

Offshore survey at Carthage, Tunisia, 1973

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Introduction

The survey of the offshore structures at Carthage was carried out in August 1973, as an essential preliminary to the intensive investigation of the harbour area of Carthage to be carried out by a British Mission over the next few years. In addition to the authors and David Davidson, the team consisted of Keith Muckelroy, who undertook some of the initial organization and research, and John Edge and Robert Hails, from the Cambridge University Underwater Exploration Group.

The work was sponsored by the Save Carthage Committee of the British Academy, which is directing the efforts of the British Mission. This international archaeological programme has recently been organized to rescue Carthage's heritage before all traces are destroyed by encroaching urbanization. The results of the first season's land excavation are due to be published in the *Antiquaries Journal*, 55, 1975. Our thanks are particularly due to M. Beschouch, Director of the Institut National d'Archéologie et d'Arts, Tunis, and other members of the Tunisian Archaeological Service, for their help and encouragement on site. Finally, we would like to thank Dr Claudio Vita-Finzi for his contribution (Appendix I) on sea-level changes and Miss Morag Dow for her assistance in the preparation of the maps.

Background to the survey

The important harbour features and coastal structures lie in the area of the Point of

Salamambo, now a part of modern Carthage, itself a suburb of Tunis. Much of the Punic and Roman site is now overbuilt with villas and a considerable proportion of the original stonework from both the city and the harbour has been incorporated into the modern buildings. The harbour area comprises two main elements (Fig. 1): two land-locked artificial harbours or 'cothons', one round and one rectangular, and a complex of stone and concrete structures lying offshore in water varying from 0.2 to 4.3 m in depth and extending over a roughly rectangular area some 150 m wide by 500 m long. This area is usually known as the 'quadrilateral of Falbe'. Further up the coast, towards the Antonine baths, the remains of buildings can also be seen in shallow water.

The aim of the summer's work was to produce an accurate survey of the structures in the water along this coastline and where possible to isolate specific problems best solved either by selective excavation on shore or by underwater excavation at a later date. The site of Carthage, and particularly the harbours and the quadrilateral, has been the subject of considerable speculation by many well-known archaeologists, the majority of which has not been based on fieldwork on site. The value, therefore, of the survey is that it relates only to evidence existing on the ground.

Much has been written about Carthage, particularly the ports. It is appropriate, however, to give a brief synopsis of Appian's description (*Libyca*, 96ff.), derived from an original description, now lost, by Polybius

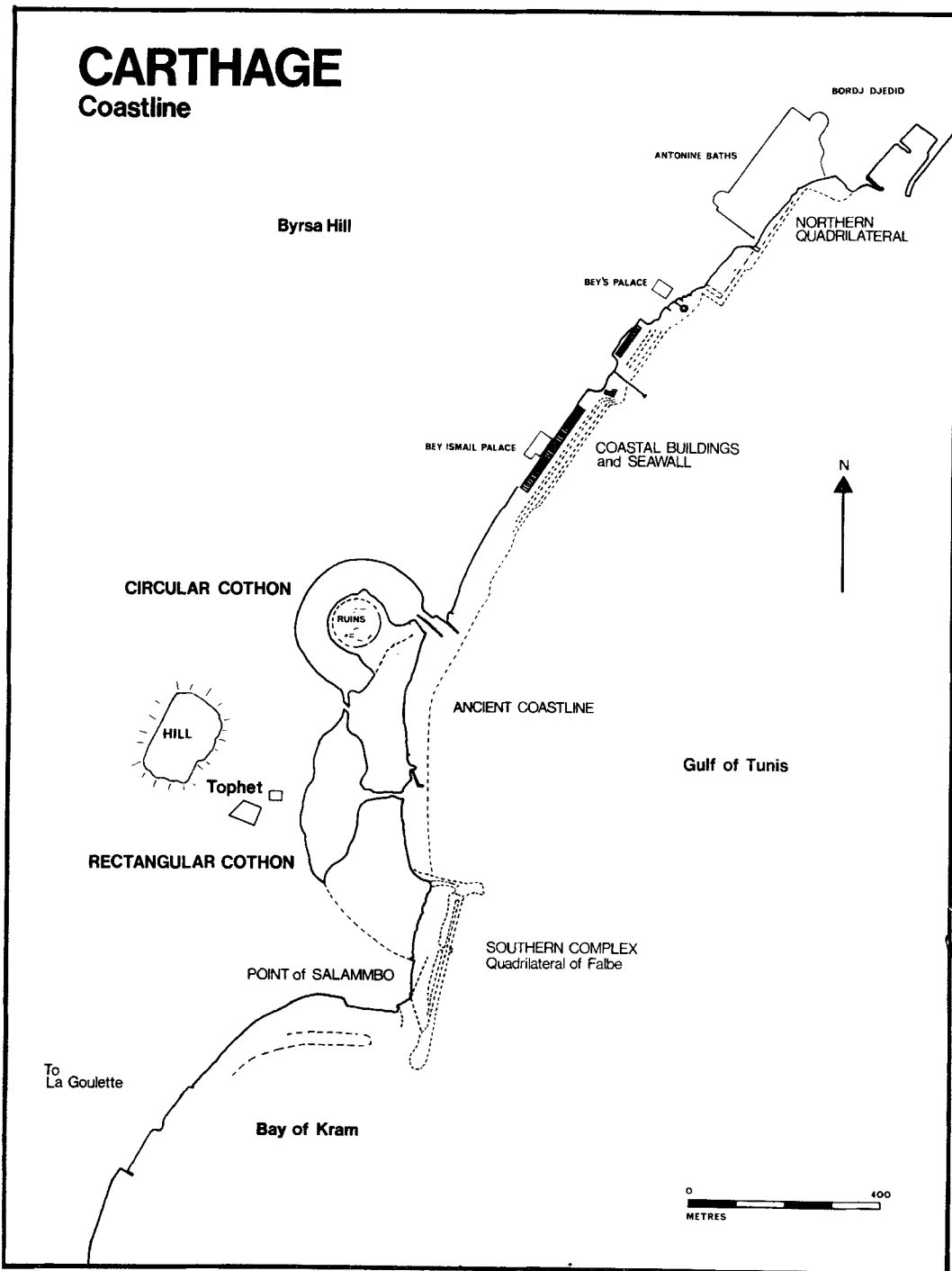


Figure 1. Carthage: the coastline.

