Appendix 1: Graser 1872, table following page 65

Re-organised table based on Graser 1872. Key: M = Mounichia, Z = Zea, E = East, N = North, W = West.

Shipshed	Harbour	Location	Width between two *"wangen"*	Width of left *"wangen"*	Left 2	Width of right *"wangen"*	Right 2
			(m)	(m)	(m)	(m)	(m)
I	M	E	3.658	-		-	
II	M	E	6.663	-		-	
III	M	E	6.663	-		-	
IV	M	NE	5.200	0.920		1.140	
V	M	NE	5.160	1.140		1.000	
VI	M	NE	5.160	1.000		0.950	
VII	M	NW	5.200	1.140		1.140	
VIII	M	NW	5.700	1.140		0.660	
IX	Z	E	4.078	0.500	1.000	0.500	
X	Z	E	5.162	-		1.020	
XI	Z	E	4.875	1.020		0.650	
XII	Z	E	5.135	0.650		-	
XIII	Z	E	5.680	1.000	2.245	1.000	
XIV	Z	E	2.690	1.000		-	
XV	Z	E	5.480	1.000		1.000	
XVI	Z	E	3.790	1.000		1.000	
XVII	Z	E	6.325	-		1.000	
XVIII	Z	E	6.325	1.000		-	
XIX	Z	E	3.237	-		-	
XX	Z	E	3.140	-		-	
XXI	Z	NE	3.370	1.000		1.000	
XXII	Z	NE	1.905	1.000		1.000	
XXIII	Z	NE	3.370	0.990		1.000	2.262
XXIV	Z	NE	5.015	1.000	2.262	0.970	
XXV	Z	NE	5.195	0.970		0.980	
XXVI	Z	NE	5.345	0.980		-	
XXVII	Z	NW	4.363	1.000		1.290	
XXVIII	Z	NW	4.363	1.290		-	
XXIX	Z	NW	4.995	1.097		1.097	
XXX	Z	NW	5.830	1.000		1.000	
XXXI	Z	NW	5.155	1.000		1.000	
XXXII	Z	NW	3.540	1.000		-	
XXXIII	Z	W	5.690	-		0.550	
XXXIV	Z	W	3.720	0.550		0.580	

Shipshed	Harbour	Location	Width between two *"wangen"*	Width of left *"wangen"*	Left 2	Width of right *"wangen"*	Right 2
			(m)	(m)	(m)	(m)	(m)
XXXV	Z	W	3.610	0.580		0.580	
XXXVI	Z	W	2.990	0.580		-	
XXXVII	Z	W	4.385	-		0.510	
XXXVIII	Z	W	4.615	0.510		-	
XXXIX	Z	W	4.295	-		-	
XXXX	Z	W	5.205	-		0.780	
XXXXI	Z	W	6.000	1.085		-	
XXXXII	Z	W	4.615	-		-	
XXXXIII	Z	W	4.335	1.360		-	
XXXXIV	Z	W	4.495	-		-	
XXXXV	Z	W	4.515	-		-	
XXXXVI	Z	E	5.025	-		-	
XXXXVII	?	?	4.520	-		-	
XXXX-VIII	?	?	4.780	-		-	
XXXXIX	?	?	5.391	-		-	
L	M	NW	5.200	1.140		1.140	

Appendix 2: Reconstructing the Capitals of the Phase 3 Shipsheds at Zea

by Mette Schaldemose

In order to obtain a basis for reconstructing the size of the capitals employed in the Area 1 shipsheds of Zea Harbour in Phase 3, the capitals and column heights from the shipsheds at Oiniadai, in western Greece, have been employed.[1] This is because the structures at Oiniadai represent the best preserved examples from a similar type of building that has been excavated in mainland Greece; in addition, the data are the closest parallel to Zea regarding column height.

