[PAGE 50]

THE DOCKS OF THE TOWN OF AEGINA

(Fig. 1-22; Pl. 10-33)

Introduction

The background of this report was obtained in three campaigns which took place in the years 1964, 1965 and 1966. A follow-up examination took place in 1969.

The work was only possible through the support of Greek Antiquity Authorities, who most willingly gave the work permit, which had thankfully been procured by the department of the German Archaeological Institute (DAI) at Athens. Tireless Kurt Seifert (Heidelberg) helped in all three campaigns. For this he deserves special thanks. Karl-Georg Siegler (Stuttgart) prepared the major part of the documentation of ashlars of the wall section which lies in the middle of the North Bay.

Günter Ploss and Karl von Hülsen, Berlin, made the documentation of ashlars of the harbour facilities in the South Bay (the Naval Harbour). The documentation of the architectural remains on the coast of the North Bay did also result from the their careful work.

Through a donation the *Koldewey-Gesellschaft, Vereinigung für baugeschichtliche Forschung e. V.* (i.e. the Koldewey Society, Association of Historical Building Research, membership corporation) was able to support the project financially in 1966. With the available funds, the team could both increased; thus being essentially improved.

Jörg Schäfer (Athens and Heidelberg) helped in the most friendly wise man with many valuable tips and advice.

In an abstract this work has already been published in abbreviated form (without the results of recent studies from the year 1969), namely in a short presentation held in Lübeck at the 24th conference of the *Koldewey-Gesellschaft für Ausgrabungswissenschaft und Bauforschung* (i.e. the Koldewey Society for Excavation Science and Architectural Research), May 24-28, 1967.[1] Furthermore, Jörg Schäfer reported on this work at the 3rd International Congress on Underwater Archaeology in Miami (Florida).[2]

Conceptual formulation and technical information

The present work is the complete presentation of all the building remains that were found in the years of the work of recording/mapping. The investigation only covers records of items that were visible above and under water; excavations or scrapings have been carried out nowhere.

The processed and mapped area covers an area of approximately 2700.000 m^2. In connecting with the measurements, and also in order to verify the measuring instruments, some 1600 reading points have been registered.

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1 *Berichte der Koldewey-Gesellschaft* 1967 and *BJb* 169 (1969), 104 ff.

2 *AA* 1968, 18 ff.

The first campaign was conducted in April 1964. In this month the water level **[PAGE 51]** is about 30 cm lower than during the other periods of the year.[3] The generally prevailing calm weather, which is typical at that time, favoured the photographic work. During this first campaign the southern part of the North Bay has been registered.

The second campaign took place in midsummer 1965. The conditions in the water were always useful in the morning hours, whereas in the afternoon they were regularly bad. During this campaign, the cartographic recording of the northern side of North Bay as well as the majority of the stone images on the banks of the North Bay were made.

The third campaign was carried on in the autumn of 1966. It should be noted that the water level was generally high and that it moved more than in spring. The winds are to be hold responsible for causing us problems, especially in late September. During this campaign, the South Bay (the "Naval Harbour") has been measured and the rocks associated with it had been recorded. Furthermore, the West Coast of the Kolonna Hill was measured as well as the remaining recordings of the blocks from the North Bay were made up.

We worked with a simple levelling instrument and a measuring rod, which was partially extended so that it could be held by one or two swimmers where the depth did not exceed 3 meters. Moreover, the soundings for the cartographic record of the sea bottom were taken from a boat. The respective sounding point, which corresponded to the location of the boat, was documented from the land. The potential error of measurement was max. 0.5 m in the horizontal plane, and max. 0.3 m in the vertical plane. As the potential scale of the cartographic record (1:500) makes these deviations disappear, subsequent check-ups carried out over the entire area did not reveal any differences. The technical equipment consisted of a levelling instrument along with measuring rods, a motor boat with rowing possibility and two-way radios. On the land as well as beneath sea level a Kontaflex II was used. All diving was undertaken with mask and snorkel.

All heights specified in the drawings refer to the point 114 of the land survey with +1.51 m a.s.l. (Plate 14).

PART I, INTRODUCTION

Topographic situation

Around the year 1966 the Geographical Service of the Armed Forces has issued a map of the island of Aegina with a scale of 1:5000. Down to every detail this map displays a good and reliable illustration of the island. Regarding the marine area beyond the coast line, however, the map has no informative value. The submerged rocks or remains of buildings are not depicted properly, because they simply were taken over from the near coastal area of the unreliable marine chart. The illustration in Figure 2 is based on this map of the Geographical Service. The modern harbour facilities to the north of the present harbour, which were commenced in 1969, are shown dashed in this presentation.

The island of Aegina is approximately triangular in shape. The north side has a length of about 13 km. A monotonous cliff coast, surrounded by cliffs here and there, offers no landmark for navigation. The length of the east coast from Cape Turlot to Cape Pyrgos has a air-line distance of about 10 km.

[3] J. Schäfer, Beobachtungen zu den seeseitigen Mauern von Larymna in der Lokris, in *AA* 1967, 544.

In the northern part of this route lies the bay of Agia Marina, which has a good anchorage. From there and southwards, the coast is rocky and steep and offers no protection for shipping.

The west coast extends from Cape Plaka in the north to Cape Pyrgos in the south. [PAGE 52] In the middle of the northern third of this coast rises the Kolonna Hill, the Acropolis of the old town of Aegina. Offshore, from the Kolonna Hill to Cape Paliopyrgos, lies a fairly wide and cliffy strip of shallow waters with a depth of 2-3 m (Fig. 2). The large bay of Marathon is located south of it. Here, the coast becomes steep and rocky and offers protection for shipping from Cape Perdika to Cape Pyrgos.

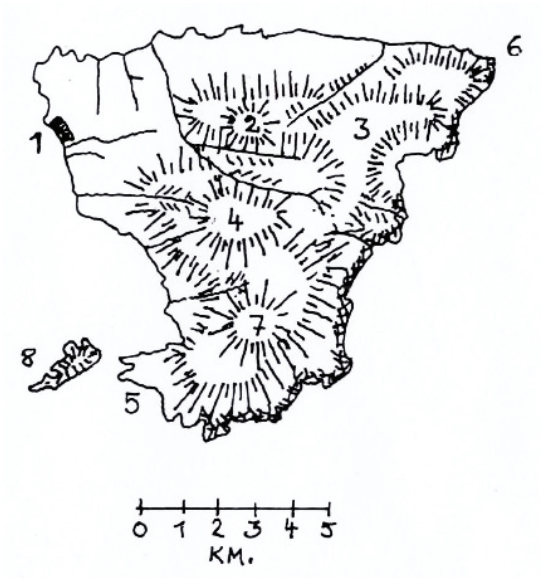

Fig. 1. The island of Aegina, general view (1 Aegina,
2 Pa1aiochora, 3 Temple of Aphaia, 4 Monastiri,
5 Perdika, 6 Cape Turlot, 7 Oros, 8 Island of Moni)

The present town of Aegina covers the entire old town area and due to its recent ambitious development, caused by the proximity of the Athens metropolitan area, it outreaches the ancient town area. In Figure 2 the North Bay is clearly visible. In the immediate vicinity south of the Kolonna Hill one can observe the faint bays where the remains of the ancient Naval Harbour, in the following called South Bay, are located. South thereof the commercial harbour, still in use today, is located. The basin of the modern harbour, which was built to the north of the commercial harbour, serves for the increasingly dense ferry services Athens—Aegina and Aegina—Poros .

The course of the city wall is not secured in all areas and therefore not identified correctly on the recent map. In the north one can see the ancient stone quarry, located directly outside of the wall. The quarry pit begins in the middle of the North Bay in about 13 m height (Pl. 10 a) and reaches, extending south-eastwards in a curved course, to the vicinity of the church of Ag. Dimitrios. According to Welter the further course of the wall is assumed following the dip east of the ruins of the Basilica. From it is supposed to have continued south-eastwards in a smooth curve toward the

corner building [PAGE 53] Odos Aphaias and Odos Achilleos. This house is indicated in the map. Here, the wall was been seen in connection with a modification.[4] The Odos Achileos leads from this corner building down to the sea.

After a brief and shallow coastal area, the coast, which consists of marl and sand, ascends along the North Bay (Pl. 10 b and 11). In a northerly direction the coast regrades and the rocky strip merges seamlessly into the sea.

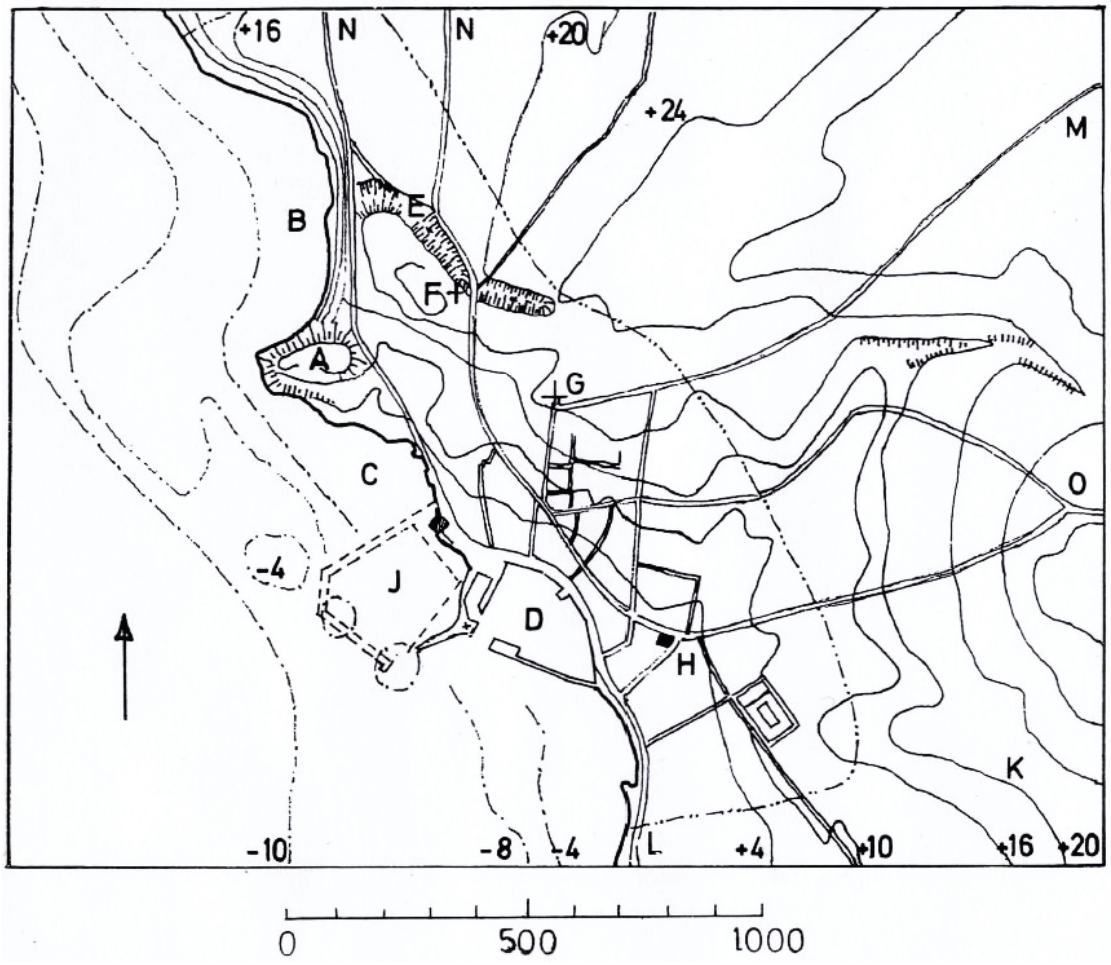

Fig. 2. The town of Aegina and its harbours, drawn after the map of the Geographical Service of the Armed Forces, published around 1966 (A Ko1onna Hill; B North Bay; C Harbour in the South Bay, the "Naval Harbour"; D recent commercial harbour; E quarry close to the North Bay, outside of the city wall; F Agios Dimitrios; G Basilika; H corner building Odos Aphaias/Odos Achilleos; J the modern ferry harbour; K Phaneromeni; L towards Perdika; M towards Kypselis; N towards Kampos; O towards Palaiochora).

The Kolonna Hill shelves steeply into the water. Here the Poros layers, with the intervening marl layers, emerge clearly (Pl. 12).

To the south of the Kolonna Hill, the coast once more regrades (Pl. 13).

4 G. Welter, *Ägina* (1938), 43, 108, *AA* 1938, 482.

[PAGE 54] From the southern corner of the North Bay, a slightly recessed swale stretches towards the east and south. Averted from the North Bay, in a gentle slope and through the southern part of this swale, which separates the Kolonna Hill from the eastern terrain, the road leads into the town. Thus, the North Bay does not provide a pre-flood for the hinterland.

From the South Bay and the northern part of the commercial harbour, a coastal erosion channel runs through the Poros layer, reaches far into the land towards the east. In earlier times the water pipe also followed the course of this channel, supplying the town with water from the area around Kondo. From time to time still today this channel is aquiferous, and thus it certainly causes a siltation of the estuary. This situation is shown in Plate 14.

The nearest aquiferous channel in a southerly direction has its origin in Phaneromeni, outside the ancient town. Its estuary is the bay to the south of the commercial port. However, this erosion channel does certainly not match the importance of the aforementioned.

Recent theories dealing with the fluctuation of the sea level and the geology of the island

When studying ancient ports the problem of fluctuation of the sea level is always of great importance.

To solve this problem, currently the following factors have to be considered:

1. regional tectonic movements of the continental coastlines;
2. wide-ranging epeirogenic movements such as isostatic compensating motions of the earth's crust, which comprehends continents as well as parts of the seabed;
3. increased, rapid sedimentation in individual ocean basins;
4. climatically induced eustatic fluctuations of the sea level;[5]
5. the temperature conditions of the oceans.[6]

All these factors are not put into question by new findings. However, in an isolated case the application appears to be very hindered. The mentioned factors often act in opposite senses, even on a temporarily different scale, thus effecting the relative sea level.[7]

Since the periods which we are observing here are very compendious, in the majority of cases the historical sciences cannot expect any answer from geology, which has to reckon with much broader periods.[8]

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5 M. Pfannenstiel, Quartäre Schwankungen des Mittelmeeres und des Schwarzen Meeres, *Vierteljahresschrift der naturforschenden Gesellschaft in Zürich*, 96, 81 ff.

6 H. Hoinkes, Die Antarktis und die geophysikalische Erforschung der Erde, in *Die Naturwissenschaften* 1961, 373.

7 H. Schläger - D. Blackman -]. Schäfer, Der Hafen von Anthedon, in *AA* 1968, 75 ff.

[PAGE 55] For the preliminary investigation it would be important to find an answer to the question whether the island was set in motion, caused by tectonic activity, as a whole or partially.[9] In fact, we were able to observe a coastal strip in about +4 m, e.g. in Perdika (Pl. 15 a) and Cape Turlot (Pl. 15 b), as well as in the North Bay (Pl. 16), i.e. approximately at the three corners of the island. The highest flood waters were measured some 12-15 m above the present level.[10] So, it seems that the level of the island has increased equally due to tectonic changes. A comparison of the height ratios along the coasts of the island in historic times seems therefore permissible.

A. Philippson[11] assumes a drawdown of the coast since the classical period by 3 meters. The depth of the water in the harbour of the South Bay (Naval Harbour) is quoted with 2,5 m; on the seaside of the outer pier of the same harbour with 3,5 m; inside the commercial harbour with 2,7 m and less - specifications that also are appropriate today. This large increase in sea level of 3 m would mean that both harbour must have been drained in antiquity. A possible siltation of the harbours, which would have resulted in an increase of the bottom of the harbour basin, must certainly be denoted as obvious.

According to Philippson[12] the geological development appears as follows:

After completion of the volcanic activity, which have occurred in two periods, the northern half of the island was submerged deep below the water level. Then, the old relief from Mesozoic rocks and Late Tertiary layers (marl and lime marl), were covered with a hard, white coat of Poros limestones. Caused by recent activities, the originally interrelated **Deckkalkplatte** of the Saronic Gulf has been fragmented into floes and lifted up. A better part of the eruptions took place under water, while a minor and later part also occurred aerial.

In the northern third of the island the non-volcanic basement of folded Mesozoic and destroyed Tertiary emerges extensively. Moreover, there the young Poros **Deckplatte** is prevalent, while the central and southern part of the island consists mainly of Andesitic lavas.