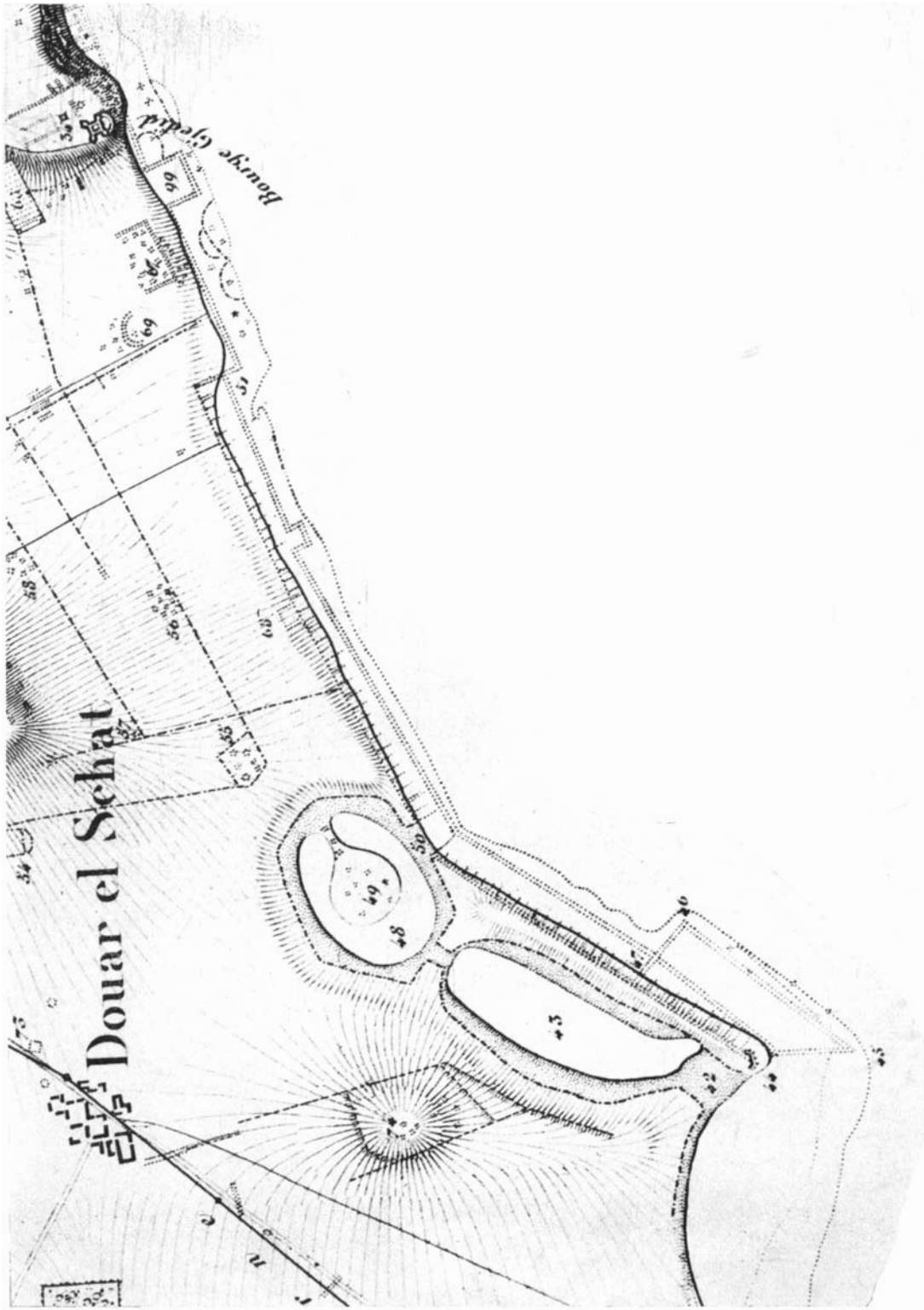


Figure 2. Falbe's map.

who was an eyewitness of the siege and destruction of Carthage by Scipio in 146 BC. From this description, one can confidently identify the circular and rectangular 'cothons' as the original Carthaginian military and commercial harbours respectively. Beyond this, and the fact that the two were connected, Appian's description cannot take us with any certainty. He gives no indication where the entrance to the cothons lay beyond saying that Scipio built a mole out from the land to deny the Carthaginians access to and from their harbour. The location of this mole is at present unknown. Continuing his description of the siege, Appian mentions the existence of a 'choma', or wide quay, running along the seaward side of the city and harbour wall, possession of which became a crucial factor in the struggle for the city. The 'choma' was apparently used by merchant shipping for loading and unloading, as well as by traders for the display of their wares. Again, however, Appian gives no more precise details of the location of this feature. It was from the 'choma' where Scipio built up a force of 4000 men and various siege machines, that the final successful assault was made on the ports of Carthage which led to the downfall of the city.

Although there is no proof that part or all of this text is not suspect, argument about the ports inevitably turns back to Appian and undoubtedly will continue to do so until the current archaeological work has provided some conclusive answers.

The survey

We deal first with the ruins on the northern coastline and then examine the possibility of there being further remains in the Bay of Kram or out to sea. The discussion proceeds to a short description of the 'cothons' before leading to the complex of ruins in the sea off the 'cothons'.

Shore line to the north of the 'cothons'

In considering the ruins in the sea between the Antonine Baths and the cothons, Falbe's

map (1833; see Fig. 2) is of particular interest. On this map, unfortunately of rather small scale, he shows compartmentalized structures stretching the length of the coast to Bordj Djedid. Only in two places are these noticeable today. Subsequently, Saumagne (1960: 166) identified these as a vaulted promenade raised to a height of 5 m above the sea, aligned on the Roman street grid. He and Lantier (1931: 486) claimed that they lay between *Cardo* XIX and XX east. Other commentators have remarked on these features, some calling them quays, and they also appear on de Rochefeuil's map (1898). Along with Falbe's, de Rochefeuil's map of soundings made in the bay provides some of the best historical evidence for the period before much of the area was developed or changed.

Close study of high level aerial photographs (Fig. 3) also gave indications of the coastal structures and these demanded attention since they had not been investigated or surveyed in detail.

Preliminary search of the water revealed a series of structures in various states of decay, of which two call for mention in this interim report. The first lies on the seaward side of the Bey Ismail Palace, and comprises a concrete rear wall, 1.50 m wide, extending 200 m along the beach (see Fig. 4). At regular intervals of 5 m lesser concrete walls, 0.80 m wide, run off into the sea at right angles to the rear wall so forming a series of compartments facing on to a broad paved road which, in turn, was protected from the sea by a double line masonry sea-wall (Fig. 5). The building, possibly identifiable as warehouses or shops, appears to be of two periods, from the evidence of two floor levels and the later blocking of a corridor running parallel to the rear wall along most of the building's length. The regularity of the plan and the similarity of the materials and method of construction to that of the Antonine Baths, built between AD 142 and 161, would indicate a date in the 1st–3rd centuries AD.

