shoreline sand-gravel ridge is migrating to the north as coastal erosion continues. Rate of erosion, however, cannot be derived with precision.

A shallow core hole (Methoni #1: Agios Nikolaos) was drilled from an elevation of 0.58 m. in the salt-marsh area behind the barrier at the lower end of the alluvial plain. Figure 13 shows a log of the sediments encountered in this boring. Corroded (Tertiary redeposited) microfauna are not included in this figure; however, contamination of marine microfauna from nearby eroding Pliocene marine silt cliffs is very possible. After penetrating ca. 0.5 m. of fill or man-derived debris, the drill encountered a dark yellow-brown to light olive grey clay formed in a freshwater swamp. Underneath this lay a thin (ca. 1 m. thick) clay-silt unit with a high organic content of roots and mottles which was formed in a coastal brackish swamp. Underlying this, from ca. 2.3 m. to 3.2 m. below the land surface, a greyish olive silt-clay was encountered. This clay included abundant shallow marine foraminiferida at the top and freshwater ostracodes at the base. From 3.2 m. to 5 m. an olive-brown mud with a freshwater microfauna indicates a coastal swamp and marine regression in the area. At 5 m. an olive-brown to olive-grey sandy silt-clay was encountered which extended to 10.2 m. below present sea level and included an abundant marine foraminiferida fauna. We thus interpret the upper silt-clay and marsh debris to be deposits of a coastal swamp, at some times brackish. The silt-clay unit underlying this is the product of a brief marine transgression over a still older freshwater swamp. Finally, the lowest 5 m. of sediments represent an earlier middle Holocene marine transgression which probably extended up to 3-4 km. north of the test hole. Clearly, relative seas levels have changed, and these levels, balanced with varied sediment input, indicate highly variable paleogeographies over the past 4 to 5 millennia. Figure 14 shows a cross-sectional interpretation of these alternating coastal environmental conditions.

The intrusion of man in this coastal area is well noted. The formation of the Venetian salt pans and the moving of the river sideways to insure a well-drained upper alluvial plain and a coastal swamp salt pan free

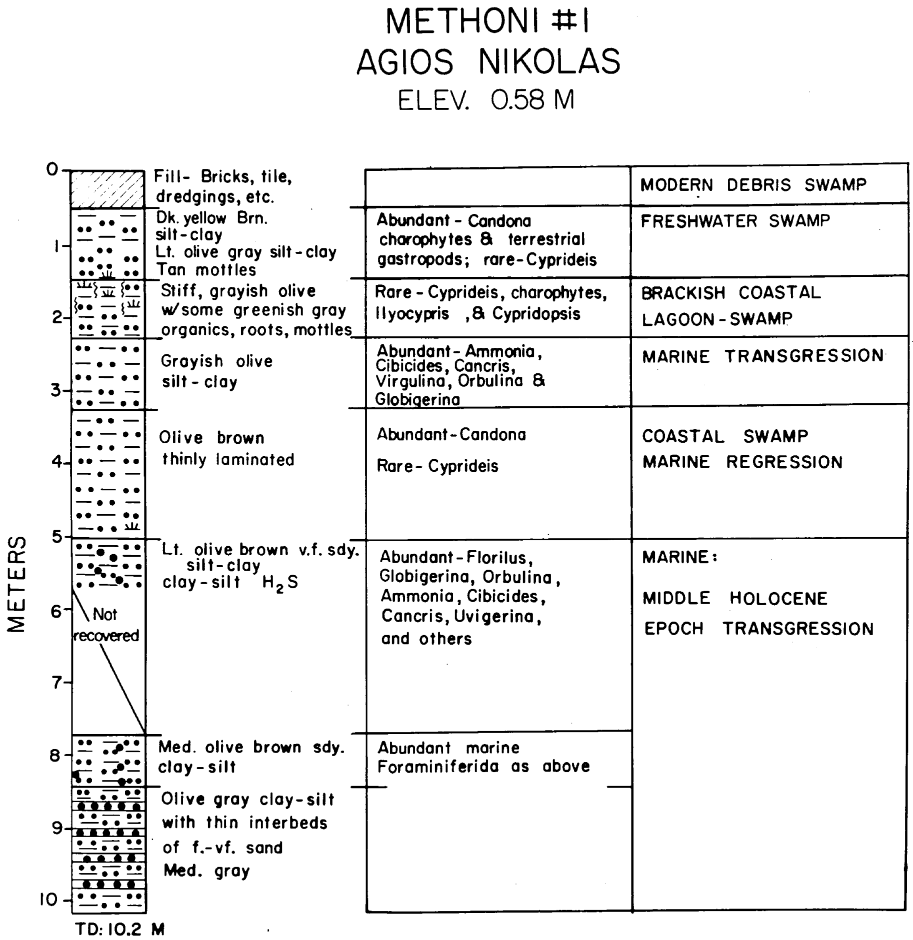


Figure 13. A well log of test hole Methoni #1 — Agios Nikolas, showing Holocene Epoch sediments, microfaunas, and interpreted coastal sedimentary environments.

of fresh water, have been previously noted. In addition, the very lowermost part of the alluvial plain has been actively used for excavation of silt-clay for pottery works that have abounded in the area at various times in the past. Thus it is possible that the very lowermost swampy area of the lower alluvial plain was man-made in Venetian times.