Despite the large volcanic eruption of Methana in the year 250 BC,[13] in historical times no tectonic change in the surrounding area of the island of Aegina took place, although the island by nature is not located in a tectonically fixed zone.[14]

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8 All of the above mentioned influences on the sea-level are not constant and permanent effective. Rather, one must reckon with individual impulses at different times, which furthermore do not always act in the same direction. From 1893 to 1930, for example, the sea level along the coast of the United States rose 0.13 feet (4 cm). In contrast, from 1930 to 1947 it rose 0.36 (12 cm). However, it is unknown to what extent this increase may be attributed to climatic variations, ref. H. A. Marmer, Sea Level Changes along the Coast in Recent Years, in *Transactions American Geophysical Union* 30 (1949), 201 (by courtesy of M. Pfannenstiel).
On this point, see also:
J. Le Gall, *Les modifications du niveau de la mer depuis l'époque Romaine en Méditerranée occidentale*.

9 Cf. note 4.

10 Cf. note 5.

11 Philippson, *Die Griechischen Landschaften*, Bd. III, Der Peloponnes, Teil I, der Osten und Norden der Halbinsel (1959), published by E. Kirsten, 46, 48, 49, 53 ff.

12 A. Philippson, *Der Peloponnes* (1892), 54, 407 f., 413, 427.

13 Strabo 1, 3, 18. Pausanias H, 34, 2.

14 E. Deptrat, Tectonique de l'Egeide, in *Bulletin de la Societe geologique de France* V 4 (1904), 335 ff.

 State of historical research

Around 120 BC Pausanias saw the harbour facilities of Aegina. He combines his topographical description with the myth of Telamon who - being on a dam that had been raised in the harbour - tried to defend himself against the charge of fratricide.

The corresponding text passages is referred to below:[15]

Προσπλεῦσαι δὲ Αἴγινά ἐστι νήσων τῶν Ἑλληνίδων ἀπορωτάτη· πέτραι τε γὰρ ὕφαλοι περὶ πᾶσαν καὶ χοιράδες ἀνεστήκασι. μηχανήσασθαι δὲ ἐξεπίτηδες ταῦτα Αἰακόν φασι ληστειῶν τῶν ἐκ θαλάσσης φόβῳ, καὶ πολεμίοις ἀνδράσι μὴ ἄνευ κινδύνου εἶναι. πλησίον δὲ τοῦ λιμένος ἐν ᾧ μάλιστα ὁρμίζονται ναός ἐστιν Ἀφροδίτης....

Τελαμὼν δὲ ὕστερα κήρυκα ἀποστέλλων ἠρνεῖτο μὴ βουλεῦσαι Φώκῳ θάνατον. Αἰακὸς δὲ ἐς μὲν τὴν νῆσον ἀποβαίνειν αὐτὸν οὐκ εἴα, ἑστηκότα δὲ ἐπὶ νεώς, εἰ δὲ ἐθέλοι, χῶμα ἐν τῇ θαλάσσῃ χώσαντα ἐκέλευεν ἐντεῦθεν ἀπολογήσασθαι. οὕτως ἐς τὸν Κρυπτὸν καλούμενον λιμένα ἐσπλεύσας νύκτωρ ἐποίει χῶμα. καὶ τοῦτο μὲν ἐξεργασθὲν καὶ ἐς ἡμᾶς ἔτι μένει·

Pausanias describes difficulties of approaching the two harbours, who then were blocked by the cliffs that were laying in the ocean (Fig. 2). In one of the harbour one usually docks, as he writes, the other he calls κρυπτὸς λιμήν. In this port, he saw the remains of the dock yard and considered that it must have been the dam which Telamon had to build. Concerning the first mentioned harbour, only the southernmost harbour, still in use today, may be considered.

Neither did he mention the great heap of stone in the North Bay (see below, p. 59 and Fig. 4) nor did he see it or hear anything about it, since it had been forgotten by the former inhabitants at his time. This leads to the conclusion that at that time this construction had already been submerged by the floods a long time ago.

In 1806 W. M. Leake visited the island.[16] At the southern foot of the Kolonna Hill, he observed an oval harbour with its pier and some remains of the harbour entrance. Further to the south was he mentions a second harbour, whose pier remains had a thickness of 15, respectively 20 ft (4.5 m, respectively 6.10 m, given that the length of a foot corresponds to 30.48 cm). Everything is found in desolate conditions. However, in both harbours the small fishing boats and caïques were sufficiently protected behind the remaining building rubble. One observation from that time seems essential: Between the two described harbours to the south of the Kolonna Hill, there were situated a series of small basins which were separated by a wall from the ocean. However, these basins were both connected to each other as well as to the harbours to the north and to the south.

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15 Pausanias II, 29, 6 ff.

16 W. M. Leake, *Travels in the Morea* (1830), 434 ff.

[PAGE 57] In the North Bay one could find a large wall foundation, still visible today, which Leake believed must have been the remains of the city walls that had been extended into the sea, having the function of a breakwater. Apparently the protective function of this building component had been interpreted wrong.

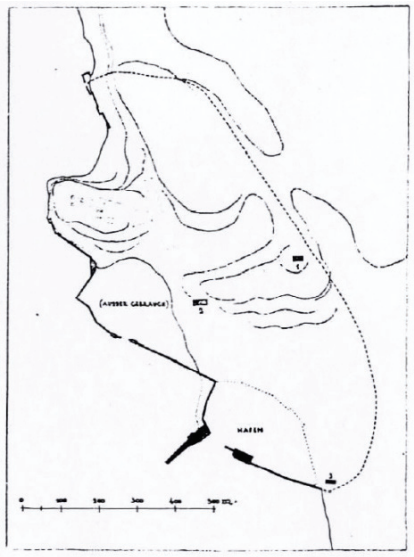

Fig. 3. The town of Aegina during 3rd and 4th century AD. To the north of the Kolonna Hill, one can see the North Bay, south of it the Naval Harbour — in the drawing labelled as "obsolete" *(AUSSER GEBRAUCH)* — and in the far south today's commercial harbour is seen *(HAFEN)* (from Welter, *Ägina*) (1. Episcopal Church; 2. Synagogue, 3 Church).

C. Bursian[17] is the only one who has both seen mentioned the dam in the North Bay.

Since K. Lehmann-Hartleben[18] obviously did not know the location well enough, he had to come to incorrect conclusions. Thus, there is no reason to pay detailed attention to his topographical descriptions, which he gives in his work.

He is of the opinion that there must have existed three harbours in the Imperial Era. Pausanias, however, did only mention the two southern harbours, and he did not mention the κρυπτὸς λιμήν to the north. This perception is incorrect. In Pausanias' time, in fact only the two southernmost harbours did exist, so that he - consequently - had called the one of them κρυπτὸς λιμήν.

The facility in the North Bay had been sunken in the floods. Lehmann-Hartleben dates the shelters in the North Bay to the Archaic period. According to him, the harbour in the South Bay (Naval Harbour) was build together with the Emporion around 322 BC by someone who Demosthenes[19] mentions as Lampis. Thus, after Lehmann-Hartleben, both to the north and to the south of the Kolonna Hill there would have been one harbour in use at that time. The third harbour, far to the south, was then additionally built in the Roman Era, during the rule of Julia Domna.

According to Welters,[20] the city wall run across the southern half of the North Bay during the 5th century BC. Welter does not mention the large breakwater in the North Bay. He dates both the harbour in the South Bay (Naval Harbour) and the southernmost harbour, which still is in use today as the commercial harbour, to 480 BC. Both are enclosed by the city walls (Fig. 3). According to Welter, the walls are torn down in 459. The ship-owner Lampis is said to have repaired the public buildings [PAGE 58] of the town around the year 322 BC. In opposition to Lehmann-Hartleben, Welter leaves open, whether or not Lampis on this occasion also did repair the walls and piers of the harbour.

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17 Conrad Bursian, *Geographie von Griechenland*, 1868, zweiter Band, erste Abteilung, 81 ff.

18 K. Lehmann-Hartleben, Die antiken Hafenanlagen des Mittelmeeres, *Klio*, Beiheft 14 (1923), 52. 65. 92. 165.

19 Demosthenes, *In Aristocratem*, 211 (691) ; Lehmann-Hartleben, *a.O.*, 30. 92.

20 Cf. note 4.

According to Welter, however, the restoration of the city wall as well as the commercial harbour is certainly attested during the reign of the empress Julia Domna (c. 250 AD). Coins from this period with the image of the harbour testify this matter of fact.[21]

References

Besides the above mentioned basic research findings of the past, the following publications dealing with this subject, have to be mentioned for completeness:

A. Tewets, Grand insulaire (1550).

O. M. v. Stackelberg, *La Grèce, vues pittoresques et topographiques* 7. e 8. livraison, Pt. 2, 1833.

Carolus Müller, *Aegineticorum liber*, 1817, 146 ff.

St. Vincent et de Boblaye, *Expédition scientifique de Morée*, Section des sciences Physiques, Tome II, Paris 1834.

Th. Graves, *Town and Ports of Aegina*, 1839, Plans of anchorages in the Gulf of Athens (map of the Brit. Admiralty). In the North Bay, only the short stretch of the wall in the centre is shown. The large heap of stones missing, the course of the city wall on the southwest side of the Kolonna Hill is clearly visible.

]. G. Frazer, *Pausanias's Description of Greece III* (1890), Z 62, on Pausanias 11,29,6. A breakwater is mentioned to the north of the two harbours, continuing into the sea as an extending of the city wall. Should this information refer to Leake, then this is certainly not the great heap of stones. However, if this is a reference to Conrad Bursian, then it may very well be the great heap of stones. References to this great building construction have then been lost in literature, and they not appear in the works of the successor.

H. Thiersch, Äginetische Studien *Nachr. der Akad. A. Wiss. Göttingen*, 1928, Heft 2.

E. Dodwell, *A classical and topographical tour through Greece*, London 1919, translated by L. Sickler, Meiningen, 1821-22.

K. G. Fiedler, *Reisen durch alle Teile des Königreichs Griechenland*, Leipzig 1840-41.

]. Russegger, *Reisen in Europa, Asien und Afrika*, Stuttgart 1843-48.

W. Rein - A. Stübel, *Ausflug nach den vulkanischen Gebirgen von Agina und Methana*, Heidelberg 1866.

S. Washington, A petrographical sketch of Aegina and Methana, *Journal of Geology*, Chicago 1897, with geological maps.

R. v. Leyden, *Der Vulkanismus des Golfs von Agina und seine Beziehungen zur Tektonik*, Publikationen, Vulkaninstitut I, Friedländer I, Zürich 1940.

The investigation of Washington provides the foundations of all knowledge. Thiersch has given a summary of the existing material and tries to summarize the geographical and philological-archaeological investigations. After Washington, von Leyden offers the latest geological descriptions which, according to A. Philippson, do not offer any substantial progress compared to Washington.

[21] S. R. Milbanks, The Coinage of Aegina, *Numismatic Notes and Monographs* 24 (1925), Pl. IV 6, 7 ; V 6, 6. Welter, *AA* 1938, 484.

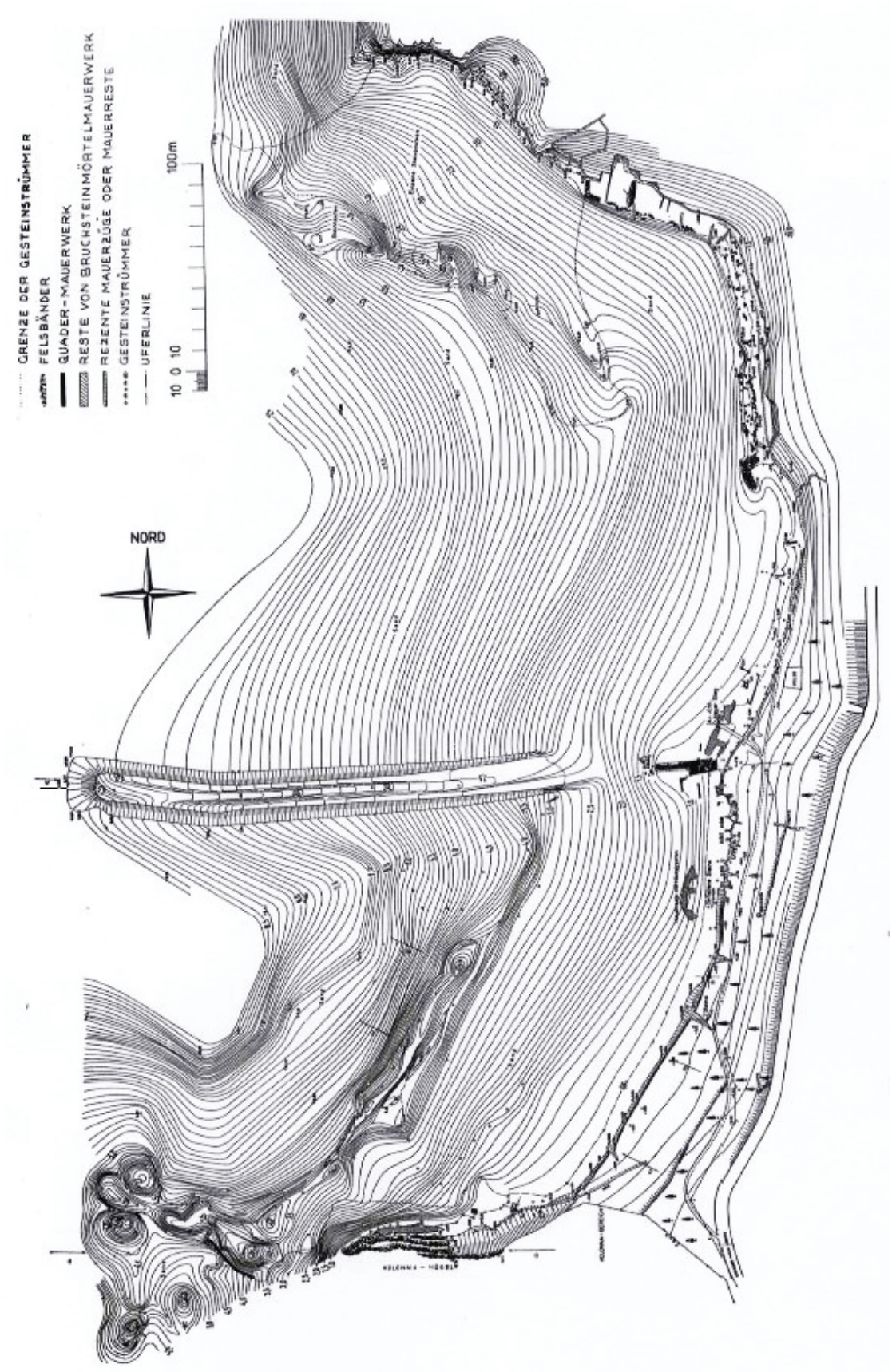

Fig. 4. The North Bay of Aegina, recorded in the years 1964 to 1966. The southern extension is the inclusion of the Naval Harbour in Figure 17 (see sections, Fig. 5) (from P. Knoblauch, Neuere Untersuchungen an den Häfen von Ägina, *BJb* 169 (1969)

Figure text translations (Fig. 4)

NORD	North
GRENZE DER GESTEINSMAUER	Borderline of the stone wall
FELSBÄNDER	Strip / belt of rocks
QUADER-MAUERWERK	Masonry of ashlars (blocks)
RESTE VON BRUCHSTEINMÖRTELMAUERWERK	Remains of a mortar rubble masonry, constructed with quarry stones
REZENTE MAUERZÜGE ODER MAUERRESTE	Recent walls or remains of walls
GESTEINSTRÜMMER	Stone debris
UFERLINIE	Shore line
KOLONNA-HÜGEL	Kolonna Hill
KOLONNA-BEREICH	Area of/around the Kolonna Hill
STRASSE NACH AIGINA	Street to Aegina
TREPPE	Stairs
KELLER	Cellar (basement)
BRUNNEN	Well
7 Steine	7 stones
4 zerfallene Steine	4 mouldered stones
Mauerreste mit Mörtelresten	Remains of walls with remains of mortar
Neuer Steg	New path
Steinhaufen	Heap of stones
Einzelne Steinbrocken	Single stone chippings
Sand	Sand