However, in terms of the whole harbour site, the most important fact to emerge from this structure was positive evidence for a rise in sea level of some 1.25 to 1.50 m since the building's construction. Sections of the ori-



Figure 3. Vertical aerial photograph showing the rectangular and circular lagoons, and the quadrilateral of Falbe. Courtesy of Service Topographique, Tunis.

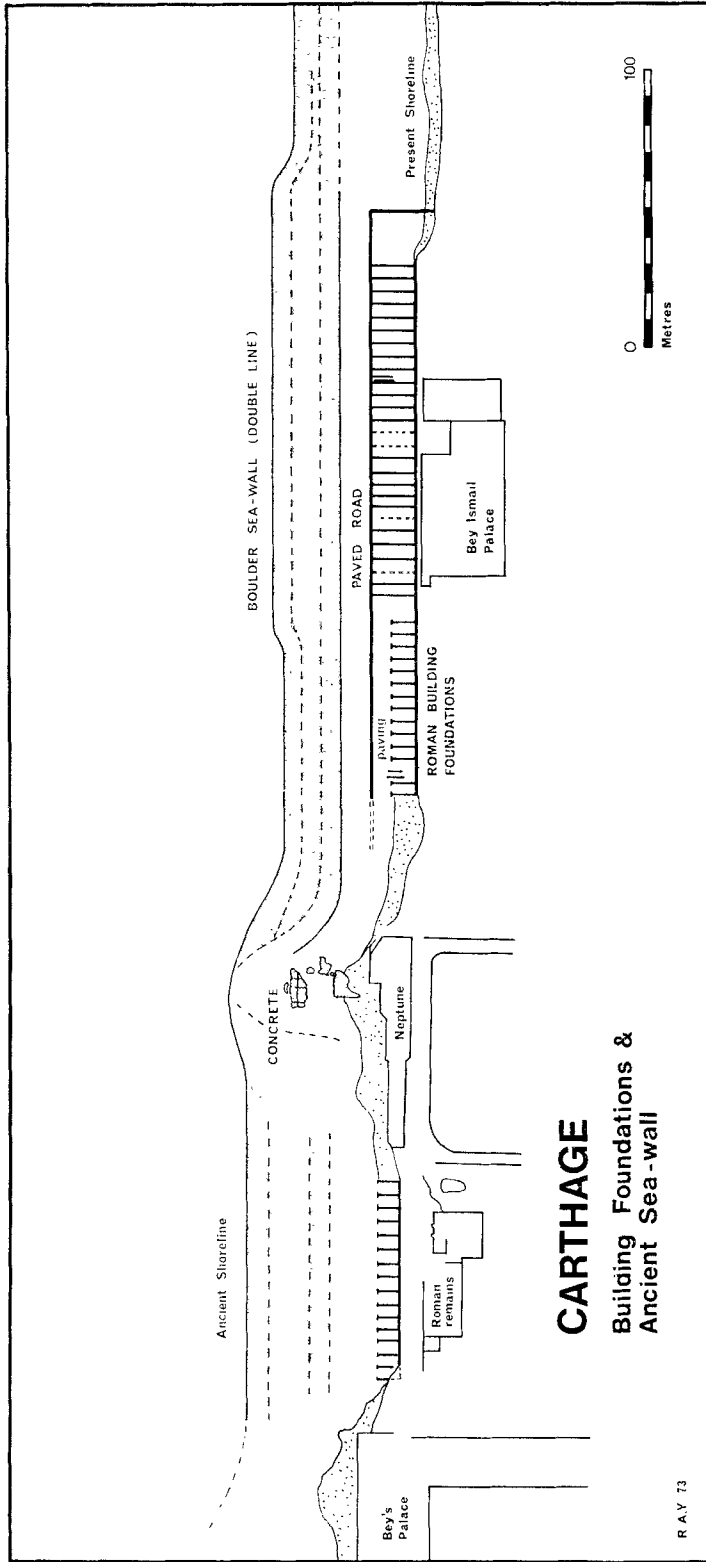


Figure 4. Carthage: building foundations and ancient sea-wall.



Figure 5. A line of compartment walls belonging to the coastal building in front of the Bey Ismail Palace. In the distance the boulders of the double line sea-wall can be seen breaking the surface. (Scale 0·10 m units.)

ginal roadway fronting the building survive *in situ* and are currently 0·25–0·4 m below water level (depending on the state of the tide), as are the paving stones at the entrance to several of the building's compartments.

Building practices change very little over the centuries, and observation of harbour quays and waterfront buildings in many Mediterranean ports has shown that the top or floor surfaces are usually at least 1 m above mean sea level, in relatively protected positions. A vertical distance of this amount seems to be sufficient protection against flooding as long as the quay or wall is not directly exposed to the open sea. At Carthage today, only a few hundred yards from the building under discussion, some older Arab houses fronting directly on to the sea have their floor levels only 1·10 m above sea level.

On this evidence, it may reasonably be postulated that the roadway in front of the waterfront building would originally have

been at least 1 m above sea level and therefore, if one takes into account the present-day submersion of the roadway, sea level must now be between 1·25 and 1·50 m higher than in antiquity (see Appendix 1). On the basis of this hypothesis and our interpretation of the remains by the water, there is no evidence to suggest that there was a vaulted promenade as proposed by Saumagne. The evidence for a sea-level change will prove to be of crucial importance in the final interpretation of the structures throughout the site and particularly the quadrilateral.

The second area of major interest lies immediately in front of the Antonine Baths and extends 200 m to the south. Initially identified from high level vertical aerial photographs, the constructions in this area display a remarkable similarity to those described above as well as to the north mole of the quadrilateral. In shallow water to seaward of the Antonine Baths, a line of

finely coursed blocks, whose northern end appears to terminate on land at the northern end of the Baths, extends in a straight line with few interruptions for 130 m to the south. This, in turn, is fronted at a distance of 8 m by a rubble embankment of massive rough-hewn blocks of similar construction to that in front of the Bey Ismail Palace and the north mole of the quadrilateral. This embankment runs parallel to the line of blocks except at a point 120 m from the north end where it turns westwards for 6 m before continuing, parallel to its original line, to the southern end. There it turns through 90° to the west and runs into the shore, so forming a large rectangular area lying immediately south of the Antonine Baths. Two lines of concrete wall run parallel to and inside the mole as it runs to the shore, and another line runs parallel to and 2 m to landward of the north-south line of blocks. These features, in association with the rubble mole, establish a homogeneity with the north mole of the quadrilateral and the buildings fronting the Bey Ismail Palace, and

thereby imply a pattern which will prove of value in determining the detail of the coastal sections of the city's street grid.

