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Palaeogeographical Evolution and Sea Level Changes during Holocene in the Prehistoric Settlement of Mikro Vouni (Samothrace Island, Greece)

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with 8 figures and 1 table

Summary. This paper deals with the Coastal and Palaeogeographical evolution of the Mikro Vouni Prehistoric settlement controlled by the sea level rise and the tectonic uplift of Samothrace Island. Mikro Vouni is a coastal settlement of great importance situated on a tell in the SW part of the island. The archaeological excavations yielded remains attesting to human occupation from the Late Neolithic period until 1,700 BC. In order to investigate the palaeogeography of the Mikro Vouni area, geoarchaeological research with borehole drilling, geomorphological, palaeontological, stratigraphical, electrical resistivity tomography, and radiocarbon dating methods was undertaken. The results of the aforementioned methods showed a coastal zone evolution highly influenced by significant uplift rates ($\sim$2 mm/yr) in combination with a transgressional process due to sea level rise. The Palaeogeographical evolution of the Mikro Vouni settlement is summarized in the following 4 stages. I) Around $\sim$6,000 BC the sea flooded the old morphological depression eastwards of the settlement (Lambi area) forming a lagoon II) At approximately $\sim$5,000 BC the settlement was founded on a small mound westwards of the lagoon which probably served as a harbor III) Around $\sim$4,000 BC the lagoon was permanently isolated from the sea and transformed into a marsh with the constant presence of water and IV) Since $\sim$4,000 BC the Lambi marsh was gradually transformed into a seasonal marsh. Mikro Vouni, from its foundation until today, for more than 7,000 years has remained unaffected by coastal erosion and sea flooding processes.

Zusammenfassung. *Holozän Palaeogeographische Entwicklung und Meeresschwankungen in der prähistorischen Mikro Vouni Siedlung (Samothraki Insel, Griechenland).* – Die vorliegende Arbeit befasst sich mit der Entwicklung der Küstenlinie und der Paleogeografie von Mikro Vouni, einer prähistorischen Küsten-Siedlung, auf einem Hügel am südwestlichen Teil der Samothraki Insel, Nord Ägäis. Der Verlauf der Küstenlinie und die paleogeografische Evolution wurden von Meeresspiegelschwankungen und tektonischen Erhebungen der Insel kontrolliert. Archäologische Untersuchungen und Ausgrabungen weisen Reste Menschlicher Aktivitäten im Zeitraum zwischen Spät-Neolithische Zeit und 1.700 v. Chr. Um die paleogeografische Entwicklung von Mikro Vouni zu erforschen, wurden Methoden wie Entnahme, Korrelation und Analyse von Kernbohrungsproben, Stratigrafie und Profilaufnahmen der Sedimente, geomorphologische, paleontologische und stratigrafische Methoden zur Datenanalyse sowie Tomographie der elektrische Widerstände und radiokarbone Altersbestimmung angewendet. Die Ergebnisse der Datenanalyse zeigen eine Küstenzonen-Evolution, stark beeinflusst von einer tektonischen Erhöhungsrate (2 mm/Jahr) in Verbindung mit einem Transgressionsprozess infolge eines Anstiegs des Meeresspiegels. Die paleogeografische Evolution von Mikro Vouni kann in die folgenden vier Stufen unterteilt werden. I) Ca. 6.000 v. Chr. Die Senke im Osten der Siedlung (Gebiet Lambi) wurde vom Meer gefüllt und bildete eine Lagune. II) Ca. 5.000 v. Chr. fand die erste ursprüngliche Ansiedlung auf einem Hügel westlich der Lagune statt, die eventuell als Hafen verwendet wurde. III) Um 4.000 v. Chr. wurde die Lagune endgültig vom Meer abgetrennt und in einen See umgewandelt. IV) Seit 4.000 v. Chr. wurde der See im Lauf der Zeit zu einem Sumpf, zum Teil auch jahreszeitbedingt. Die MikroVouni Siedlung wurde seit Ihrer Gründung bis heute, mehr als 7.000 Jahre, von Küstenerosion und Meeresüberflutungen nicht beeinflusst.

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1 *Introduction*

Samothrace Island is situated in the northeastern part of the Aegean Sea (Fig. 1). The name Samothrace (Samothraki = ΣΑΜΟ-ΘΡΑΚΗ = high-THRACE) indicates the high altitude of the island. This is due to the central mountainous massif, Mt. Saos, whose highest peak is Feggari (1,611 m). Samothrace is the highest island of the northern Aegean, used by sailors as a characteristic marker point since ancient times.

Mikro Vouni is a coastal settlement on a tell, in the southwestern part of the island, on the west bank of the Polipoudi torrent (Fig. 2). The settlement has an area of 2½ acres and the summit of the mound attains an elevation of 12.80 m a.s.l. Mikro Vouni is thus far the oldest settlement of the island, and archaeological excavations have yielded anthropogenic deposits ~9 m thick. Occupation of the site began in the Late Neolithic (late 6th first quarter of 4th millennium BC), continued during the Middle and the Late Bronze Age, and was abandoned around 1,700 BC.

From its early facies, the settlement at Mikro Vouni seems to have been incorporated in the Aegean exchange network. Obsidian from Melos reached Samothrace already in the Late Neolithic period. However, the most important finds that confirm these exchanges come from the Middle Bronze Age levels (19th–18th century BC). Belonging to the developed framework of the palatial economy of Crete, perhaps of Knossos, and most probably related to the supply of metals from the Northeastern Aegean region, these are Minoan documents in clay, which are the earliest to have been found at such a distance from Crete.