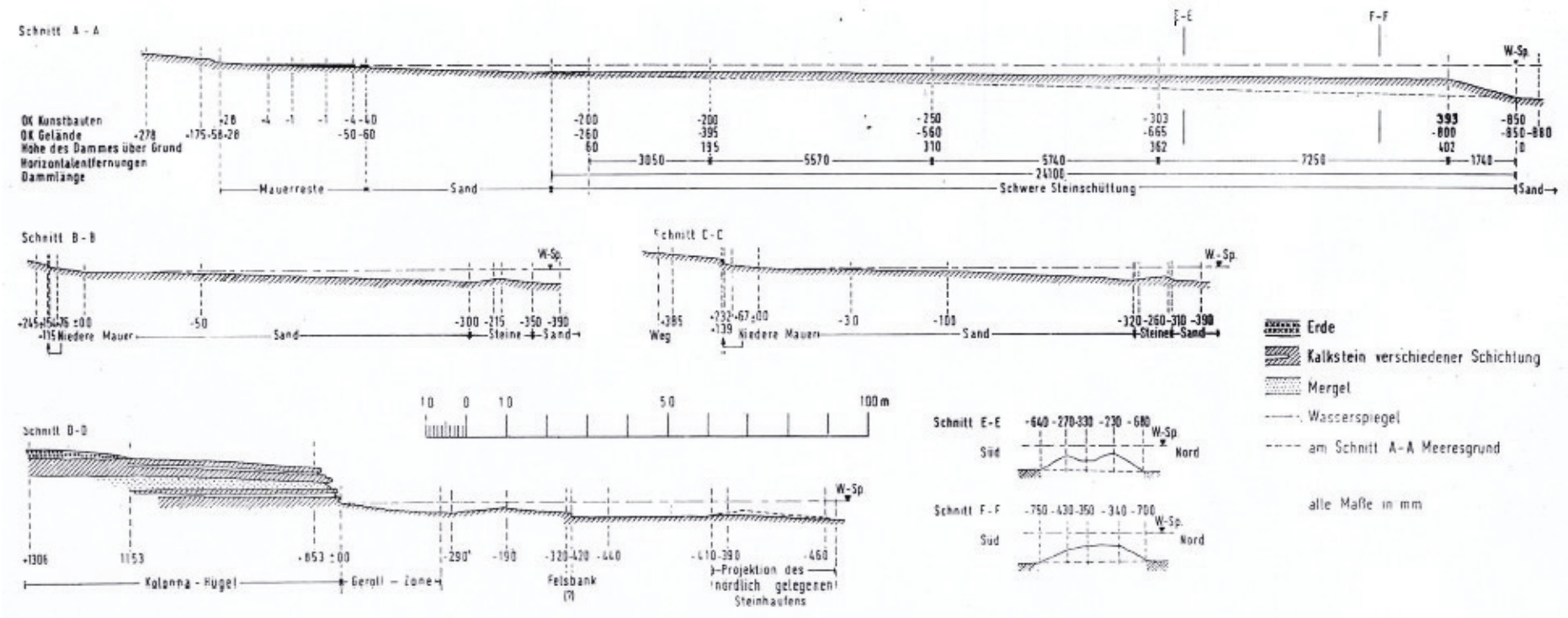

Fig. 5. Section A-A through the foundation and the breakwater
Section B-B and C-C through the shallow water in the southern half of the North Bay
Section D-D through the Kolonna Hill and the upstream heap of stones
Section E-E and F-F cross-sections through the breakwater.
Location of the sections: A-A, B, B-, D-D see Fig. 4, E-E, and F-F, see section A-A

Figure text translations (Fig. 5)

Erde	Soil
Kalkstein verschiedener Schichtung	Limestone in different layers
Mergel	Marl (a sort of clay)
Wasserspiegel (W.-Sp.)	Water level
Meeresgrund	Ocean bed (bottom of the ocean)
Alle Maße in mm	All measures in mm
Schnitt	Section
Süd	South
Nord	North
OK Kunstbauten	OK structures
OK Gelände	OK area (territory/premises)
Höhe des Dammes über Grund	Height of the dam above ground level
Horizontalentfernung	Horizontal distance
Dammlänge	Length of the dam
Niedere Mauer	Lower wall
Mauerreste	Remains of walls
Sand	Sand
Steine	Stones
Holonna-Hügel	Kolonna Hill
Geröll-Zone	Area with boulders (pebbles)
Felsbank	Reef, shelf/shelves
Weg	Path
Projektion des nördlich gelegenen Steinhaufens	Projection of the heap of stones, laying to the north
Schwere Steinschüttung	Embankment/package of heavy stones

PART II, DESCRIPTION OF THE VARIOUS PORTS

The North Bay

Preface

Our description takes a starting point at the steep earth slide, at the south side of Kolonna [PAGE 59] Hill. The heights quoted at the upper edge of the Kolonna Hill do not correspond to its highest point. Prior to the new excavation, carried out by the *Bayrische Akademie der Wissenschaften* (i.e. the Bavarian Academy of Sciences) and which begun in 1966, the height was 16.4 m. At the foot of the slopy cliffs there are extensive remains of a mortar rubble masonry, constructed with quarry stones and riddled with pottery sherds. These remains are debris parts of the collapsed city wall, which besides also served as a supporting wall at this point (Plate 12). Following the coast line northwards (Fig. 4), a wall of unknown age can be observed directly on the beach. It consists of boulders of all shapes and sizes, is low, heavily battered, and is constructed without care in dry masonry technique. Uphill, east of this wall and at some distance from the strandline, a remarkable wall remain has survived between the contour lines of 6 m and 7 m, running some 200 m from the boundary of the Kolonna Hill in the south to a recent staircase, approximately in the middle of the North Bay. This wall was added to the map, based on Greek surveying documents. As far as recognizable without having carried out any prospection, it seems to be a 3.5 m wide double-leaved wall. At the fixed point "B" on the coast, wall remains of all kind that seem to belong the same structure complex begin to be visible towards the north. They stop at the cellar (Fig. 4) (for details see below, p. 66 ff.). Both in the southern half and in the northern half of the North Bay heaps of stones can be seen on the seabed. In Figure 4 their location is visible by the irregular and concentrated course of contour lines. Mistakenly, Welter has confused the concentrations of the southern half for being wall remains. The middle rock fragment in Plate 13 is about 0.7 m wide and 1.6 m long, it is a protruding reef (Pl. 17 a).

The breakwater (cf. Fig. 4 and 5)

In the middle of the North Bay resides a large, stacked breakwater. It stretches about 300 meters out to sea. With a length of 241 m, this construction consists of stones and blocks of every shape, with a size up to 0.5 m length and 0.35 m with. Ashlars were not observed, but here and there pottery sherds of every kind, sintered together with their surroundings, are scattered into the structure. Plate 17 b may give an impression of the material. Plate 18 a shows the embankment of the breakwater in the sandy bed of the North Bay.

The shape of the breakwater can be appears from the longitudinal and cross sections in Figure 5; its foot is not ashore, but resides approximately 67 m away from the coast, submerged some 1.70 to 2.00 m. In its longitudinal direction the upper side of the breakwater does not lie on a levelled axis, but shelves seaward from 2.00 m to 4.15 m below the present water level. Seen from the land, the first 55.4 m are still taking a horizontal course; the above-described seaward decline then extends to a length of 185.60 m. The western tip of the breakwater has at all times been notably exposed to the

motion of the sea, hence it is strongly ablated. Caused by a rising sea level and the progressive ablation, its main weak point, which initially was at the top, moved towards the inland.

The cross-sections through the breakwater look strikingly similar **[PAGE 60]** to the drawings that Georgiades[22] made of similar buildings. Also in Aegina the outer edges of the top of the heaped stones are piled higher than the middle zone. Since there was no need of changing the production method in over thousands of years, it seems bold to draw conclusions on the production technology, and furthermore to conclude on a dating based thereupon. Based on the findings and without further ado, it is inconclusive to what extent siltations have occurred sideways to the breakwater. Plate 18 b displays the view from the top of the breakwater towards the harbour which it shelters. Scale and dimension of the drawing reveal the size of the structure.

If not the highest point of the breakwater would be 2.00 m and its lowest point 4.15 m below the present water level, it would be perfectly suited both to hold the frequently surging waves, which come from the north, and thus transforming the part of the North Bay, where the town lies, to a beautiful harbour. Assuming that, over the years, the top of the breakwater has been ablated by the swell approximately 1.00 m, as indicated by the shape of the forefront of the breakwater, and moreover provided that the breakwater originally must have protruded from the water with min. 0.5 m, the following calculation of determining the water level at the time of the breakwaters construction has to be concluded (cf. Fig. 4 and 6):

Corresponding to the sea level at the front of the breakwater, the height is	–4,50 m
less: estimated ablation	+1,00 m
plus: necessary height above the water level for efficiency reason	–0,50 m
equals: height of water level over sea level at the time of construction	–4,50 m
today the height of water level is at	–0,45 m
that equals a difference of the water level of	3,55 m

Up to -4.00 m above sea level, the shape of the breakwater has been completely preserved. This concludes that no ablation has occurred, or at least had not occurred to any significant extent. A parallel calculation, corresponding to the above mentioned calculations, would yield the following picture:

The breakwaters height above sea level at the above mentioned position	–4,50 m
less: estimated ablation	+1,00 m
plus: necessary height above the water level for efficiency reason	–0,50 m
equals: height of water level over sea level at the time of construction	–4,50 m
today the height of water level is at	–0,45 m
that equals a difference of the water level of	3,55 m

[22] Georgiades, *Les ports de la Crèce dans l'antiquité* (1907) Taf. 3 (Eretria), 6 (Histiaia).

A structure of such dimensions would only be useful when [PAGE 61] the water level would range somewhere between 3.55 m and 4.05 m below recent level, i.e. at least 3.80 m. In this case, the heap of stones to the west in front of the Kolonna Hill (Fig. 6) would in the same way protrude from the water as all the rocky reefs quoted by Ph. Négris (Fig. 7).

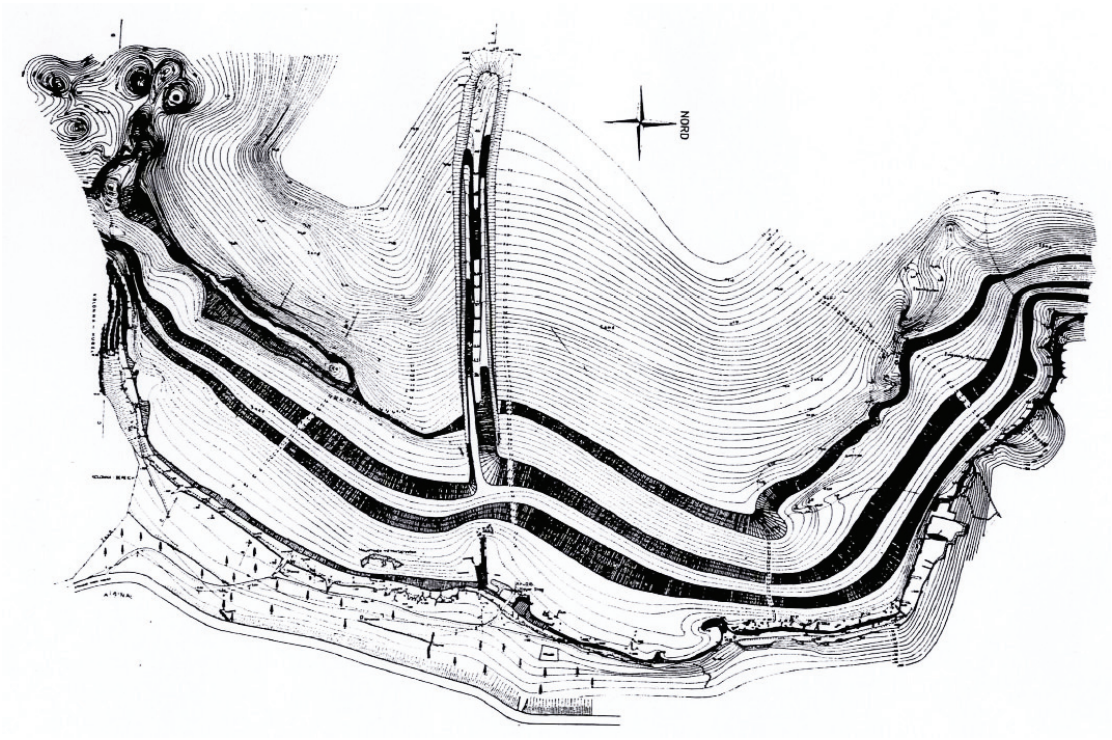

Fig. 6. Presentation of different sea level heights with regard to the effectiveness of the great breakwater.
The first shore area from the west minus 3.55 m a.s.l.
The second shore area from the west minus 2.35 m a.s.l.
The third shore area from the west minus 1.75 m a.s.l.
Eastern shore area today minus 0.45 m a.s.l.
The striations represent the degree of fluctuation of the tides, the elevations describe an average from the sea level heights.

Thus a good usable harbour would have existed in the southern half of the North Bay, which, even though without a pier, would have met all the requirements of Early Navigation. Sheltered by the breakwater and the reefs, the ships could be anchored in the roads, and in case of need they could be pulled on the beach.[23] With the [PAGE 62] aid of wagons or animals such a breakwater could at any time have been projected from the land side.

[23] A. Köster, *Das antike Seewesen* (1923) 77 ; K. Lehmann-Hartleben *a.O.* 11.

If we now adopt this individualisation of the harbour, this immediately raises the question of where the wall was.

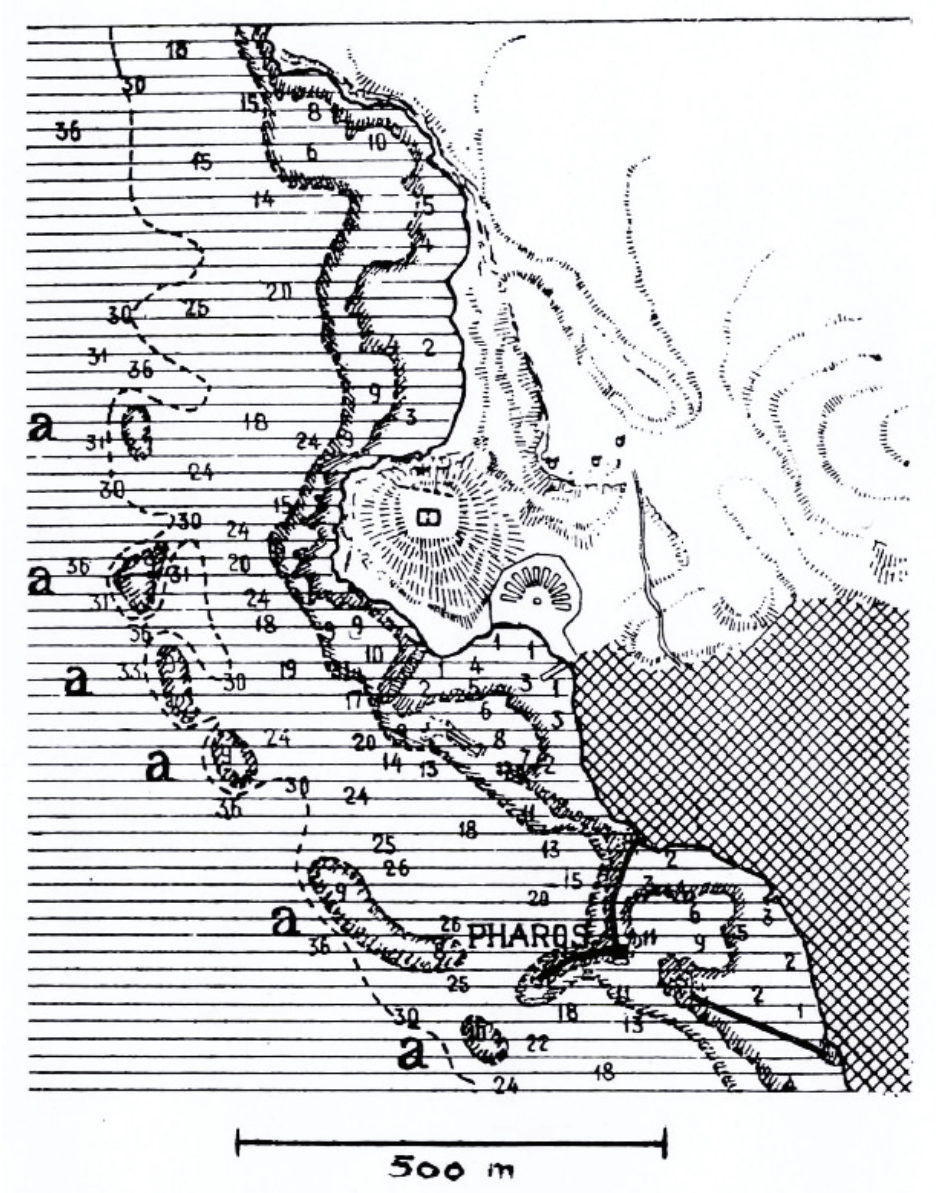

Fig. 7. The area surrounding the harbours of Aegina (from Ph. Négri's Vestiges antiques submergés). The depths are given in feet (= 30.48 cm); near the coast they do not match the factual circumstances.