It seems highly likely that the structure in front of the Baths and those on the shore to the south formed a maritime promenade which was conceived as a whole. The present break in the line of the remains which occurs on the coast by the Bey's Palace is probably to be explained partly by the encroachment of the present shoreline at this point, and partly by the disturbances caused by the building of the Palace. The overall conception seems to have been of a straight terrace in front of the Antonine Baths, following the line of *Cardo XX*, with a re-entrant to the south, from which point the wall continued southward on the line of *Cardo XIX* (Bradford, 1957: 237). It is impossible to comment on the small projection in the line (northern quadrilateral) off *Bordj Djedid* owing to its recent destruction in the course of building work associated with the Presidential Palace, but it is very likely that it belonged to the

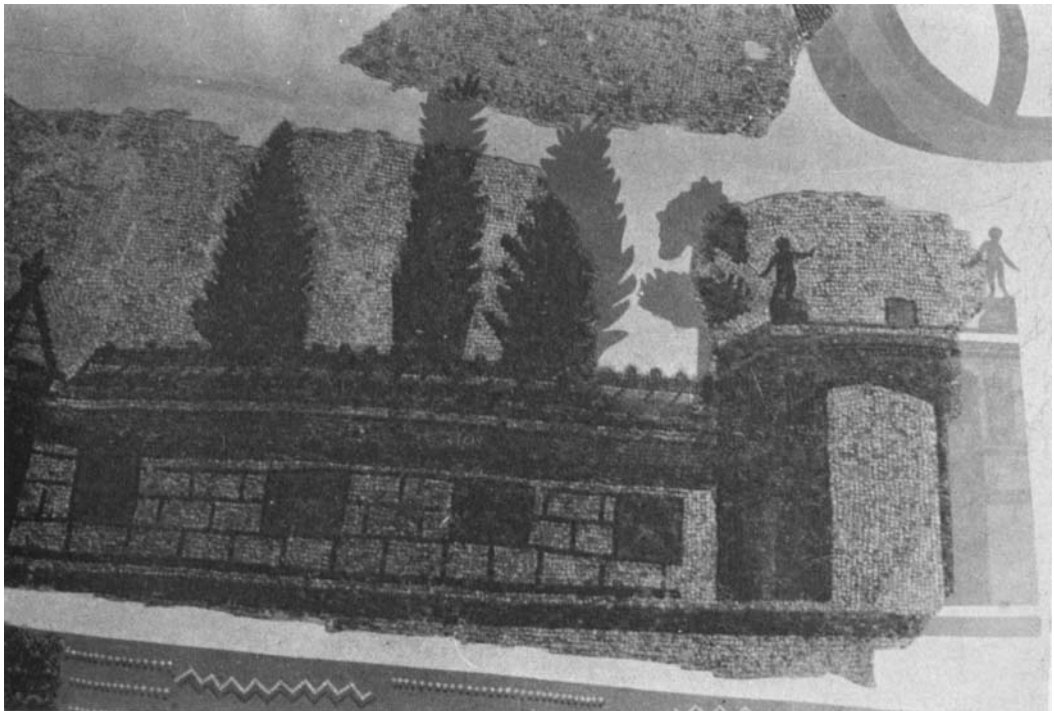


Figure 6. A close-up of a detail of the mosaic found at Carthage showing a triumphal arch by the shore and some of the waterfront buildings. Photo: Bardo Museum, Tunis.

same scheme, and that it represented some prominent building at the end of the promenade¹¹. This coastal complex terminated at the southern end in the quadrilateral of Falbe.

A possible insight into the appearance of this group of buildings may be gained from a 4th century mosaic found at Carthage (Fig. 6) and now in the Bardo Museum (inv. 2772, now in Room XXIII). The elements in the mosaic appear to coincide in sequence with the major buildings remaining on the sea front at Carthage. The essential feature on the mosaic is a triumphal arch standing proud of a porticoed marine promenade and this may possibly explain the platform of very solid concrete which lies today in front of the present Neptune restaurant. The platform projects 40 m in front of the general building line and necessitates a deviation in the outer line of blocks. Now eroded in such a way as to expose the details of its original timber-laced



Figure 7. The original location of a wooden former in the concrete platform in front of the Neptune restaurant.

construction (Fig. 7), the platform would seem to represent the remains of either the core of a massive mole or a platform of hydraulic concrete. The details of the construction techniques are remarkably preserved and are paralleled by those found in the concrete mole at Thapsus (Yorke & Dallas, 1968: 25). There is no evidence further out to sea of a continuation of a mole, but it should be noted that the concrete lies at the end of the Decumanus Maximus, the customary position for a triumphal arch.

Bay of Kram

A number of commentators have suggested the existence of an outer harbour in the Bay of Kram. Furthermore, some commentators have gone so far as to suggest that the external harbour mentioned by Appian lay seaward to the east of the 'cothons'¹². Courtet (1897: 127) was prompted to impose an outer harbour in this area and in support of this he cited several areas of rock in the bay which, he stated, formed the surviving foundation of a mole running out from the shore at the southern end of the bay and then turning north, parallel to the coast. This, he stated, formed an outer harbour to supplement the 'cothons', which in his opinion were too small to sustain the volume of trade expected of such a flourishing maritime city. Courtet's work prompted de Roquefeuil (1899: 19) and Hantz (1900: 53) to conduct a thorough hydrographic survey of the area. The principal fact arising out of their survey was that there were no constructions lying in deep water in the area of the Point of Salamambo or along the coast to the north.

The examination in 1973 of the sea-bed from the east of the 'cothons' and in the Bay of Kram, using both divers and an echosounder, produced negative results; therefore the existence of a large outer harbour consisting of long moles extending to the east and south must be discounted. Cousteau and Poidebard (Poidebard, 1948: 380) came to the same conclusion. Any structure heavy enough to break surface and protect such a large enclosed area is unlikely to have disappeared without leaving a substantial

mound or anomaly on the sea-bed (cf. Thapsus, Tunisia). The possible locations for the harbour are therefore limited to the 'cothons' and the inshore area covered by the survey. We have referred to the two lagoons as 'cothons' for the purpose of this discussion without prejudice to further findings from the land excavations which started on the circular lagoon in 1974.

The 'cothons'

The water in the 'cothons' today is shallow (about 0.30 m) and stagnant. The bottom alternates between fine silt and hard packed gravel. Along the eastern shore of the rectangular 'cothon' near the modern entrance channel to the sea, remains of a revetment wall of dressed blocks can still be seen. The 'cothons' are too shallow for underwater excavation techniques, and therefore must await land-based methods in due course. Excavation to a depth of 3 to 4 m may be required on the assumption of the suggested change in sea level.