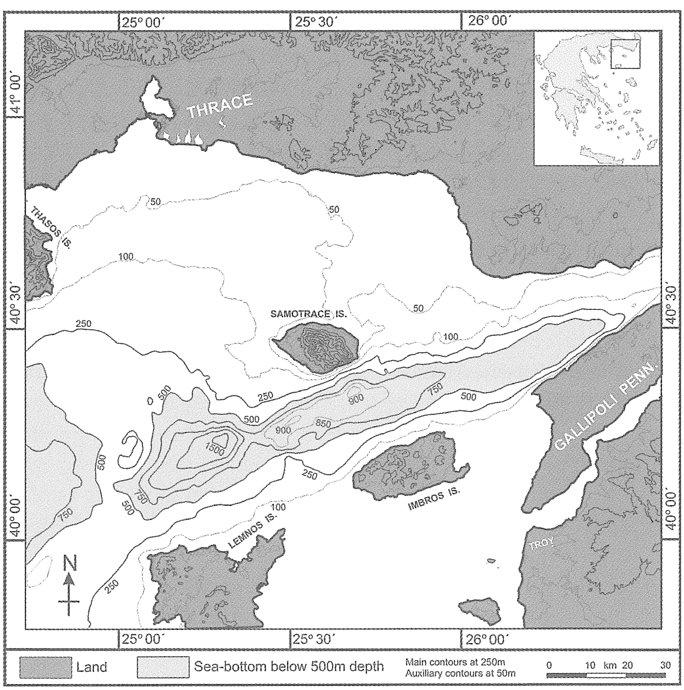

Fig. 1. The location of Samothrace Island in the NE Aegean Sea. The North Aegean Trough is indicated in light grey colour.

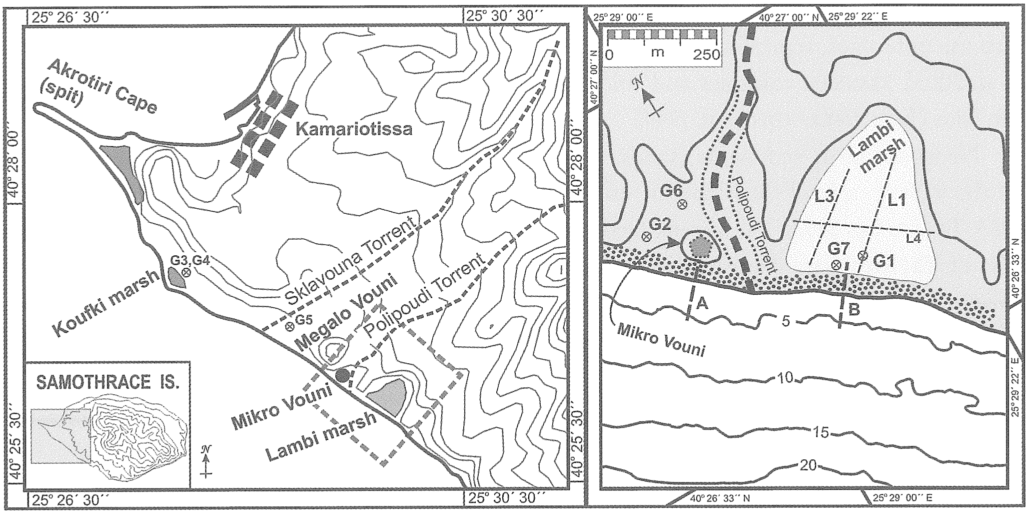

Fig. 2. a) Site map of SW Samothrace Island. b) Site map of Mikro Vouni Prehistoric settlement. Morphology, borehole locations (G1–G7) and E.R.T. lines (L1, L3, L4), beach profiles (A & B).

It is evident that Mikro Vouni was an important site with commercial activity, and prehistoric ships would need to be able to approach the settlement safely. But seafarers approaching Samothrace Island had to confront the absence of a natural harbor. This paper contributes to the open problem of locating a safe area for such a harbor in the vicinity of the settlement.

1.1 *Regional Setting*

Samothrace is situated in the NE part of the E–W continental shelf of the north Aegean. In this area the shelf is 35–60 km wide and 20–85 m deep (Fig. 1). The imaginary line that connects Mount Athos (Chalkidiki peninsula) in the west, the southern coast of Samothrace (Mt. Saos) and the Gulf of Saros to the east is the approximate southern margin of the continental shelf. South of this line, an extensive tectonic trench, the Northern Aegean Trough, dominates the seabed morphology with depths exceeding 1,600 m (Fig. 1). As a result, no continental shelf appears south of the island, but a steep downslope does; the area is tectonically active with neotectonic faulting (Pavlides et al. 2005).

During the last glacial maxima sea level drop, ~120 m below present sea level, the continental shelf mutated into a dry land while the entire area fused with eastern Macedonia and Thrace, and Samothrace Island became a continental mountain. The sea was situated 0.3–2 km away from the SE side of the island, while along the northern and western sides of the island morphology reveals gentle slopes towards the dry plain of the shelf.

Samothrace is attributed to the Circum-Rhodope Belt (Kaufmann et al. 1976), consisting of Mesozoic schists, marbles, and Jurassic ophiolites, gabbro, diorite, basalt, diabas (Davi 1963, Tsikouras 1992). Eocene limestones were deposited on the ophiolites. The central and eastern part of Mount Saos consists of Miocene granite (Davi 1963, Christofides et al. 2000) that penetrated into the ophiolites, representing a domelike projection of batholith that lies below (Vouvalidis et al. 2005). Miocene volcanics and volcaniclastics were deposited along the western margins of Mt. Saos (Eleftheriadis et al. 1994).

Neogene clastic sediments (sands, sandstones, gravel, marly sandstones) were transgressed on the western side of the island. In several places they contain Pliocene marine molluscs (Davi 1963, Tsikouras 1992). Pleistocene terrestrial coarse clastic sediments originating from the erosion of Mt. Saos were deposited in the periphery of the mountain, as morphological covers and palaeovalley fill. In addition, Holocene clastic sediments were deposited in the low altitude terrain, as extensive soil cover, recent alluvial fill of torrent valleys and as marshy deposits (Lambi and Koufki marshes) along the SW coastal area (Syrides et al. 2005).

2 *Materials and methods*

Seven boreholes (G1 to G7) up to 30 m depth, with a total length of 102 m, were drilled along the coastal area of the SW part of Samothrace Island, five of which (G1, G2, G5, G6, G7) in the vicinity of Mikro Vouni (Fig. 2) aiming to investigate the Holocene stratigraphy and correlate with the ERT readouts. Four boreholes were drilled into two marshy areas, Koufki (G3, G4) and Lambi (G1, G7), while the other three (G2, G5, G6) close to the outlet of the Polipoudi and Sklavouna torrent valleys towards the sea. Drilling was undertaken by a drilling machine on a truck and core sampling was undertaken with a T101 type corer (1.5 m length). Simultaneous casing of the borehole was used in order to avoid mixing and contaminating the core samples.