Oiniadai
Echinus:
Lower diameter: 0.62 m
Upper diameter: 0.76 m
Height: 0.20 m

The calculation of the ratio between the diameters of the lower and upper *echinus* at Oiniadai is used in the calculation of the reconstructed upper diameter of the *echinus* at Zea:
0.76 m : 0.62 m = **1.23**

Abacus:
0.80 x 0.80 x. 0.20 m

The calculation of the ratio between the *abacus* and the upper *echinus* diameter is used in the calculation of the reconstructed width of the *abacus* at Zea:
0.80 m : 0.76 m = **1.05**

Columns:
Height: 6.7 m (centre of range, see Vol. I.1, Chapter 8.2.4).[2]

Zea
The lower diameter of the *echinus* in the eaves columns is equal to the reconstructed upper diameter of the top drum in the eaves column:
Lower diameter of the *echinus*: 0.55 m
Calculation of the upper diameter of the *echinus*:
0.55 m x **1.23**[3] = <u>0.68 m</u>

The lower diameter of the *echinus* in the ridge columns is equal to the reconstructed upper diameter of the top drum in the ridge column:
Lower diameter of the *echinus*: 0.53 m
Calculation of the upper diameter of the *echinus*:
0.53 m x **1.23** = <u>0.65 m</u>

The reconstructed width of the *abacus* of the eaves columns is based on the upper diameter of the *echinus*:
0.68 m x **1.05**[4] = <u>0.71 m</u>

The reconstructed width of the *abacus* of the ridge columns is based on the upper diameter of the *echinus*:
0.65 m x **1.05** = <u>0.68 m</u>

The reconstructed heights of the *echinus* and *abacus* in the **eaves columns** at Zea are based on the ratio between the height of the Oiniadai columns (6.7 m) and the reconstructed height of the eaves columns at Zea (5.37 m):
5.37 m : 6.7 m = **0.80**

And thus: 0.20[5] m x **0.80**[6] = <u>0.16 m</u>

1. See Sears 1904.
2. Sears 1904: 229. Sears states that the height of the columns at Oiniadai is *ca* 6.6 m. In the calculation of the height of the *echinus* and *abacus* at Zea, the result is the same whether the calculations are made using a height measurement of 6.6 or 6.7 m. See also Vol. I.1, pp. 162–165.
3. Ratio between lower and upper diameters of the *echinus* at Oiniadai, see above.
4. Ratio between the upper diameter of the *echinus* and the width of the *abacus* at Oiniadai, see above. The significant digits are of great importance here, for if it was rounded up to 1.1, the calculated width would be 0.75 m for the *abacus* of the eaves columns and 0.72 m for the *abacus* of the ridge columns, and thus 0.04 m wider. This level of precision may very well have been unlikely in the actual capitals of the ridge and eaves columns. A range in the two sizes of the capitals seems more likely.
5. Height of the *echinus* and *abacus* at Oiniadai.
6. Ratio between the height of the columns at Oiniadai and that of the eaves columns at Zea, see above.

The reconstructed heights of the *echinus* and *abacus* in the **ridge columns** at Zea are based on the ratio between the height of the Oiniadai columns (6.7 m) and the reconstructed height of the ridge columns at Zea (6.71 m):
6.71 m : 6.7 m = **1.0**

And thus: 0.20[7] m x **1.0**[8] = <u>0.20 m</u>

Zea Reconstruction Summary
Eaves columns
Echinus:
Lower diameter: 0.55 m
Upper diameter: 0.68 m
Height: 0.16 m

Abacus:
0.71 x 0.71 x 0.16 m

Ridge columns
Echinus:
Lower diameter: 0.53 m
Upper diameter: 0.65 m
Height: 0.20 m

Abacus:
0.68 x 0.68 x 0.20 m

7. Height of the *echinus* and *abacus* at Oiniadai.
8. Ratio between the height of the columns at Oiniadai and that of the ridge columns at Zea, see above.

Appendix 3: Reconstructing the Capitals of the Phase 2 Shipsheds at Zea

by Mette Schaldemose

In order to obtain a basis for reconstructing the size of the capitals employed in the Area 1 shipsheds of Zea Harbour in Phase 2 (both versions), the capital and column heights from the east front of the Propylaia have been employed.[1] This is due to the fact that the Propylaia's capitals are well documented and contemporary examples, and the building lies in relatively close proximity to Piraeus.

Propylaia (east front)

Echinus:
Lower diameter: 1.207 m
Upper diameter: 1.615 m
Height: 0.224 m

The calculation of the ratio between the diameters of the lower and upper *echinus* on the east front of the Propylaia is used in the reconstruction of the upper diameter of the *echinus* at Zea:
1.615 m : 1.207 m = **1.34**

Abacus:
1.666 x 1.666 x 0.291 m^2

The calculation of the ratio between the *abacus* and the upper diameter of the *echinus* is used in the calculation of the reconstructed width of the *abacus* at Zea:
1.666 m : 1.615 m = **1.03**

Columns:
Height 8.01 m[3]

The reconstructed height of the Phase 2 columns based on the column drums found in Area 6 in Zea: 6.71 m (centre of range, Vol. I.1, Chapter 8.2.4).