The Italians constructed anti-tank traps across the area during World War II. It is possible that the "low alluvial plain" (FIGS. 2, 3) represents the areal extent of the coastal marshy embayment backwards in time to Hellenistic or earlier times, but a precise date has not yet been determined. It is also important to note that the configuration of a high and low alluvial plain may in part be tectonically derived. However, it seems more likely that this configuration is a normal development of the drowning of an ancestral river valley by a late Holocene rise of relative sea level in the area and by man's diversion of the river to the western side of the alluvial plain. Figure 14 shows a geomorphic profile across the alluvial plain at the northern end of the Gulf of Methoni. The lowermost part of the swampy area of the alluvial plain is possibly emphasized by man's intrusion into the area. The lowermost clay-silt and very fine sand unit encountered in the bore hole Methoni #1, is shallow marine in origin (see FIG. 14) and equivalent to that of the near-shore area of the Gulf of Methoni. Thus, the Gulf of Methoni extended farther to the north at some time during the past 3-4 millennia. It is not possible at this time to give a precise dating to the marine transgressions shown.

The Harbor of Methoni: Effects of the Intrusion of Man

The very earliest representations of the harbor of Methoni clearly show a "fishhook-shaped" mole. This mole probably dates from Roman times but certainly existed from the 12th century to the 19th century. Numerous Medieval diagrams, an example of which is shown in Figure 5, clearly show the nature of the mole, which extends from the southern end of the fortress around and into the NW corner of the embayment. The early diagrams show that a break in the mole existed

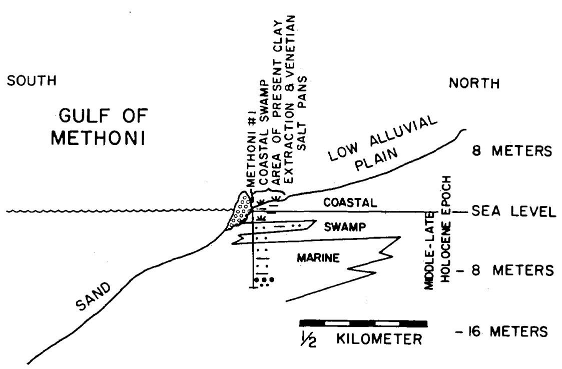


Figure 14. A profile showing the geologic elements in the shoreline-coastal swamp area at the north of the Gulf of Methoni. Transgressive and regressive elements observed in test boring Methoni #1 — Agios Nikolas are shown. Note vertical exaggeration.

near the southern end of the fortress, where it was crossed by a drawbridge. It is probable that the inner harbor never was very deep. Very likely large ships that approached the area would have been docked on the outer side of the crescent-shaped mole where water drops off rapidly to a depth of 5-10 m. On the other hand, all of the diagrams from Medieval times to the early 19th century show smaller ships at anchor between the mole and the fortification walls. The French Expedition publications in the 1830s clearly indicate that the Methoni harbor was still usable at that time, although beginning to fall into ruins.

Now the old, inner harbor is useless to man. It is largely filled in with silt, cobble, and construction debris, and its entrance is entirely blocked by the new mole which was built perpendicular to the fortress in the decade of 1890. Since then silting has continued to such an extent that the small fleet of fishing vessels may anchor only at the eastern end of the new mole. For any vessel with a draft of more than 0.5 m. the older Methoni harbor area is not serviceable. The sheltered area north of the modern mole is filled with silt and sand, whereas the Bourtzi and fortress area south of the modern mole, which is also sheltered, is filled in only with rocky construction debris, a further confirmation of the migration of river sediments and the dominance of a NW, littoral transport in Methoni embayment.

It is possible that the break in the mole, covered by a drawbridge (see FIG. 5) may have been a flushing device to allow currents and waves refracting around the tip of fortress Methoni to move directly into the harbor in a northerly direction, counter to the average littoral drift. Should this have been, indeed, a "flushing device," it may account for the long-lived harbor of Methoni. The "fishhook-shaped" harbor at Methoni was to all other appearances constructed counter to good engineering practices in the sense of littoral drift flowing into the area, a small river exiting into the harbor area, and no apparent means of dredging to keep the harbor open. The mere fact that the harbor existed from the 12th century onward (and possibly a millennium earlier) and was still capable of holding ships in the early 19th century suggests that some device was operating to keep it clear of silt. It is known that Roman engineers and others were capable of developing flushing devices to keep ports open. Although the structure hypothesized for this purpose at the junction of the mole of Methoni with the fortress Methoni is not typical of those used by the Romans, it might be possible that this structure was used to keep the harbor clear of silt for nearly 2 millennia.