Recovered core samples have an outer diameter of 89 mm. Core samples were split in the middle along their axes into two halves – a working and an archive half – photographed, described lithologically, wrapped with plastic film and stored in wooden boxes. Working halves were transported to the Department of Geology at the Aristotle University of Thessaloniki for further sedimentological, stratigraphical and Palaeontological analysis.

Three Electrical Resistivity Tomography lines (Dahlin 2001) were measured at the area of Lambi (Fig. 2) with the purpose of examining the region's subsurface stratigraphy. Lines L01 (225 m long) and L03 (260 m long) were measured in a direction perpendicular to the coastline and line L04 (460 m long) was parallel to the coast line (Fig. 2). Note that L03 crosses borehole location G1. An advanced resistivity meter with automated multiplexing and data-logging was used for data collection. Pole-dipole data-sets with inter-electrode spacing of a = 5 m and maximum dipole separation of N = 8a were collected.

All measured ERT sections were processed using a 2-D inversion scheme which performs iterative optimization based on a smoothness constrained inversion (Tsourlos 1995). The inversion algorithm uses a 2.5-D Finite Element Method (FEM) scheme as the platform for the forward resistivity calculations which was also used to perform topography corrections when required (Tsourlos et al. 1999).

Nine samples from the borehole cores were carbon dated. Of these, seven were dated with the AMS technique, while the other two with the conventional decay counting method. Material included marine shells (5 samples) and marshy sediments (4 samples) rich in organic matter. The ages were calibrated with the Oxcal software (Bronk-Ramsey 2008), thus providing chronological constraints on the sedimentary units.

The coastal area in front of the Mikro Vouni and Lambi marsh was surveyed by means of morphological profiles and sediment examination. The beach sediments were examined by in situ statistical measurements of the sizes, since most of the materials were cobbles and pebbles with diameters up to 20 and even 30 cm.

3 *Results*

3.1 *Lithostratigraphy*

Data from the boreholes as well as the geological fieldwork indicate that along the low relief coastal area around Mikro Vouni, Holocene sediments were deposited and partially cover a pre-Holocene Basement.

Pre-Holocene stratigraphy

The pre-Holocene basement includes sediments of the Neogene and locally the Pleistocene Periods. Neogene sediments predominate forming the hilly terrain of the area. A variety of mainly clastic sediments, sands, silty sands, gravels, sandstones, sandy marls, loams and clays scatter exposed on the cultivated land (Syrides et al. 2005). Borehole drilling confirms these sediments below the Holocene cover (Fig. 3). They consist of olive-grey coarse loamy sand with gravel and cobbles in G3, G4 boreholes, light grey-brownish sandy loam with gravel in G5, olive grey loam in G6, while in G1, G2, G7 a grey green cohesive clay with large (up to 5 cm) clear selenitic gypsum crystals was found. It is remarkable that although this clay is more than 20 m thick (penetrated for 20 m in G1), it was unknown on the island.

Holocene stratigraphy

Holocene clastic sediments cover and fill low-lying flat and depressed areas, as well as torrent valleys. Their exact thickness and lithology, along the valleys and the marshy areas of the SW coastal zone of Samothrace, were investigated with seven boreholes (Fig. 2). The stratigraphical synthesis of the correlated columns, the depositional facies and the radiocarbon dated faunal and sedimentological indicators (Table 1) are presented in Fig. 3.

The lithological data evaluation (Syrides et al. 2005) allowed the following recognition of the depositional facies in the sediments of SW Samothrace:

- Facies A: lagoonal. These include dark grey – grey green fine grained silty – clayey sands, silts, clays. They contain brackish molluscs (*Cerastoderma glaucum*, *Bithynia/Hydrobia*) and were deposited into a calm aquatic environment that partially communicated with the sea. Sediments of Facies A were found in the Lambi and Koufki areas, in boreholes G1, G7, G3 and G4 respectively.