Zea

The calculations are based on the columns and capitals of the east front of the Propylaia. The lower diameter of the *echinus* in the eaves and ridge columns at Zea is equal to the reconstructed upper diameter of the top drum in the eaves and ridge columns:
Lower diameter of the *echinus*: 0.44 m
Calculation of upper diameter of the *echinus*:
0.44 m x **1.34**[4] = 0.59 m

The reconstructed width of the *abacus* of the eaves and ridge columns is based on the upper diameter of the *echinus*:
0.59 m x **1.03**[5] = 0.61 m

The reconstructed heights of the *echinus* and *abacus* in the eaves and ridge columns at Zea are based on the ratio between the height of the columns of the east front of the Propylaia (8.01 m) and the reconstructed height of the eaves and ridge columns at Zea (6.71 m):
6.71 m : 8.01 m = **0.84**

The *echinus* is thus: 0.224[6] m x **0.84**[7] = 0.19 m

The *abacus* is thus 0.291[8] m x **0.84** = 0.24 m

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1. Dinsmoor & Dinsmoor 2004: 93–94, 100–101, 373–374. It has proven difficult to find a column of an equal height to the columns at Zea and with a fully preserved capital from a 5th-century BC building in Athens. The columns from the east front of the Propylaia have been chosen despite the fact that they are higher than the reconstructed columns at Zea.
2. Dinsmoor & Dinsmoor 2004: 101. The width of the *abacus* increases from the lower part toward the upper part. The difference is 0.005 m. In order to find the maximum width of the *abacus* at Zea, the upper width of the *abacus* from the east front of the Propylaia is used.
3. The average height of the columns is 8.528 m, the total height of *echinus* and *abacus* is 0.515 m; the average height of the columns is thus 8.01 m.
4. Ratio between lower and upper diameters of the *echinus* on the east front of the Propylaia, see above.
5. Ratio between the upper diameter of the *echinus* and the width of the *abacus* from the east front of the Propylaia, see above.
6. Height of the *echinus* on the east front of the Propylaia, see n.1.
7. Ratio between the height of the columns from the east front of the Propylaia and at Zea.
8. Height of the *abacus* on the east front of the Propylaia, see n.1.

Zea Reconstruction Summary
Eaves and ridge columns
Echinus:
Lower diameter: 0.44 m
Upper diameter: 0.59 m
Height: 0.19 m

Abacus:
0.61 x 0.61 x 0.24 m

Appendix 4: Calculating the Dimensions and Section of the Gutters of the Phase 3 Shipsheds at Zea

by Mette Schaldemose

Gutter Dimensions

The following information was employed to aid in reconstructing the dimensions of the gutter of the roof of the Area 1 shipsheds in Zea Harbour.

1. The size of the roof. In this case, calculations are multiplied by two because two roofs slope toward the same gutter, a feature called a 'butterfly roof'.

Length of the roof (the longitudinal measurement of the tiled roof): 89.58 m x 2 = 179.16 m (588 ft)
Sloping height of roof: 6.61 m x 2 = 13.22 m (43 ft)
Roof area: 89.58 m x 6.61 m x 2 = 1,184.25 m^2 (3,885.33 ft)
Slope of roof: 13º

2. Torrential rain. According to Dr. G. Kallos of the Information from the Atmospheric Modelling & Weather Forecasting Group at the Department of Physics at the University of Athens, as much as 80–120 mm precipitation can accumulate in a six-hour period during torrential rains in present-day Athens. Such rains occur especially in October and November. In antiquity, an abundance of pine, cypress and olive trees grew in the environs of Athens, which suggests that the climate may have been wetter than modern times.

3. Amount of runoff. In order to calculate the amount of water runoff in relation to the size of the roof surface of a butterfly roof, the calculator hosted by the website "Calculating Your Roof Runoff" at http://vacd.org/winooski/winooski_raingarden_water.shtml was employed. The calculations, made on 8 August, 2009, are summarised as follows:

> Footprint of house: width: 43 ft x length: 588 ft
> Number of downspouts: 1
> Inches of rain: 4.72 (120 mm, see above)
> The number of gallons from each rainspout for 4.72 inches of rain is 73,865.26 gallons.

