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Revisiting the construction techniques of harbour structures in Classical and Helenistic Cyprus, 480-31 BC

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Abstract
This short report presents a preliminary study of harbour structures in Classical and Hellenistic Cyprus, 480–31 BC. Previous research on the island has already compiled a rich corpus of information on the subject (e.g., Raban, 1995; Leonard, 2005; Theodoulou, 2006; Empereur *et al.*, 2017). Despite these considerable efforts, the construction techniques of harbours have been constantly examined through the interpretative framework of the Phoenician and Greek traditions (Raban, 1995; Marangou, 1997; Theodoulou, 2006). While acknowledging its limitations, this study attempts to objectively characterize the construction techniques identified in Cyprus through the case study of Amathus, a submerged Hellenistic harbour on the south coast.

Keywords: Cyprus, harbour structures, construction techniques, Greek and Phoenician traditions, Amathus, Classical and Hellenistic periods.

Introduction

Throughout the Classical (480-310 BC) and Hellenistic (310-31 BC) periods, the Cypriot city-kingdoms (*polities*) played an important role in the maritime exchanges of the eastern Mediterranean, as well as a significant number of sea battles (e.g., Arr. Alex. II. 20.125), as both the archaeological and historical records testify. During these periods, harbour structures gradually appeared on the coasts of the island (Theodoulou 2006: 265), as each Cypriot polity began to invest in the necessary harbour infrastructure to secure a safe gateway for the import and export of goods and the protection of their naval ships.

Harbour structures in Cyprus have long captured the attention of traveller-scholars (e.g., Hogarth, 1889: 90) and archaeologists visiting the island. Despite the interest, these impressive constructions still remain poorly documented in terms of their construction techniques, often hastily described as

following one of either the Greek or Phoenician traditions.[1] Therefore, by undertaking an architectural study of these structures an understanding of their construction techniques can be obtained, whilst questioning the extent to which the Greek and Phoenician traditions are truly representative of the structures.

Harbour archaeology in Cyprus

The first step towards an archaeological study of the island's ancient harbours was a compiled work titled *Αρχαίοι λιμένες εν Κύπρω* ("Ancient Harbours of Cyprus"), published by Kyriakos Nicolaou in 1966, wherein nineteen sites were identified (Nicolaou, 1966: 7-11). The first harbour to be investigated was that of Karpasia by Joan du Plat Taylor in the 1930s (du Plat Taylor, 1980; 1981). This was followed by the investigation of Nea Paphos harbour by the British Army in the 1950s, when a training mission - "Operation Aphrodite" - made an underwater survey of the ancient harbour basin. A preliminary report of the findings was submitted to the Department of Antiquities. In the 1960s, Witold Daszewski revisited Nea Paphos harbour and conducted a more comprehensive archaeological and historical study of the site (Dasweski, 1987: 171-175; see also Leonard, 2008: 131).

The survey by Elisha Linder and Avner Raban is also of great importance, as they documented many surviving harbour structures along the coasts of northern Cyprus before the Turkish invasion in 1974 (Raban, 1995: 139-190). Nicholas Flemming's survey of Salamis in 1973 was the first in Cypriot harbour archaeology to combine the application of geology and archaeology (Flemming, 1974; Flemming, 1987). In 1972, an underwater survey was conducted along the coastline of Cape Kiti, aiming to locate the anchorage of Hala Sultan Tekke (Åström, 1986; Engvig and Åström, 1975; Demesticha, 2018: 64).

After the events of 1974, important harbour excavations and surveys began by foreign expeditions on the south coast of the island. The excavation of Kition's shipsheds, which began in 1976 (Yon, 2000; Yon and Sourisseau, 2010), and the geoarchaeological study of Kition harbour, and that of the anchorage at Hala Sultan Tekke anchorage highlighted the significant coastal progradation in the area (Devillers *et al.*, 2014; Gifford, 1978). Giangrande's survey (Giangrande *et al.*, 1987: 185-197) between 1983-1984 along the west coast of Cyprus identified a series of potential anchorages. The survey and excavation of the submerged harbour basin of Amathus conducted by the French School at Athens in the 1980s revealed the exceptionally well-preserved Hellenistic harbour structures (Empereur, 1995). Between 1993-1996, the *Mycenaeans and Trade project* investigated a Late Bronze Age anchorage near Maroni-Tsaroukas, which revealed a ceramic deposit that reflected the international trade of the period (Manning *et al.*, 2002). In 1996, PAHEP (Paphos Ancient Harbour Exploration Project) conducted a geoarchaeological study of the harbour basin of Nea Paphos (Hohlfelder *et al.*, 1998: 141-157). All the above-mentioned research projects led in 1993 to the International Symposium *Cyprus and the Sea* (Karageorghis and Michaelides, eds., 1993), organized by the University of Cyprus and the Port Authorities of Cyprus, where the archaeological interest of the ancient harbours of the island was highlighted.