One of the best insights into the state of the harbour area before any modern development took place is gained from Falbe's plan (Fig. 2). In particular, the rectangular cothon is shown as being about 500 m long, extending almost to the Bay of Kram, and about 200 m wide. The partially silted lagoon ran much closer to the present shoreline on the east and to the site of Tophet on the west. Whilst Falbe's dimensions will need verification on the ground, the enclosed area of water would provide a generous-sized harbour compared with the existing lagoon whose dimensions are now only 300 m by 120 m at the widest point. The entrance could have been to the south into the Bay of Kram as shown on Falbe's map which was made before the redevelopments of the mid-19th century^[3].

From evidence under water, it is apparent that the ancient coastline would have been 50–60 m further out to sea along the length of the site from the Antonine Baths to the quadrilateral. The seaward edge would have been marked by the boulder sea-wall now under water. As a consequence of this, there would then have been sufficient land space to

the east for the seaward arc of the circular 'cothon' to be completed. On the evidence of earlier maps and photographs, the present-day entrances to both 'cothons' from the sea seem to be entirely modern.

The provision of entrances directly to the east without some form of protecting mole, whilst appearing perfectly feasible, does not accord with good nautical sense. The frequent north or north-easterly winds build up seas which drive directly on to the shore at Carthage, making navigation into a narrow channel both difficult and dangerous for heavily laden sailing ships driven by a following wind and sea. This fact also renders it impossible to agree with any interpretation of the coastal underwater remains which requires ships to moor along this shore.

The quadrilateral of Falbe

One of the main elements of the quadrilateral is the north mole consisting of massive rough hewn blocks. This extends out to sea from the present beach line for some 100 m to the point where it joins the east mole, thence continuing for a further 50 m (see Figs 8 and 9). At the western end, where the mole is widest, traces of a roadway were located in the form of coursed blocks aligned on either side and joined by tying courses at two points. Further east these blocks could not be located, presumably owing to erosion by the sea. The indications, however, are that a paved road extended along the top of the north mole and that this road was protected on either side by rough blocks built up above the level of the main mass of the mole. The broadening of the north mole at its eastern extremity may possibly indicate a destination for this roadway. This suggestion is made bearing in mind that a building called *Les bains des femmes* was constructed on the landward end of the north mole in the mid-19th century^[4] and although the building has since disappeared these parallel lines of blocks could be part of its foundations.

A massively constructed east mole constitutes the second major element in the quadrilateral (Figs 8 and 10). Like the north mole, it is constructed of rough-hewn blocks

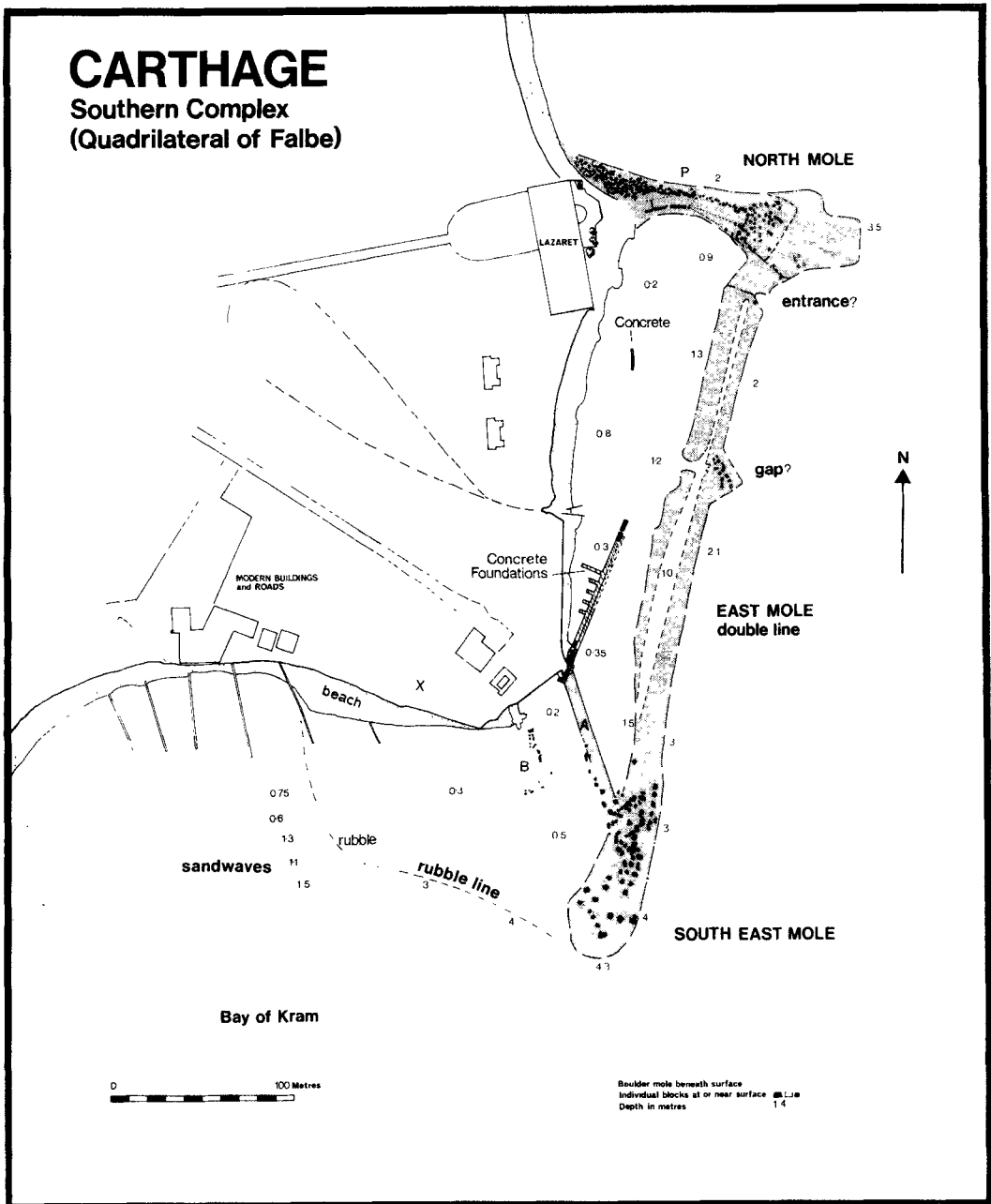


Figure 8. Carthage: Southern complex (quadrilateral of Falbe).

apparently simply dumped into 3 m of water. (This method of mole construction is attested by several ancient authors, cf. Vitruvius, *de Architectura*, v. 12.) The junction of the north and east moles is not clearly defined as the junction is not firmly completed. The

double line of the east mole ends 13 m south of the north mole and the method of construction in the gap changes. In particular, the inside line of the east mole veers sharply eastward to join the curve of the north mole at right angles. Secondly, there is an indenta-