When the French Expedition first studied the Methoni harbor[52] they believed that the mole was formerly continuous. The harbor was still 2-4 m. deep (1-2 fathoms). They observed that the harbor had been deeper in earlier times. The infilled harbor contained rolling cobbles and other coarse structural debris. The members of the French Expedition concluded that the opposing currents of the westerly littoral drift at the head of the embayment and waves breaking through the gap in the ancient mole caused sediment to deposit in the resultant eddy or backwater area. It is our hypothesis that cause and effect are just the opposite. With the breakdown of the mole, coarse debris infilled the inner harbor. When the engineers of 1890-96 built the new mole perpendicular to the fortress, they completely cut off the ability of currents to flow through the harbor and began the present cycle of sand-silt deposition which has completely destroyed the older harbor area.

The construction of the newer mole occurred in the last quarter of the 19th century, approximately 1890-96. Inquiries as to the time and reason for the construction of a newer mole, perpendicular to one that sufficed for at least 600, and possibly 1600, years, led to the following interesting information from Mr. Takis Demodos of Methone to Dr. Kevin Andrews of Athens.

Athens, Greece
10 April 1973

Dear Professor Kraft,

I have just received the following reply from Takis Demodos in Methoni:
"(translated) . . . The story that fishermen told you here 20 years ago about the silting-up of the harbour of Methoni is true. I can confirm it for Professor Kraft. Not the father but the grandfather of the fisherman, Loukas Masarelo, warned

52. J. B. G. M. Bory de St. Vincent, *Expédition Scientifique de Morée, Section des Sciences Physiques* 2 (Paris 1836).

the engineers that if they built the mole in the direction in which they did in fact build it, then the harbour would silt up, as actually happened. The new mole was built between 1880 and 1890 (I don't know exactly when). Louka Masarelo was at that time the best seaman in Methoni: an old man. His own father, Giovanni Masarelo happened to be in Methoni harbour, the night of April 30, 1825 when (Admiral) Miaoulis set fire to the 28 Turkish ships. The Genoese vessel of Giovanni Masarelo was burned together with the Turkish ships. He married a woman of Souli (one of those whom Ibrahim Pasha had brought here from Missolonghi as prisoners-of-war), and Loukas was born—the grandfather of my own friend Loukas, who told you the story about the Methoni mole. A seafaring family from Genoa, generation after generation. My friend who told you the story of the mole is still alive". . .

I hope this narrative, with its interesting link with the Greek War of Independence, may be of use to you.

The moral of the tale is Don't interfere with Nature.

Yours sincerely,
Kevin Andrews

Inasmuch as the French were renewing efforts in the 1830s to complete the northern moat, we may infer that harbor silting had not yet proceeded so far as to indicate the present outcome. Nevertheless, despite rising sea level and its tendency to deepen the harbor area, many factors were at work leading to eventual infill by sediment. Not the least of these was the alteration by man of long-established water-flow patterns, as well as long-term deterioration of the older time-tested harbor facility.

Several attempts were made to develop a moat between the northern portion of the Methoni fortress and the mainland. This moat is extensively excavated but was never dug deep enough so that the Ionian Sea and the northern portion of the Methoni embayment could connect. Had this been allowed to happen, wave trains and resulting currents moving through might have helped flush and keep clear the entire northern edge of the embayment, and the harbor of Methoni might still be a major port facility. On the other hand, the moat and fortification structures extending from the corner of the embayment inland around the northern wall are now filled in with silt to heights of 1 m. above sea level. The shoreline is 70+ m. away from the beginning of the moat. One can now walk into the moat area to stairs from the platform which received ships two to three centuries ago.

Coastal Change and Paleogeographic Reconstruction

We have discussed the elements of coastal change around the northern and eastern periphery of the Methoni embayment. Dominant processes have been those of wave action causing a wave-cut platform and cliff retreat, littoral drift systems moving sediments into and out of the embayment area, and the intrusion of sediment into the embayment via a small stream flowing southward across the alluvial plain. The stream at present forms a very small delta and probably never formed a major delta intrusion into the Methoni embayment. In view of this, wave-erosional and transport processes have been dominant for at least the past several millennia.

Another obvious element of change of coastal configuration or morphology is that of relative sea-level change during the waning of the Wisconsin-Würm glaciation and the Holocene Epoch which followed (10,000 years B.P. to present). Present studies of worldwide sea-level change show that a relatively rapid rise of level of sea has occurred by eustatic means throughout the Holocene Epoch. This melting of the world's ice caps and gradual rise of the entire world's ocean surface has been documented by many geologists. From 15,000 to 20,000 years ago, sea level lay over 100 m. below present. It rose rapidly until 6,000-7,000 years B.P. For the Holocene Epoch a great divergence of opinion exists as to the nature of eustatic sea-level changes. Mörner,[53] working in Scandinavia, and Fairbridge,[54] on a worldwide basis, projected sea level to have reached present levels between 4,000 and 6,000 years B.P. and then to have fluctuated above and below the present sea level. Ters[55] identified similar sea-level fluctuations throughout the mid-late Holocene Epoch based on research in NW France; her work, however, suggests that sea level never rose above present. Jelgersma,[56] working in the Netherlands, on the other hand, showed a relatively smooth, eustatic sea-level rise throughout the Holocene Epoch with a gradually decreasing rate. Hafemann[57] suggested that eustatic sea-level rise has continued to the present at a rate of 1.7-2.2 m. over the

53. N. A. Mörner, *A Late Quaternary History of the Kattegatt Sea and the Swedish West Coast* (Sver. Geol. Untersok 63 No. 3, 1969).