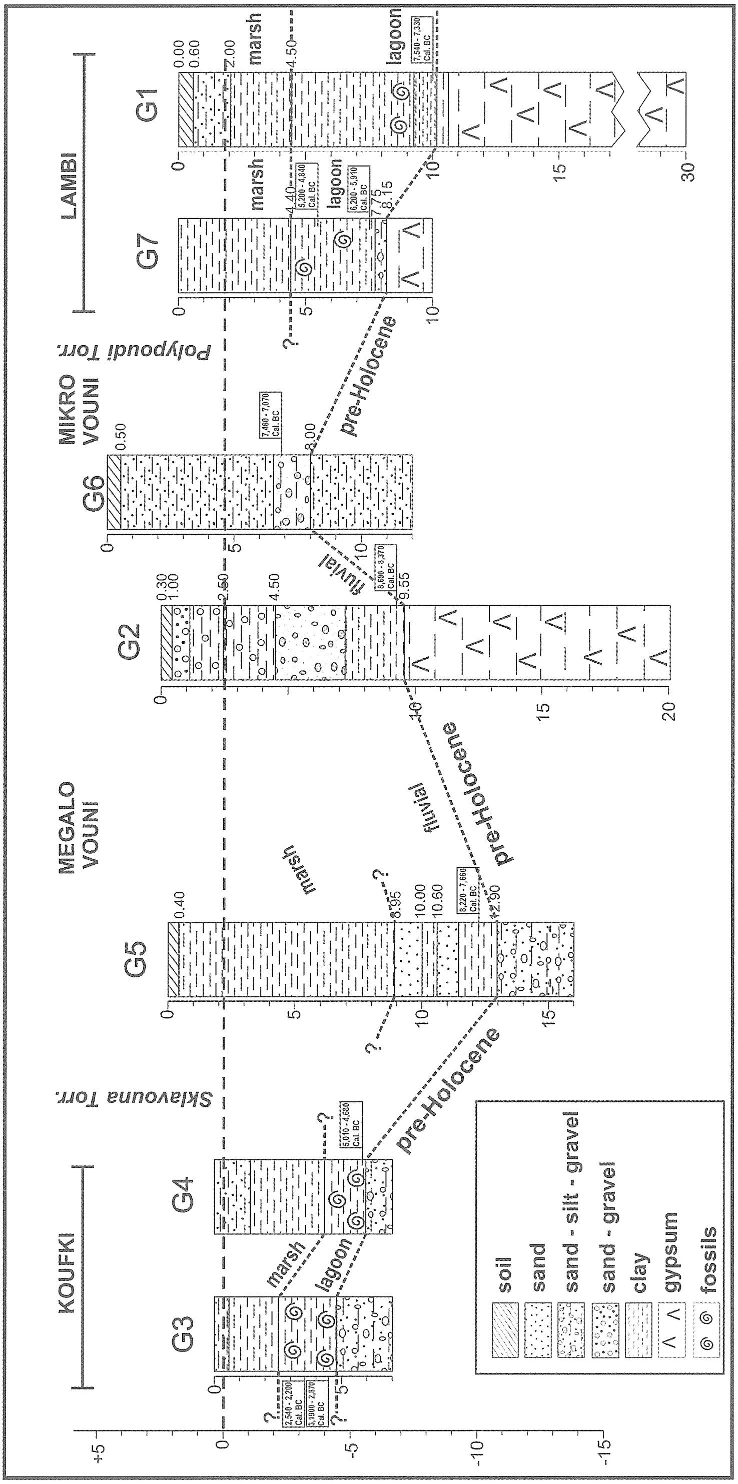

Fig. 3. Synthesis of the lithostratigraphy (Syrides et al. 2005), depositional facies, and radiocarbon ages of the seven boreholes (SW coastal area of Samothrace).

- Facies B: marshy. They consist of dark grey to blackish loamy – sandy loamy sediments rich in organic matter and contain remnants of plants and land snails. They were deposited above sea level in areas where an accumulation of stagnant water could exist like wide torrent valleys in low altitude, or in flat isolated areas like coastal flats, or former lagoons. They were found 2–5 m thick in the Lambi and Koufki areas above the Facies A sediments, but also ~9 m thick (G5) in the wide valley of the Sklavouna torrent. At the base of Holocene, thin marshy sediments also exist in boreholes, G1, G2, G5 and G7.
- Facies C: fluvial These include clastic sediments of all grain sizes, but mainly coarse sand, gravel and cobbles. They represent the debris of the torrents and were deposited in the torrent valleys and flood plains (boreholes G2, G5, G6). The depositional facies are controlled by morphology. The coastal terrain with the morphological depressions (Lambi & Koufki), the valleys (Sklavouna Torrent) and the torrent channels allowed the evolution of different depositional environments simultaneously. For this reason all the facies co-exist diachronically and in some places succeed each other or interfinger. Lateral expansion and continuity of the sedimentary beds was also confirmed by the ERT measurements. Especially in marshy areas (Lambi and Koufki) a characteristic succession between the lower Facies A (lagoonal) and the upper Facies B (marshy) is observed.

Biostratigraphical data from coastal lagoons and marshes are very accurate records for the reconstruction of the palaeoenvironmental and palaeogeographical changes, because they are affected directly by the sea. Lambi marsh is an 18-acre triangular flat area, adjoining the Mikro Vouni tell eastwards (Fig. 2). At present it is reclaimed agricultural land with a ground elevation of +1.80–2.00 m a.s.l. A cobble barrier, 4–5 m high, isolates this area from the sea, while in the periphery a low hilly terrain isolates the area from the neighboring torrent valleys allowing only surficial runoff and low terrigenous influx. Two boreholes G1 (30 m deep) and G7 (10 m deep) were drilled along the seaside (Fig. 2), both of them penetrating the same strata (Fig. 4). At the base, below 10.10 m depth in G1 and 8.15 m in G7, olive grey to dark grey Neogene cohesive clays with gypsum crystals were found. Above the clays a thin layer (8.15–7.75 m) of dark grey-blackish loamy sand with little gravel is deposited in G7, while a similar bed in G1 is situated between 9.40–10.10 m depth, consisting also of blackish loamy sand with scattered gravel. The bed contains organic matter and plant remnants and corresponds to an early marshy environment that was established on a low flat morphological surface that formed on the Neogene clays. Differences in depths indicate that the pre-Holocene surface was not flat. Above this, up to 4.50 m depth in both G1 and G7 boreholes, dark grey to grey-greenish soft plastic clays with fine bedding were found. They contain scattered shells of *Cerastoderma glaucum, Bithynia/Hydrobia* and Ostracodes. This is a monotonous brackish fauna that characterizes restricted coastal lagoons with temporal communication with the sea (Facies A). Sediment texture and bedding indicates also a calm aquatic depositional environment with very fine grained sedimentation. Upwards between a 4.50–2.50 m depth in both boreholes, fine bedded dark grey clayey sediments appear. Lack of any mollusc fauna indicates drastic isolation from the sea, while fine bedding reflects that the calm aquatic environment continues to exist. Change towards a marshy environment (Facies B) with enough water is very possible. Between 2.50 m and the surface, light grey brown (at the base) to dark grey brown (at the top) sandy loam with small scattered calcareous concretions, and few

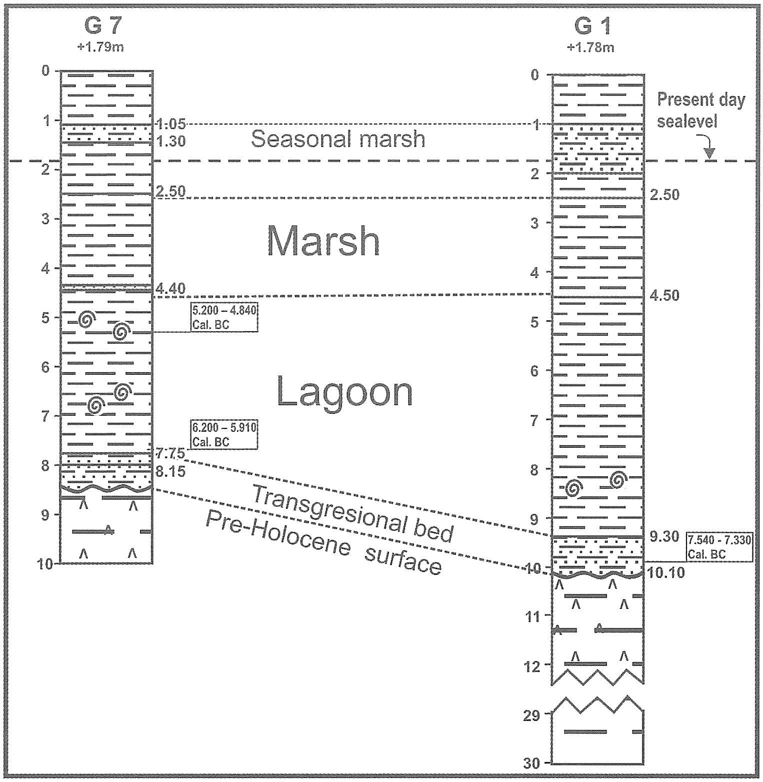

Fig. 4. Lithostratigraphy and correlation of boreholes G1 and G7 in the Lambi area.