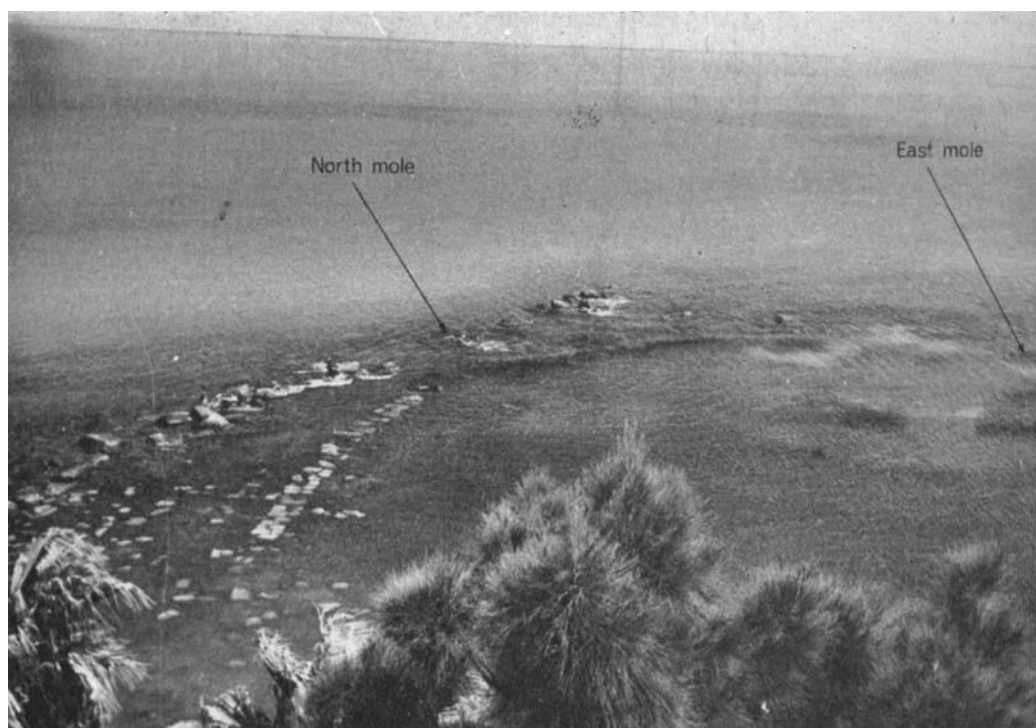


Figure 9. North mole of the quadrilateral and its junction with the east mole.

tion in the outer edge of the east mole at this point. The boulders closing the gap are smaller than those on the east mole and do not merge with the blocks of the north mole which form a more coherent line on the south side and are characterized by their large size (some measure as much as 2 m³). It seems, therefore, that originally the two moles may not have been connected and the gap may have been filled in at a later time. There is a strong indication that there could have been an entrance from the sea at this point.

The east mole extends from this junction with the north mole in a roughly southerly direction for some 375 m (Fig. 10). Over this distance its average width is 25 m, with traces of a possible gap 6 m wide at a point 115 m from the junction. This gap is particularly marked in the inside line of blocks. At the southern end the character of the mole undergoes a radical change in that the size of the individual blocks is greatly increased, as is the width of the mole by some 10 m.

From the beach opposite the southern end of the east mole, the line of a concrete wall extends north-eastwards into the quadrilateral at an acute angle for some 90 m; it appears to have been faced with finely coursed masonry blocks and is fronted by a broad platform 2.50 m wide. From the back of the wall a series of concrete walls project at right angles forming compartments. Five walls are identifiable today, but there are indications that the series of walls continues under the *posidonia* weed and sand which obscures much of the area of the quadrilateral. The type of concrete construction, the wall dimensions, and the spacing of the compartment walls are very similar to the building in front of the Bey Ismail Palace, and we may therefore suppose that this installation is of the same period, namely 1st–3rd centuries AD.

Further south, a group of structures (area A & B, Fig. 7) is easily identifiable. The two most prominent elements consist of a pair of concrete and block walls, or small moles,

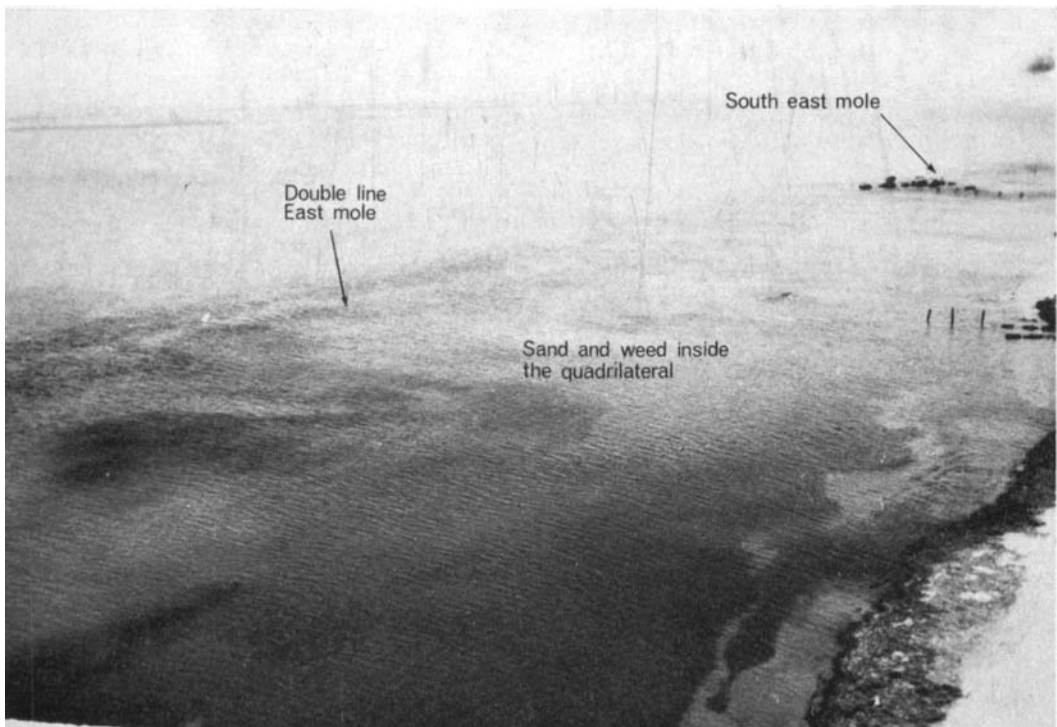


Figure 10. The quadrilateral looking south, showing the double-line east mole and part of the south-east mole where it breaks surface.

running out to sea in the direction of the southern tip of the main eastern mole from the point dividing the quadrilateral from the Bay of Kram. The lines run approximately parallel to one another and 32.5 m apart. The western wall of mole A extends 45 m, the eastern wall possibly as far as the east mole, thus blocking any entrance to the quadrilateral from the south and thereby invalidating the theory (Baradez, 1958) of an entrance into the quadrilateral through the south-east end of mole A^[5].