54. R. W. Fairbridge, "The Changing Level of the Sea," *SciAm* 202 N.5 (1960) 70-79; idem, "Part 3. The Quaternary Record: Quaternary Sedimentation in the Mediterranean Region Controlled by Tectonics, Paleoclimates and Sea Level," in *The Mediterranean Sea,* ed., D. J. Stanley (Stroudsburg 1972) 99-113.

55. M. Ters, "Les Variations du Niveau Marin depuis 10,000 Ans le long du Littoral Atlantique François," in *Le Quaternaire: Géodynamique, Stratigraphie et Environment, Travaux Français Récenté.* 9ᵉ Congrés Internat. de l' INQUA (Christchurch, New Zealand, 1973) 114-135.

56. S. Jelgersma, *Holocene Sea-level Changes in the Netherlands,* m. ed. *Geol. Sticht,* series C-VI (1961).

57. D. Hafemann, "Ansteig des Meersspiegels in Geschichtlicher Zeit," *Die Umschau* 60 N.7 (1960) 193-196.

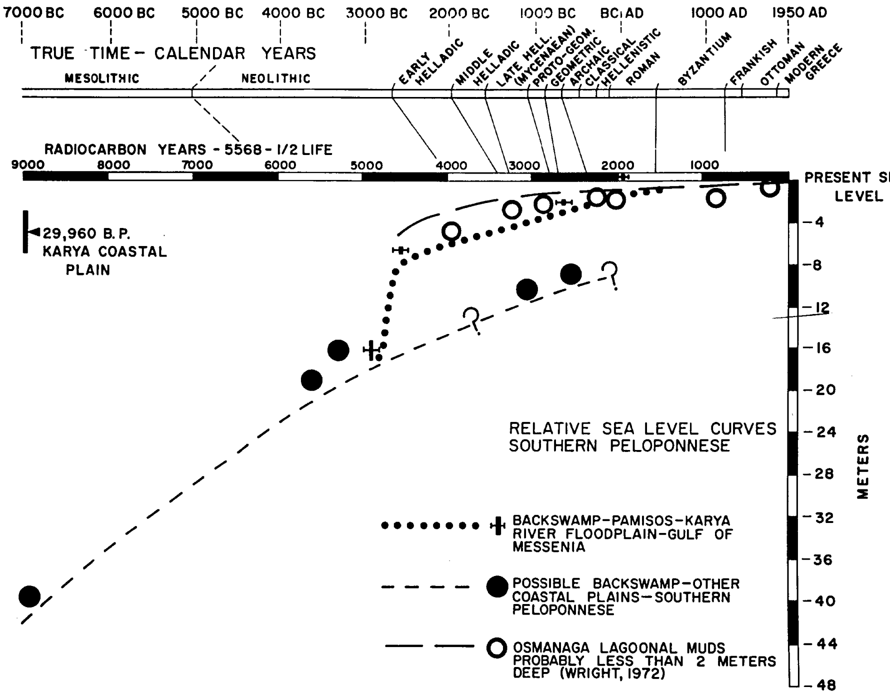


Figure 15. Three potential relative sea-level rise curves constructed from data in various embayments of southern Peloponnese. Note the problem of the overwhelming variable tectonic effect. Data from Kraft, Rapp, and Aschenbrenner, op. cit. (in note 62); Loy and Wright, op. cit. (in note 62).

past 2 millennia. A Late Holocene sea level study in the Tyrrhênienne Sea by Pirazzoli[58] suggests at least a short segment of smoothly rising sea level in the Mediterranean approximately 2,000 years ago. Flemming[59] suggested that eustatic sea levels, based on evidence around the western Mediterranean Sea, have not changed over the past several thousand years. Flemming allows for a divergence of ±0.5 m. from his interpretation.

The characterization of eustatic sea-level, world-wide effects over the latter part of the Holocene Epoch remains in doubt. That doubt, however, does not preclude the application of information about local relative sea-level rise to potential paleogeographic interpretations. For instance, Flemming[60] has studied tectonic subsidence and upwarping of the Peloponnese and the Aegean area, in which he determined that the extreme SW flank of the Peloponnese was undergoing tectonic depression at rates of up to 2 m. of subsidence in 1,000 years (Flemming and others).[61] However, this rate cannot be projected backwards through the various millennia of the Holocene Epoch in a linear manner. In addition, other work by the present authors and others in the area of the Bay of Navarino and at the head of the Gulf of Messenia suggests that a component of eustatic sea-level rise should be added from evidence in the Greek coastal area (FIG. 15).[62] It is likely that a separate and different relative sea-level curve will eventually be established for other embayments of the strongly tectonically evolved coast of Greece. Unpublished data from more recent studies by the authors elsewhere in Greece strongly support this hypothesis.