small gravel grains, were found in both boreholes. The texture of the sediments is similar to loamy deposits from seasonally flooded marshes. It is therefore reasonable to assume that before the land reclamation in the middle of the previous century, local people witnessed seasonal marsh flooding during wintertime and drying during the summer in the Lambi area.

Borehole stratigraphy, although it represents only two spots in Lambi, can be directly correlated with the ERT readouts. Geophysical results in the area are in very good agreement with the borehole information and confirm the continuation of the beds throughout the area.

In Fig. 5a the processed subsurface resistivity distribution of section L03 is depicted in a grey scale image (dark colors correspond to low resistivities) together with the G1 borehole information. Clearly the geolectrical image has two main geoelectrical formations: a very low one (resistivity <2 Ohm-m) which corresponds to marshy-lagoon sediments and one of higher resistivity (>2 Ohm-m) which, based on drilling information, corresponds to pre-Holocene formations.

The result suggests that in this section the lagoon sediments continue up to 200 m of the section. A more comprehensive geoelectrical image visualizing all geoelectrical sections measured at Lambi is depicted in Fig. 5b and indicates the continuation of the formations identified by the drilling in the area.

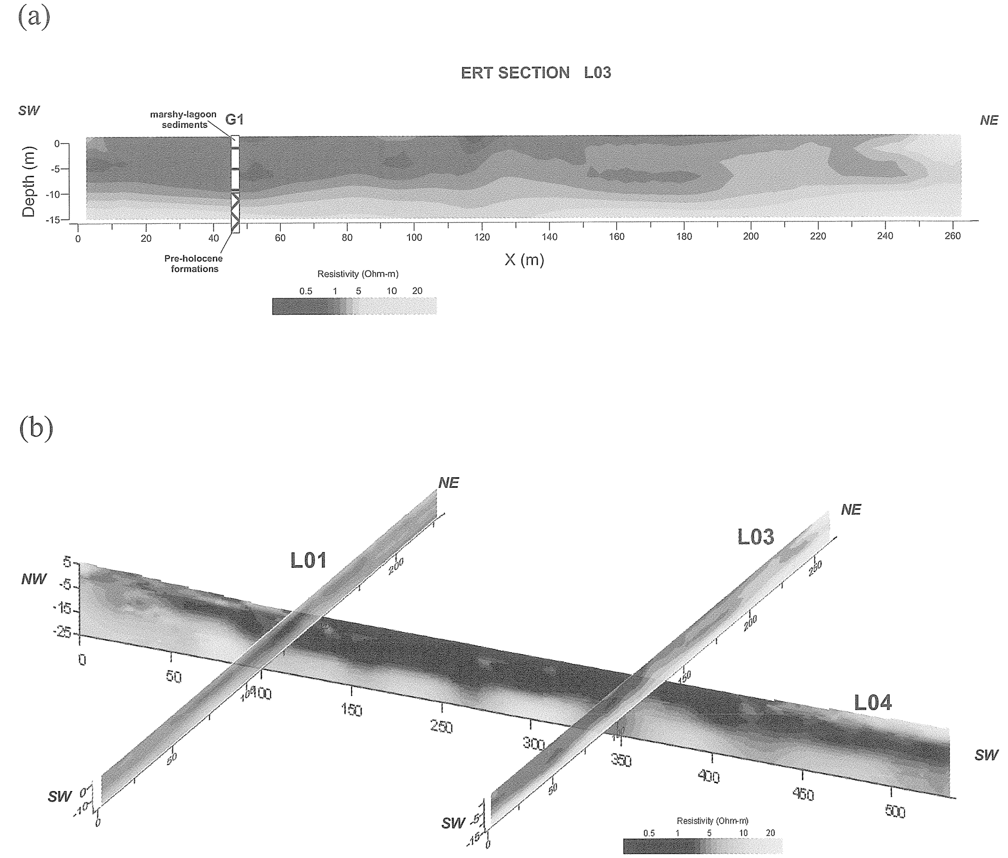

Fig. 5. (a) Subsurface resistivity distribution of section L03 in grey scale, together with G1 borehole information. (b) Combined geoelectrical image of all geoelectrical sections measured at Lambi.

3.2 *Radiocarbon Dating*

The ^{14}C method was used to date 5 (five) mollusc shell and 4 (four) marshy sediment samples in the layers of the sedimentary sequence. Both conventional decay counting (2 samples) and the AMS technique (7 samples) were used (Table 1).

The marshy sediment samples G1 and G2 (Table 1) were analyzed using the conventional decay counting method by the DEMOCRITUS Laboratory of Athens. All the other samples were dated by the CAIS AMS Laboratory of the University of Georgia, USA.

The conventional radiocarbon ages of the marshy sediment samples have been converted into calendar years by using the OxCal Ver. 4.0 software (Bronk-Ramsey 2008) based on the last atmospheric dataset (Reimer et al. 2004). For the mollusc shell samples, the conventional radiocarbon age was converted to calendar age by using the MARINE04, internationally accepted calibration curve for marine data (Hughen et al. 2004), and a local marine reservoir correction factor (ΔR) of 151 $\pm$ 40 as average value for the NE Aegean Sea.

Table 1. Radiocarbon ages for dated samples from the cores of the SW part of Samothrace Island (Mikro Vouni Settlement), calibrated after INTCAL 04 (Reimer et al. 2004) and Marine04 (Hughen et al. 2004).

