THRACIA PONTICA V

VARNA 1994

SOMMAIRE

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17 Selon Christophe Giros, que je remercie pour cette indication.

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UNDERWATER EXCAVATION AT THE ANCIENT PORT OF THASSOS

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Since 1984 the Greek Department of Underwater Antiquities in collaboration with the French School of Athens has been excavating a classical ancient harbour at Thassos - an island in the Northern part of the Aegean Sea.

The present-day harbour of Thassos is situated on the ruins of the ancient port.

The shallow depth, which varies from 1.5 m to 3 m, as well as great quantity of displaced stones and the bad visibility due to the modern sewage that empties into the ancient port, made working condition very difficult.

. However, despite all these difficulties, we have managed to get a clear picture of the ancient port of Thassos.

We are now sure of the correct topography of this port, wich corresponds to LIMEN KLEISTOS, recorded on ancient inscription found at Thassos.

We have also uncovered three periods of constructions: the Archaic, the Late Classical and the Early Christian.

THE ARCHAIC PERIOD

The discovery of the archaic port was a surprise to us. It is larger than the classical one and lies outside of it, towards the open sea. The archaic mole starts from NE of the geen beacon light by the entrance of the present-day harbour and can be traced for the distance of 120 m westward towards the modern landing pier.

The mole is built of schist and marble. The marble blocks which are 2.2 x 1 x 1 m in size formed the top courses of the mole. They were laid out as headers and stretchers and were connected to one another with double axe-shaped metal clamps, from which only the clamp-holes have remained. We have dug two trenches along the inner and outer sides of the mole and we found out that it consisted of at least four or five courses. The schist blocks are 1.5 m in wigth and 0.30 m thick. Their building pattern is the same as that of the marble blocks, and in many cases they have clamp-holes of the same type as those of the marble ones.

The outer side of the mole consisted of four thick courses constructed so that to be able to protect the mole from the waves.

The inner side consisted of five courses of schist including the socle that projected beyond the rest. The mole was built upon a layer of sand and gravel artificially constructed on the top of of the natural rock.

The double axe-shaped fastenings were used at the end of the 6th and during the 5th century B.C.

This mole was destroyed at some point during the end of the 4th century B.C. as demonstrated by seals on the handles of amphorae from Thassos, which we found encrusted into the beach-rock. One handle bears the names of THASION and ARISTODIKOS and dates to the last decade of the 4th century B.C.

The distruction of this mole was probably due to an earthquake or a landslide, and the beach rock was formed immediately afterwards.

THE CLASSICAL PERIOD

The Closed Classical port was built on dry land, as shown by the method of its construction, which differs significantly from other ports such as that at the harbour of Amathus in Cyprus, where blocks were placed into the sea.

A sea wall starts from the western side and continues westward for 120 m ending at a circular tower, which was excavated in 1984.

At this point the wall turns a corner and continues in NE direction for 31 m, reinforced at its end by another circular tower. The first circular tower is 8 m in diameter and the second tower is 8.66 m.

On the opposite side the sea wall meets the city wall at a right angle. This section of the sea wall is 148.6 m long measured from its beginning to the point of its intersection with a third circular tower, which has a diameter of 10 m.

At this point it makes an angle, and continues westward for 45 m, where there is a forth tower 9.6 m in diameter.

We have dug a trench along the east side of the 3rd tower, where three courses of schist blocks were uncovered, each one being 0.40 m high. Under the foundation of the tower there is a great number of Attic black glazed scherds, which date this tower to the end of the classical period. A trench dug at the foundations of the 4th tower date it to the same period as the 3rd tower.

All the structures, described above, are in fact extensions of the city wall fortifications which encircle the military port, thus forming a closed harbour in a way, that it corresponds to the ancient term LIMEN KLEISTOS.

To the East side of the classical port we discovered some others installations, that were a surprise to us. It is a long wall about 40 m long which is situated at the inner part of the harbour basin, between the 3rd and 4th towers, and right in front of it to the ancient sea wall that connects the two towers. This wall turns at a right angle for another 20 m and stops there. It was constructed by schist slabs in 5 courses sometime at the end of the 6th or the beginning of the 5th century B.C. and it continued to be used even in the 4th century B.C. After that a new 4th century wall was built, and the space between the old and the new one was filled with rubble. Both walls face NW, but they are not parallel.

In 1988 during modern dredging works along the eastern part of the basin, a part of an ancient quay was discovered. It consisted of schist blocks similar to those along the archaic mole. We collected black glazed sherds, some fragments of Thassian amphorae and the neck of a Chian amphora, all dating to the 5th century B.C.

The quay, together with the two sea-walls, create a rectangular unit of some kind of harbour installation, so far unidentified. In our opinion there is a possibility that the ancient ship sheds were built here.

THE LATE ROMAN - EARLY CHRISTIAN PERIOD

The closed classical port ends with a north-western tower.

During the Late Roman period a new mole was constructed towards the west to join the northwestern tower with another structure, approximately 130 m away from it.

This mole was found to exist along the inner side of the basin, just bellow the present-day mole.

Three trenches dug along its inner side produced a series of monolithic rounded columns, placed vertically in a semicircular order. The columns end at a rectangular structure consisting of two courses of architectural pieces. The rectangular structure belonged probably to a fortification tower.

The foundations of this tower vary from course to course. The bottom course consists of a line of rectangular blocks that were robbed from a 6th century B.C. building, as is indicated by its axe-shaped metal-clamps. Two clamps lead were discovered in situ. The second course consisted of various architectural pieces belonging to earlier buildings and were connected to one another with mortar junction. The preserved height of this tower is up to 0.40 m. A great quantity of LR1 - LR13 amphorae has been recovered from the excavated areas, thus dating this structure and the mole between the 4th and the 7th century A.D.

Many of these amphorae bear graffiti on their shoulders. It should be noted that part of the exterior side of the mole was protected from the waves by toppled architectural pieces thrown into the sea, that had originated from earlier buildings. A great deal of rubbish is always found in a harbour thrown from ships or from the piers, so that we were lucky enough to raise from the sea a very important inscription, which gives much information about the topography of the town and dates to the middle of the 5th century B.C.

We also collected many sherds dating from archaic times to the Turkish occupation, as well as beautiful sculptures such as the funerary stele depicting a warrior and two unfinished metopes from Roman times which show warriors fighting with swords.

Our investigation at the ancient port of Thassos will continue in 1992 in the area of the commercial harbour, that lies to the East of the closed port.

HOW THE HERODIAN HARBOUR OF CAESAREA WAS BUILT?

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A. The Literary Sources

Josephus Flavius' books are our ancient literary source for the construction of Caesarea and Sebastos. He was active some three generations after their inauguration by Herod, yet Josephus had spent time in Caesarea, long enough for careful observations around the city and its harbour, which was still in full operational state and much as Herod had built it. If there were few later additions, it seems as if Josephus did not include them in his narrative, which is always in the past tense, whenever describing Sebastos, its components and its construction. So he wrote[1]:

"...and the greatest work (in Caesarea) which has caused the greatest labour, was the establishing of a protected artificial harbour of still water, as large as the one in Piraeus, and which included quays, additional basins and extra mooring berths; but what was especially notable about this construction was that he got no material suitable for so great a work from the place itself, but completed it with materials brought from outside (the country) at great expense. Now this city is situated in Phoenicia, on the route to Egypt, halfway between Dor and Joppa. These are lesser cities, with poor mooring places, since they lie open to the southwest wind, which constantly sweeps the sand up from the sea floor on to the shore and thus does not permit a smooth landing. Most of the time merchantmen must ride unsteadily at anchor off shore.

To correct this topographic drawback, he (Herod) laid out a circular harbour on a scale large enough for a large fleet to be moored by the shore, and let down enormous blocks of stone to a depth of 20 fathoms. Most were 50 feet long, not less than 18 feet wide, and 9 feet high (15.3 x 5.5 x 2.7 m). The structure which he threw up as a barrier against the sea was 200 feet wide. Half of this opposed the breaking waves, warding off the surge breaking there on all sides. Consequently it was called *Prokumatia* (breakwater).

The rest comprised a stone wall, set at intervals with towers, the tallest of which, quite a beautiful thing was called Drusion - taking its name from Drusus, the stepson of Caesar, who died young. A series of vaulted chambers was built into it for the reception of those who come from the sea, and in front of the vaults - a wide, curving quay encircled the whole harbour, very pleasant for those who wished to stroll around. The entrance, or mouth, was built towards the north, for this wind brings the clearest skies.

The foundation of the whole encircling wall, on the port side of those sailing into the harbour,was a tower, built up on a broad base to withstand the water firmly, while on the starboard side were two great stone blocks, taller that the tower on the opposite side, upright and yoked togrther.

A continuous line of buildings, finished off with highly polished stones, formed a circle around the harbour, and in their midst was a low hill, carrying a temple of Caesar visible from afar to those sailing towards the harbour" (JA, XV: 331-339).

In his other composition, *The Jewish War against Rome*, Josephus wrote as follows (JW, I: 408-415):

"Having calculated the relative size of the harbour he let down stone blocks into the sea, to a depth of 20 fathoms. Most of them were 50 feet long, 9 feet high, and 10 feet wide (15.3 x 2.7 x 3.1 m), and some even larger. When the submerged foundation was finished, he then laid out the mole above sea level, 200 feet across. Of this, a 100 foot portion was built out to break the force of the waves, and consequently was called the Prokumia (break-water). The rest supported the stone wall that encircled the harbour. At intervals along it were great towers, the tallest and most magnificent of which was named Drusion, after the stepson of Caesar. There were numerous vaulted chambers for the reception of those entering the harbour and the whole curving structure in front of them was a wide promenade for those who disembarked. The entrance channel faced north, for in this region, the north wind always brings the clearest skies.

At the harbour entrance there were colossal statues, three on either side, set up on columns. A massively-built tower supported the columns on the port side of ships entering the harbour; those on the starboard side were supported by two upright blocks of stone - yoked together, higher than the tower on the other side. There were buildings right next to the harbour also built of white marble, and the passageways of the city ran straight towards it, laid out at equal intervals. On a hill directly opposite the harbour entrance channel stood the temple of Caesar, set apart by its scale and beauty. In it there was colossal statue of Augustus, not inferior to that of Zeus at Olympia, on which it was modelled, and one of the Goddess Roma, just like that of Hera at Argos. He dedicated the city to the province, the harbour to the men who sailed in these waters, and the honour of the foundation to Caesar".