A question remains regarding the tectonic versus eustatic effects of relative sea-level rise or change in the

58. P. Pirazzoli, "Les Variations du Niveau Marin Depuis 2000 Ans," *Memoires du Laboratorie de Geomorphologie de l' Ecole Pratique des Hautes Etudes* 30 (Dinard 1976).

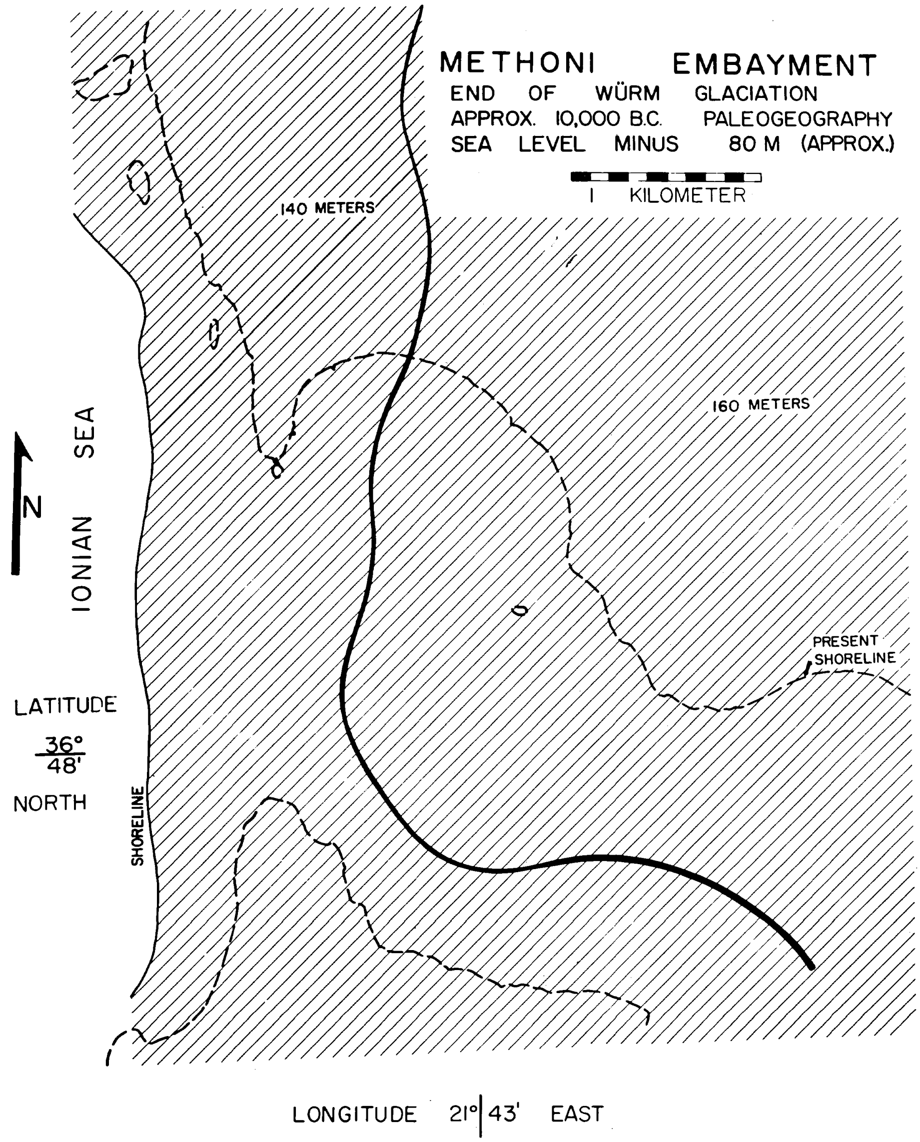
59. N. C. Flemming, *Archaeological Evidence for Eustatic Change of Sea Level and Earth Movements in the Western Mediterranean in the Last 2000 years. Special Paper 109 of the Geol. Soc. of America* (1969).

60. Idem, "Eustatic and Tectonic Factors in Relative Vertical Displacement of the Aegean Coast," in *The Mediterranean Sea,* D. J. Stanley, ed. (Stroudsburg 1972) 189-201.

61. N.C. Flemming, N.M.G. Czartoryska, and P.M. Hunter, "Archaeological Evidence for Eustatic and Tectonic Components of Relative Sea Level Change in the South Aegean," in *Proceedings of the 23rd Symposium of the Colston Research Society Held in the University of Bristol, April 4-8, 1971* (London 1973).

62. J. C. Kraft, G. Rapp, Jr., and S. E. Aschenbrenner, "Late Holocene Paleogeography of the Coastal Plain of the Gulf of Messenia, Greece, and Its Relationships to Archaeological Settings and to Coastal Change," *Geol. Soc. of America Bull.* 86 (1975) 1191-1208; J. C. Kraft, *A Reconnaissance of the Geology of the Sandy Coastal Areas of Eastern Greece and the Peloponnese. Technical Report No. 9, College of Marine Studies, University of Delaware* (Newark, Delaware 1972); W. G. Loy and H. E. Wright, Jr., "The Physical Setting" in MacDonald and Rapp, op. cit. (in note 1) 45-46.