Sample No Sample code / Lab. Number	Depth below m.s.l. (m)	Material	$\delta^{13}C$ (‰)	Conventional R/C age (yrs BP) ($^{13}C/)^{12}C$ corr.)	2 σ calibrated age
G1 (Γ1) DEM 1412	8.03 – 8.28	Marshy sediment	-26.11	8364 ± 30	Cal BC 7540 – 7330 (9490 – 9280 Cal. BP)
G2 (Γ2) DEM 1413	6.9 – 7.14	Marshy sediment	-26.2	9288 ± 35	Cal BC 8690 – 8340 (10640 – 10290 Cal. BP)
G3a (SAM2004/01) UGA 14471	3.13 – 3.20	*C. glaucum*	-0.44	4370 ± 40	Cal BC 2540 – 2200 (4490 – 4150 Cal. BP)
G3b (SAM2004/02) UGA 14472	4.44 – 4.50	*C. glaucum*	+1.12	4860 ± 40	Cal BC 3190 – 2870 (5140 – 4820 Cal. BP)
G4 (SAM2004/03) UGA 14473	5.52 – 5.58	*C. glaucum*	-0.54	6470 ± 50	Cal BC 5010 – 4680 (6960 – 6630 Cal. BP)
G5 (SAM2004/04) UGA 14474	9.87 – 10.07	Marshy sediment	-25.50	8810 ± 70	Cal BC 8220 – 7660 (10170 – 9610 Cal. BP)
G6 (SAM2004/05) UGA 14475	1.94 – 2,09	Marshy sediment	-26.19	8220 ± 60	Cal BC 7460 – 7070 (9410 – 9020 Cal. BP)
G7a (SAM2004/06) UGA 14476	3,42 – 3,48	*C. glaucum*	-6.96	6610 ± 50	Cal BC 5200 – 4840 (7150 – 6790 Cal. BP)
G7b (SAM2004/07) UGA 14477	5,85 – 5,93	*C. glaucum*	-7.77	7670 ± 50	Cal BC 6200 – 5910 (8150 – 7860 Cal. BP)

Evaluation of the ages of the samples with their depths (Fig. 7) and correlation of the estimated ages with the proposed sea level curves for the region showed that a distinction into two different groups ensues which also coincides with the geographical distribution of the samples. The first group includes all the samples from 5 boreholes in the vicinity of the Mikro Vouni settlement. Two boreholes (G1, G7) with three dated samples (G1, G7a, G7b) in Lambi marsh (Fig. 2), one borehole with one dated sample (G5) in the valley of the Sklavouna torrent and two boreholes with one sample each (G2 and G6) very close to the Mikro Vouni tell. Comparing with the sea-level curves proposed for the area, all these samples gave particularly old ages for the depths in which they were found. Two of the samples (G2 & G6) gave ages inconsistent with stratigraphic order and the ages of the remainder of the samples. Although both ages come from marshy sediments rich in organic matter, they are clearly outliers (possibly due to human impact on Mikro Vouni habitation).

The second group comprises three samples (G3a, G3b, G4) from two boreholes in the present day ephemeral marsh at the SW end of Samothrace Island (Fig. 2), whose local name is Koufki. The calculated ages of these samples have a good correlation with the proposed sea level curves for the area (LAMBECK & PURCELL 2005, VOUVALIDIS et al. 2005).

3.3 *Coastal geomorphology in Mikro Vouni and Lambi marsh*

In the vicinity of the area studied, a few small torrents discharge very coarse materials from high altitude erosional processes on Mt. Saos into the sea. The coastal sediments consist mainly of very large-sized cobbles and pebbles. 80% of the size distribution falls between 20 mm and 180 mm. The coast is exposed to the open Aegean Sea in S–SW directions, encountering high wave action. The coarse beach material and high wave action create a steep morphological beach profile with slopes varying from 9° to 11°.

In front of the Mikro Vouni tell (Fig. 2) the coastal profile (Fig. 6A) inclines uniformly to the sea from backshore to foreshore area, but in front of Lambi marsh (Fig. 2) the coast forms a barrier beach (Fig. 6B), isolating the backshore area from the open sea.

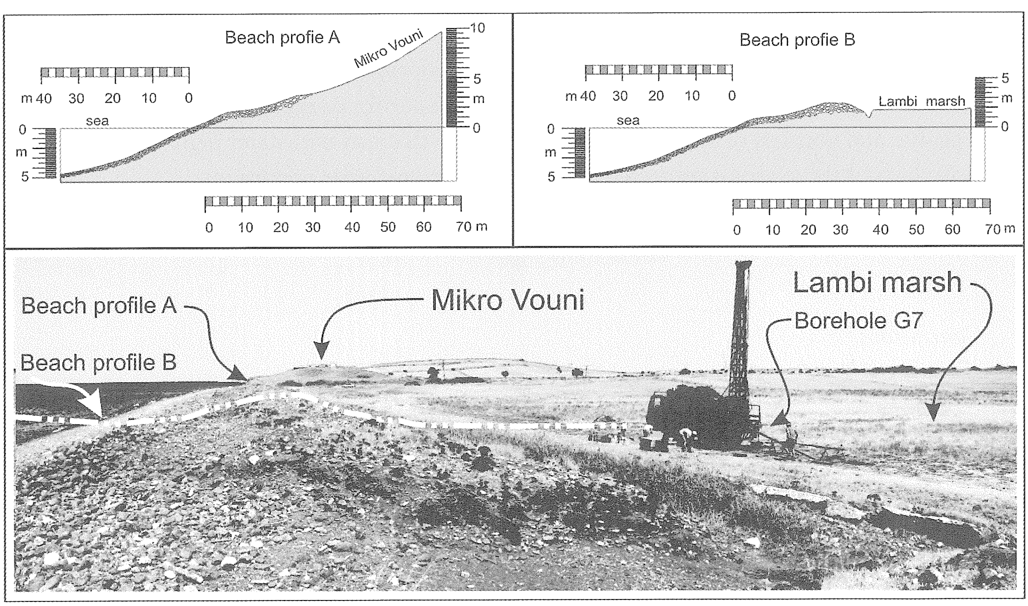

Fig. 6. Beach profiles of the beach in front of A) Mikro Vouni and B) Lambi marsh. Borehole drilling in the Lambi marsh.