The amount of water runoff is 73,991.10 gallons, which equals 280,086.78 litres of water.

4. The size of the gutter. In order to calculate the size of the gutter required to shed this amount of water the calculator hosted by the website "Downpipe and Eaves Gutter Calculator" found at http://www.roof-gutter-design.com.au/Downp/applet.php was employed. The calculations, made on 8 August, 2009, are summarised as follows:

Inputting the area of the roof (1,184.25 m^2), the slope of the roof (13º) and the millimetres of rain per hour (20 mm) results in a minimum section area of the gutter of 26,945 mm^2. This amount of water can be accommodated in a gutter measuring:

Internal width: 0.20 m; internal depth: 0.20 m.

This gutter is thus reconstructed with an internal section area of: *ca* 40,000 mm^2.[1]

1. The measurements from the two Internet sites are used with the reservation that they are web-page calculations and thus not calculated by a trained engineer.

Appendix 5: Reconstructing the Valley Beam in the Phase 2 Shipsheds and the Architrave in the Phase 3 Shipsheds

by Mette Schaldemose

The dimensions of the valley beam (in Phase 2, both versions) and architrave (in Phase 3) of the roof of the Zea shipsheds in Area 1 are calculated from the dimensions of a number of stoai that appear in Coulton's work on the subject.[1] The width of the valley beam/architrave is calculated from the width of the *abacus* below it (the total width of the valley beam/architrave is divided by the total width of the *abacus*), and the height of the valley beam/architrave is calculated using the ratio between the height and width of the valley beam/architrave. The total height of the valley beam/architrave is divided by their total width.

Comparative stoai: width ratio of *abacus* to valley beam/architrave[2]

The following dimensions yield the width ratio between the *abacus* and the valley beam/architrave:[3]

Stoa of Attalos in Athens: width of architrave 4.68 m: width of *abacus* 5.91 = 0.79 m

South Stoa from the Heraion in Argos: width of architrave 6.23 m: width of *abacus* 8.53 = 0.73 m

Stoa of Philip at Delos: width of architrave 11.20 m: width of *abacus* 13.39 = 0.84 m

Stoa of Philip in Megalopolis: width of architrave 5.15 m: width of *abacus* 5.66 = 0.91 m

Harbour Stoa in Miletus: width of architrave 5.08 m: width of *abacus* 5.66 = 0.90 m

Stoa J on Samothrace: width of architrave 14.39 m: width of *abacus* 17.09 = 0.84 m

The average of the measurements above is **0.84 m**

<u>Valley beam Phase 2</u>

The reconstructed width of the *abacus* on the eaves and ridge columns at Zea is 0.61 m

The calculated width of the valley beam at Zea is therefore: **0.84** x 0.61 m = <u>0.51 m</u>

<u>Architrave Phase 3</u>

The reconstructed width of the *abacus* on the eaves columns at Zea is 0.71 m

The calculated width of the architrave at Zea is therefore: **0.84** x 0.71 m = <u>0.60 m</u>

Comparative stoai: height-width ratio of valley beams and architraves

The following dimensions help compute the ratio of height to width of comparative architraves in order to find the height of the valley beam/architrave at Zea:

Stoa of Attalos in Athens: height of architrave 3.00 m: width of architrave 4.68 = 0.64 m

South Stoa from the Heraion in Argos: height of architrave 5.37 m: width of architrave 6.23 = 0.86 m

Stoa of Philip at Delos: height of architrave 8.20 m: width of architrave 11.20 = 0.73 m

Stoa of Philip in Megalopolis: height of architrave 4.18 m: width of architrave 5.66 = 0.74 m

Harbour Stoa in Miletus: height of architrave 2.89 m: width of architrave 5.08 = 0.57 m

Stoa J on Samothrace: height of architrave 10.85 m: width of architrave 14.39 = 0.75 m

The average of the measurements is **0.72 m**

1. These dimensions have been scaled off Coulton 1976: figs. 37, 39, 40 and 42–44.
2. Coulton 1976: 259, 281. The Harbour Stoa in Miletus is dated to the late 4th century BC. Stoa J at Samothrace is dated to 250–150 BC. See also Vol. I.2, Chapter 2: n.47–48, 50, 75.
3. The dimensions are scaled off the reconstructions; they are not recalculated to the scale of the buildings.