In Welters opinion of the city's building history, the wall was enclosed the acropolis, while the harbour must have been located outside of the town. Without an excavation of the perimeter frontage development of the Acropolis, this problem is not solvable.

Gradually, the usability of the breakwater was depleted by the rising of the sea level, until it finally was no longer visible. This **[PAGE 63]** raises the question of what maximum sea-level height is just reconcilable with its function ability?

Supposed that the sea level would not be 3.80 m but only 2.35 m below recent level, as is shown in Figure 6, half of the entire structure would be submerged. Since the required projection is missing above sea level, hence the effectiveness of the entire structure would be more than questionable. In addition, the foot of the breakwater would be located 30 to 40 m away from the waterline, at a depth of about 0.6 m. The heaps of stones located in front of the Kolonna Hill would lie under water, and these cliffs would present a danger of navigation. The conglomeration of stones in the middle of the southern part of the North Bay, which were located offshore at the time of the construction of the breakwater, would then be laying only 30 meters from the beach, thus presenting a dangerous shoal and practicably disabling this harbour. However, this situation would already occur if the sea level would be reduced with 2.85 meters.

Therefore, in the southern half of the North Bay, the entire harbour was unusable from then on.

As the remote siltation does not have any effect on the these considerations it had not been accounted. Even a simple heaping up of the breakwater, which followed the rise of the water, would only have preserved the harbour area from the north-west surf, but it would not have averted the dangers that emerged from the newly arisen shoals in front of the Kolonna Hill and before the harbour beach.

It was not until a later date, when the sea had risen even further, that these dangers had been overcome. In the meantime, the city developed away from the North Bay to the south. Moreover, just at that time new demands with regard to structural harbour engineering had evolved, so that the once so large and impressive and certainly effective structure was revealed from destruction.

Ever since there was no longer any harbour, the closure of the city by a wall with a corner building in the middle of the North Bay was possible and useful.

The foundation at "L" in the middle of the North Bay (point "L", Fig. 8 and 9; Pl. 19 a - b.) consists of non-plastered ashlars. The scanty remains of mortared ashlar masonry lie above these layers. The whole system consists of two parts.

In a westerly direction, with a length of 33.65 m, the longer northern part protrudes straight into the sea. The short southern part has a length of approximately 14.40 m. Both parts begin on the same land-based location, while the long part extends exactly westwards into the sea, the short part slightly declines in a southern direction. The long part was originally made from ashlars, that had been hewn regularly, laid without mortar. It consists of two leaves of which only the stretchers have been preserved. Nowhere headers, extending into the cavity between the leaves, are to be found. The spacing had been filled with uneven ashlars that, however, had been placed with care. No technical statement can be made of the wall, which later on was mortared on top of this foundation, as it was way too corroded and too much eroded. **[PAGE 66]** Ascertained is, however, that the mortar has entered into the older lower layers, which were originally unsolidified. Furthermore it is ascertained that this mortared wall had a width of about 1.5 meters and was erected on the filling of the double-

leaved earlier part. On the north side one can clearly see how careful the edge distance of 0.30 m. has been kept.

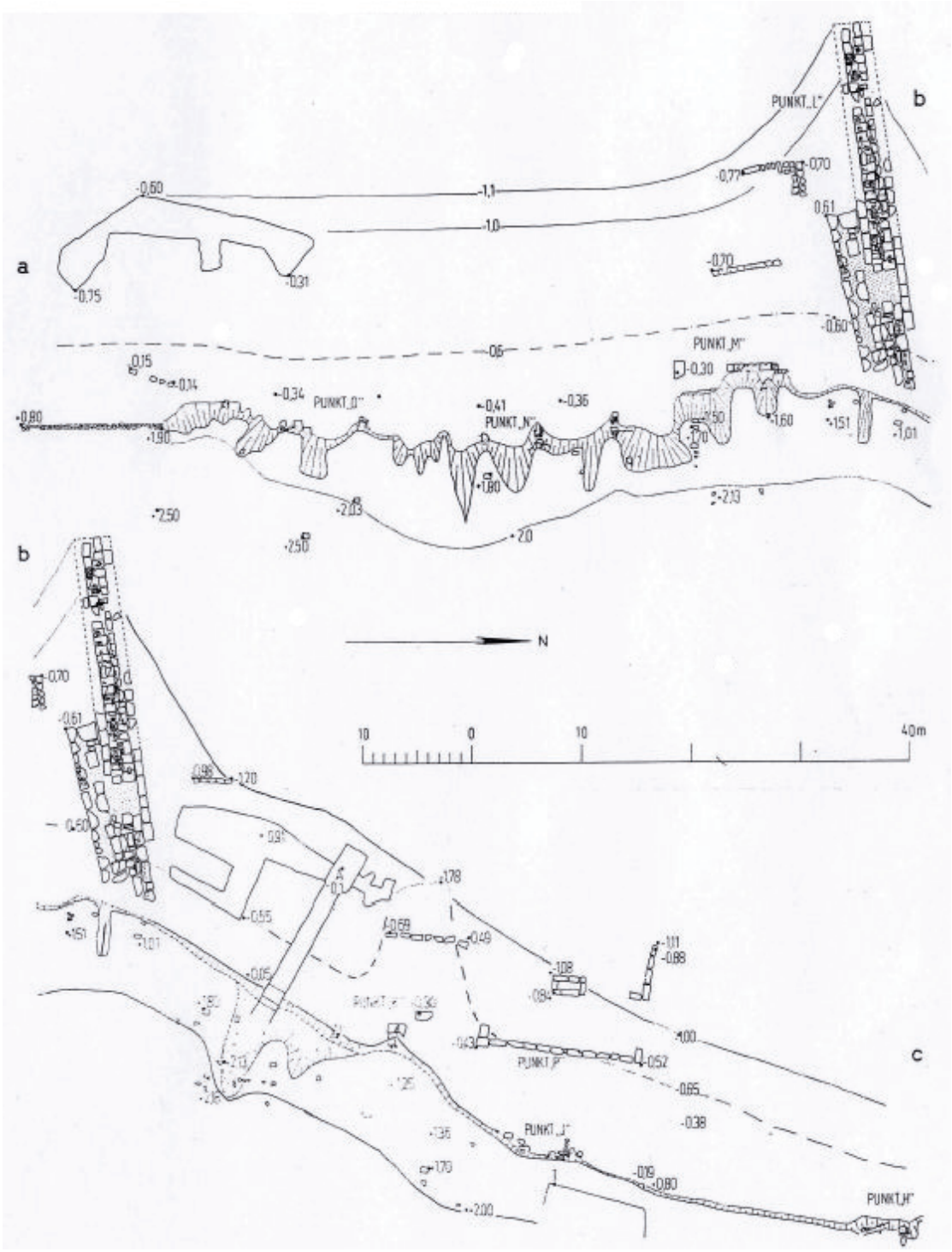

Fig. 8. Wall structure on the southern part of the eastern bank of the North Bay, recorded in 1965 and 1966 (cf. Fig. 4, 9-16 and Pl. 19 a-b, 20 a-b, 21 a-b, 22, 23 a) (from P. Knoblauch, Neuere Untersuchungen im den Häfen von Ägina, *BJb* 169 (1969)

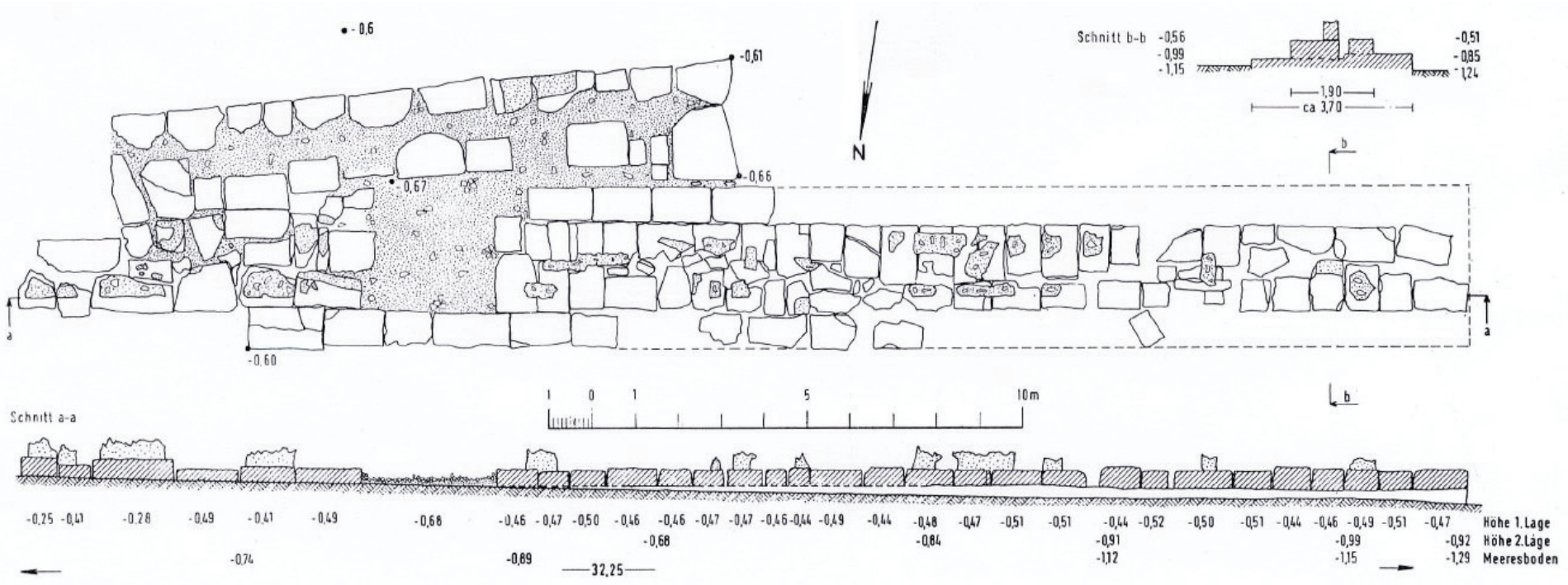

Fig. 9. Recording of stones of the remnant stone wall on the coast in the middle of the North Bay (point "L" in Fig. 8, also Pl. 11 and 19 a-b), recorded in 1965

Here and there, in the area of the edge distance, an eradication of the original foundation can be perceived on the outer edge (Pl. 19 b).

The short part, which is angled slightly to the south, also consist of a double-leaved masonry. However, the leaves are not composed of ashlars, hewn from all sides, but of stones which have been worked only on three sides, and that in such a way that their upper and bottom side are even and parallel to each other, the outer side being straight.

Without prospection the filling of the cavity between the leaves is not determinable.

The short foundation seems to have been partially superstuctured, since on the south side two remains of what could derive from an bricked structural element can be seen. The ashlars laying in front of the foundation have collapsed (Fig. 4).

The extent to which apparently blocks unsolidified series and the south of the base, the rows of blocks north of it, and also the extensive remains of rubble stone masonry mortar of the environment with this foundation associated itself is no longer detectable. It is no longer possible to determine to what extent the rows of the apparently unsolidified ashlars, are associated with this fundament. This also applies to the south of the fundament as well as the rows of ashlars to the north of it, and furthermore also to the widespread remains in the area that derive from a mortar rubble masonry, constructed with quarry stones.

The northern part of the foundation is older. This opinion is based on the fact that the northern part was partially ablated when the southern part was added, and that the southern, shorter part obviously was constructed without bracing technique. This is indicated by the course of the northern row of ashlars from the southern component. In a simultaneous erection of the whole construction, one would assume a uniform building technique. In case of a subsequent construction of the northern part, the remains of the clear north front of the first-erected southern part would then be visible. However, this contradicts the findings (Fig. 9).

The remaining visible ruins in the coastal area of the North Bay.

As described above (p. 59), these building remains are divided on an equal wall structure from 6 to 7 m a.s.l. as well as on various layers of stones and rows of ashlars from the fixed point "B" to the foundation of the cellar (Fig. 4 and 8). The effect of the surf is so great that these remain consistently change their position and gradually are lost. The 1966 conditions of the areas around the points H, J, K, M, N, 0 and P, shown in Figure 8., are depicted in Figure 10-16 and Plate 20 a-b, 21 a-b, 22, 23 a. The extensive burn marks at point N and those adjacent to the point north of it should be mentioned. Regarding the course of the wall, the type of the building development and the settlement in this part of the town, no clarity can be obtained without an exploration in the entire south-eastern coastline area of the North Bay. According to Welter, the points M, N and O belong to the wall. The author pursues this interpretation only reluctantly because such extensive **[PAGE 68]** burn marks, which are also visible the foundation of the wall, appear to be incomprehensible in connection with a city wall.

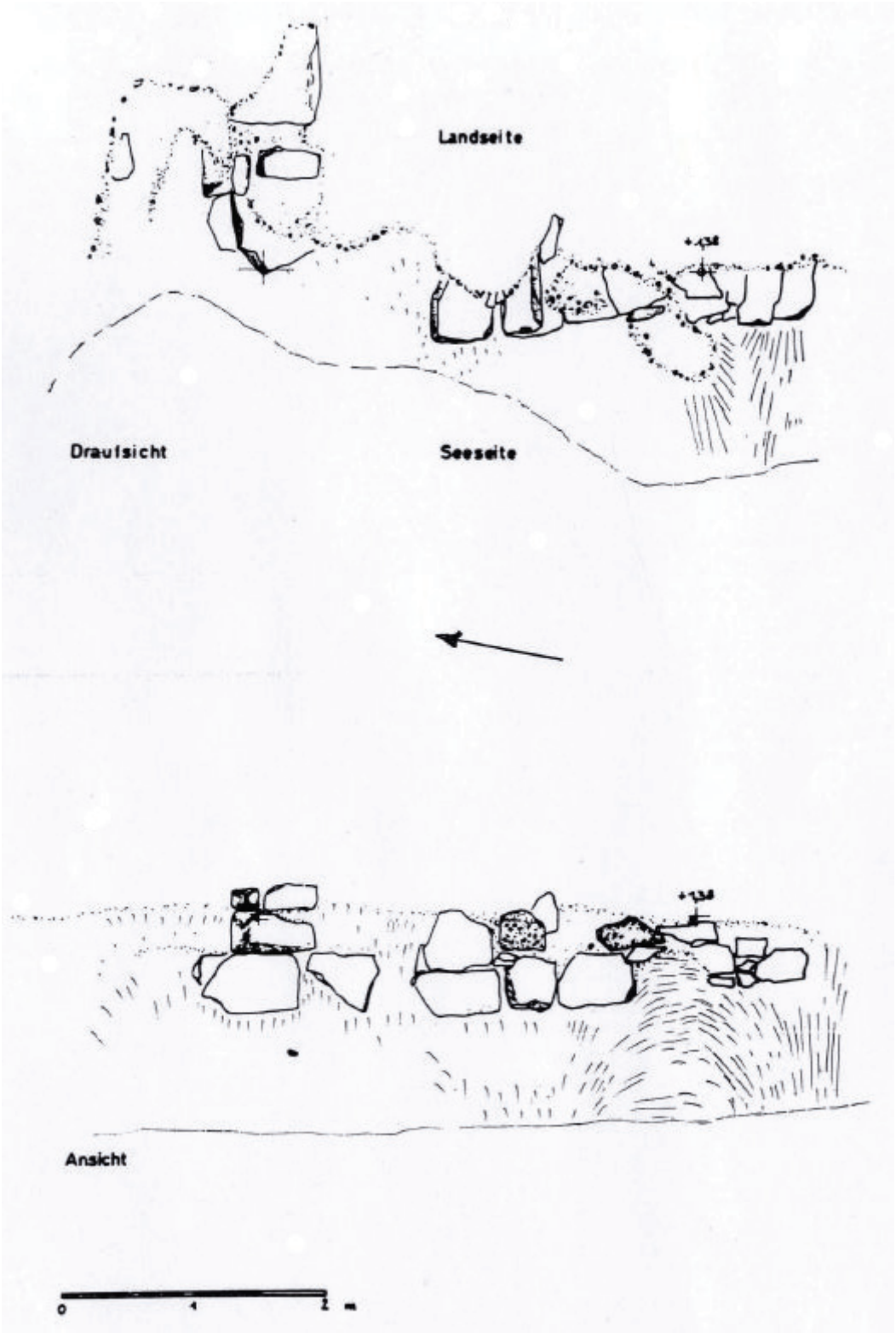

Fig. 10. Point "H" in Fig. 8 (see Pl. 20 a)

Draufsicht = topview, plan view	**Ansicht** = side view, elevational view
Landseite = landside	**Seeseite** = seaside

With regard to the location within the city as well as the quantity of the building remains, which come to light here, excavations are highly desirable.