The harbour in Josephus' description was called *Sebastos*, the "Benefictus", the Greek form of the Latin title *Augustus*, which was given to Caesar by the Roman Senate. The two differing names: "Caesarea" - for the city, and "Sebastos" for the harbour, had a very distinguished administrative difference. While Caesarea was a provincial *Polis*, with her semi-autonomic municipal institutions, such as Akko, Ashkelon, and the cities of the *Decapolis*; Sebastos was a Royal or state entity,with its revenues going straight to the Royal court in Jerusalem. The fact that Herod added new Polis within the boundaries of Judea, or his Jewish Kingdom, was considered as a deed of sacrilege and probably was the reason the Talmud called her "A post stake within Judea". Sebastos, as a separate entity was mentioned in several cases by Josephus[2], as well as in the epithet of Caesarea, on her coins that were issued up to the time of Nero (68 AD):

"Caesarea which is by the Sebastos harbour"3.

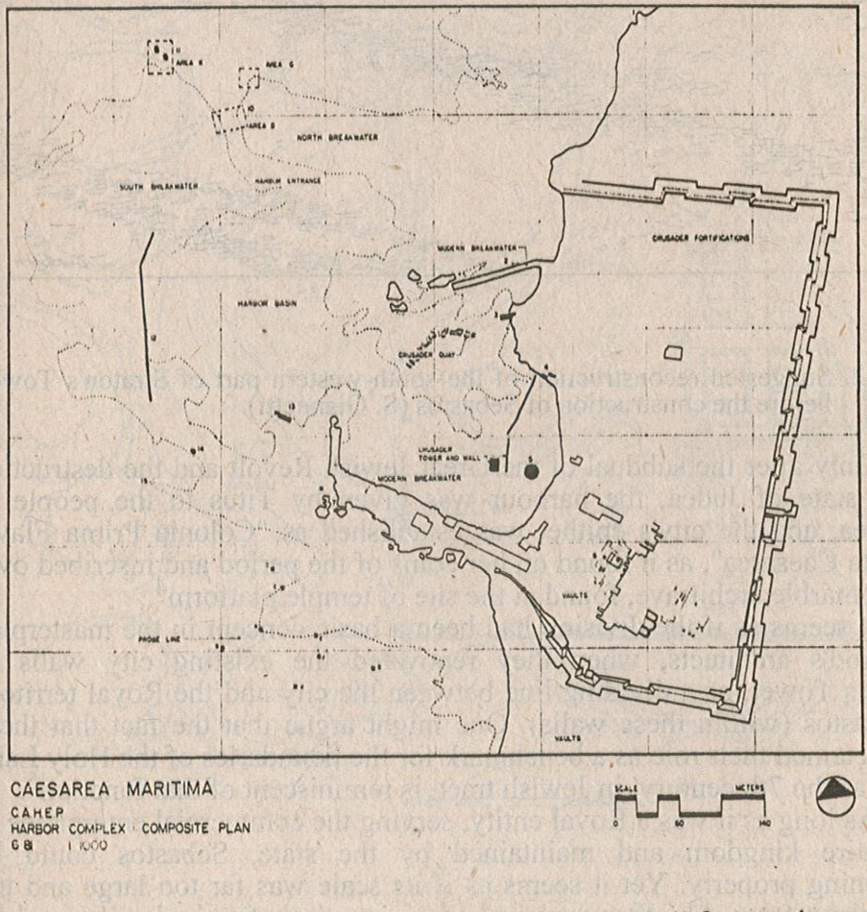

Figure 1. General plan of the harbour and the various areas of researches.

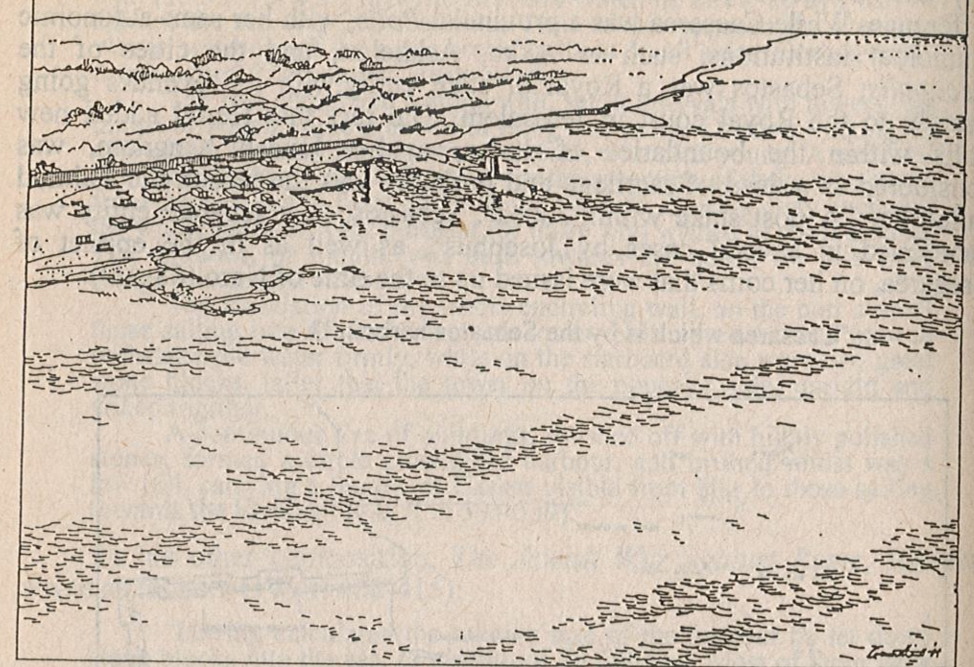

Figure 2. Suggested reconstruction of the south-western part of Straton's Tower, before the construction of Sebastos (S. Giannetti).

Only after the subdual of the Great Jewish Revolt and the destruction of the state of Judea, the harbour was given by Titus to the people of Caesarea, and the city's epithet was established as "Colonia Prima Flavia Augusta Caesarea", as it found on her coins of the period and inscribed over a large marble architrave, found at the site of temple platform[4].

It seems as if the division had been a basic concept in the masterplan of Herod's architects, when they renovated the existing city walls of Straton's Tower, as a dividing line between the city and the Royal territory of Sebastos (within these walls). One might argue that the fact that these walls retained their role as a benchmark for the boundaries of the Holy Land as late as the 7th century, in Jewish tract, is reminiscent of that function[5].

As long as it was a Royal entity, serving the commercial enterprises of the entire kingdom and maintained by the state, Sebastos could be functioning properly. Yet it seems as if its scale was far too large and too dear to be mastered by the municipal administration of a single city, such as Caesarea. For this reason, and due to the fact that the great moles were laid

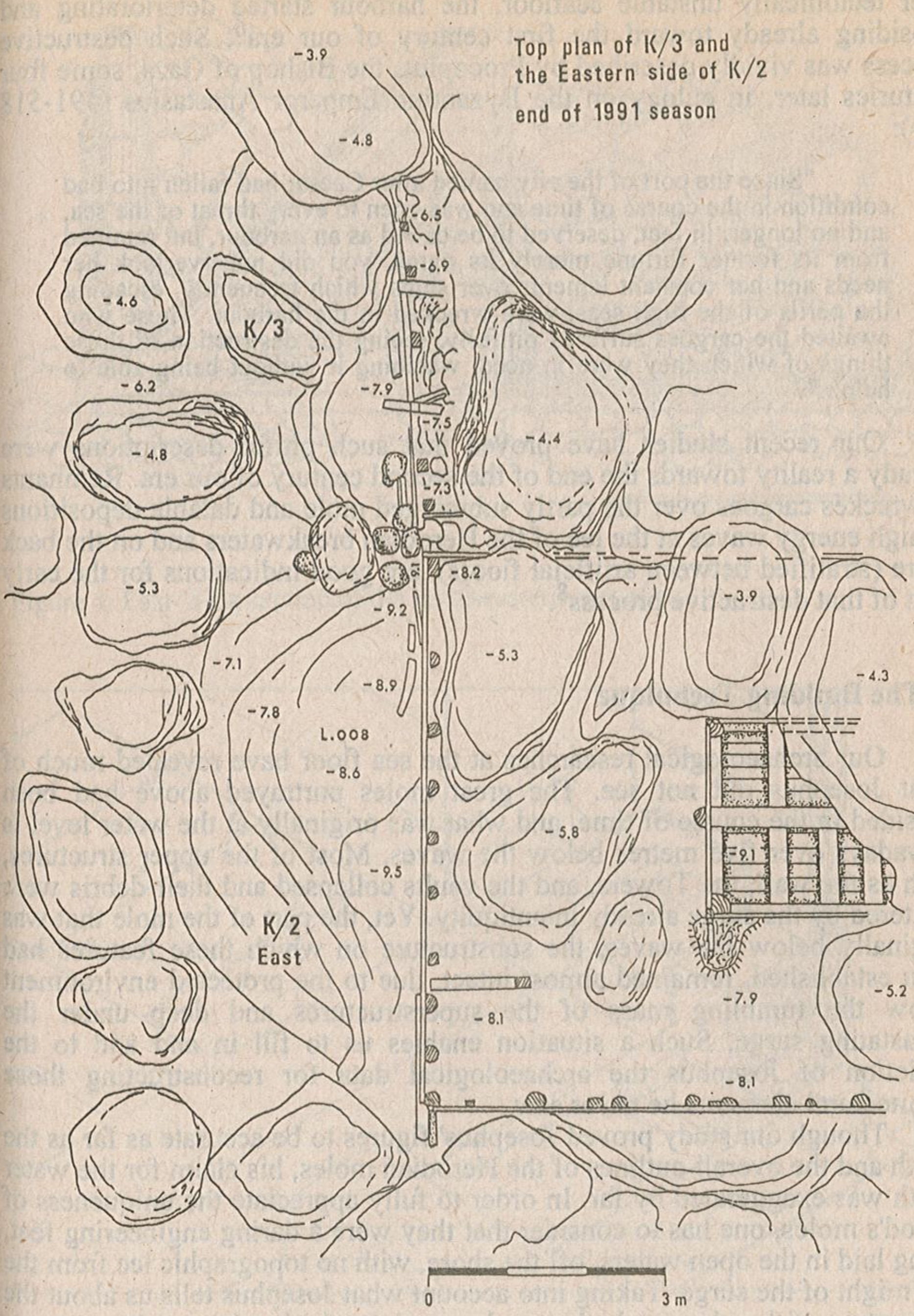

Figure 3. Plan of the rectangular form at the base of the Drusian at the northern tip of the great mole, area K-2 (Z. Friedman).