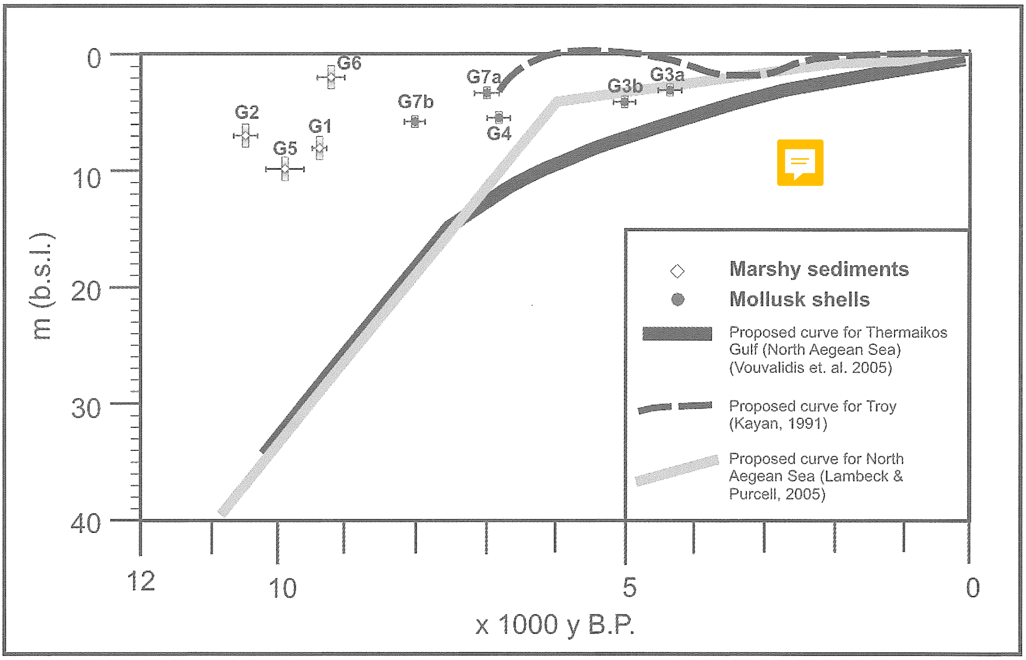

Fig. 7. Graph of the sea level indicator C^{14} ages for Samothrace Island in comparison with proposed sea level curves for the North Aegean Sea (Kayan 1991, Lambeck & Purcell 2005, Vouvalidis et al. 2005)

The barrier beach was created by high wave action, transporting the sediments along the beach, following the prevailing direction of the neighbouring coastal areas. This barrier has a steep profile and consists of very large-sized sediments that can withstand high wave action. In this way the backshore area is protected even against extreme wave conditions.

Significant longshore transport can be observed today that accumulates materials and creates a spit at Cape Akrotiri, 3 km to the NW of Mikro Vouni (Fig. 2).

4 *Conclusions*

4.1 *Sea level changes*

The sea level graph in Fig. 7 contains relative sea level points and their associated error ranges for the SW part of Samothrace Island, in relation to three proposed sea level curves for the North Aegean Sea (Kayan 1991, Lambeck & Purcell 2005, Vouvalidis et al. 2005). Five (5) marine shell samples and four (4) marshy sediments rich in organic matter were dated (Table 1). The mollusc shells are benthic shallow dwellers originating from sediments deposited in a very shallow marine – lagoonal coastal environment that can be considered as near sea level indicators (vertical error is estimated at ~0.5 m). The marshy sediments rich in organic matter samples originate from deposition in a very shallow calm water environment, the vertical error being ~1 m.

According to the carbon dating results two different groups with the geographical distribution of the samples exist. The first group includes all the samples (6 samples) from 5 boreholes in the vicinity of the Mikro Vouni settlement and the second group includes the three samples from Koufki, a present day ephemeral marsh in the SW end of Samothrace Island. These two relative sea level datasets obtained in two different areas of the coastal zone (Mikro Vouni & Koufki) did not fit in the same way with the used sea level curves.

The present depths of the four samples (G1, G5, G7a, G7b) from the Mikro Vouni dataset (G2, G6 excluded as outliers) compared with the sea level curves for the area & (Lambeck & Purcell 2005, Vouvalidis et al. 2005) indicate a characteristic uplift of the area, which can be estimated at 20 m in the last 10,000 years (Fig. 7). The mean rate uplift is calculated at ~2 mm/yr.

The Koufki dataset compares well to the eustatic sea level model of Lambeck & Purcell (2005) for the North Aegean Sea. As the samples indicated the sea level for the time span between 4,350 – 6,800 BP, the data from Samothrace Island cannot support the theory that during that time period the sea level was approximately the same or higher than what it is today, as was the case in Troy (Kayan 1991). The reason for this is that the distance between Samothrace and Troy, although only ~60 km, is interposed by the North Aegean Trough which probably played a critical role in the differences of the relative sea level changes between these two major archaeological sites. Geoarchaeological evidence establishing the above theory indicates that the relative sea level in the last 5,000 years never reached or eroded the archaeological strata of the Mikro Vouni prehistoric coastal settlement inwards from the present coastline.

4.2 *Coastal evolution during Holocene transgression*

The key to the evolution of the coastal region in the area studied appears to be the sea level rise coupled by the tectonic uplift of Mt. Saos (Vouvalidis et al. 2005). According to Lambeck & Purcell (2005) the sea level rose rapidly to 6,000 B.P. and then decelerated.

The tectonic uplift was estimated to have an average rate of 2 mm/y. Therefore for the period before 6,000 years BP, the net vertical movement resulted in a transgression of the coastline and a landward migration of the beach system (stage I, Fig. 8).

At the point the sea level reached the pre-Holocene surface of Lambi, the first transgressional sediments were deposited as shown in the boreholes (Figs. 3 & 4). Soon afterwards longshore transport and high wave action formed a barrier beach along the entrance of Lambi embayment enclosing a shallow lagoon with restricted connection to the sea (stage II, Fig. 8).

Fine grained sedimentation of silt and clay inside the lagoon along with the absence of mollusc fauna, indicates isolation from the sea (stage III, Fig. 8).

After that period, sea level rise decelerated and accordingly the combined effect of tectonic uplift and sedimentation eventually uplifted the bottom of the lagoon above sea level and transformed Lambi to a seasonal marshy environment (stage IV, Fig. 8).