Figure 16. A paleogeographic construction of the area of the Methoni embayment at the end of Würm glaciation, approximately 12,000 years before present.



Methoni embayment. However, a fairly close approximation can be made for middle-late Holocene positions of relative sea level in the Methoni embayment. The high slopes of shoreline topography, projected into deep adjacent water bodies, tend to minimize potential errors of geographic reconstruction. It is possible to combine hypothetical and empirical relative sea-level information with rates of coastal erosion and change in coastal morphology and thus construct paleogeographic maps of the Methoni embayment area.

The paleogeography of the Methoni embayment area at the end of Wisconsin-Würm glacial times was one of parallel rocky mountainous ranges extending southward along the westward side of the Messenian peninsula to, and south of, the island of Sapientza (FIG. 16). To the east of the limestone ridge lay a deeply incised valley with a stream flowing N-S and thence SE, through the area of the present strait between Sapientza and the mainland, into the Mediterranean Sea. At that time, ca. 12,000 years B.P., the shoreline-deltaic area of this stream would have been to the east of the island of Sapientza. The sea level in the Mediterranean-Ionian Sea was probably more than 80 m. below its present level (FIG. 16).

In the early-middle Holocene time (Early Neolithic Period) the Mediterranean-Ionian Seas had risen to approximately 20 m. below present sea level. Only a very narrow channel existed between the peninsula of Methoni and the island of Sapientza. In addition, the Mediterranean Sea intruded into the present Methoni embayment area, covering the land to a depth of over 10 m. (FIG. 17). Thus in the Early Neolithic Period,

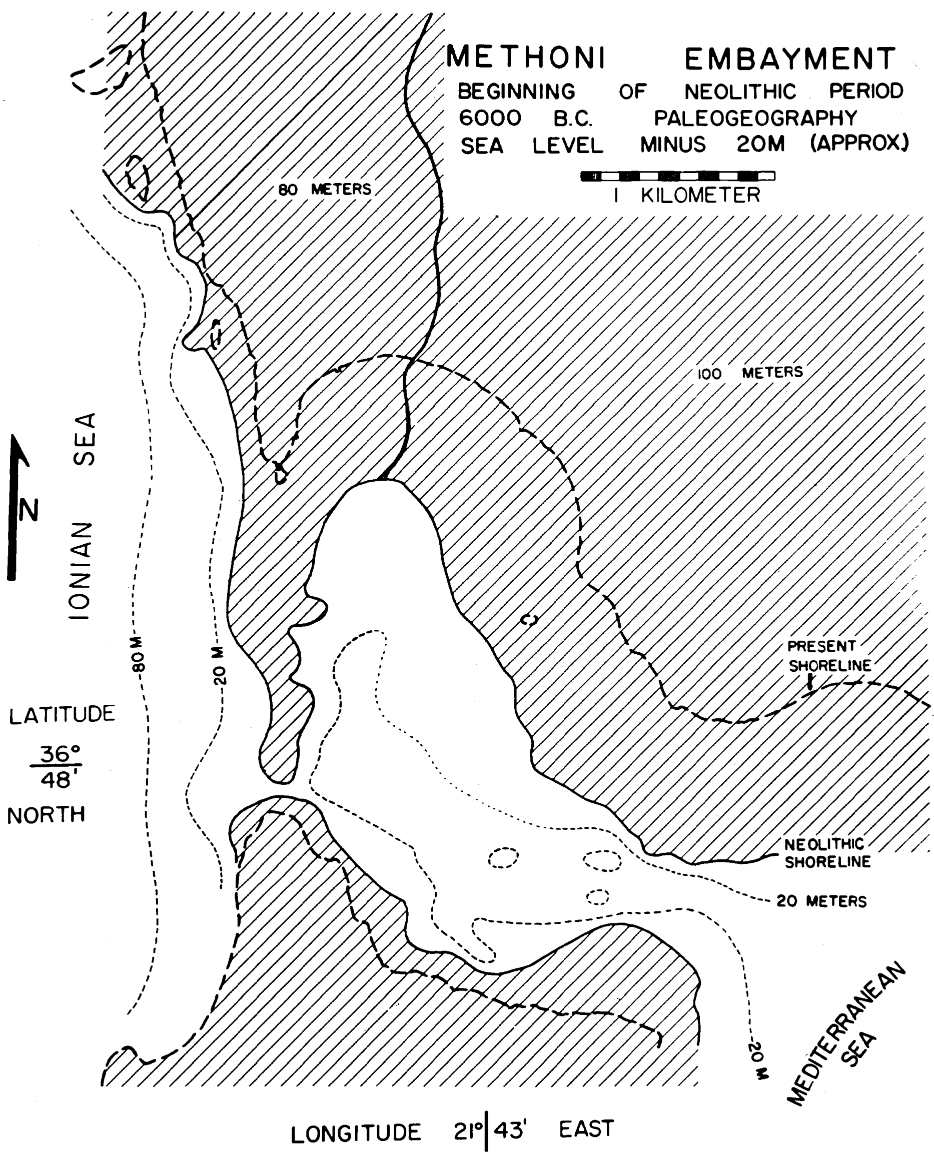


Figure 17. A paleogeographic reconstruction of the Methoni embayment in earliest Neolithic time, approximately 8,000 years before present.

approximately 6000 B.C., a deep, sheltered arm of the sea existed in the Methoni area. From that time onward sedimentary infill of marine sediments accompanied the intrusion of sediments via the stream flowing in from the north. Relative and eustatic sea-level rise continued at a rate greater than sediment infill and the embayment area expanded.