over tectonically unstable seafloor, the harbour started deteriorating and subsiding already toward the first century of our era[6]. Such destructive process was vividly described by Procopius, the Bishop of Gaza, some four centuries later, in eulogy on the Byzantine Emperor Anastasius (491-518 AD):

> "Since the port of the city named after Caesar had fallen into bad condition in the course of time and was open to every threat of the sea, and no longer, in fact, deserved to be called as an harbour, but retained from its former fortune merely its name, you did not overlook her needs and her constant laments over ships which frequently, escaping the perils of the high seas, were wrecked in the harbour. Those who awaited the cargoes suffered pitifully, seeing the destruction of those things of which they were in need, watching it without being able to help..."7

Our recent studies have proved that such pitiful descriptions were already a reality towards the end of the second century of our era. Remnants of wreckes cargoes over the partly submerged mole and datable depositions of high energy waves at the lee of the Herodian breakwaters and on the back shore (stratified between artificial floors), are good indications for the early start of that destructive process[8].

B. The Building Technique

Our archaeological researches at the sea floor have revealed much of what Josephus did not see. The great moles portrayed above had been subsided in the course of time, and what was originally at the water level is nowadays over five metres below the waves. Most of the upper structures, such as the wall, the Towers, and the vaults collapsed and their debris were scattered by the surge already in antiquity. Yet, the part of the mole that was originally below the waves, the substructure on which these features had been established, remained almost intact, due to the protected environment below the tumbling mass of the superstructures and deep under the devastating surge. Such a situation enables us to fill in and add to the depiction of Josephus the archaeological data for reconstructing those architectural elements he never saw.

Though our study proved Josephus' figures to be accurate as far as the width and the overall outlines of the Herodian moles, his claim for the water depth was exaggerated by far. In order to fully appreciate the uniqueness of Herod's moles, one has to consider that they were a daring engineering feat, being laid in the open waters, off the shore, with no topographic lee from the full might of the surge. Taking into account what Josephus tells us about the mal-nature of the place and what we know about the local coastal processes, we can estimate the scope of the problems that were to have proper engineering answers to in the planning of these moles:

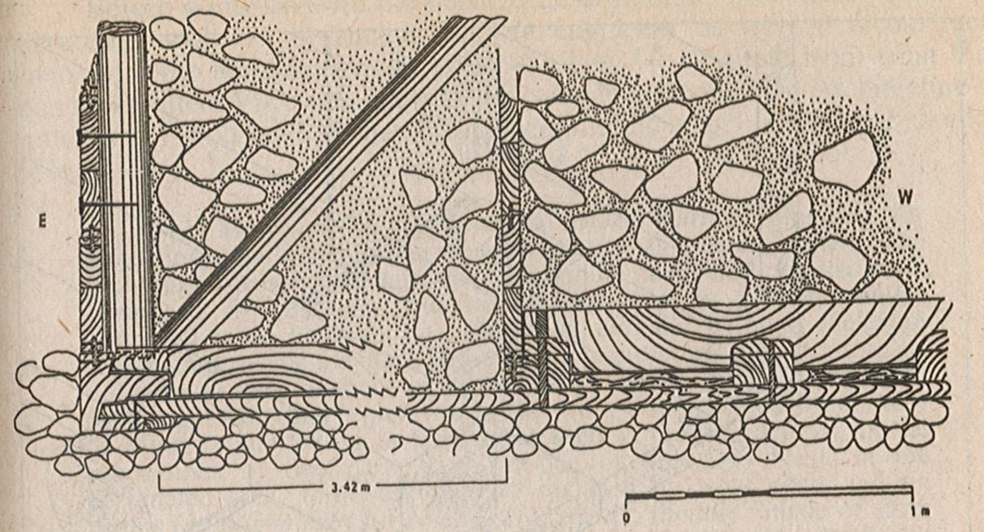

Figure 4. East-West section of the north-eastern part of K-2.

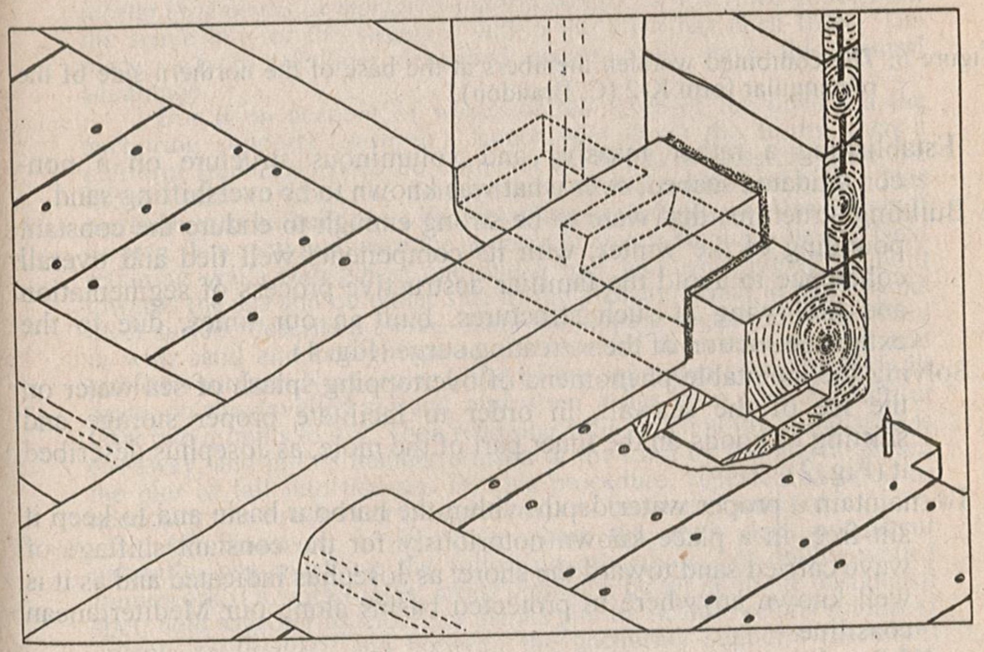

Figure 5. The combined wooden members at the base of the eastern side of the rectangular form K-2 (C. Brandon).

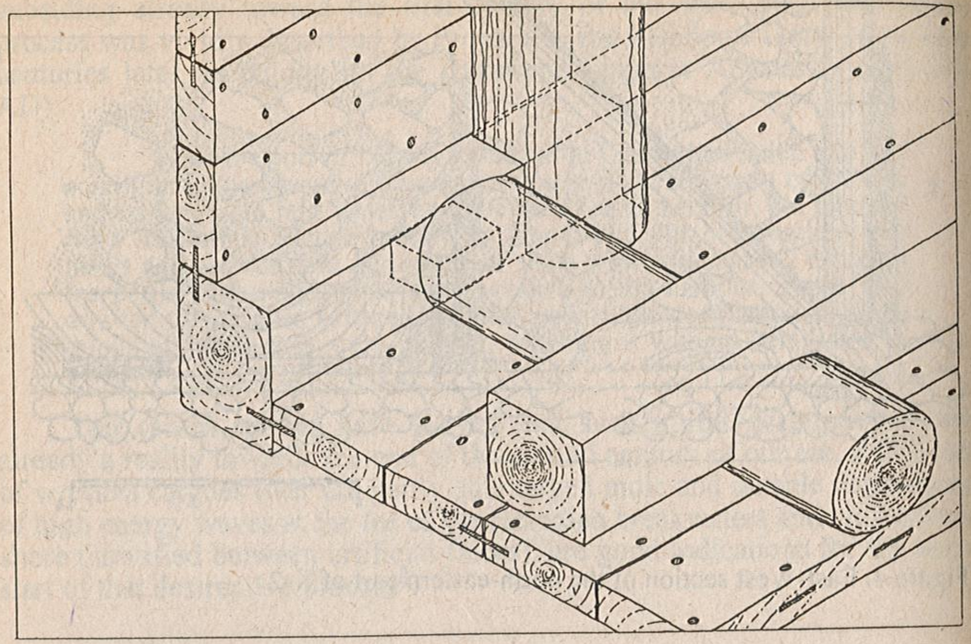

Figure 6. The combined wooden members at the base of the northern side of the rectangular form K-2 (C. Brandon).

1. Establishing a rather massive and voluminous structure on a non-consolidated seabed, over what was known to be evershifting sand.
2. Building structures that were to be strong enough to endure the constant pounding of the winter, with its components well tied and overall coherence to avoid the familiar destructive process of segmentation and hollowing at such structures, built in our times, due to the extensive suction of the retreating surge (Fig. 1).
3. Solving the inevitable phenomena of overtopping splash of sea water on the lee of the seawall, in order to facilitate proper storage and shifting of goods on the inner part of the mole, as Josephus described it (Fig. 2).
4. To maintain a proper water depth within the harbour basin and to keep it silt-free, in a place known notoriously for the constant shiftage of wave carried sand toward the shore, as Josephus indicated and as it is well known anywhere in protected basins along our Mediterranean coastline

While today this inevitable problem is dealt with by repeated dredging, the ancients did not have the heavy duty machines for such an operation, and for that reason preventive measures should have been applied as an imperative feature in the overall planning of the harbour.

Before going on with the detailed description of how these problems were dealt with by the ancient harbour engineers, as we can reconstruct them from the archaeologically collected data, let us quote from what the Roman architect Vitruvius wrote in his canonic textbook "On Architecture", at the time Herod built his harbour, concerning how such a structure should be built.