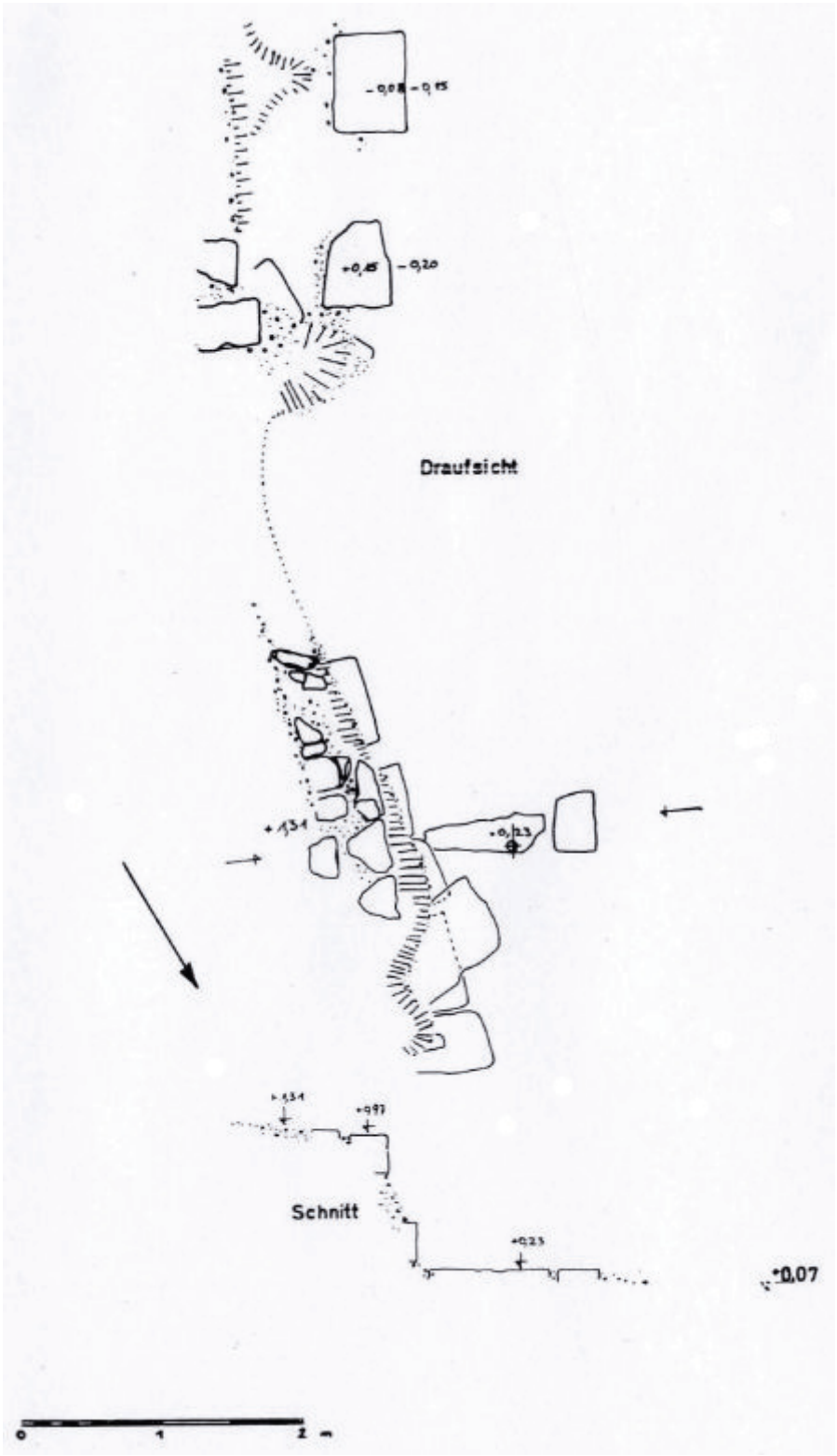

Fig. 11. Point "J" in Fig. 8 (see Pl. 20 a)

Draufsicht = top view, plan view	**Schnitt** = section view

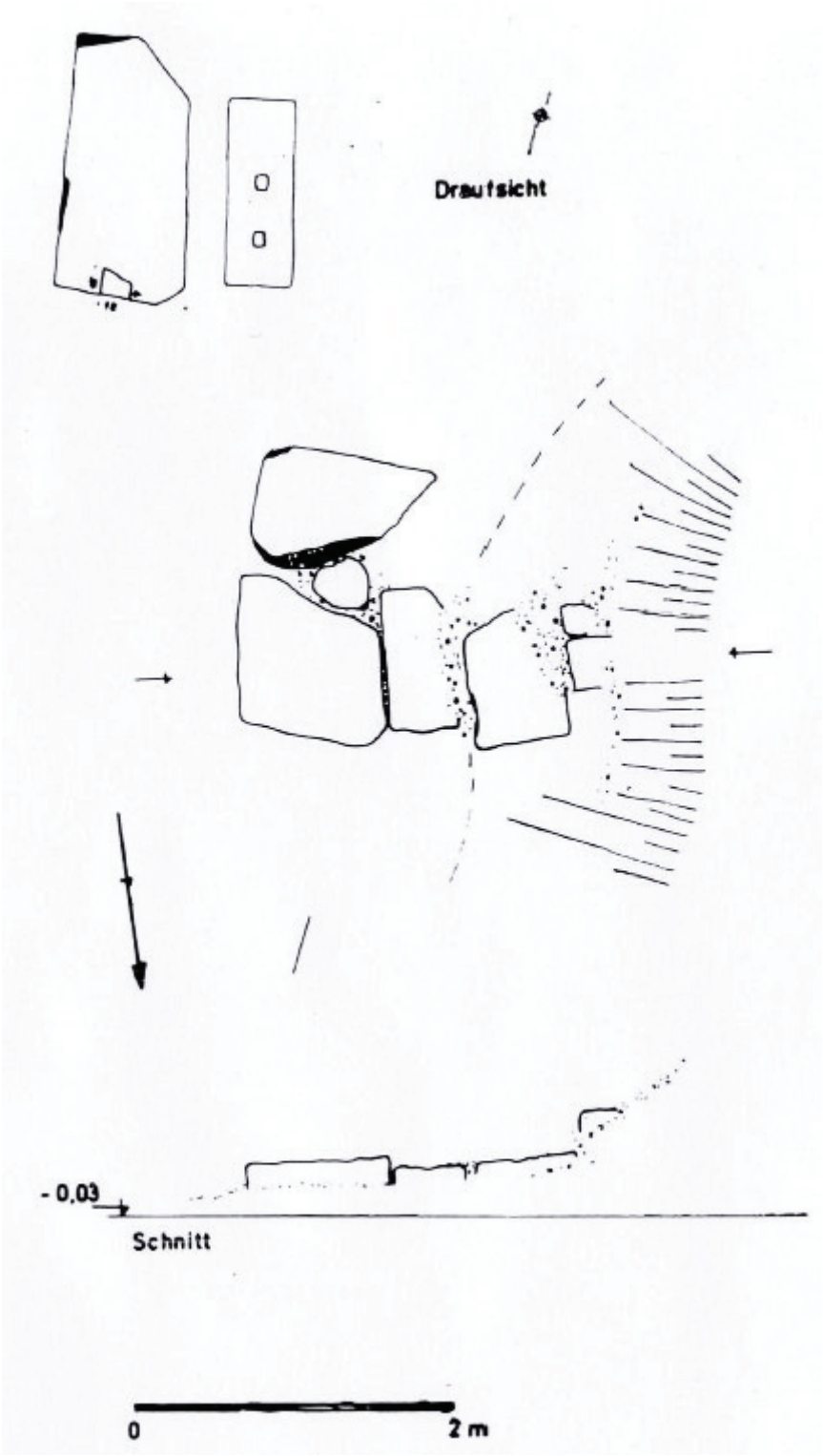

Fig. 12. Point "K" in Fig. 8

Draufsicht = top view, plan view	**Schnitt** = section view

[PAGE 69] Since all the buildings in the North Bay - with the exception of the breakwater - were laying on shore, and because hence there had to be a sufficient forefront area between them and the

beach line, it can be assumed that the sea level at the time of erection of the constructions must have been close to -2.2 m a.s.l. This corresponds to rise of sea level of +1.75 m to present day.

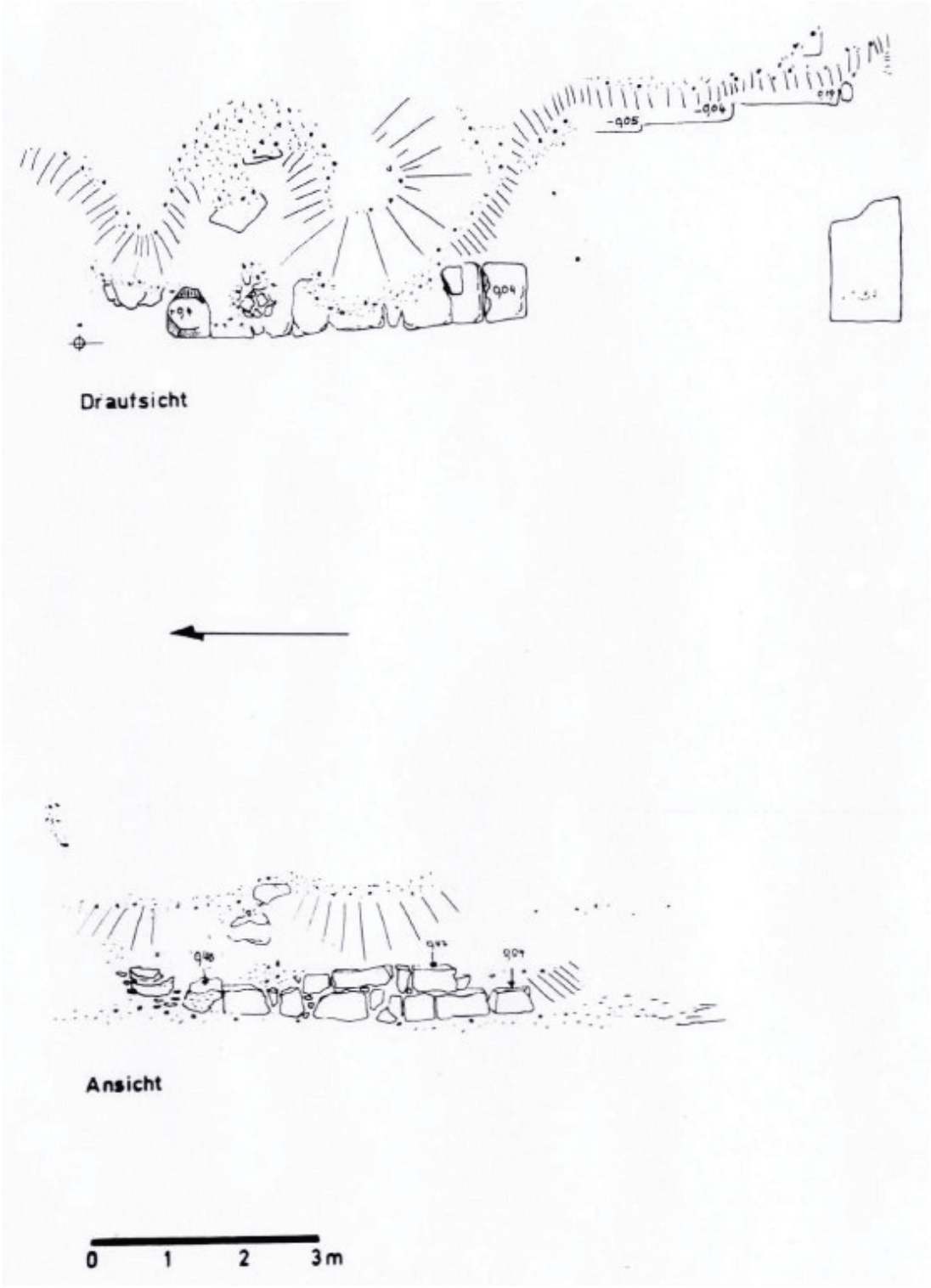

Fig. 13. Point "M" in Fig. 8 (Pl. 21 a)

Draufsicht = top view, plan view	**Ansicht** = side view, elevational view

Fig. 14. Point "N" in Fig. 8 (Pl. 21 b and 22)

Brandspur = trace(s) of burning

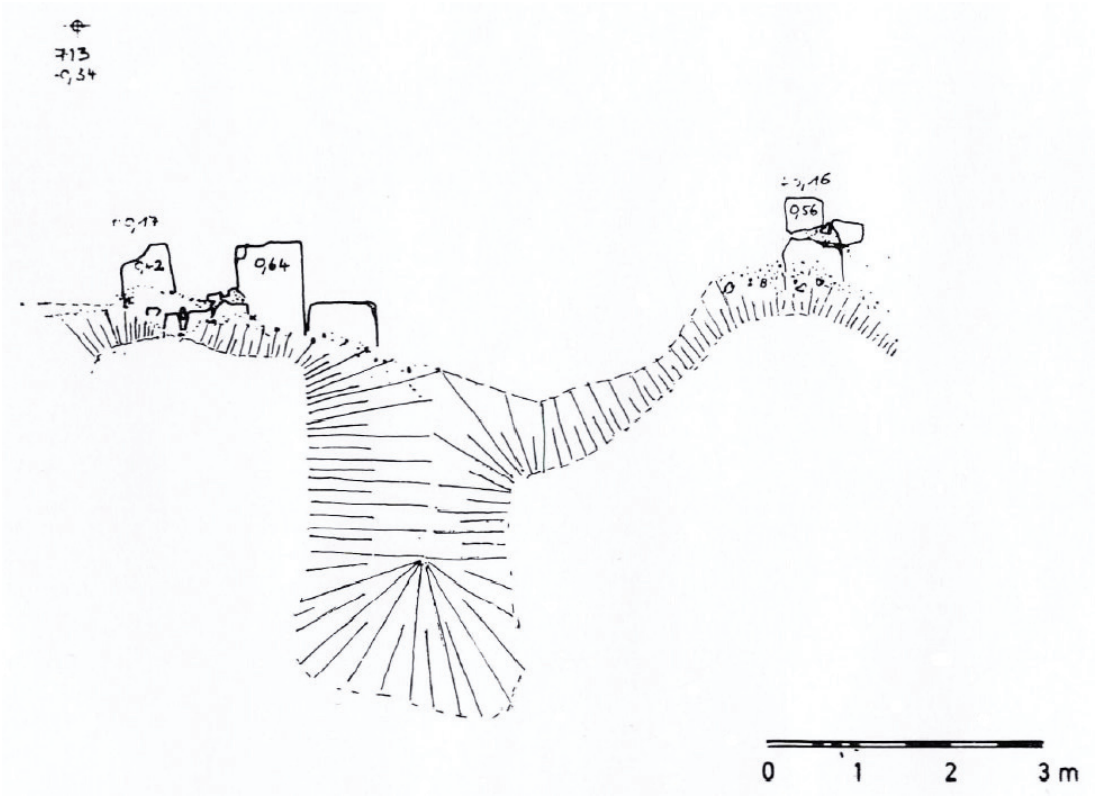

Fig. 15. Point "O" in Fig. 8

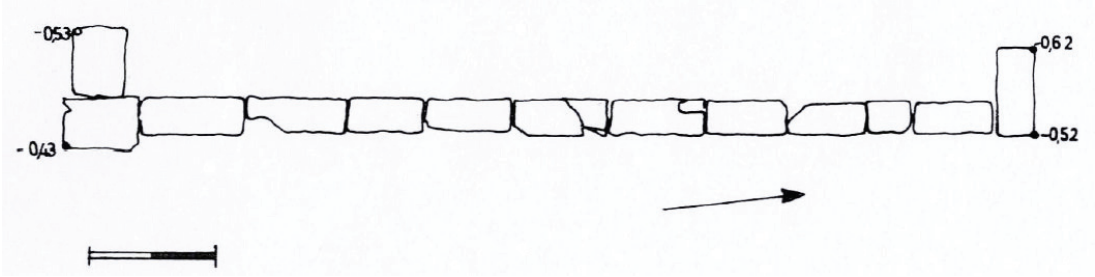

Fig. 16. Point "P" in Fig. 8 (Pl. 23 a)