Although the Methoni embayment of Neolithic times had an open access to the Mediterranean Sea to the SE, the spine of Eocene limestone along the western flank protected the area from strong attack by wave trains traveling across the Ionian Sea. Man may already have occupied the area, although Neolithic remains are at present unknown. The island of Nisakouli at this time was part of the flanking highlands to the east of the embayment. From Neolithic times, or middle Holocene Epoch, onward, the precise reconstruction of relative sea-level change in the Methoni embayment becomes more difficult. On the other hand, rates of shoreline change, as evidenced by archaeologic evidences, may be determined with some precision. If one uses the minimal interpretations of Jelgersma,[63] with her "smoothly rising at ever lower rates" eustatic sea-level curve, very specific geomorphic configurations can be developed. On the other hand, should Mörner,[64] Fairbridge,[65] or Ters[66] be correct regarding fluctuating sea

63. Jelgersma, op. cit. (in note 56).

64. Mörner, op. cit. (in note 53).

65. Fairbridge, op. cit. (in note 54).

66. Ters, op. cit. (in note 55).

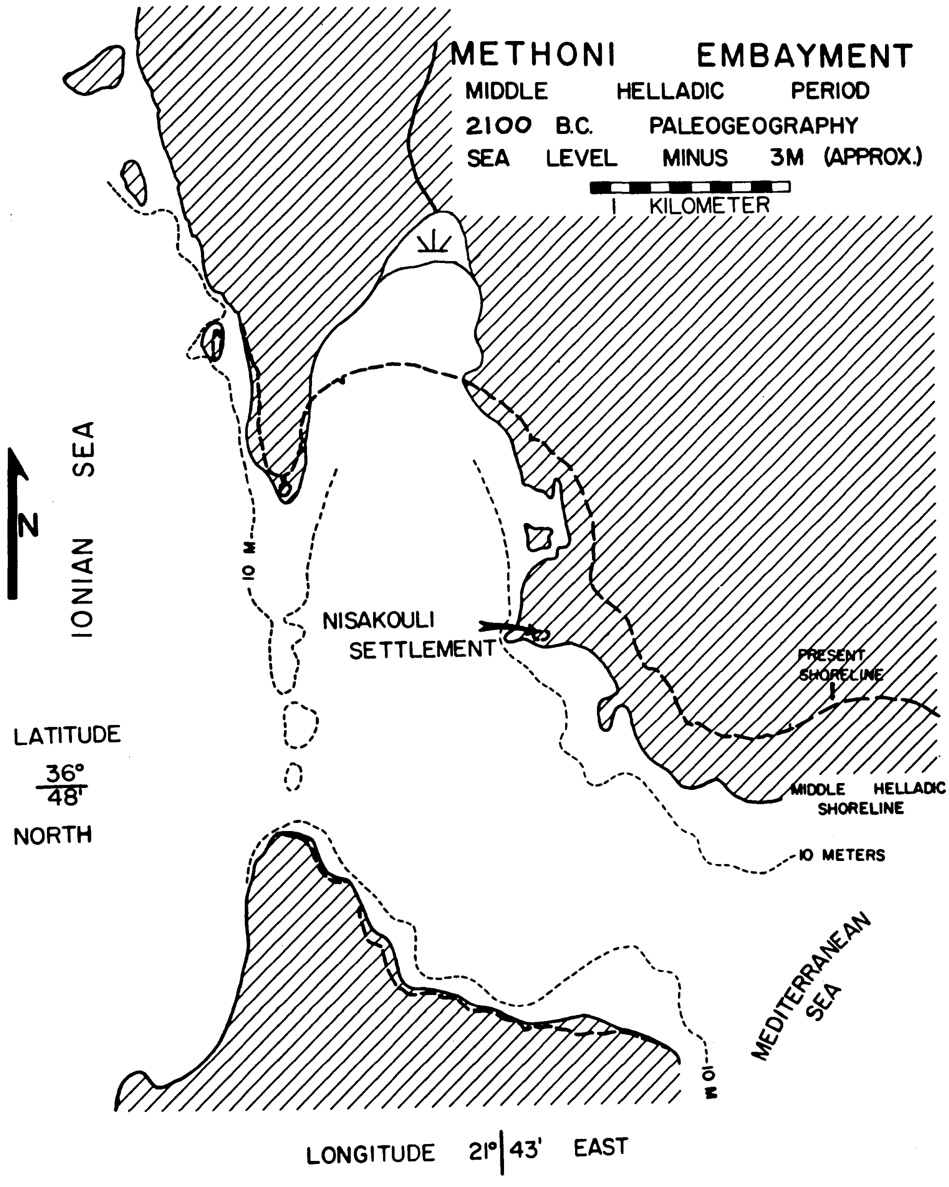


Figure 18. A paleogeographic reconstruction of the Methoni embayment area in Middle Helladic times, approximately 2100 years B.C. The marine. embayment extended over 3-5 km. north of the present shore as indicated by sediments in Methoni #1 and the low alluvial valley.