Valley beam in Phase 2

The reconstructed width of the valley beam of the shipsheds in Zea Harbour is 0.51 m. The calculated height of the valley beam at Zea is therefore: 0.51 m x **0.72** = 0.37 m

Architrave in Phase 3

The reconstructed width of the architrave of the shipsheds in Area 1 at Zea Harbour is 0.60 m. The calculated height of the architrave at Zea is therefore: 0.60 m x **0.72** = 0.43 m

Appendix 6: Survey and Recording Methods

by Bjørn Lovén

Survey technologies have made dramatic advances since the early years of archaeological recording, with ever shrinking margins of precision. Even so, traditional manual surveying with a theodolite and taped distances can produce true-to-scale, two-dimensional plans of high quality, resulting in an optimal margin of precision of about 1 cm over 50–100 m. Adding numerous spot-heights to the plans will add some degree of three-dimensionality. Manual surveying with this margin of precision is very rare in the field of archaeology and is, except for Dörpfeld's section of the colonnade dividing Shipsheds 17(η) and 18(χ) (Pl. 20b) in Zea, absent in previous shipshed research. The quality of this kind of work tends to vary greatly depending on the level of training of the surveyors and the care with which they work. Sites surveyed using only tape measurements are problematic since their margins of precision hinge, as R.C. Anderson says, on "swinging plumb bobs and tape measures blowing in the wind."[1]

Relatively recent advances in technology have made structural survey methods quite simple and highly accurate. The first major advancement over manual methods was the development of Electronic Distance Measurement (EDM) devices beginning in the 1970s. The 1980s saw the wide introduction of the total station, in which the distance measuring device was incorporated into the telescope of a theodolite, thus eliminating errors due to parallax. The total station has proven to produce more consistent and accurate results than manual survey equipment.

When the total station is used to its full potential with CAD (Computer Aided Design) software, such as that used by N. Fradgley's English Heritage survey system in the American Agora Excavations and the Zea Harbour Project, it produces three-dimensional wire-frame models capable of efficient recording with a very high level of detail. The digital plan produced with Fradgley's system is essentially a 1:1, three-dimensional model of the surveyed area. Naturally, the potential of this system for the study of ancient buildings is enormous. By adding the third dimension, and by improving the accuracy significantly, it has a tremendous advantage over traditional manual surveying techniques.

The most recent advance in surveying techniques is the reflectorless laser measurement system, which has been incorporated into the newer total station models such as the Leica TCR 300 and 400 series. On land this allows the surveyor to 'shoot' directly to the feature, often aided by an assistant with a 'pointer' (Fig. 65). This produces very precise survey measurements. The reflectorless laser mode is uniquely useful at sites where the ruins are preserved to a height which the prism-holder or pointer cannot reach. This system was used to survey features out-of-reach or inaccessible due to safety reasons, such as parts of the Classical fortifications on the Koumoundouros Hill south of Mounichia during the ZHP investigations in 2007. In shallow water (down to about 2.20 m), a classic EDM prism pole is used (Fig. 66).

On land, three-dimensional laser-scanners produce even better true-to-scale, three-dimensional models of the highest possible scientific quality with minimal processing time. Although its cost is formidable, such equipment has been used with great success on a variety of projects, such as the Eumenes Stoa on the South Slope of the Athenian Acropolis.[2]

Turning from recording methods to recording media, we encounter a serious problem in the instability of fibre-based drafting materials which become distorted by variations in temperature and humidity. As Anderson has stressed, a true-to-scale drawing must include a scaled grid, so that any distortions introduced in the replication process can be controlled. Drawings often become distorted when reproduced in publications, and here again a grid is essential to allow reasonably trustworthy measurements to be scaled from plans. Plans with a horizontal bar scale of adequate

1. Brinker & Minnick 1995. This section has benefited from discussions with R.C. Anderson, former architect to the Agora Excavations, Athens.
2. Dr. M. Lefantzis, pers. comm., 2006.

length and quality can be trusted when applied to lines running in directions parallel with the scale. Measurements scaled from plans in other directions will almost inevitably be distorted depending on the variability of the fibre-based materials.