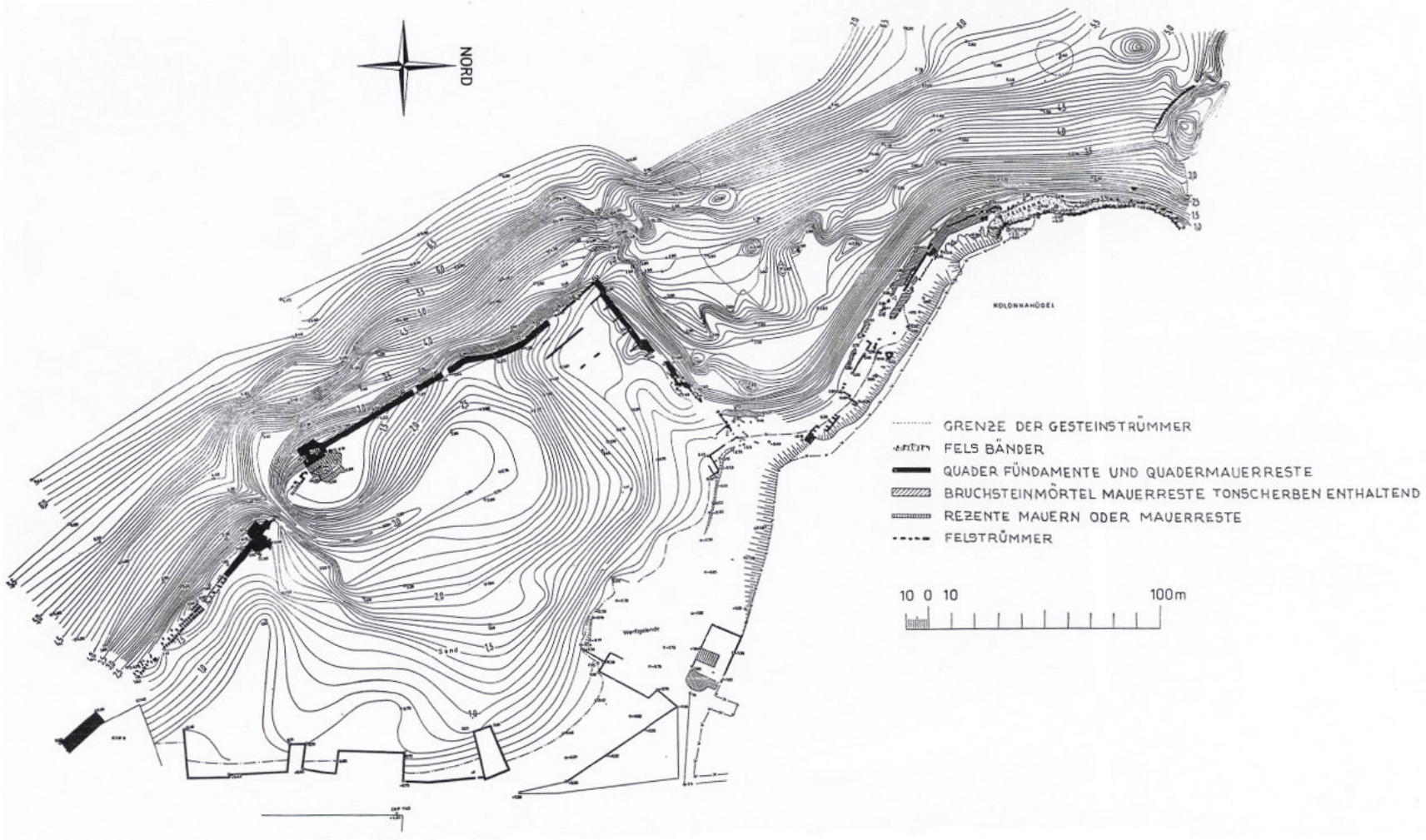

Fig. 17. Recording of the Westshore of the Kolonna Hill and the naval harbour (the northern extension is the recording of the North Bay, to be seen in Fig. 4). HP *[Höhenpunkt = geodetic point]* 114 with a height of +1.51 m a.s.l. is the reference point for surveying the whole area. Recorded in 1966

Figure text translations (Fig. 17)

NORD	North
GRENZE DER GESTEINSTRÜMMER	Borderline of the stone debris
FELSBÄNDER	Strip / belt of rocks
QUADER FUNDAMENTE UND QUADERMAUERRESTE	Foundations of ashlars (blocks) Remains of masonry of ashlars
BRUCHSTEINMÖRTELMAUERRESTE TONSCHERBEN ENTHALTEND	Remains of a mortar rubble masonry, constructed with quarry stones, that contains fragments of pottery sherds
REZENTE MAUERN ODER MAUERRESTE	Recent walls or remains of walls
FELSTRÜMMER	Rock debris
Kolonnahügel	Kolonna Hill
Brunnen	Well
Werftgelände	Dock-/shipyard area

[PAGE 73] The west coast of the Kolonna Hill

Already along the North Bay, the western third of the rock faces of the Kolonna Hill fall steeply into the water. (Pl. 12). The same picture is reflected west of the Kolonna Hill (Pl. 23 b).

Every time when the clay layers, that lie between the Poros layers, are eroded, the single pieces of Poros rush into the sea. This results in the emergence of shelves, on the surface of which, in one case, two well-holes are visible - an unmistakably indication of the fact that in earlier times the Kolonna Hill protruded further into the sea.

However, based on the fact that after a narrow boulder zone only a few rocks do occur on the seaward, it can be expected that the erosion process was slow.[24]

Based on the aforementioned findings it cannot be determined how far the Kolonna Hill did protrude into the sea in former days. Perhaps the excavations on the Kolonna Hill will give some better information. Otherwise, only a long-term monitoring would allow to draw any conclusions. Following the coastline in a south-easterly direction, at the point where the cliff-lined coast ends (Fig. 17; Pl. 24), one comes across city wall foundations. No stone recordings were made of these parts, however, the visible parts were measured and entered into the mapping. The finding shows a double-leaved wall (Pl. 25), whose inner and outer leaves are visible at separate points in the foundation. The filling of the wall lies around the foundation remains, sintered and eroded by the water. In all likelihood, at least parts of the wall were built after the "chamber" principle.[25] The thickness wall probably about 5.0 m (Welter quoted the level with 5.75 m). A part of the wall, whose landside leaf has disappeared, has survived near the south-western wall bending. Here almost one third of the wall filling has been preserved (Pl. 26 a). Ashlars, which limit a passage to the right and to the left, can be seen in the area of the wall foundation, as well as an appertaining collapse can be spotted in the area of the wall filling. Today the passage finds itself at a low level, allowing the water to extrude at a normal water level. Certainly, this wall was not erected directly into the water but, in order to protect the wall, an adequate beach line was left in front of it. By all means this resulted furthermore in the quite welcomed effect, that the passage then featured a drainage capability, which is essential for its operability. **[PAGE 74]** Summarizing these considerations, one comes to the following conclusion: A flood plain of at least 5 m - necessary for the motion of sea at this point - results in a beach line which, at the time of its construction, was situated at a height of -1.4 m, related to mean sea level. Thus, since the construction of the wall, the sea level has increased by at least 0.95 meters.

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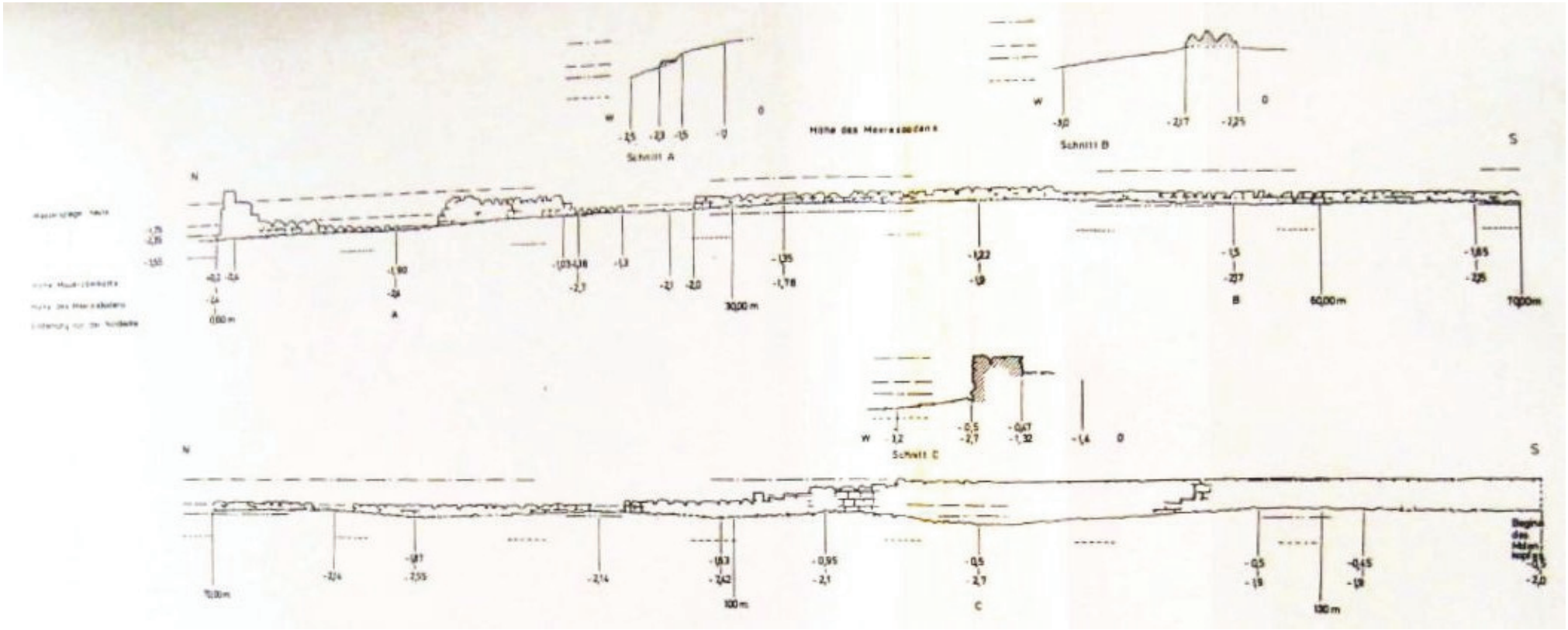
[24] It should be mentioned that the Poros layers fall westwards and north-westwards of the Kolonna Hill. In about 60 to 70 m they would reach the sea bed - given that they fall equable. In historical times this has certainly never happened. They did rather brake off the coast *[become detached]*. Beyond a narrow coastal zone of 3 to 4 m, interrelated areas of boulders or rubble are not visible any longer. After 17 to 20 m, the sand bed declines very steeply to 3.50 m. After a further 40 m, the sea bed reaches a depth of 5.50 m. From the cartographic recording (Fig. 17), one can clearly observe this graduation.

[25] Cf. note 3.


Höhe des Meeresbodens
Schnitt A
Schnitt B
Schnitt C
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W
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C
30,00 m
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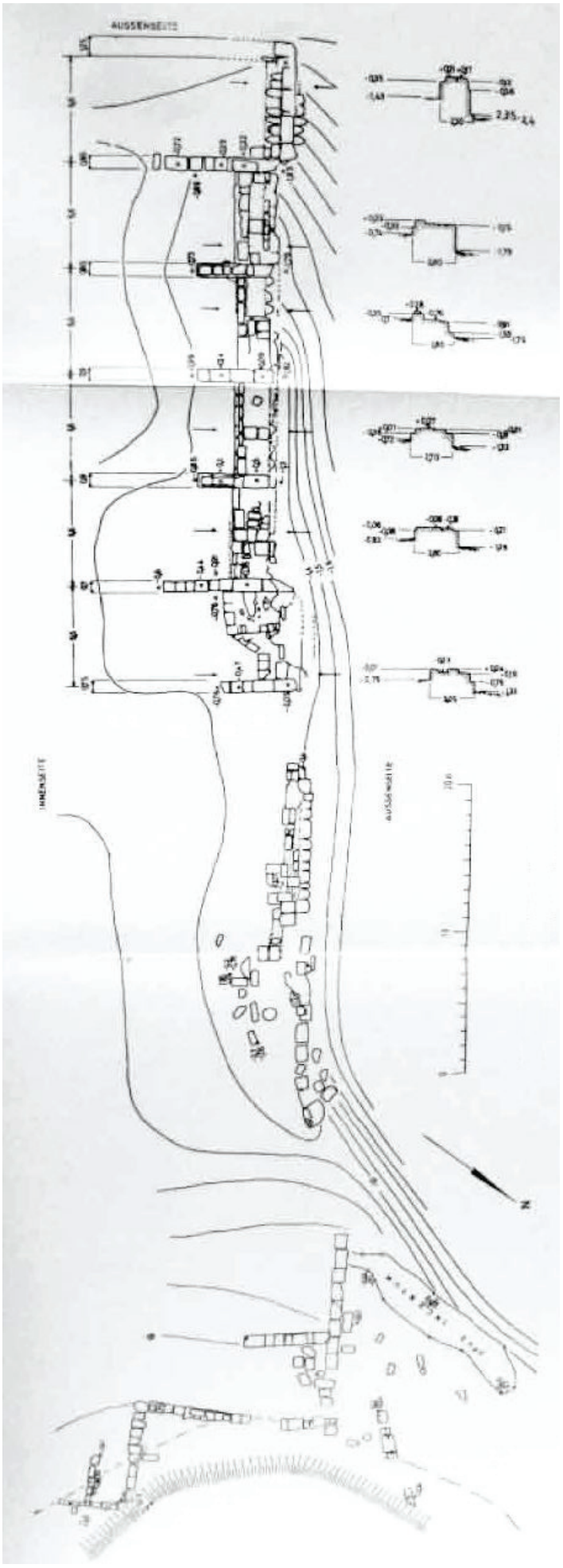
70,00m
100 m
130 m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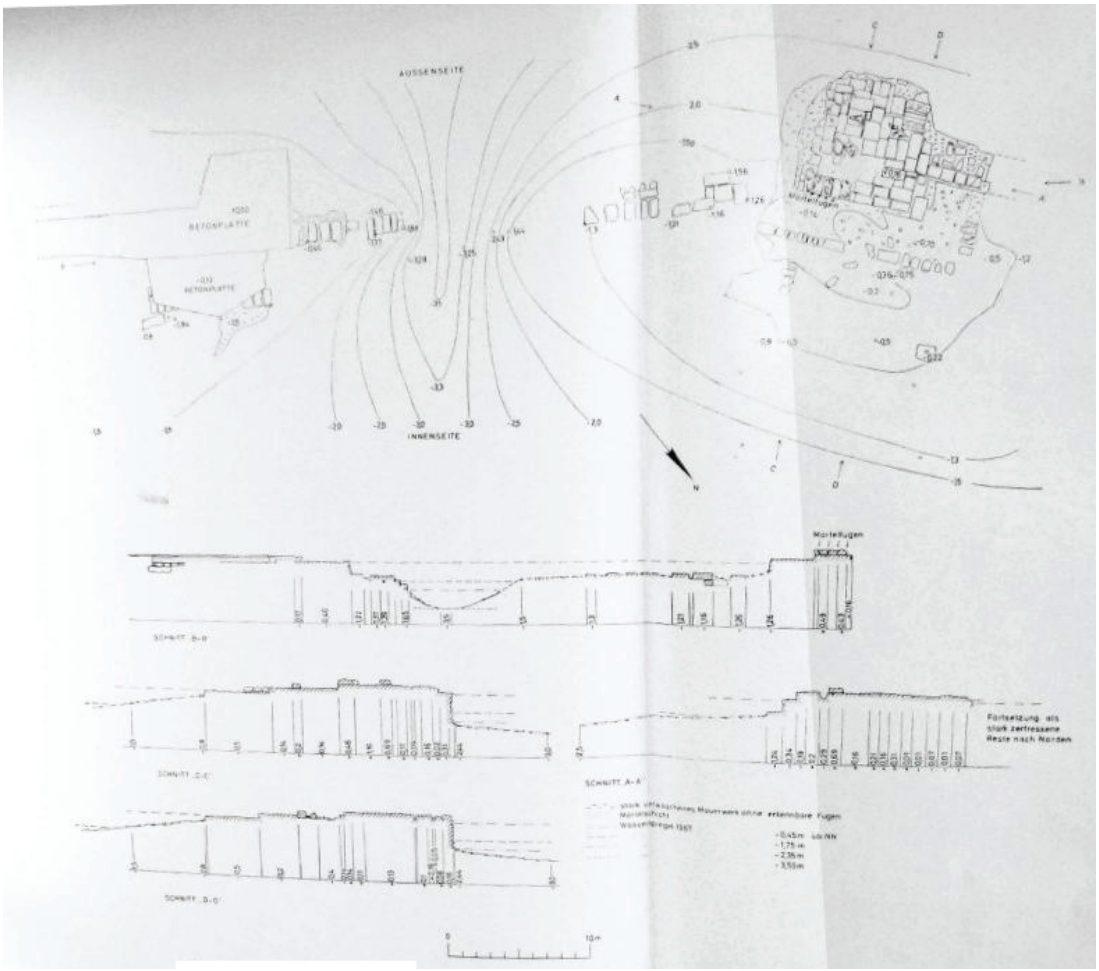
AUSSENSEITE
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BETONPLATTE
Mörtelfugen
SCHNITT B-B'
SCHNITT C-C'
SCHNITT A-A'
SCHNITT D-D'
Fortsetzung als stark zerfressene Reste nach Norden
-0,45 m
-1,75 m
-2,35 m
-3,55 m
0
10m

The harbour in the South Bay

Preface

Plate 13 shows the overall situation whereas Figure 17 depicts the cartographic recording. Without the existence of structures, this coast would not be serviceable as harbour. Here, the country comes completely plain ashore to a shallow bay. It should be pointed out that at this spot a valley encounters sea from the inland. At the time of recording, the bay in the east was surrounded by three coffee houses and a cinema, while a small shipyard had been established in the north. Except for parts of the northwest side, the walls of the harbour are clearly to be seen in the water.