levels, identifying eustatic positions of sea level becomes extremely difficult. Horizontal positions or geographic map construction on the other hand, should be feasible since the degree of slope of existing topography into the sub-marine areas are relatively high. In addition, there is archaeological evidence that certain submerged areas were once above sea level.

As relative and absolute sea level continued to rise, the limestone ridge extending southward from the Fortress area to the island of Sapientza gradually became submerged. With this submergence the width of the channel between Sapientza and the peninsula gradually increased. Accordingly, waves from the Ionian Sea intruded with increasing effect into the embayment. From the time when a wide sill of greater than 10 m. depth existed, the waves traveling across the submerged ridge began erosive processes with much of their present form. Wave refraction around this ancestral peninsula of Methoni had an ever-increasing effect on the hills lying along the eastern side of the embayment. The development of wave-cut benches and cliff retreat must have started between 3000 B.C. and 2000 B.C. Initially, the waves had a maximum erosion effect on the SE flank at the promontory. However, as relative sea-level rise continued, the effect spread along the entire eastern and northern shores.

By Middle Helladic times, beginning ca. 2100 B.C., the straits between the peninsula at Methoni and the island of Sapientza were open almost to their present extent. Relative sea level is hypothesized to have been ca. 3 m. below present level at that time. However, interpretations could vary from sea level near its present position to a sea level ca. 6 m. lower. The Nisakouli settlement existed on a promontory extending into the Methoni embayment from the east. Waves refracted around the submerged ridge south of Methoni and converged around the promontory at Nisakouli. Relatively rapid shoreline erosion and cliff retreat began. From this time onward it is hypothesized that wave erosion and transportation processes would have been dominant in the Methoni embayment. With increasing effect as sea level reached its present level, the cliffs retreated to the east and to the north. One can gain an appreciation of the distances of cliff or scarp retreat with the increasing amounts of wave-caused erosion from profiles in Figure 10. Figure 18 shows a paleogeographic reconstruction of the Methoni embayment at approximately 2300 B.C., the beginning of the Middle Helladic period. Such a reconstruction may be made with great accuracy in view of the relatively steep slope of the land surface into the sea. Accordingly, the geographic position of the shoreline can be shown, although the precise sea level is questionable. The locations of archaeological remains and the testimony of historical records thereafter become extremely important in positioning the shoreline. In addition, models of processes of coastal change become very similar to those presently active in the area. The present, ongoing coastal processes seem likely to have begun in the Middle Helladic period.

Conclusions

The embayment of Methoni on the SW corner of the Messenian peninsula has had a long-term occupancy, at least from Middle Helladic times. Studies of currently ongoing geomorphic processes and how they must have applied to the past, plus rates of change of coastal position as documented by archaeological evidence, have enabled the construction of a series of paleogeographic maps of the Methoni embayment. The valley of Methoni and its embayment have changed from a narrow, fertile valley with occupancy around the fringes to a marine embayment progressively encroaching and drowning the valley system to its present level.

Accompanying this intrusion of a marine embayment has been the opening of a wide strait along the western flank towards the Ionian Sea. With the increase of wave activity sometime after the Neolithic period, probably in Early-Middle Helladic times, massive cliff retreat has occurred with up to 700 m. of possible coastal retreat and erosion along the less resistant silt cliffs of the eastern Methoni embayment. This cliff retreat has proceeded at a rapid rate via wave-generated erosion into soft silts and sands accompanied by drowning of the embayment of Methoni with a continuing relative sea-level rise. This coastal erosion continues at a relatively high rate and numerous archaeological and currently occupied sites are falling into the sea. During the mildest sea state, with only a very light wave slapping at the base of the cliff, one may observe plumes of silt moving into the marine area and out into the deeper part of the embayment. In addition, sediments moving in the littoral drift stream to the north and west enter the ancient harbor of Methoni and contribute to the silting process.

A combination of detailed historical analysis, study of the archaeological record for time-position information, and analysis of the evident geologic processes, enables the construction of paleogeographic maps of the Methoni embayment with considerable precision. These studies of physiographic processes with projections of geography backwards in time may be used to form projections of the future of the Methoni embayment. We have also seen that man's intrusion into the area has affected sedimentary processes in the harbor area. The information gained from studies of this sort might be applied to existing problems of occupancy of the coastal area in the Methoni embayment or to coastal problems in similar physiographic settings elsewhere in the eastern Mediterranean area.

Acknowledgments

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