"(2) However, if we have no natural harbour situation for protecting ships from storms, we must proceed as follows. If there is an anchorage on one side and no river mouth interferes, then a mole composed of concrete structures (*structurae*) or rubble mounds (*aggeres*) is to be built on either side and the harbour enclosure constructed in this manner. Those concrete structures which are to be in the water must be made in the following fashion. Earth (*pulvis*) is to be brought from that region which runs from Cumae to the promontory of Minerva and mixed in the mortar used in these structures, in the proportions of two parts earth to one of lime. (3) Next, in the designated spot, formwork (*arcae*) enclosed by stout posts and tie beams (*stipitibus robustis et catenis inclusae*; literally "made of stout posts and braced around the circumference with chains") is to be let down into the water and fixed firmly in position. Then the area within it at the bottom, below the water, is to be levelled and cleared out (working) from a platform of small crossbeams (? *ex transtilis*). The building is to be carried on there with a mixture of aggregate and mortar (*caementis ex mortario materia mixta*), as described above,until the space left for the structure within the form has been filled. The places which we have described above, then, have this natural advantage.

But if on account of waves or the force of the open sea the anchoring supports (*destinae*) cannot hold down the forms, then a platform (*pulvinus*) is to be built out as firmly as possible from the shore itself or from the foundations of the mole (*crepido*). This platform is to be built out with a level upper surface over less than half its area. The section toward the shore is to have a sloping side. (4) Next retaining walls (*margines*) one and a half feet wide are to be built towards the sea and on either side of the platform equal in hight to the level surface described above. Then the sloping section is to be filled in with sand and brought up to the level of the retaining wall and platform surface. Next a pier (*pila*) of the appointed size is to be built there, on this levelled surface, and when it has been poured is left at least two months to dry. Then retaining wall which holds in the sand is cut away, and in this manner erosion of the sand by the waves caused the pier to fall into the sea. By this procedure, repeated as often as necessary, the breakwater (*progressus*) can be carried seaward.

(5) However, in locations where the earth does not occur naturally, one must use the following procedure. Let double-walled framework (i.e. cofferdams; *arcae duplices*) be set up in the designated spot, held together by close set planks and tie beams (*relatis tabulis et catenis conligatae*), and between the anchoring supports (*destinae*) have clay packed down in baskets made of swamp reeds. When it has been well tamped down in this manner, and is as compact as possible, then have the area bounded by the cofferdam (*saeptio*) emptied and dried out by means of water-screw installations and water-wheels with compartmented rims and bodies. The foundations (*fundamenta*) are to

be dug there, within the cofferdam. If the foundations are to be on a rocky, solid bottom, the area to be excavated and drained is to be larger than the wall (*murus*) which still stand above, and then filled in with a concrete of aggregate, lime and sand (*structura ex caementis calce et harena*). (6) But if the bottom is soft, the foundations are to be covered with charred alder or olive wood pilings and filled with charcoal, as described for the foundations of theaters and city walls. Then the wall is to be raised of squared stone (*sacum*) with joints as long as possible, so that the middle stones (*medii lapides*) may be well tied together by the joints. The space inside the wall is to be filled with rubble packing or concrete. Thus it may be possible to built a tower upon it. (Vitruvius De Architectura, 5.12. 2-6)9.

Having the historical sources quoted, the problems presented, and the contemporary standards of engineering formulated, we might better comprehend the additional facts which have been studied in the site (Fig. 1).

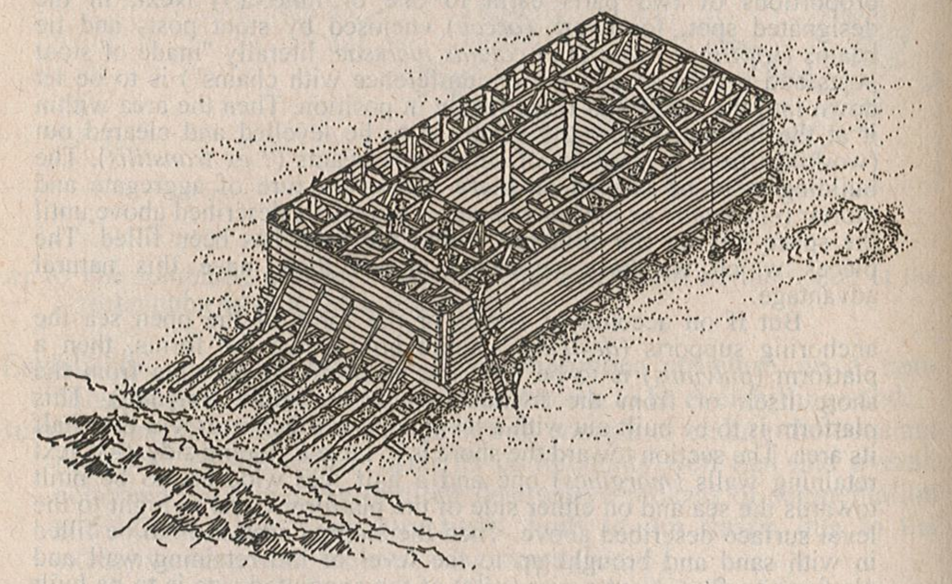

Figure 7. Artist rendering of the final phase of construction of wooden caisson K-2 on the sea shore, being filled with hydraulic cement to its lower third (C.Brandon).

Sebastos was planned at the site of the former inner harbour of Straton's Tower, the southern one of that town had in the 2nd century BC. On its south-west this artificially quarried basin was protected by a rocky promontory, over 100 m long and about 20 m wide, which was selected by Herod's architects to be the stem for the great mole (Fig. 2)[10]. The other, northern mole, had based on the rocky shelf, some 300 m away, in accordance with the designated side of the main harbour basin.

The first feature to be build in the sea was probably an artificial island, at the place where eventually the top of the main mole would be, some 500 m N-NW of the top of the southern promontory and about 350 m due west of the stem of the northern one.

During the 1990-1991 seasons of field work we have discovered a series of wooden forms in which aggregated *pozzolana* had been packed, that served as a base for that island. One of these forms which have survived almost intact all over its lower part, was about 14 x 7 m, with its original height just over 4 m, probably the depth of the sea floor at that site at the time of construction. The wooden form had been constructed on the shore in the regular shipbuilding tachnique of that period. That is to say a shell-first system, in which side beams were laid, with composed boards of planks fastened by mortises and tenons attched to them as floor and side walls (Figs. 3, 4).

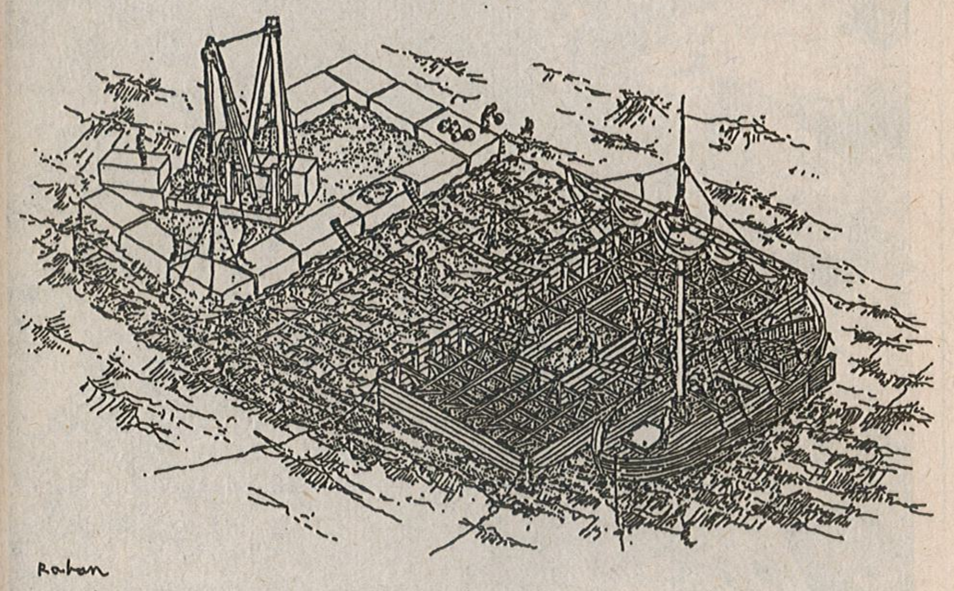

Figure 8. Artist rendering of the initial stage of construction of the artificial island at the base of the Drusion (C. Brandon).

After completing that rectangular shell, upright trimmed round and square section timbers were added over the floor and along the inner face of the side walls. Cross beams and diagonal ones einforced the structure that had in it inner compartments (Figs. 5 - 7). Mixture of volcanic ash was added, filling it up to about one third of its height and left to be dried and consolidated. Then, the form had been towed in the water to the site in the open sea and moored by iron chains in all four corners. Additional loads of rubble and *pozzolana* was then added into the caisson, from barges, in measured