The shallow bay was finalised by two lines of wall, of which the north-western line leads straight into the sea in a south-western direction, and to which a another wall, at right angles to it, is attached in a south-easterly direction. The harbour entrance finds itself in the middle of the course of this wall. On the northwest side the wall is characterised by two bendings which, as we shall see later, are associated with the ship houses adjacent to the northwest wall. The course of the recent coast line in its present oval shape cannot have been the original landside boundary. Here the siltation, and to some extent certainly also a deliberate backfill, has played a significant role.

In a heavy rain, close to the south of the northern coffee house, near the passage through the wall, we found two ashlars which were eroded by the incoming water (Pl. 26 b). But then, a few days later, the stones were submerged again. Unfortunately, this humble finding no sufficient prove for determining the forefront of an inner quay. A structure like this would normally include several such quays, however, their existence can only be determined by means of an excavation. Before the establishment of the modern harbour basin, the south-west wall ran straight through to the north-east corner of the commercial harbour. Regarding the earlier state behind the quay wall, which connects the Naval and the commercial harbour, a reference to Leake's note shall be pointed out (p. 56).

On the northwest side the relief of the harbour bed possesses a shallow plain with a breadth of approx. 35 m that takes almost the entire depth of the harbour basin. Here, most certainly, ship houses have been standing; this will be discussed later in the description of the north-west wall (see below, p. 77). The remains of ship houses, which Welter mentions in the south-east, could not be identified any more. If not the tides, though not too strong, would produce a suction effect in the area of the harbour entrance, as well as in the many places where the outer pier is badly damaged, and moreover, if not the sea level had risen, then the port would have been silted up completely a long time ago. **[PAGE 75]** For reasons that are discussed below (p. 79), the piers and ship houses seem to have been built on dry land, which raises the question of their foundation.

There seem to exist two possibilities of foundation. The order of description of these possibilities does not imply the authors preference for either one or the other (Fig. 17).

The first possibility would be the following:

Before the construction of the harbour there was only a shallow bay, whose beach was much further inland than today. The beach was shallow and flat. In the eastern part one could see the traces of the land-side inflow caused by siltation. At that time, however, the motion of the sea coming from north-west had ensured that the deposits were largely driven off towards south-east.

The isobath -2.5 m (= -2.05 m below the present average sea level), closely running in front of the Kolonna Hill, came from the north-west and continued in the same direction straight on to the south-east. At the point at which the north-western harbour wall was connected to the city wall, it possibly had a small deflection to the southwest. From here it probably continued east of the former cinema directly to the harbour promenade, where it then caught up with the connection of its present location. However, this cannot be said with certainty, but to some extent it would explain the comments made by Leake (p. 56).

Now, in the construction of the harbour, the area of the ship houses as well as the foundations of the walls were banked up to a height above the sea level at that time, and then the ship houses and the wall were erected in top of it.

Caused by the subsequent offshore sedimentation in front of the north wall, which emanates from the erosion in the area of the Kolonna projection, the notch between the north-west wall and the city wall was aggraded, and because of that they could no longer be carried away. The siltation of the harbour by the landside influx caused a narrowing of the basin. The symptoms of this siltation, being effected both from the outside and the inside, as well as the debris of destroyed walls, are the reason why these landfills are not easily visible or determinable any longer today.

The "basins" between the Naval and the commercial harbour, mentioned by Leake, would then have been shaped by the fact that the south-eastern part of the south-western harbour wall was lying seawards, at a certain distance of the shoreline, and that for unknown reasons the space had not been filled completely. Due to the destructions, caused by the construction of the modern basin, an investigation is not possible any more.

The second possibility would be the following:

A group of cliffs, lying in the bay, was used to build the walls. If necessary, here and there the missing height of the foundation could be **[PAGE 76]** obtained by a bankfill. In the area of the ship houses this would have been most needed.

The only counterargument against the first possibility is the very poor levelling of the top edge of the backfill. Thus, the western corner of the harbour and the wall at section C, to be seen in Figure 18, are founded at a deeper level than it would normally be the case. The ratios of inclination of the outer embankment are very plane. They are between 1 : 4.5 and 1 : 6.8. Over a distance of 35 m, the seabed declines with similar conditions.

In Anthedon, Schläger found the steepest slope of the embankment in the northern pier with 1 : 4.1, while the smallest slope was 1 : 4.7. All other ratios of inclination in Anthedon are ranged between 1 : 2 and 1 : 3 (except in the eastern mole with 1 : 7.8). These tendencies correspond to the proportions at the breakwater in the North Bay of Aegina with 1.0. Unfortunately, no conclusive evidence for the existence of a landfill can be provided hereby, especially because the angle of inclination may have been changed by debris and siltation.

Except for in the report by Leake (see above, p. 56), a to some extent plausible argument for the conceived direction of the isobaths in front of the wall cannot be found. Given the existence of some natural rocks who would have stopped the affluxion of the water coming from the northwest, the most probable counterargument against the second possibility is the fact that the siltation of the harbour must already have existed during the construction of its walls. The author tends to favour the first possibility, which, however, does not rule out that here and there ashlars may have been implemented/integrated in the construction of the south-west wall. Definitively, these questions can only be resolved by means of an underwater excavation.

The North-West Pier and the ship houses

The beginnings of the northwest wall from the landside has served no hydraulic construction purposes. These are the remnants of which are related to the city wall, which at this point had been connected to the Naval Harbour. This was also the only spot were lewis holes were found. The nature of the foundation remains shows that there is no technical and temporal relation with the outer parts of the North-West Pier. Furthermore, it seems that were at least three construction periods. Another remnant of this group of constructions (Fig. 19) - which is, however, not to be identified any more - is the strip of mortar rubble masonry, located at this corner on the seaside.

A gap of about 8 m follows, in which are found no traces of building remains. Then some first constructional remains of the North-West Pier are to be found in a very bad state of preservation. Following the rubble to the south-west, i.e. into the sea, the conditions are improving. It is a masonry that originally was constructed of carefully and well worked ashlars of normal size.

Since the surface is very battered, nothing certain can be said about its construction. However, it seems clear that this is not a double-leaved **[PAGE 77]** masonry. The masonry reaches down to the sea bottom, where in some places the protruding foundation is visible. At least in the butt joints the walls are mortared.

The average thickness of the wall is 2.80 m (Fig. 19). At regular intervals 6 rows of stretchers protrude into the basin (Pl. 27 b). Plate 27 depicts the ending of the south-eastern row of stretchers. The distances between the centres of each wall tongues are exactly 6.60 m. The interior width varies from 5.75 to 6.17 m. In the majority of cases it measures 5.77 m. For the correlative distances of the

ship houses in Piraeus, Bernhard Graser quotes 4.27 to 6.01 m.[26] Substituting these series of wall tongues inland, casually one might think of another 3 wall tongues, the last of them which would begin around the last land-side end of the actual North-West pier debris. One could even proceed this row.

The length of the ship houses can be assumed to be 37 to 40 m.[27]

This would result in the following:

The very slim northern part of the South-East Pier constitutes the outer wall of the ship house(s) (Fig. 17). But even if the South-East pier constitutes the wall of the ship house(s), it cannot directly approach the North Tower of the harbour entrance, whose location obviously seems to be predetermined. As long as the pier simultaneously constitutes the side wall of the ship houses, the required perpendicular angle to the north-western wall of the harbour forces it to a change of direction. Obviously the construction(s) were carried out by two working groups. One began at the tower of the harbour entrance, seeking for the western corner on a straight path. Simultaneously the other group built the ship houses with the North-West Pier. The two groups found their contact point by buckling the South-West Wall twice near the entrance of the ship houses.

South-eastwardly in front of these wall remains a horizontal plane lies in the harbour basin in an absolute level of -1.0 m. This area is covered with a layer that consists of mortar, stones and pottery sherds. From this area, the harbour bed declines moderately to a depth of -2.80 m, related to s.l., respectively 2.35 m below the present sea level.

It is very difficult to tell, whether this layer constitutes the sintered remains of the ship houses or the remains of a floor pavement. Further south-westwards, in front of the last three courses of the wall, there lie some foundations of ashlars (Pl. 25). The presence of ship houses at this location is therefore assured. What is striking is the absence of keel channels. The walls cannot be part of the keel channels, because they rise too high. Furthermore, it has to be noticed that here the ground of the harbour lies approx. 0.5 m to 1.0 m higher than outside of it. On the outside, in some places the foundation of the walls is visible. On this see the 1st, the 4th and the 6th cross-section of the wall counted from the left in Fig 19, and **[PAGE 78]** see also Plate 28 a. Therefore the author tends to believe that this material, which finds itself within the harbour in the area of the ship houses, must be the remains of the ship houses. In this context the piece of a semicolumn (Pl. 28 b) should be mentioned, which was found in 1965 at the eastern end of the city wall, i.e. directly lying on the corner where the city wall met the harbour wall.

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[26] B. Graser, Meine Messungen in altathenischen Kriegshäfen, in *Philologus* 1872, 31. Band I (old numbering) 1.

[27] D. Blackman, in S. Morrison - R. T. Williams, *Creek Oared Ships* (1968) 181 ff. Here the relevant material, especially from Piraeus, is discussed.

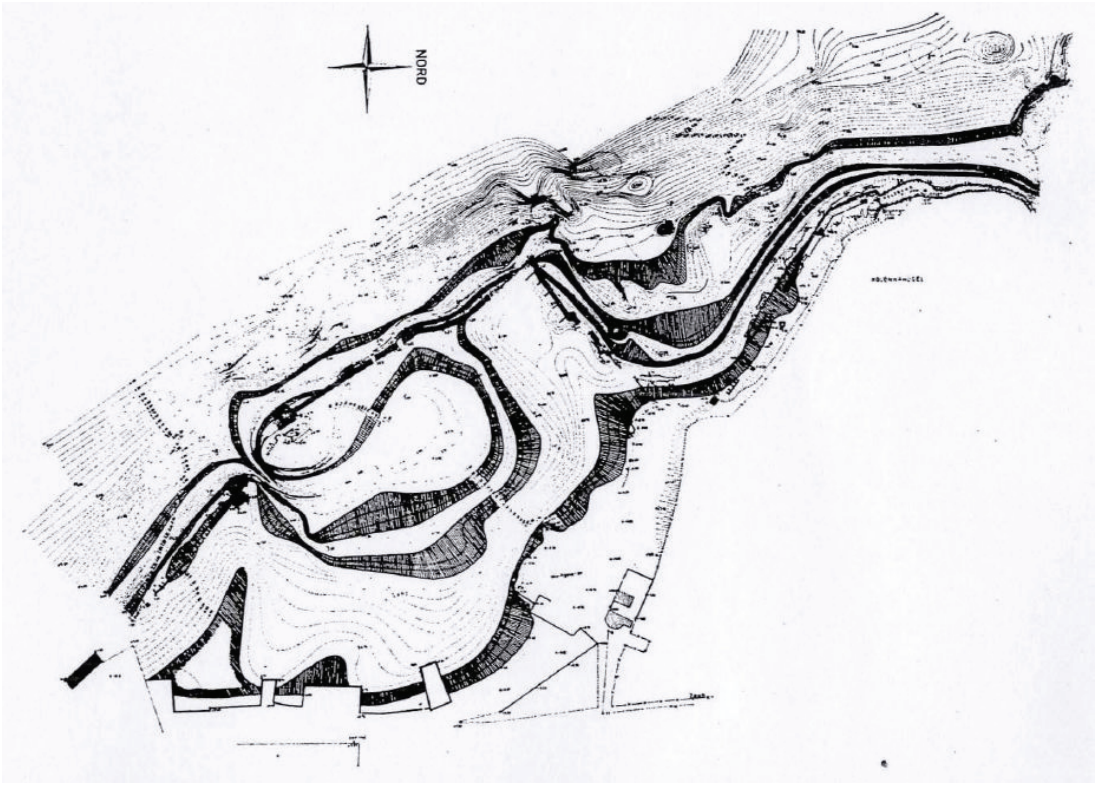

Fig. 21. Representation of different sea-level heights in the South Bay in respect of the practicability of the particular buildings.

First shore zone [littoral zone] from the west -3.55 m above s.l. [sea level]

Second shore zone [littoral zone] from the west -2.35 m above s.l. [sea level]

Third shore zone [littoral zone] from the west -1.75 m above s.l. [sea level]

Eastern shore zone [littoral zone], recent -0.45 m above s.l. [sea level]

The strips represent the degree of fluctuation of the tides. These are the sea levels, which can be determined from the above-mentioned [numerical] values.

Generally there was so much space at the end of the ship houses that materials and equipment could be stored there. Practically seen the ship houses would then have been accessible from behind. However, the northern harbour wall, which also constitutes the rear wall of the ship house(s), is only 2.80 m wide. Since at least half of the width would have been reserved for the city wall, an access, located at the inner side, could barely have featured enough space to transport materials of any kind.

Beyond that, no traces of steps or foundations of stair constructions have come to light on the inside. The partition walls of the ship houses are completely embedded into the city wall. No passages are visible. It must **[PAGE 79]** therefore be adopted, in this case, that the ship houses were entered from the harbour side and that the materials were brought in from there. Obviously, in cases of an occupied ship house, the narrowness which would complicate the handling of material(s), was accepted. A weakening of the North-West Wall was not hazarded.

The foundation of the NW wall of the Naval Harbour is located at a depth of -1.55 m over s.l., respectively -1.10 m below the present average water level.

This wall, with its slenderness, must not be constantly exposed to the motion of the sea, therefore the water level must be reduced at least by a further 0.65 m to a height of -2.20 m above s.l. Since the time for the erection of this wall, an increase of 1.75 m would have to be concluded at this point.

The front of the ship houses is located at -1.35 m over s.l., respectively -0.90 m below the present average water level (Fig. 17). As mentioned previously, the remnants of the destroyed ship houses are still lying at this spot, covering the keel channels. Thus, it can be assumed that the ground has risen by about 0.35 m.

As is well known, ship houses are built aground.[28] Assuming a 5 m foreland in front of the ship house gates, during the period in which the ship houses were built, the water level would have had to be another 0.3 m lower than today. Thus, a rise in sea level by 0.90 + 0.35 + 0.30 = 1.55 m minimum would have to be concluded. At that time the water level was therefore at about -2.00 m above s.l.

The South-West Pier and the harbour entrance

This pier lies up to the pier head entirely in the water. To some extent only several ashlars are visible, lying in a row (Pl. 29 a). Especially the slenderness of this wall is striking, which in the area of the ship houses, i.e. on the northern edge, is only about 1.25 m thick. In the following piece, that has been preserved better, its thickness is about 2.60 to 2.8 m (Pl. 29 b). For a wall that would be exposed to the surf, which might be the case here, a single-leaved construction with a thickness of 3.8 to 4.0 m would statically be a very disadvantageous solution. This conclusion was already stated by Schäfer in connection with his investigations of Larymna. The South-West Pier is a single-leaved wall which is only 2.60 to 2.80 m thick. Hence, in order to be out of reach of the surf, it was built so high above water level.*[NB!]*

Figure 18 gives an complete account of the character of the wall. As a general rule, two rows of ashlars are still visible of the entire construction. It should be noted that the foot of the wall has not been found; it is certainly buried under the debris.