Seasonal marshes remained until modern times, when reclamation of the marshes transformed the area to cultivated land. The present day surface is about 2 m above sea level (stage V, Fig. 8).

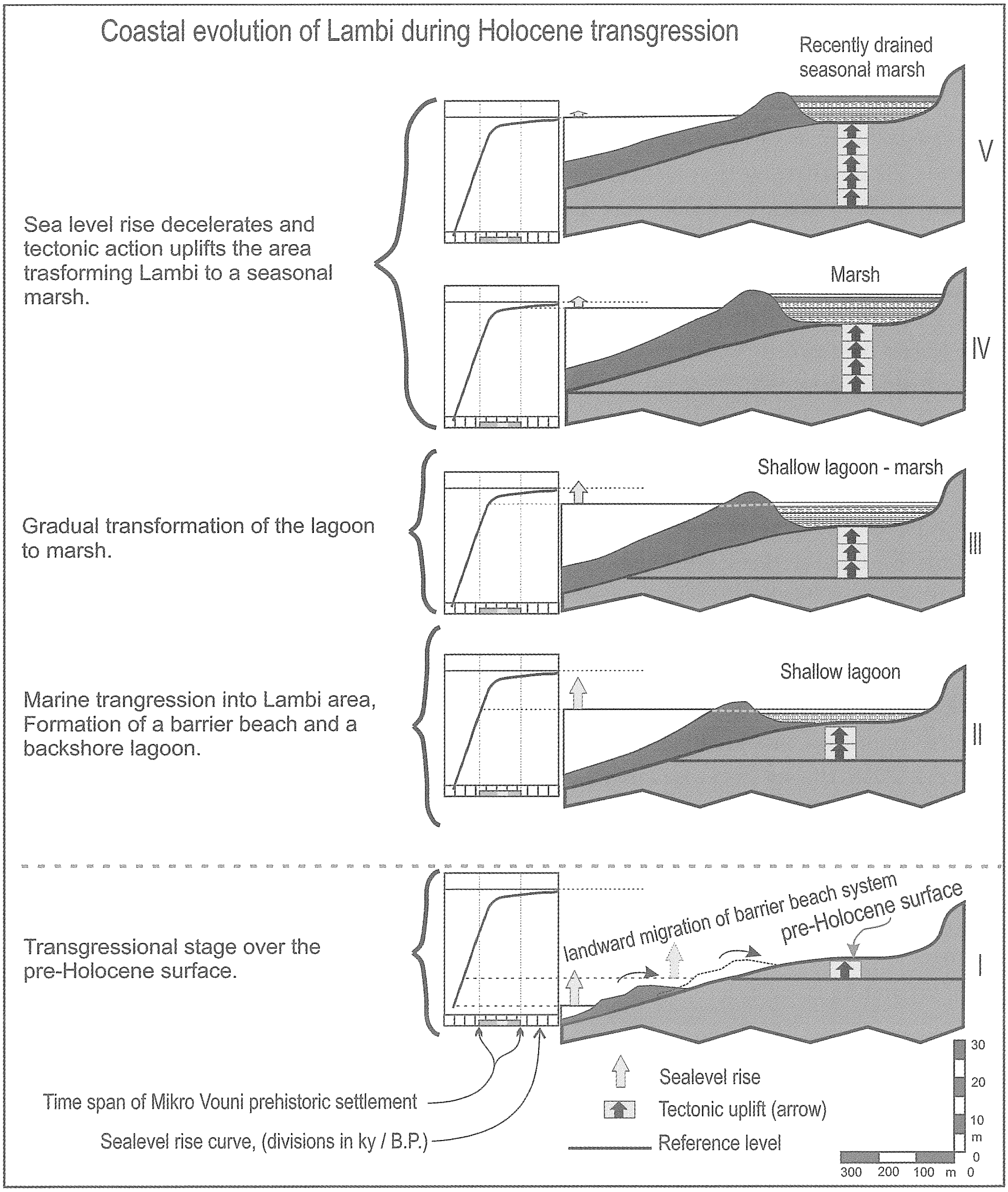

Fig. 8. Proposed coastal evolution of the Lambi area during Holocene transgression.

4.2 *Palaeogeographical evolution of Lambi*

The reconstruction of Holocene palaeogeographic evolution for the coastal area of Mikro Vouni settlement is based on the evaluation of the stratigraphic, palaeontological and chronological data. This data allows a time-scaled scenario for the impact of the Palaeogeographical changes on human habitation of the settlement. According to this scenario, Lambi area was a lagoon and used as a harbor for the needs of the settlement. The geomorphological setting of Lambi area, in combination with the coastal zone profile, preserved lagoonal and marshy conditions for a long time period during occupation of the settlement.

Mikro Vouni was founded on a low hilly terrain close to the sea. Lambi lagoon, presumably used as a port, was situated eastwards of the settlement. Both of them were located at the same distance from the seashore. Preservation of such an old coastal settlement and its port close to sea for more than 5,000 years, surviving coastal erosion or flooding by the sea, is owed to the specific local tectonic regime that is responsible for the uplift of the area.

Summarizing the results, the palaeogeographical evolution for Mikro Vouni – Lambi area was the following:

1. Around ~6,000 BC the sea flooded the old morphological depression of the Lambi area forming a coastal lagoon as indicated by the stratigraphical data (Facies A).
2. At approximately ~5,000 BC the prehistoric settlement of Mikro Vouni was founded on a small mound close to the sea. At the time of its foundation, Lambi was already a lagoon that could be used by ships. Human intervention may have been necessary for the construction of a small-scale excavation used as an inlet, and judging from the human ability and equipment available in that era, that such an undertaking had taken place is conceivable.
3. The lagoon was permanently isolated from the sea and transformed into a marsh with the constant presence of water. This stage is estimated according to the stratigraphic and chronological data at ~4,000 BC (younger than G7a age).
4. Since ~4,000 BC, Mikro Vouni was situated diachronically close to the sea and the Lambi marsh gradually became a seasonal marsh. This is due to the specific local tectonic regime in Samothrace as shown by the coastal evolution during the Holocene period. As a result, the old coastal settlement remained above sea level for such a long time, and the ground elevation of Lambi marsh is situated at an elevation of 2 m a.s.l. despite the low rates of sedimentation.

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