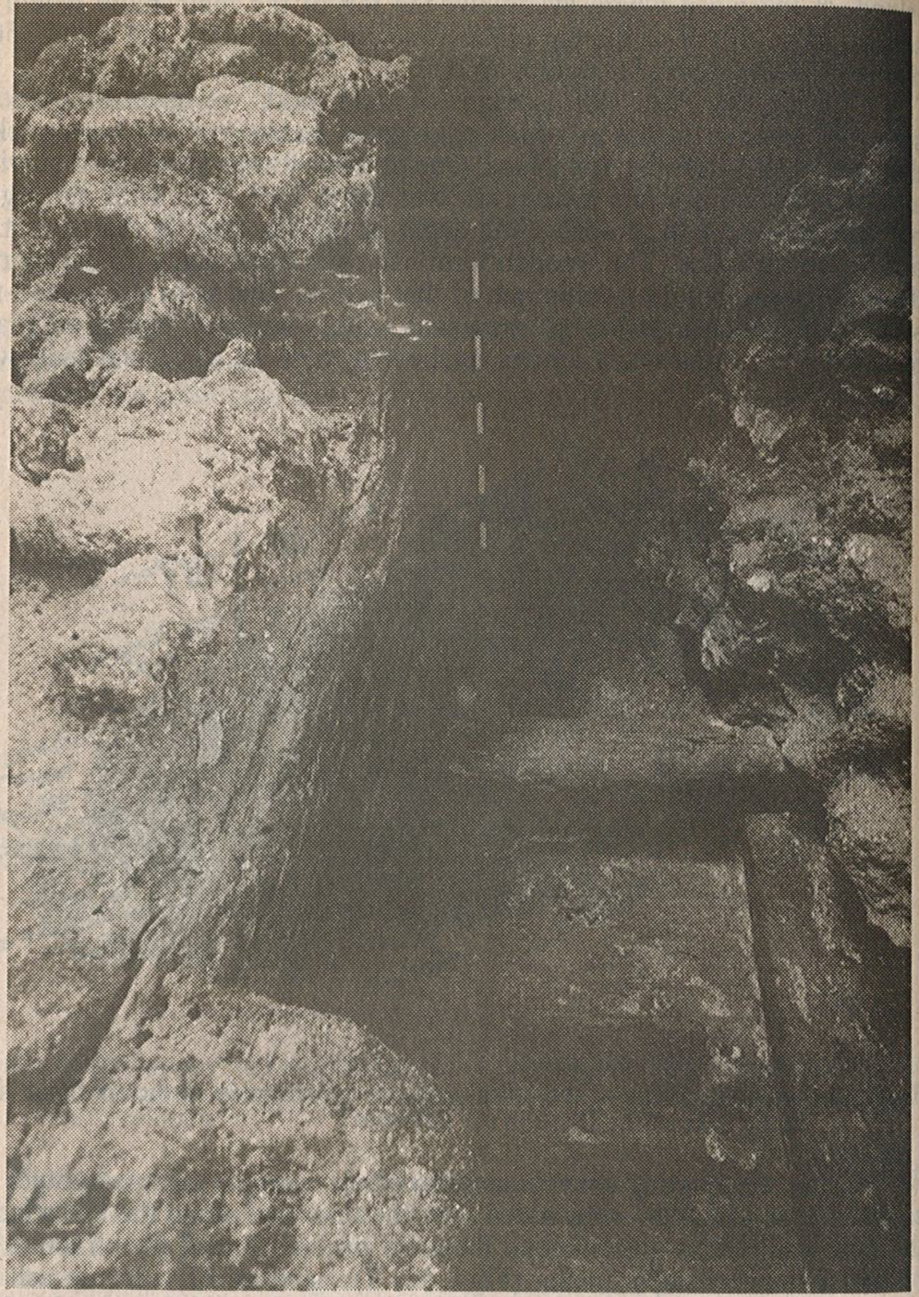

Figure 9. The eastern part of the inner compartment at the wooden form K-2, looking south (D. Sion).

quantities, so as to cause its gradual, even subsidence, till it rested on a rubble cushion that was made for it on the sandy seafloor. The neighbouring form would have been submerged next to the first one, as close as possible. The sides of the caissons were retained with piles of rubble and the gap between the forms were filled with *pozzolana* packed in sacks (Figs. 8, 9). The combined platform, probably 30 x 60 m in size was covered with paving slabs, on which the largest tower was built, probably the "Drusion", mentioned by Josephus, quite likely with a function of a lighthouse[11]. Initial lab analysis suggests that both the wooden timbers for the caisson and the volcanic components of the *pozzolana* had been imported from Italy[12].

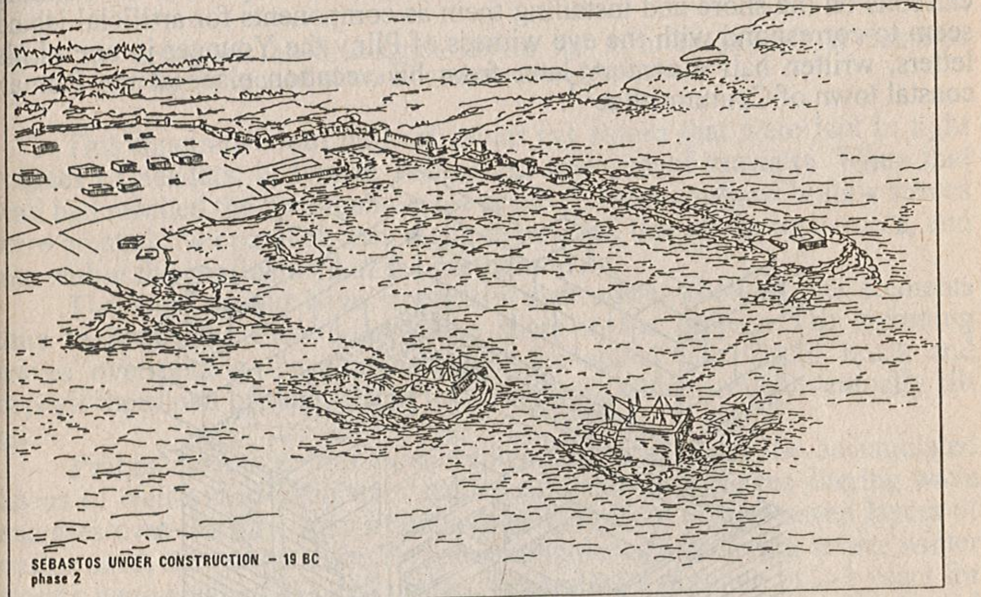

Figure 10. Artist rendering of Sebastos under construction (A. Raban).

Another artificial island of a similar type of construction was installed half the way along the curved line of the main mole at the turn of its course from west to a northerly direction (Fig. 10).

Another type of wooden form was used in a later phase, along the line of thespinal wall and the external course of the "Prokomia". When this skeleton composition had reached the stage of blocking off the surge, another artificial island was established at the designated tip of the northern mole. There, the wooden forms were made in somewhat "lighter" mode of construction. One such form we have studied in area G. The caisson with no planked floor had beencomposed of rectangular form of heavy square slipper beams, on top of which double walls of mortised planks were inserted, fastened to a series of uprights, which were installed on top of slipper in 1.5 apart. The hollow in between these uprights and within the double walls was filled, on land with fluid mixture of volcanic ash, fine grain tuffa and lime. When dried that cement had a specific gravity of 0.6 only. Then, the einforced form was towed to the site at the tip of the northern breakwater, moored in place with iron chains on sinkers and eventually subsided all the way to its nestle over the rubble cushioned, sealed, due to the additional burden of water soaked in the cement. At that stage the inner hollow within the frame was filled by aggregates of rubble,volcanic ash and lime, *pozzolana*, up to its rim, at water level. When hardened by absorbing the seawater the form was used as a platform on which the uper structures were laid (Fig. 11). This process of building caissons on the shore and installing them as components for artificial island seem to correspond with the eye witness of Pliny the Younger in one of his letters, written half a century later from his vacation place at the Roman coastal town of Centumcellae[13].

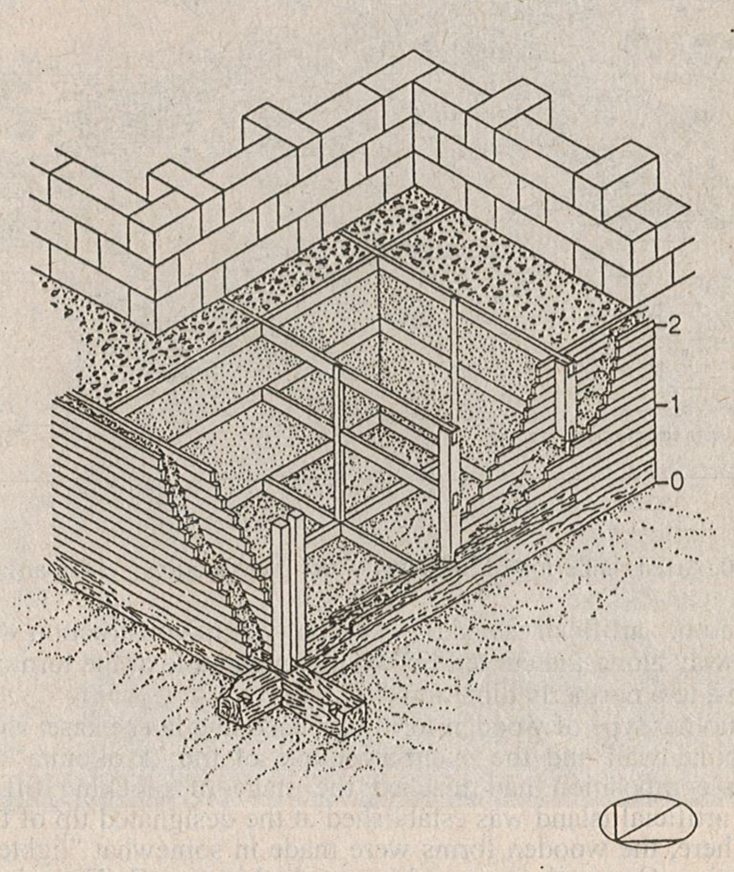

Figure 11. Isometric rendering of the north-western corner of the wooden form,its fill and upper ashlar courses, at area G (S. Talaat).

During the second phase, after the line of caissoned cement forms was laid at the designated course of the spinal wall, and a segmented one was laid parallel to it - some 30 m away,toward the open sea, (the *Prokomia*) a third parallel was laid, within the other two,along the designated line of the quay (or promenade, as Josephus named it) (Fig. 12).

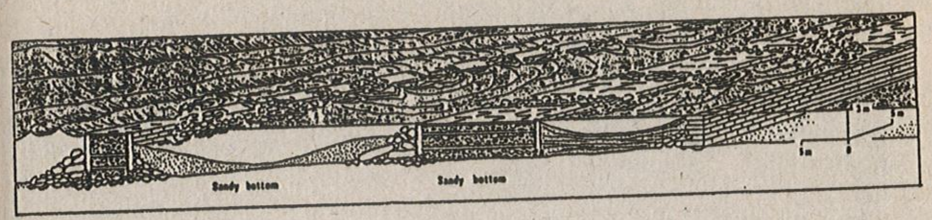

Figure 12. Schematic block diagram across the main breakwater of Sebastos during its second phase of construction (A. Raban).