The remaining feature in the area which has shown on aerial photographs over a period of 40 years consists of two sand waves, extending eastwards inshore across the Bay of Kram^[6]. Inshore sounding confirmed their existence and search of the sea-bed revealed an anomalous spread of small squared blocks and sherds. As yet, however, the nature of any features obscured by the sand waves can only be conjectural pending an excavated section under water: the possibility, however,

exists that the sand waves obscure the remains of a quay, or the original coastline.

Interpretation of the southern complex

Two basic ideas have been put forward for an interpretation of the quadrilateral by Gsell (1920; II: 48) and Baradez (1958: 51)^[7]. Gsell followed Appian, who wrote of a wide quay or 'choma', and chose to identify the quadrilateral as this wide quay^[8]. Baradez interpreted the quadrilateral as an outer commercial harbour and 'choma' enclosed by moles, and believed that this outer harbour protected the entrance to the mercantile 'cothon'.

If one takes account of the important evidence that sea level was higher by 1.25–1.5 m in antiquity, and notes the current depths within the quadrilateral, it appears that the area originally lay at or above sea level. In addition, the area is certain to have been

extensively robbed for the construction of the neighbouring palaces. This would seem to indicate that at least in a final phase, the quadrilateral was a raised platform adjoining the commercial harbour.

On the evidence of its manner of construction, the idea of the structural unity of the quadrilateral is brought into question most particularly in the area of the north and east moles. The north mole stands as a sea defence in its own right and continues appreciably beyond its junction with the east mole. At the junction, the abrupt change in the character of construction is not compatible, in civil engineering terms, with a strong corner at the most exposed part of the installation. Secondly, the extension of the north mole beyond the junction would be redundant if the two moles were designed as one unit. The suggestion may therefore be put forward that either there was an entrance at this point or the east mole was a later addition.

As a logical progression in the site's development, the south-east mole may originally have been constructed to protect the southern entrance of the rectangular 'cothon'

from the prevailing north-easterly wind. As a second development, the north mole may then have been added to provide a degree of shelter for small boats outside the main harbour, with or without the addition of the east mole.

In the final stages of the port's development the sea area between the south-east mole and the north mole may have been protected further by the addition of the east mole, the entrance to this small enclosed harbour being in the lee of the north mole. The east mole may have been built as a single line of boulders and reinforced at a later stage with the second line or indeed this second line may have been the final development to close off the harbour and protect the raised platform that was later constructed.

Until the inside of the quadrilateral can be excavated, the balance of evidence must suggest that in its final stages the quadrilateral was a wide platform protected to the east by a double-line sea wall, not untypical of those further north, and may have been the platform that some identify with the 'choma' from which Scipio launched his final assault on Carthage in 146 BC.

Appendix 1

In his authoritative study of the western Mediterranean, Flemming (1969: 85) concluded that there had been 'no net eustatic change of sea level in the last 2000 years to within an accuracy of ± 0.5 m', and that all cities in the area displaced from their original relation to sea level occurred either on deltas or in volcanic or seismic zones. It should be noted that Flemming (1969: 79) did not exclude a eustatic component, and merely claimed that it could not be isolated by the analytical methods he had adopted. Indeed, in a later study—concerned with the Aegean—he pointed out that there were two sites, Ile Ste Marguerite (near Cannes) and Monastir, in the western Mediterranean that did not conform to the original scheme and suggested that their submergence could be explained by a eustatic rise of the order of 0.20 m in 2000 years (Flemming, 1972: 198). In brief, although some of the more extravagant claims

formerly made for post-classical sea-level changes in the Mediterranean can now be dismissed, there is still room for a slight rise (probably no more than 0.50 m) since the Roman period. Nevertheless the need remains to guard against postulating such a rise when an alternative explanation will suffice. Blanc (1958: 172) described a post-Severan deposit off Leptis Magna which invited an explanation in terms of a rise in sea level, but stressed the need for detailed investigation to test the hypothesis (cf. Flemming, 1969).

In the case of Carthage the possibility of coastal erosion, and the concomitant collapse of man-made structures, must be borne in mind (Bradford, 1957: 232). Given our evidence for submergence by 1.25–1.50 m, however, we feel justified in postulating subsidence by a little over 1 m since the 1st–3rd century AD: to ascribe submergence wholly

to a eustatic rise would amount to assuming a corresponding amount of uplift at the 27 sites which Flemming (1969: 58, 65, 100) found to have retained their original relationship to sea level!

There is ample evidence for late Quaternary crustal deformation in northern Tunisia (Castany, 1962). That it has continued until the present day is illustrated by the uplift in 1953 of a beach near Sidi bou Said by 2–3 m along a distance of about 150 m (Castany, 1953–4: 58). Nevertheless we must guard

against making earth movements as much an *ad hoc* source of explanation as eustatic changes were in the past, and our account should be seen as an attempt to evaluate crustal movement at Carthage on the basis of archaeological evidence, in the hope that the results will in due course be set against long-term tectonic trends in the area.

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Appendix 2

The pottery

During the examination of the quadrilateral's north mole a small deposit of amphoras and unguentaria was located in *c.* 2 m of water immediately to the north of the mole. The

proximity of the deposit to the mole and the lack of sherds on the sea-bed elsewhere in the area may suggest the presence of a wreck in the vicinity.

1. Amphora of Spanish type, Dressel 2,

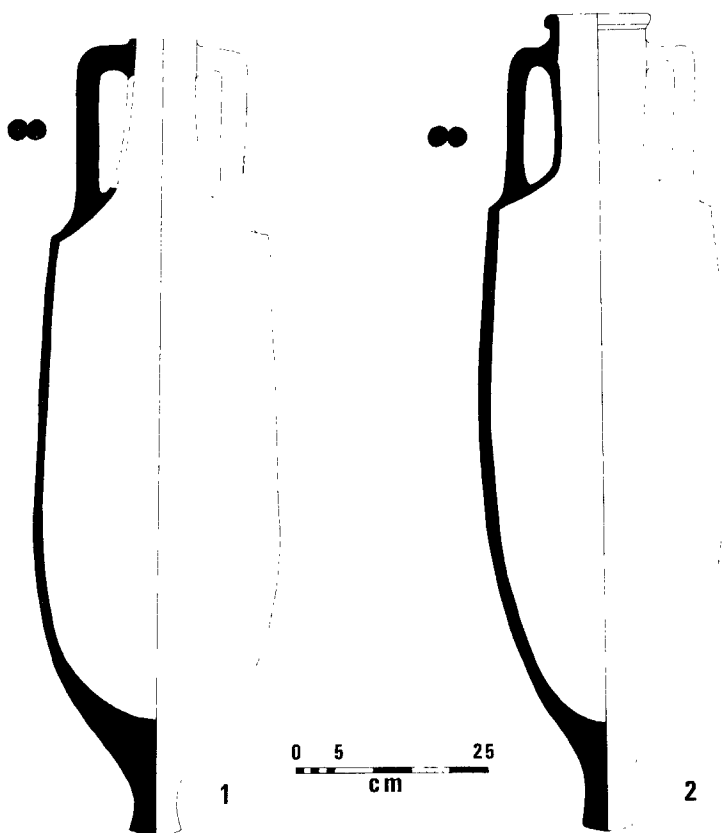


Figure 11. Amphoras. Scale 1: 10.