It is not till the surrounding of the pier head, that the remains become considerable. The wall was mortared at least in the butt joints. The harbour entrance **[PAGE 80]** was protected and marked by two quadrangular towers, whose bases are still visible (Pl. 31). Obviously, this system has been repeatedly expanded and renewed. The recordings of the stones of the harbour entrance (Fig. 20) show two similar towers on both sides of the entrance, whose exact size remains undeterminable. Ascertained is, however, that once both heads had been enlarged towards the inside and, in later times, that at least had been build at the right head, which can clearly be seen in the better-preserved

[28] C.f. note 23.

ashlars and the better preserved mortar. The ashlars of the pier head are about 60 cm long and 35 to 42 cm wide. At some time the harbour entrance itself has been narrowed artificially. The author is of the opinion that this has happened at an early stage, because in the subsequent amplification of the towers nothing has happened at this point. Moreover, only at a low water the narrowing makes sense (Fig. 20). In order to give bathers a better stay, today the south-eastern pier head is covered with a [large] concrete paving panel. From here and forth, the wall continues in the same manner to the cinema corner and in front of the construction of the modern harbour till the South-East corner of the commercial harbour (Pl. 30 and 32). The measurement of this part has been postponed to a later date at the time of our investigations. Since the walls were lost at least partially during the construction of the modern harbour basin, unfortunately now this investigation is no longer possible.

Their location, however, is known. By examining the findings in relation to earlier sea-level heights, the following considerations and conclusions can be obtained: At the outer wall the seafloor is 2.4 to 1.8 m below s.l., that is 1.95 m and 1.35 m below recent average sea level. Due to the slenderness of the pier, a foreland of minimum 4 meters is needed to protect it from the direct sea motion. In order to acquire this, at least another 0.4 m has to be added the above values, so that one would end up with a sea level decrease of 2.35 m, respectively 1.75 m. At the time of construction of the Naval Harbour, the sea level would then have had an absolute level between -2.8 m and -2.20 m. A limit for the lowest level is given by the level of the ship houses and the shape of the harbour entrance.

Then the narrowing parts of the harbour entrance would suddenly have gotten a real function. For the usual ships at that time the water depth would have been sufficient, even if not taking a siltation of the entrance into consideration. Due to the suction effect of the tides in this area and because of the general shape of the cross-section through the entrance (Fig. 20) which does not allow a dimple without compromising the buildings at the entrance, a siltation of significant scale may not be expected.

The commercial harbour

In the area of the commercial harbour no investigations were carried out. The information on the conditions at the time of the work of recording, given in the present schedule (Fig. 22), **[PAGE 81]** is sufficient The depths are known. What is lost for all time, is a quay wall in the harbour, which was torn down during the construction of today's quay wall, which separates the big from the small harbour. In contrast, the other quay walls in the south, east and north and partially also in the south-west have been preserved since they are lying underneath the modern courses of walls, which also in medieval times have been used as a base for reconstructions. Good evidence of this is the Tower of the Morosini, which among other was rebuilt by this Doge (Pl. 33). The water depth in the commercial harbour is about 2.7 m, partially the harbour has been deepened by dredging. In connection with the construction of the modern ferryboat harbour (Fig. 22), the formerly plentiful remains of the joining wall between the Naval Harbour and the commercial harbour have been

removed. Both their location as well as the location of the side walls in Plate(s) 30,32 is captured in the map of the area.

PART III, SUMMARY AND ATTEMPT OF DATING

In the discussion of the breakwater in the North Bay, the various piers in the South Bay, the ship houses and the city wall, along the coast of the Kolonna Hill, very different values of the effectual sea levels at the time of the construction of the individual buildings.

We have investigated the functional capability of the various buildings, determining the required water level at the time of construction. In doing so, their shape and the technical task were to be considered. This means that all the above mentioned negative level shifts, calculated within a certain range which is hard to determine, could be bigger, but in no case smaller than estimated.

The result can be summarized in the following table (all dimensions in m; see also Fig. 6 and 21).

From the table it is clear that

1) at a depth of -4.00 m, the Naval Harbour was dry. The Kolonna Hill stood about 30 meters into the sea, at one point even up to 60 m.

Considering Figure 7 based on the Negri's paper, we see that all the off-shore reefs, which are marked in the drawing with "A", stood out from the sea.[29] Only with a small reef they blocked the entrance to the North Bay, which was protected by the fully functional breakwater. Therefore, at that time, only the North Bay could have been used as a harbour, not least also because the fact that the area of the harbour in the South Bay (Naval Harbour) was dry. A dual harbour on both sides of the Kolonna Hill, as presumed by K. Lehmann-Hartleben, has not existed.

2) The other structures, such as city walls, Naval Harbour and ship houses in the south of the Kolonna Hill and all facilities in the North Bay, could have been built at the same **[PAGE 82]** time, [30] considering only the height of the water level.

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[29] Ph. Négris, Vestiges antiques submergés, in *AM* 29 (1904), 348 f.

[30] In Fig 17 the three critical points are seen, namely the west corner of the Naval Harbour in the southern third of the South-West Pier and the two entrance towers. Here a foundation in water would have been necessary. Since the depth, however, was only 0.6 m, no particularly extensive precautionary measures were needed to build the piers, as suggested by Schläger in connection with the investigations in Anthedon (see also line 7 of the table above, p. 82). The problem here is not based in the technology of the construction of the wall, but in the fact that the water has scoured the wall foot from the very beginning, which would be regarded as a technical defect in the system.

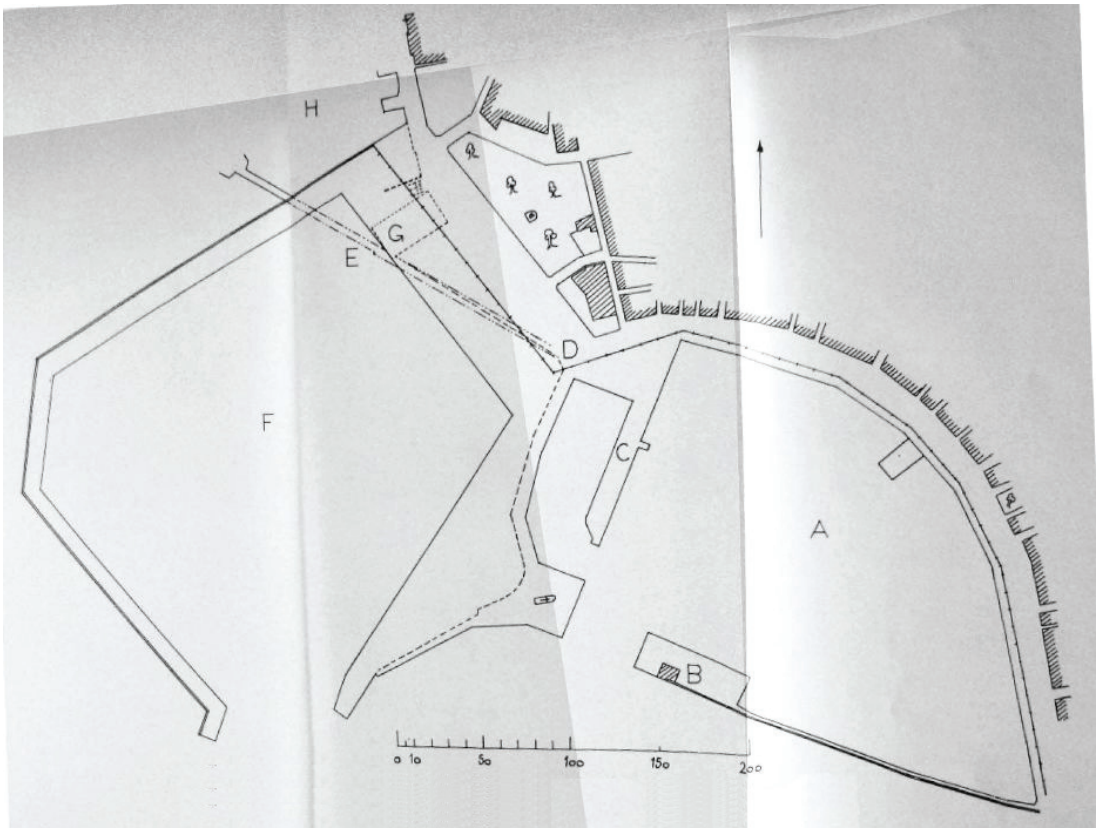

Fig. 22. The recent commercial harbour (A) and the ferry boat harbour (F). On the eastern side of the harbour entrance (B) the tower of Morosini was situated (see Pl. 33). During the construction of pier C, the ancient ashlars were torn out, which everywhere else rest under the recent quay walls. Former open-air cinema (G), ancient compound wall (D-E) between the Naval Harbour (H) and the commercial harbour (A). The drawing is based on Greek documents.

	Investigated area m	Highest required water level above s. l. at the time of construction m	From column 2: rise of water level until today m	Possible highest water level above s. l. at the time of construction m	From column 4: rise of water level until today m
	1	2	3	4	5
1	North Bay Breakwater	from -4,00 to -4,50	from +3,55 to +4,05	from -4,00 to -4,50	from +3,55 to +4,05
2	North Bay Buildings	-2,20	+1,75	-2,20	+1,75
3	City wall West coast Kolonna	-1,40	+0,95	-2,29	+1,75
4	NW wall Naval Harbour	-2,20	+1,75	-2,20	+1,75
5	Ship houses Naval Harbour	-2,00	+1,55	-2,20	+1,75
6	SW wall Naval Harbour general	-2,20	+1,75	-2,20	+1,75
7	SW wall Naval Harbour lowest elevation (length ca. 10 m)	-2,80	+2,35	(-2,80)	(+2,35)

The siltation of the Naval Harbour, which is correlated to the rise in sea level, **[PAGE 83]** does not allow a good reconstruction of previous states (Fig. 21). Based on the drawing it is, however, possible to recognise the waterline in the vicinity of the walls and in front of the ship houses at the time of its construction. In the meantime, the siltation which has approached from the east, has narrowed the harbour basin very much. Certainly, it has occupied the entire space up to the landward quay (which still has not been found). The siltation in the North Bay, however, is not so much of consequence, because no inflow from the land is possible.

Under the assumption of a linear water level rise, [31] the following chronology could may be deduced since ancient times:

Large breakwaters in the North Bay — *1880 BC*

Construction of the 1st harbour in the South Bay — *480 BC*

Last reconstruction of the harbour in the South Bay — *750 AD*

[31] P. Knoblauch, Neuere Untersuchungen an den Häfen von Ägina, in *BJb* 169 (1969), 104 ff.

As for the extent of sea level fluctuations as well as their timing and duration, so their individual impacts - as shown above - not known. To a certain degree the construction phases, mentioned above, can be obtained by a comparison with the evidences of what has been preserved.

A Naval Harbour, whose walls are built on dry land and which is provided with ship houses, is secured. At least in parts of the walls mortar was found.

A Naval Harbour with ship houses can only have been built in the heyday of Aegina, that means before 452 BC, the year of the destruction of Aegina. Since we know that both the city wall and the harbour were built in 480, this date is set. Thus, in the year 480 BC, the walls of the south-western Naval Harbour, the entrance towers with their narrowed languets and the ship houses had been built.

The city walls did probably enclose two harbours: the commercial and the Naval Harbour; then they continued along the foot of the Kolonna Hill - approximately parallel to the current course of ruin(s) - following up on the Kolonna Hill from where it descends into the North Bay. Here it either followed along the location where today, at a very low level, a marginal and non-definable wall is to be found, or it followed at half height the existing course of a wall to the centre of the North Bay, from where it then increasingly continued rightward to the quarry.

The North Bay was no longer in use as a harbour, the parts of the breakwater still visible had no effect for navigation, and the non-visible remains were even a danger.

The buildings, formerly erected here at the time of their use, were abandoned or were still resided outside the wall.

The city wall followed the quarry, from there it continued close to the location where the basilica was later erected, on Odos Achilleos, in order to follow this way to the southern corner of the commercial harbour. Likewise, also this harbour had at this time probably be included in the wall enclosure. However, no structural evidence is available to proof this.

In 452 BC the Athenians dismantled both the city wall and the harbours.

[PAGE 84] Since the ship houses were military facilities, they had surely also been destroyed. Therefore, with the exception of some more or less significant remnants of the 480 BC-built walls, in 452 BC nothing should be found.

In 322 BC, the ship-owner Lampis erected public buildings and the "Emporion", whether this also included all sections of the harbour is not apparent from the written sources.[32] The discovered building remains, however, would certainly fit chronologically. In the meantime, the sea level had not increased too much. The walls, which were destroyed by the Athenians approximately 130 years

[32] Demosthenes, *In Aristokratem* 211 (691) :
.... κατεσκεύασεν τὴν πόλιν αὐτοῖς καὶ τὸ ἐμπόριον ....
regarding the ἐμπόριον c.f. Lehmann-Hartleben *a.O.*, 28 ff.

earlier, could easily have been rebuilt on dry land on the same spot, using still existing remains. The insignificance of Aegina at that time makes it very improbable that the ship houses were rebuilt too.

The presumption of Welter, that the coins from the era of Julia Domnas attest an restoration of the harbour area, can thoroughly be supported by the results of the investigation of the buildings. The wall used to run along the trace of the South-west wall of the Naval Harbour, then it ran along the North-west side of the former rear panel of the ship houses, from where it then turned northwards in order to reach the city walls, running along the remnants of a mortar rubble masonry.

The parts of the city wall, built in a chamber system, were not yet built at that time. As for the rest of the wall, the above mentioned remarks do remain.

Compared to 480 BC-conditions, the siltation of the Naval Harbour basin of 322 BC was not significant.

In 122 AD, i.e. about 450 years later, Pausanias visited Aegina.

The breakwater of the North Bay was no longer visible. The city wall and the harbour wall were destroyed. The North-west wall ruins of the Naval Harbour looked like a dumped dam that protruded into the sea. This led Pausanias to place the legend of Telamon there, which - as we know - is wrong. A destruction of the Naval Harbour and the wall between 320 BC and 122 AD, nothing has come down; however, there were plenty of opportunities.

Undoubtedly, at that time the main focus of the building activity were in the commercial harbour. This was of good use. The rising water level was advantageous. The sedimentation that took place here, had not the same extent as in the South Bay. In addition, the city had also moved further south.

Nevertheless, traces of this activity can be seen in the Naval Harbour. But the harbour could never regain its old importance. Ship houses were not rebuilt. Later masonry was placed on the existing foundations, which for the most part stuck out from the surge, respectively were lying in the water level at that time. The mortar remains must likewise date to this period.

[PAGE 85] The restoration of the seaward-side walls of the Naval Harbour would probably have been easier than a complete rebuilding along the coast. Then, at the corner of the city wall and the North-west wall of the Naval Harbour, the construction of buildings, of which traces are visible as a rectangular foundation, begun. The city wall, built in the chamber system,, was extended straight to the east, until a right angle was obtained/achieved between the two connected walls. Moreover, the city wall was re-erected on top of the old foundations.

There question remains, however, when the great breakwater in the North Bay was built. It has become clear that the calculation attained by means of the linear shift of the beach is not realistic (see above, p. 83). On the other hand it is certain, that the breakwater in the North Bay was built much earlier than the remaining constructions. It would be obvious to date its construction period in the $7^{th}/6^{th}$ century BC. This would be contemporaneous with the independent Aegina (730-459). The

oldest known coinage in Aegina, dated to the middle of the 7th century, implies this independent state. Regarding this theory, however, we must clarify - in case this assumption is correct - that the water level had increased by 2.00 m in 250 years. It is remarkable that no reports in this issue are known.

The widely branched trading, which included both Spain and Egypt,[33] reveals how large the merchant fleet of Aegina must have been already at that time.

It cannot be excluded that the great breakwater already might have existed in the period of the Greek Colonization, a time when Hesiod praised seamanlike glory of the Aeginetans.[34]

« οἱ δή τοι πρῶτοι ζεῦξαν νέας ἀμφιελίσσας,

πρῶτοι δ' ἱστί' ἔθεν νηὸς πτερὰ ποντοπόροιο »

Stuttgart PAUL KNOBLAUCH*

*) *Translation: mag.art. Sascha Mauel, Thessaloniki (2010)*

33 C.f. note 4.

34 Hesiod, Fragt. 205, ed. Merkelbach - West.