This innermost wall built of ashiar cut stones that were laid in tight courses of headers, in typical Phoenician tradition of seawalls. When that wall had reached the height above the sealevel, three confined hollow spaces were created: two parallel ones along the curved line of the main mole, and one within the confinement of the northern mole.

The work would have stopped at that stage, allowing the elements time to contribute their constructive share in the project. The incoming waves overrunning the *Prokomia* and the spinal line would break and deposit their load of sand within these hollows, which would eventually silt up.

Probes we made into these deposits have exposed the accumulated layers of well-sorted grain sizes sediments, demonstrating the altering wave energies over the time span of deposition (Fig. 13). Five to seven layers of coarse sand, shingles and shells representing deposition during severe winter storms were counted in these probes, suggesting a duration of 2-3 years for the natural process of siltup of these hollows. When filled in with carried sand the hollows were covered bya laeyr of rubble, sealing the captured sediments and used as a base for the paving slabs of the promenade and floors of the storage vaults. The ashlars of the quay can be traced today along the lee side of the wesrern mole for over 200 m. The courses were built of a standard side header 0.6 x 0.6 x 2.1-2.5 m, of which the large dimension is the one retaining to the neighbouring blocks in tight fitness, so as to have maximum drag between them. Such structural mode would secure the endurance and integrity of the quay for long periods of repeated suction impact (Fig. 14).

In the third phase the *Prokomia*, or *Prokomatia* was confined as a segmented line of subsidiary breakwater, relatively narrow and not much above the sea level, being some 20-30 m outside the spinal wall of the mole it would cause breakage of the surge, leaving an ample settling area on its lee, in

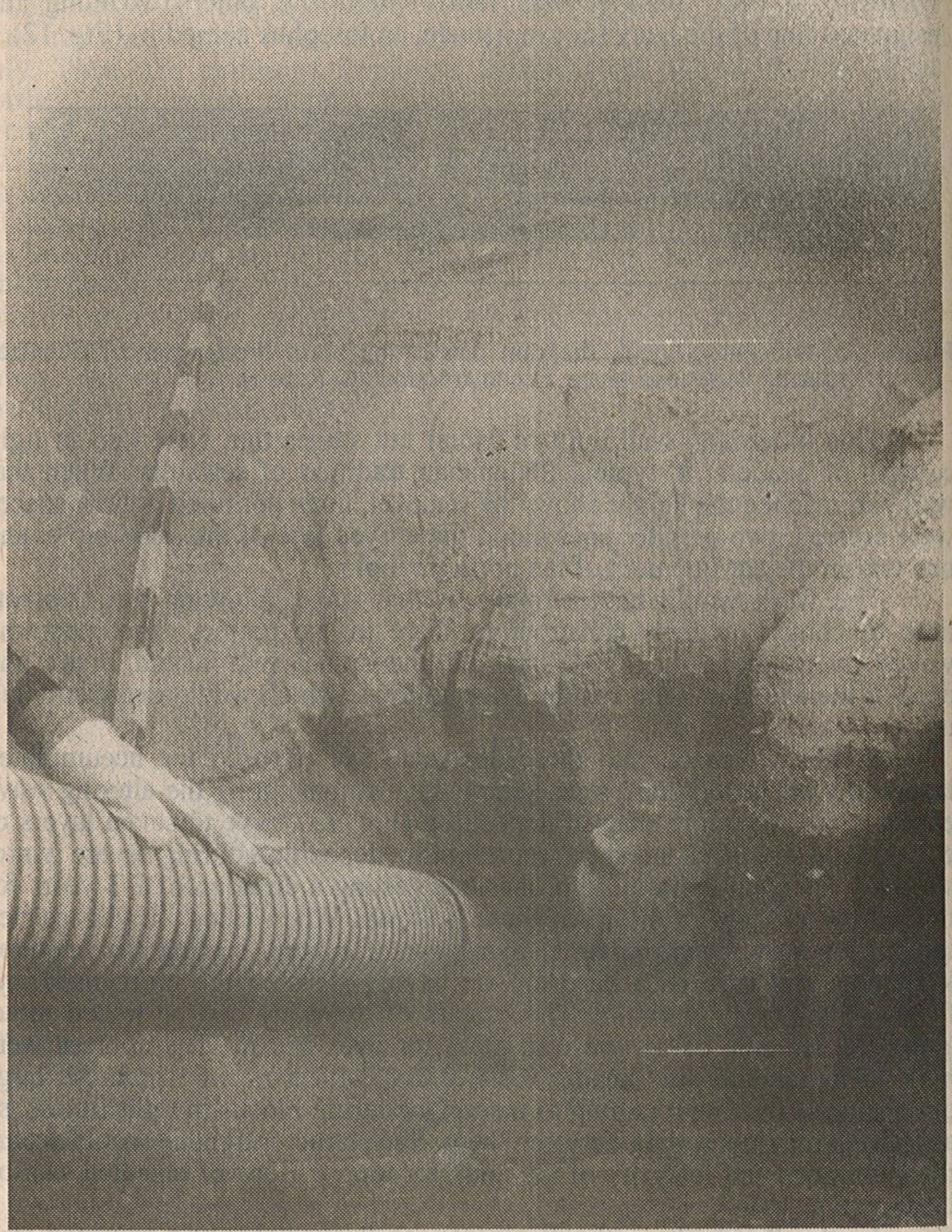

Figure 13. Well sorted sand deposition within the body of the great Herodian mole (area D).

which the wave energy would be absorbed. The main role of that structure would have to prevent splash of sea water over the spinal wall, wetting the storage vaults that were on its lee. Breaking and settling the waves' energy away from the main mole would also ease the destructive impact of undertrenching current at the base of the main mole (Fig. 15). Being a segmented line, with openings for rip currents, would keep the settling area on the lee of the *Prokomia* from the piling up of sea water and from being silted up in the course of time. It seems as if this unique subsidiary structure was added only to the main mole, which faced the open sea and the full impact of the surge. We did not find any remnants of it along the northern mole, which faced the wind of the faairest weather, as Josephus attested.

Figure 14. A diver over a course of ashlars at the base of the quay of the main mole (area B).

Along the south side of the main mole this extra breakwater still remains almost intact, though subsided by 5-6 m, like the other components of the main harbour basin of Sebastos, due to what seems to have been a tectonic faulting (Fig. 16)[14].

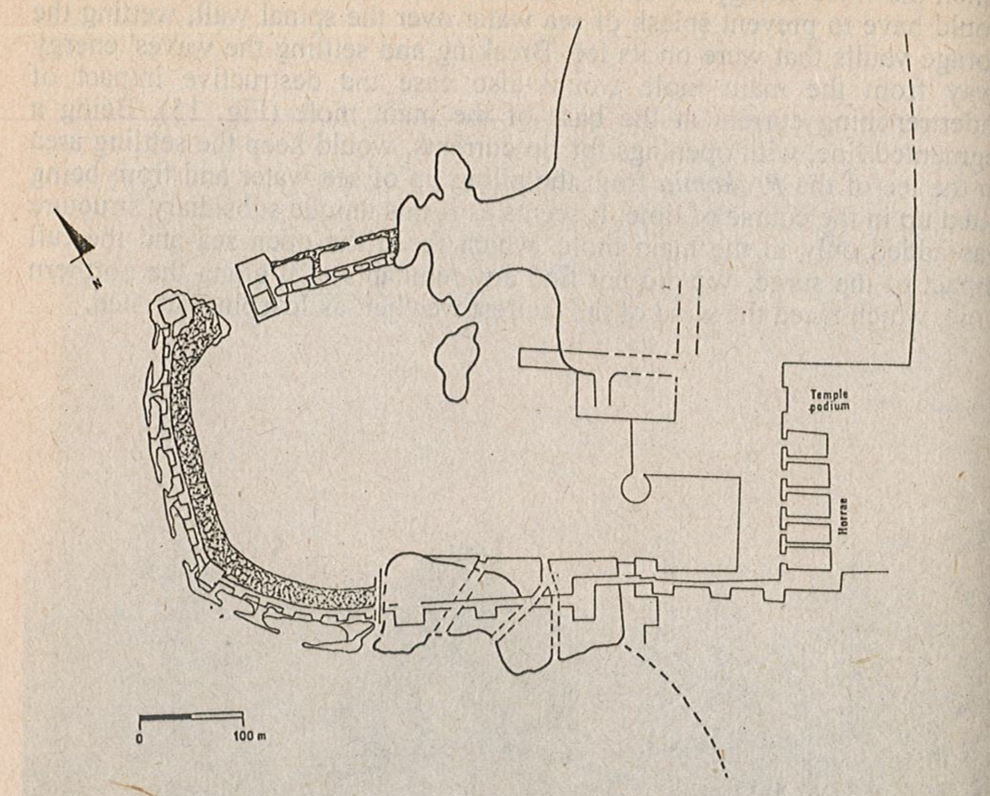

Figure 15. Schematic rendering plan of Sebastos at its third phase of construction (A.Raban).

With the completion of the third phase of construction, the harbour basin was closed and well sheltered from the surge.This would make it a settling body of still water - a terminal for the shifting sand and for that reason - due to be gradually silted. In order to nullify such an inevitable natural process, a flushing current was initiated, flowing out through the harbour entrance. Such a flushing current was conceived by letting extra water to be added to the harbour basin by inflow through a series of shallow channels diagonally crossing over the main mole along its southern side. Each channel had its opening facing the surge with a base somewhat above the sealevel, so as to take only incoming waves, with constant inflow of water. Incorporating with a wider settling basin along its course, such a channel would feed the harbour basin with additional quantities of siltfree water. Vertical grooves for insertion of sluice gates would enable proper control over the rate of the inflow in various sea conditions (Fig. 17). The additional quantities of water would find the way out through the harbour mouth, flushing it property (Fig. 18). Confirmations for the successful flushing

Figure 16. Aerial photography showing the siluate of the submerged Herodian harbour. Note the spade-like shape of the subsidiary breakwater on the left-hand side (= south).

of the harbour basin were found by us on the sea floor Within the main basin, under layers of wave carried deposits there is a distinguished thin layer of fine mud with some first century sherds on it. Such a sediment is typical for still waters and represent the time Sebastos was intact and operating. The absence of sandy particies in the mud indicates that there was no siltation of the harbour from the open sea. Yet, when we started probing the seabed just outside the harbour mouth, we have exposed a deposit over two meters thick, of mud, dirt and kinds of garbage from the harbour - a dumping site for whatever was being carried away by that outflowing flushing current. Actually a full scale exhibition of artifacts which were found mostly at that site, including a score of clay vessels of fine Italian ware, wooden instruments,metal figurines etc.(Area D)[15].