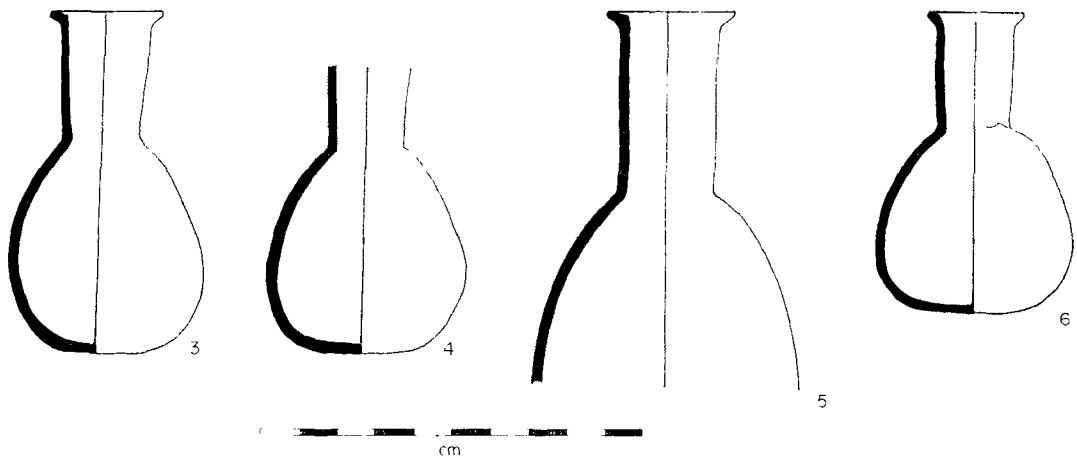


Figure 12. Unguentaria. Scale 1 : 2.

- probably from Tarraconensis. *c.* mid-1st century–*c.* mid-2nd century AD (Fig. 11).
2. Amphora of Spanish type, Dressel 2, probably from Tarraconensis. *c.* mid-1st century–*c.* mid-2nd century AD (Fig. 11).
 3. Unguentarium of fine buff fabric with brown slip on the neck; irregular shape (Fig. 12).
 4. Unguentarium of fine orange fabric with brown slip on the neck (Fig. 12).
 5. Unguentarium of fine buff fabric with brown slip on the neck (Fig. 12).
 6. Unguentarium of fine orange fabric with red slip on the neck (Fig. 12).
- Vessels 3–6 find parallels in the Athenian Agora, where they are dated to the Augustan period. (Robinson, H. S., 1959: 15, 31).
- The authors are grateful to Dr A. J. Parker and Mr Philip Kenrick who kindly examined this pottery.

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Notes

- [1] Evidence of the northern quadrilateral is lost for ever. De Roquefeuil (1898: map 4) noted that the remains under Bordj Djedid were impressive but he said that it was difficult to distinguish artificial structures from natural rock. If this was the case, one might suspect his judgement in interpreting the structures in the Bay of Kram. Gsell (1920, II: 69) stated that the northern quadrilateral had sides, 50, 35, 65 and 35 m, built of enormous stones some 4 m long. Harden (1939: 7) notes that the sides of the quadrilateral were 200 ft by 115 ft (60 m × 34.5 m) which ties up well with Gsell's dimensions. Saumagne (1960: 167) gives details of the remains of walls and columns that he found under Bordj Djedid and relates them to de Roquefeuil's observations.
- [2] Whereas Courtet proposed a large harbour in the Bay of Kram, Hantz (1900) produced plans and soundings of what he called a small auxiliary port near Khereddine. The entrances to both these proposed harbours faced north-east, exactly the direction of the prevailing wind and swell which makes their suggestions even less plausible. Torr (1891: 281, 1893: 374) and Oehler (1893: 326) suggested that there was an outer harbour formed of piers in the sea to the east of the 'cothons', but this must be discounted.
- [3] The enclosed area of the rectangular 'cothon' alone could have been approximately 10 ha and the whole port including the circular 'cothon' could have been 15 ha. Beulé (1861: 114, pl. 4) gives the dimensions of the rectangular cothon as 456 × 325 m, or 15 ha and he states that he found these dimensions for the harbour by excavation. However, his dimensions include the area of the Tophet and are therefore too generous in its width. By comparison, Leptis Magna enclosed 10.2 ha; Portus Traiani, 30.5 ha; Forum Iulii, 11 ha; Centumcellae, 9.8 ha and Hadrumetum, 20 ha. On these comparisons the 'cothons' would have formed a harbour of a reasonable size.
- [4] A photograph of the Lazaret and the 'bains des femmes', dated 1860, is reproduced by Sainte Marie (1884: 155).
- [5] Baradez put forward the theory that the quadrilateral represented an outer port enclosed by moles. He placed the entrance to the rectangular 'cothon' midway up the quadrilateral in an east-westerly direction where today there is a small drain channel from the 'cothon'. His main thesis, that the quadrilateral represented an enclosed outer harbour, was arrived at quite simply: he took all the 'straight lines' observable on his aerial photographs and drew them out. As a unit they formed the outline of a convincing harbour.
- [6] De Roquefeuil (1898: 34) notes these sand waves during his hydrographic survey and termed them 'dos d'âne'. He also suggested that there may have been a small harbour behind them. Cintas (1973: 70) believes that the main harbour was behind the sand waves and that the 'cothons' were a later addition by the Romans and never served as part of the Punic harbour. This interpretation seems unlikely.
- [7] There are in fact as many theories for the quadrilateral as there are authors, but it is not appropriate to list them all here.
- [8] Gsell (1920, II: 74) also believed that ships would have been unloaded against the east mole. The objection to this is that it would be impossible to ensure the safety of ships moored on the eastern side of the quadrilateral without substantial defences further out to sea. De Roquefeuil's survey had already shown that these did not exist, but Gsell dismissed the objection on the specious grounds that the 'choma' was built here for lack of a better position!