Plans surveyed to a digital format using a total station or a laser scanner are not faultless, as they do not have a constant precision. The precision depends on the distance to the target: the greater the distance to the target, the larger the absolute errors. In the ZHP survey the Leica TCR 407 was used, which has a precision of 2 mm + 2 ppm in 'fine' mode. In the interests of taking a more accurate and scientific approach it would be advisable to apply modern survey techniques and publish architectural plans as CAD files, either in a parallel publication on the Internet or in a data storage medium with printed publications.

In sum, it is important to distinguish between sites surveyed by traditional means and those surveyed by digital means. The former method entails making judgements of accuracy and reliability. The latter, because archaeology is a destructive and hence irreversible process, is the responsibility of present-day archaeologists and their legacy to future generations.

The architectural drawings that have been consulted in this study were scanned directly from the publications and then analysed in CAD programs and PhotoShop CS4.

Appendix 7: Zea Harbour Area 1 Sediment Descriptions

by M.M. Nielsen

The sedimentation in the basin of Zea Harbour (Area 1) is not uniform. In some parts the sediments are very deep, particularly in the southern section of Area 1 that have been destroyed by modern harbour construction. In others, particularly around the well-preserved structural remains in the northern half of Area 1 (Pl. 40), there is no, or only very little, sedimentation, usually only consisting of soft organic material.

The top surface is generally covered with a very loose and soft organic material, light brown to green in colour, and *ca* 0.01–0.02 m thick. This surface layer can be found in the entire harbour; it is not included amongst the stratified layers, due to its negligible thickness and loose composition. The sediments below are fairly uniform, despite occasional variations locally. As a rule, the top layer (below the top surface) is dark grey to black in colour, while the layers below are more light grey to light brown in colour. Occasionally, the sediment colours vary somewhat, e.g. appearing greyish-black and in other places, whilst at the same level, brownish. This is probably due to anchoring and wave action in the harbour. Furthermore, a lot of modern and ancient material is found mixed in the sediments, especially close to the surface. Only in a few cases have the sediments had closed contexts, such as areas around colonnade foundation blocks C9/10:2 and C10/11:3 (Fig. 169), or inside rock-cut trenches for column bases or other structural features (see below).

However, despite the great variation throughout Area 1, it is possible to summarise a general stratum description of the area, with three principal strata.

Layer 1: Modern Waste and Rubble

The upper layer is generally *ca* 0.10–0.25 m thick. The sediments are dark grey to black in colour. Their composition varies from mostly soft, organic material (with few ancient finds but a very high quantity of modern litter), to concentrations of stones and rubble (with a varying quantity of finds, ancient and modern).

The soft organic material is usually located closer to the modern quay, mainly up to *ca* 3 m west of it (towards the harbour basin). The rubble material usually increases further seawards, and it also has various marine life. This often contains a large amount of small limestone fragments and some rounded stones, similar to those from Layer 2 (mostly *ca* 0.05–0.10 m in diameter). Large irregular limestone fragments are also present (*ca* 0.15 m+ in diameter). Occasionally, large limestone fragments penetrate several layers due to their size, and mix Layers 1 and 2.

Layer 2: Mixed Context

Layer 2 is a fairly uniform layer of limestone fragments, sand, rubble, fragmented ceramic material and varying marine life. The layer is most clearly defined within structural features such as rock-cut foundation trenches for the colonnades (particulary in C7/8:4; C9/10:1; C10/11:2; C13/14:2; C14/15:1–2; C16/17:9–10 (C7/8:3, 5) and C23/24:8; Pl. 40).

The layer varies in depth according to context, though generally it is *ca* 0.10–0.15 m deep in the northern part of Area 1, and *ca* 0.20–0.35 m in the southern part. At places it reaches almost 0.50 m, but only where modern dredging has destroyed the bedrock, in the very southern part of Area 1 (especially between C14/15:2 and C14/15:4).

The layer colour varies from light brown to light grey and occasionally dark grey. The colour of the sediment is not necessarily related to strata, but rather the depth and organic contents of the sediment matrices. The top of the layer is contaminated in several places by pockets of dark, soft sediments penetrating from the surface layer. This is most likely due to vessels anchoring, and in some cases, the tunnelling of marine worms.