Figure 17. The entrance to one of the flushing channels at high tide.Looking south, toward the open sea.

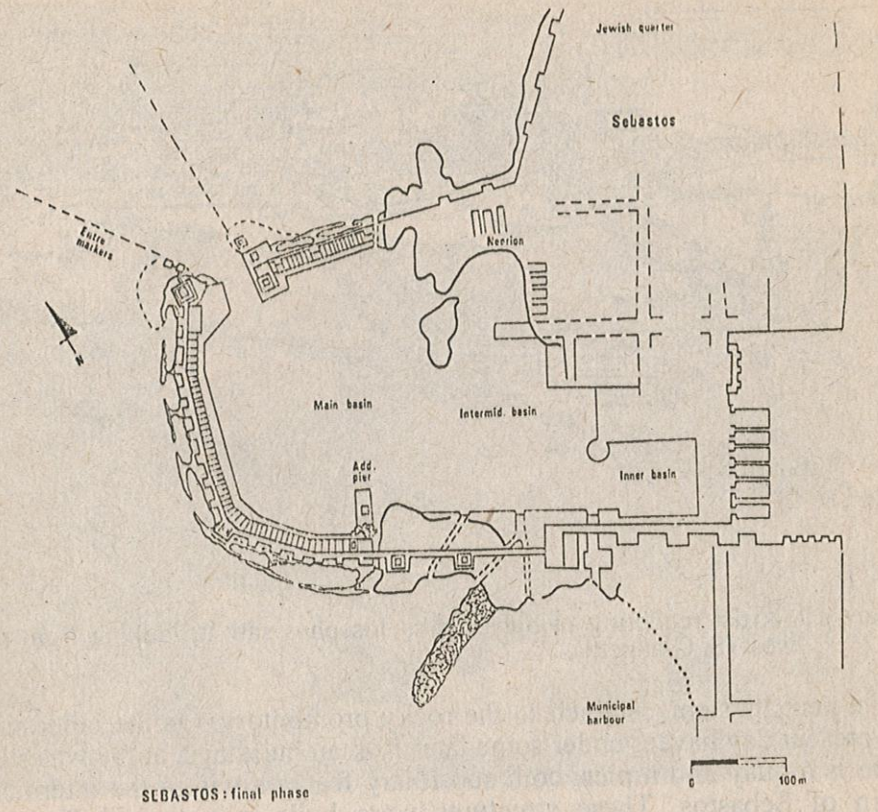

Figure 18. Schematic rendering plan of Sebastos at its final phase of construction (A. Raban).

The final stage in the building of Sebastos included the upper structures, some of which Josephus saw and described. Among these features there was the spinal wall along the mole, the towers in it and the vaulted chambers within its confinement. Square slabs of cut stones were laid for the promenade (Fig. 19). Subsidiary jetties were settled, dividing the harbour to three mooring basins, one within the other. One such jetty was studied at the south side of the harbour jutting of the southern mole, to the north, dividing between the main (outer) and the intermediate harbour basin. This pier was constructed by parallel side walls of ashlar headers and was topped with pavers of cut stones, carefully laid over a sand fill (Area F)[16]. East of that pier, at the part of the harbour that did not subside (on the lee of the fault line) one can see the edge of the quay along the inner face of the south

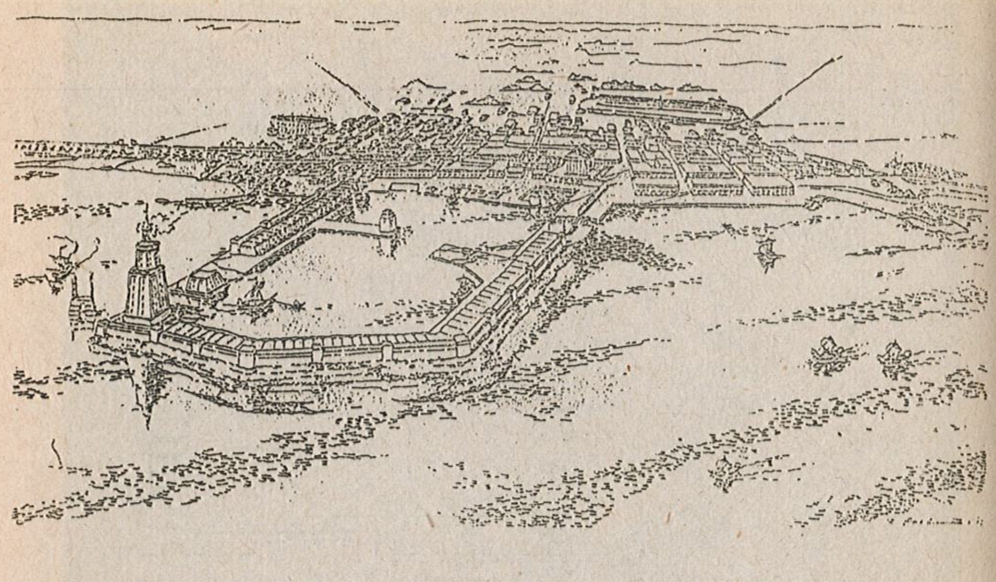

Figure 19. Artist rendering of Sebastos as Josephus saw it, looking from south-west (S. Giannetti).

mole, near its stem, retained to the rocky promontory. On the other side of the present day haven, under some later Roman buildings, at the water level, there is a quay and a pier, both subsidiary features within the intermediate basin of Sebastos. These structures were built in a typical Phoenician tradition of tightly laid long slim headers, as was recommended by Vitruvius in his last paragraph quoted above (Fig. 20). It is amazing to realise how intact these structures still are after 2000 years, when a much more recent pier next to them which was built less than 20 years ago is almost dismantled already[17].

In inner rectangular basin that had been dug-out artificially over a century earlier was incorporated as the innermost harbour basin of Sebastos, with a series of large vaults along its easrern edge and the large temple which was dedicated to Augustus and Rome on top of them, overlooking the entire harbour.

Along the vertical face of this eastern edge of the inner basin we have exposed a line of marine fauna, *vermetides* and *ostaea*, marking the sea level at the time, much at its present elevation.About half a metre above that line there is a pierced mooring stone jutting from the quay (Fig. 21).

At the tip of both moles of the main basin there are huge masses of tumbling block, from the elaborated superstructures that crowned the harbour mouth. We already mentioned above one of them, the "Drusion", which was on the north-west side. This lighthouse which is an essential navi-

Figure 20. An inner quay and jetty on the northern side of the intermediate basin of Sebastos, looking to the north.

gational aid, marking the way to the harbour for ships sailing in toward a rather low coastline, is reconstructed on the model and drawings not according to our archaeological data from the site, but based on leterary descriptions of the "Pharos" in Alexandria and the Roman lighthouse of Leptis Marna in Lybia[18].

On the tip of the north mole, next to the eastern side of the harbour channel, there was a structure not smaller than the "Drusion". Its tumbling mass comprises huge rectangular cut stones,some of which are over seven meters long (Fig. 22). Some of these blocks were fashioned at one end with a recessed scarf and hemispheric sockets for the wooden shafts for capstans on which chains were rolled up across the entrance. In order to withstand the drag of pulled chains the blocks had been fastened to each other with iron clamps fixed to their place in the cut grooves by molten lead. Frozen flows of lead found at the foots of that tumbling mass under 10 m of water, indicate

Figure 21. The eastern quay of the presently land-looked inner basin, looking from the south (M. Little).

that the lead had been poured after the blocks were laid in place,in the water. This delicate work, as the accurate displacement of the blocks, would demand use of free divers, working under the water and probably using snorkels for breathing. Such professional divers were known in the Roman world as members of the guild of "urinators"[19].

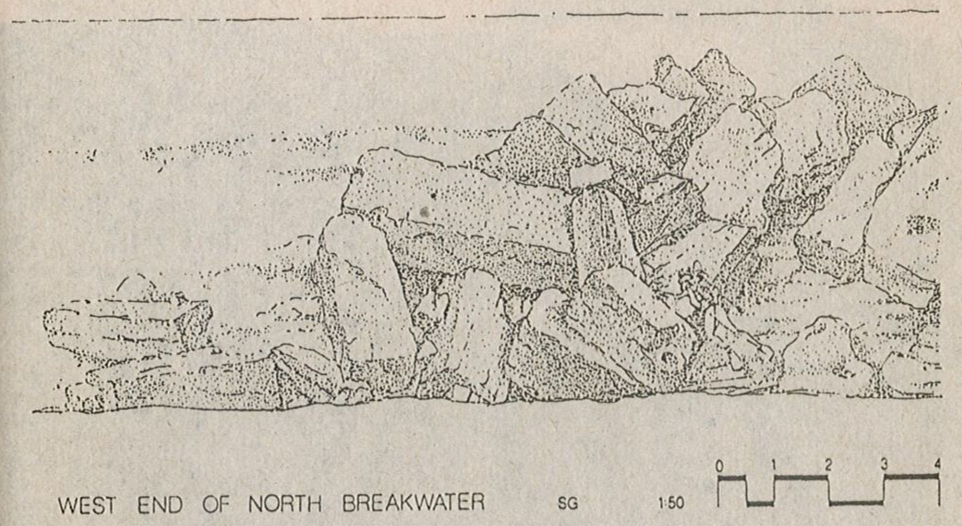

Figure 22. Artist rendering of the tumbling mass at the tip of the northern mole, from the west (S. Giannetti).