The composition of the layer is fine-grained sand, gravel, rubble (i.e. flaky, broken and rough limestone fragments of varying sizes, *ca* 0.05–0.10 m in diameter) and larger fragments of limestone, almost all coarse and irregular in shape (sub-angular). Cobbles of varying sizes are also found (*ca* 0.05–0.10 m in diameter) in this layer.

Occasionally, it has been necessary to divide Layer 2 into two distinct sub-layers. The reasoning behind this is that while the sediments are similar, the layer includes modern finds in the upper part whilst none are found in the lower part. It is noted that in Area 1 the lower part of Layer 2 is still a mixed context, probably closed before more recent times.

Layer 3: Natural Bedrock

In Area 1, Layer 3 is bedrock. In several areas the bedrock is destroyed by modern dredging. The extent to which this has happened varies greatly from area to area. In some cases destruction is complete, eliminating all indications of ancient structural remains. This is seen primarily in the areas about 2.0 to 10.0 m to the east of the T-jetty, and between about 0.0 to 5.0 m west of the modern quay (Pl. 40). To the west of the modern T-jetties no bedrock is preserved.

In some cases the bedrock breaks up very easily. This is a frequent and natural problem, due to the greatly varying quality of the bedrock found throughout the Piraean peninsula. In the northern part of Area 1 of Zea Harbour, in particular north of C16/17(η) and in the south between C14/15:2 and C14/15:4 (the area of C14/15:3), the bedrock is very poorly preserved. Excavation in parts of these areas has not been possible since the bedrock is powdery and crumbles when exposed. In the southern part, around the severely damaged rock-cut colonnade foundation C14/15:3 (Pl. 13), large sections have been destroyed by modern harbour works, and as a result the bedrock here is crumbling and breaking up.

Index Lapidum – Inscriptions

Inscription[1]	**Date**	**Reference**
IG I^3 52, 30–31	434/3 BC	First Callias Decree
IG I^3 153	450–430 BC	Naval base superintendents
IG II^1 167, 68–69	307/6 BC	The gallery of the long walls
IG II^2 244, 90–95	337/6 BC	Construction work at Mounichia
IG II^2 463	307/6 BC	Repair of the fortifications
IG II^2 505, 12–13	302/1 BC	Metics contributing to the shipsheds and the arsenal
IG II^2 786, 7; 834, 14	229/8 BC	Repair of the fortifications
IG II^2 1054, 58–59	347/6 BC	Arsenal inscription
IG II^2 1604, 72	378/7 BC	103 *triremes*
IG II^2 1611, 3–9	357/6 BC	283 *triremes*
IG II^2 1613, 302	353/52 BC	349 *triremes*
IG II^2 1627, 398–405	330/29 BC	372 shipsheds
IG II^2 1628, 552–559	326/25 BC	372 shipsheds
IG II^2 1629, 1030–1036	325/24 BC	372 shipsheds
IG II^2 1656–1664	395/4 BC	Conon's restoration of the Piraean fortification walls
IG II^2 1668	347/6 BC	Arsenal of Philon *syngraphe*

Index Locorum – Ancient Sources

Author	**Reference**	**Bibliography**
Aeschines	*On the Embassy 2.174* *Against Ctesiphon 3.25*	Adams 1919
Aeschylus	*Persians 341–343*	Sommerstein 2009
Andocides	*On the Peace 3.7*	Harris 2000
Appian	*Mithridatic Wars 5.30–32, 34, 36–37; 6.40–41*	White 1912

1. For references mentioned in the text and the preserved original inscription, see: the 'Searchable Greek Inscriptions', by The Packard Humanities Institute: http://epigraphy.packhum.org/inscriptions/main, or the online version of 'Inscriptiones Graecae', by Berlin-Brandenburgische Akademie der Wissenschaften: http://www.bbaw.de/bbaw/Forschung/Forschungsprojekte/ig/de/Startseite.

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Cratinus	*Fr. 197*	Edmonds 1957
Demosthenes	*Against Aristocrates 23.207*	Vince 1935
Dinarchus	*Against Demosthenes 96*	Burrt 1954
Diodorus Siculus	*11.41.2* *14.42.5*	Oldfather 1946; Oldfather 1954
Dionysius of Halicarnassus	*6.92.6*	Cary 1940
Eustathius	*GGM II, 312.20–25*	Müller 1861
FGrH 328	*Philochoros F 56a*	Jacoby 1967
Herodotus	*5.97; 6.116; 7.89; 7.144; 7.184;* *8.66–67; 8.91–93; 9.32; 9.107–108*	Macan 1895; 1908; see also Godley 1920; 1925
Isocrates	*4.93, 7.66*	Mirhady & Too 2000
Livy	*31.26.5, 31.47.1–2*	Sage 1985
Livy	*45.27.11*	Weissenborn 1959
Lysias	*Against Agoratus 13.46* *Against Eratosthenes 12.40* *Against Nicomachus 30.22*	Lamb 1930
Pausanias	*1.1.2–4; 1.29.16*	Jones 1918
Plato	*Gorgias 455d–e; 517c; 519e*	Lamb 1925
Plato	*Critias 116B*	Bury 1929
Plutarch	*Themistocles, 4.1*	Perrin 1914
Plutarch	*Demetrius, 43.3*	Perrin 1920
Plutarch	*Sulla, 14.7*	Perrin 1916
Polybius	*Histories 5.89; 62.2.6*	Paton 1923
Pseudo-Plutarch	*Vit. Pseudo X Or., VII 851D*	Barcroft 1878
Strabo	*Geography, 14.2.5*	Jones 1929
Thucydides	*1.93.3–8; 2.24; 2.4.2*	Smith 1919
Thucydides	*3.22.4; 4.48.2; 7.12.3–4*	Smith 1920
Vitruvius	*De Architectura 5.12.7*	Morgan 1914; Granger 1931
Xenophon	*Hellenika 2.1.28–29; 2.2.20 ; 2.3.8;* *4.5.9; 4.6.14; 4.8.9–10; 6.5.9*	Brownson 1918

Bibliography

Abbreviations	
AA	Archäologischer Anzeiger
AAA	᾿Αρχαιολογικὰ ᾿Αναλεκτα ἐξ ᾿Αθηενῶν (Athens Annals of Archaeology)
ActaHyp	Acta Hyperborea
AD	Αρχαιολογικόν Δελτίον
AEphem	᾿Αρχαιολογική ᾿Εφημερίς
AJA	American Journal of Archaeology
AM	Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung
AntJ	The Antiquaries Journal. The Journal of the Society of Antiquaries of London
Archaiognosia	᾿Αρχαιογνοσια
ASCSA	American School of Classical Studies at Athens
AST	Araştirma Sonuçlari Toplantisi
BAntFr	Bulletin de la Société Nationale des Antiquaires de France
BCH	Bulletin de Correspondance Hellénique
BJb	Bonner Jahrbücher
BSA	The Annual of the British School at Athens
DOP	Dumbarton Oaks Papers
DossAParis	Les Dossiers de l'Archéologie
GGM	Geographi Graeci Minores
GRBM	Greek, Roman and Byzantine Monographs
Hesperia	Hesperia, Journal of the American School of Classical Studies at Athens
Historia	Historia, Revue d'Historie Ancienne
IJNA	International Journal of Nautical Archaeology
IstMitt	Instanbuler Mitteilungen
JHS	Journal of Hellenic Studies
JIAN	Journal International d'Archéologie Numismatique
JRA	Journal of Roman Archaeology
Latomus	Latomus. Revue d'études latines
LibyaAnt	Libya Antiqua
MDAI (I)	Mitteilungen des Deutschen Archäologischen Instituts, Abteilung Istanbul
MedMusB	Medelhavsmuseet, Bulletin (Stockholm)
MonAnt	Monumenti Antichi Pubblicati dall' Acadamia dei Lincei, Roma
OpArch	Opuscula Archaeologica (Skrifter Utgivna av Svenska Institutet i Rom)
OpAth	Opuscula Atheniensia (Acta Instituti Atheniensis Regni Sueciae)
OpRom	Opuscula Romana (Acta Instituti Romani Regni Sueciae)
Philologus	Philologus, Zeitschrift für klassische Philologie
Phys.Chem.Earth	Physics and Chemistry of the Earth
PoDIA	Proceedings of the Danish Institute at Athens
Polemon	Πολέμων, Αρχαιολογικόν Περιοδικόν
Prakt	Πρακτικὰ τής εν Αθήναις Αρχαιολογικής Εταιρείας
Syria	Syria. Revue d'Art Oriental et d'Archéologie
Talanta	Τάλαντα. Proceedings of the Dutch Archaeological and Historical Society

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