As Josephus tells us there were statues, crowning columns, which had been set on top of upright rocks. Two bound together on the right side of those sailing into the harbour are clearly visible on aerial photographs and have been studied by us for several working seasons (Area K). They have been found to be made of artificial conglomerate, and their position made them excellent navigational aids for defining the western edge of the sailing course into the harbour. The matching "Tower" on the eastern side was found by us, buried in the sand, just north of the tip of the northern mole, where it should have been according to Josephus. It is a cement block of 15 x 15 m,and some remnants of its wooden form survived along its sides. The towers on both sides of the entrance had been settled on sandy bars, shallower than the seafloor nearby. It seems as if the curved line of the main mole had altered the way the wave carried sand was travelling along the nearshore and the combining factors of the breakwater of Sebastos together with the local wave climate deposited some of it just outside the entrance. The functioning flushing current kept the harbour channel siltfree and defined the accumulating sand bars on its both sides, in the open sea. The towers marked these bars, defining the navigational channel toward the entrance (Fig. 23).

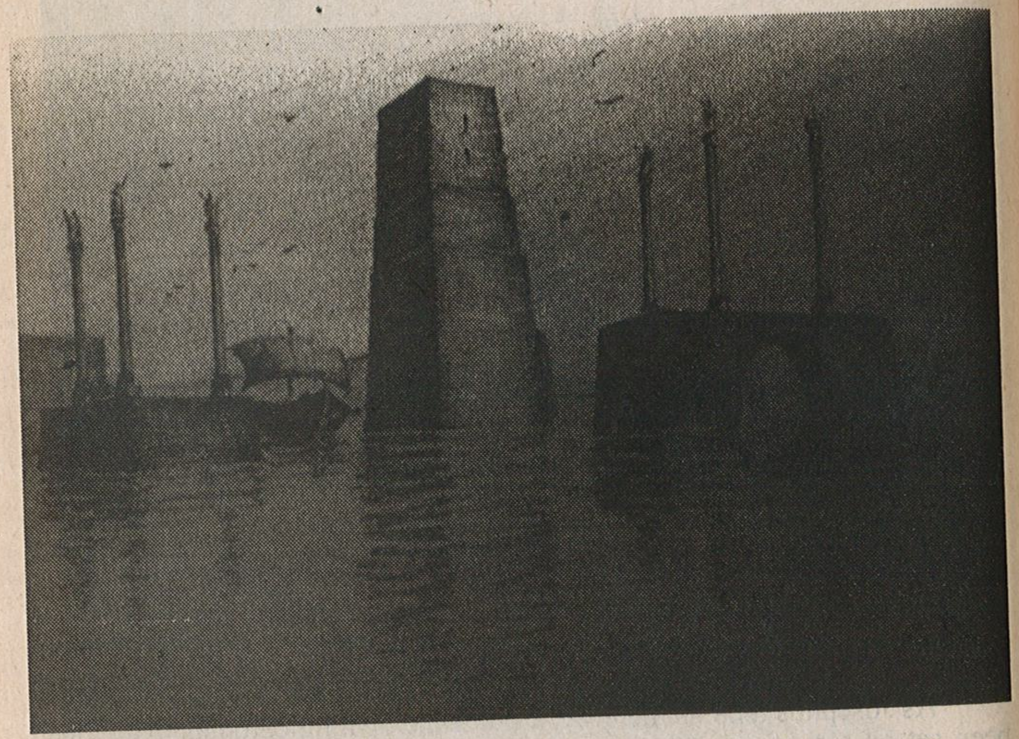

Figure 23. Artist rendering of the entrance to Sebastos at the Herodian era, looking from without, toward the south west (S. Giannetti).

The in-sailing ships that were guided to Sebastos from afar, by the smoke and the fire at the top of the Drusion, and into it bythe towers, were held at the tip of the northern mole, next to the control building of the harbour master for inspection of their credentials, cargo, bill of lading and taxation. Then they would be tugged into their designated berth next to one of the harbour quays, for unloading, loading and even wintering when needed (Fig. 24).

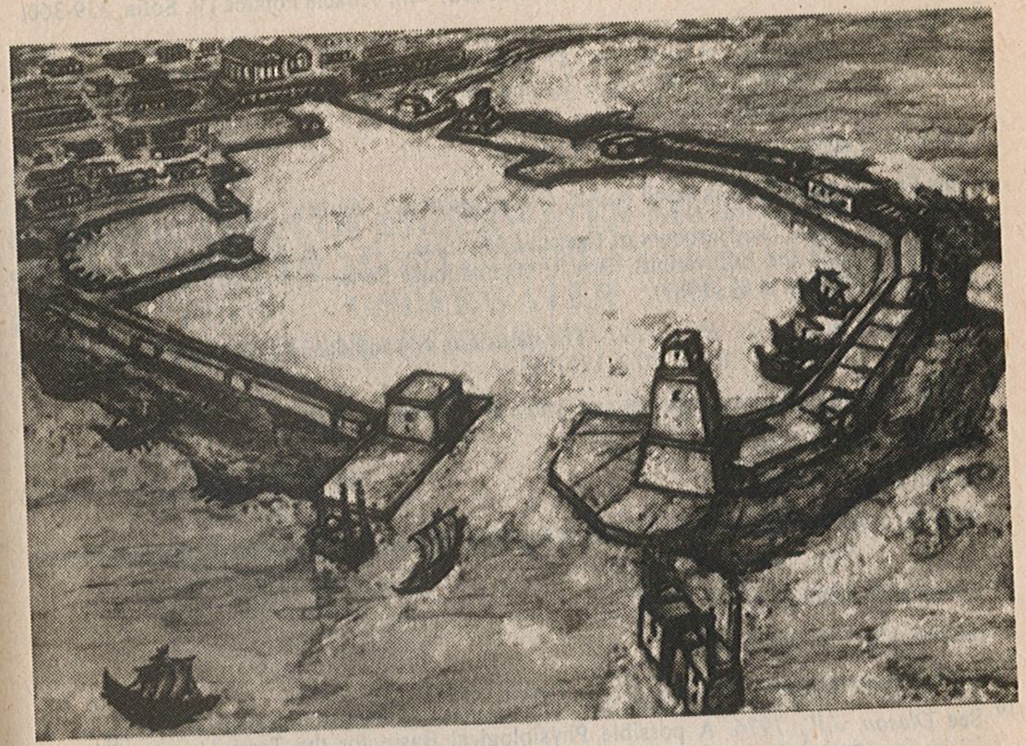

Figure 24. Artist rendering of Sebastos and its entrance (A. Raban).

The capability of Sebastos to offer wintering berths to large fleets of merchantmen made the harbour favourable over others in the Roman Empire and contributed much to its prosperity.

NOTES

1 The text here is based on the English translation of J.P.Olson in his article "Herod and Vitruvius: Preliminary Thoughts on Harbour Engineering at Sebastos, The Harbour of Caesarea Maritima". - In: *A.Raban* (ed), Harbour Archaeology, B.A.R. International Series,257, Oxford, 1985, 165-172.

2 cf. JA, 17: 87; JW 1: 610-613.

3 See Ringel, J., 1985. Césarée de Palestine. Ophrys, Paris, p. 83 (hereon - Ringel, 1975).

4 Ibidem, p. 85.

[5] See discussion in *A. Raban*, 1987. BASOR, 268, 71-88.

[6] See discussion in *Raban, A.*, 1991. The subsidence of Sebastos: When the Herodian breakwaters in Caesarea were flooded? - In: Thracia Pontica IV, Sofia, 339-360.

[7] Procopius Gazaeus, Panegyricus in imperatorim Anastasium, xix. - In: *Migne, J. P.* (ed), Patrologia Graeca, vol 87 (3), Paris 1863, cols 2817-2818. The English translation is after L.I. Levine in his book Roman Caesarea, QEDEM, 5, Jerusalem, 1975, 18.

[8] See note 6, above.

[9] This English translation is based on *J.P. Olson* (see note 1, above).

[10] *Raban, A., 1989.* The Harbours of Caesarea Maritima. - In: *J. P. Olson* (ed), vol.1: The site and the excavations, B.A.R. International Series 491 (i, II), Oxford (Hereon, Raban et al., 1989).

[11] See above and *Vann, R.L., 1991.* The Drusion: A candidate for Herod's Lighhouse of Caesarea. - IJNA, 20.2, 123-139.

[12] For the source of the wood species see *Raban* et al. 1989, 191-194.

[13] Pliny the Younger Ep. (letters), 6.31.

[14] *Raban* et al. 1989, 120-123.

[15] Ibidem, 115-119; *Holum et al., 1988.* King Herod's Dream - Caesarea on the Sea. Norton Pub., New York, 91-93.

[16] *Raban* et al. 1989, 124-127.

[17] Ibidem, 151-153, 289-291.

[18] For full discussion see *Vann, R.L., 1991.* Op cit.

[19] See *Oleson, J.P., 1976.* A possible Physiological Basin for the Term Urinator Diver. - American Jpurnal of Phiology, 97, 22-29.

CLASSIFICATION OF UNDERWATER ARCHAEOLOGICAL SITES ALONG THE MEDITERRANEAN COAST OF ISRAEL: FINDS FROM UNDERWATER AND COASTAL ARCHAEOLOGICAL RESEARCH

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In 1964 scuba divers discovered prehistoric artifacts and bronze nails near kibutz Hahotrim, south of Haifa.

In 1968 two children were free diving at the Municipal South Beach of Haifa, when they discovered a pottery bowl and a few bronze artifacts on the sea bottom. These initial finds represent the beginning of an on going "surge of discoveries" which has been taking place along the coast of Israel. From this point on, extensive "diving surveys" have been carried out on the shallow continental shelf and have led to the discovery of many archaeological sites and artifacts which range from Neolithic period to modern times.

The underwater surveys and excavations have revealed a vast amount of new information which greatly enriches our understanding of the history of sea faring, ancient navigation, trade, technology, and the material culture of Israel's early coastal inhabitants. This new wealth of information enables us to classify and list underwater archaeological sites along the Mediterranean coast of Israel.

THE CIRCUMSTANCES THAT LED TO THE NEW DISCOVERIES

The recent proliferation of findings are the result of several factors brought about by man and nature.