[1] The Phoenician tradition is characterized by rock-cut structures (seawalls and basins) and free-standing ashlar-built harbour structures placed on either a rocky sea bottom or an artificial foundation level (e.g., Tel Dor, Tabat el-Hammam, see Raban, 1985, 27-30; Raban, 1995: 143; Frost, 1995: 6; Blue, 1997: 41-43; Gould, 2000: 299-300; Baika 2009: 436). The Greek tradition is associated with the use of rubble as a foundation level and for the construction of breakwaters (e.g., Delos and Samos archaic breakwaters, see Blackman 1982: 185; Baika 2009: 436-437).

A series of research projects and publications on the subject followed this event. Anna Marangkou's book *Τα λιμάνια της Κύπρου* (The harbours of Cyprus), published in 1997, presented the harbours of Cyprus (namely Kyrenia, Salamis, Amathus, Nea Paphos, Marion, Lapithos and Karpasia) in relation to photographic material of the 19th century, taken by the company Coode and Partners which repaired and reinforced the island's harbours at that time. Important studies, such as John Leonard's PhD thesis, *Roman Cyprus: Harbours, Hinterlands and "hidden powers",* documented the ancient harbours and anchorages of the Roman period (Leonard, 2005). Likewise, Theotokis Theodoulou's (2006) PhD thesis, which focused on the Classical and Hellenistic harbours of Cyprus. A recent and important publication for Cypriot harbour archaeology is that of Amathus Hellenistic harbour by Jean–Yves Empereur, where the results of the excavation are presented (Empereur *et al.*, 2017). Finally, a series of Masters dissertations tackled issues concerning the anchorages and the harbours of the island, including Justin Leidwagner's survey on the south central coast of the island (specifically Episkopi Bay and Akrotiri) (Leidwagner, 2004; 2005a-b), Duncan Howitt Marshall's located an anchorage site at Kouklia-Achni were 120 stone anchors were identified (Howitt-Marshall, 2012), Lefki Papacosta's (2017) published report titled *The Late Roman anchorage of Cape Petounda, Cyprus*, and Zinonas Socratous' (2018) unpublished dissertation, *Cypriot ports during the Classical and Hellenistic periods: the case of Kourion*.

Currently, several harbour-related projects are ongoing, such as the collaborative Dreamer's Bay project by the University of Leicester and the University of Southampton, which aims to contextualize the preserved harbour structure within the wider landscape of the Akrotiri peninsula (Blue *et al.*, 2018; Blue *et al.*, 2019; James *et al.*, 2021). Also, Maniki's anchorage on the southwest coast of Cyprus is the focus of a multidisciplinary research program, under the direction of the New York University (Connelly, 2018). The recent publication of Kition's naval harbour has offered valuable information for the only excavated shipsheds on the island (Callot *et al.*, 2022). Furthermore, the excavation and study of the silted interior harbour basin of Amathus has been ongoing since 2014 by the French School at Athens (Thely *et al.*, 2016; Thely *et al.*, 2020 a-c). Finally, the opening of Amathus' submerged harbour as the first underwater archaeological park on the island in 2022 has started a new chapter in Cypriot harbour archaeology (Marelab, 2021).

Ancient harbours and anchorages have been the primary area of focus of research since the first years of maritime archaeology in Cyprus (Demesticha, 2018: 64). Nevertheless, the potential for further research in this area is vast. While harbour archaeology on the island has focused mainly on the localization of the sites in relation to the history of their associated coastal settlement, few projects have carried out systematic studies of the construction techniques of preserved harbour structures.

Research question

As stated above, there are few cases of systematic documentation of harbour structures on the island. Most published descriptions tend to pinpoint evidence of the Greek or Phoenician tradition rather than describing the structure itself. Regarding Karpasia, Goodwin (1984: 383) writes: *"The harbour moles are probably of Phoenician origin"*. Similarly, Młynarczyk (1990: 183) states that *"Cypriote harbours such as the port of Salamis, are presumably modelled on Phoenician examples…*", and Raban (1995: 165) likewise argues that the "*Lapithos main mole consisted of two building phases.... the earlier phase was built in the Phoenician style....".* In her book on the harbour at Salamis, Marangou (1997: 69) writes that *"The wall…was built with ashlar blocks... the Phoenicians did not use this technique... It*

was a technique clearly Greek..."[2]. From these examples it is evident that the harbour structures of Cyprus have been constantly studied through the lens of the Greek and Phoenician traditions. As such, the statement made by Thedoulou (2006: 262-263) that *"The existence of Aegean elements (in the harbours of Cyprus), cannot be attributed necessarily to the affinity of the islanders with the Greek world but to the common socio-political organization (of Greek poleis and Cypriot polities) without excluding also the contribution of cultural links with the Greek world"*[3] triggers the need to pursue an objective study of the architecture of these monumental structures, without arguing what is Greek and what is Phoenician. The question is: can the construction tradition of harbour structures on the island be seen solely as projections of the Greek and/or Phoenician traditions?

Methodology

To obtain an objective and deeper understanding of the construction techniques of the harbour structures of the Classical and Hellenistic periods in Cyprus, a rigorous literature review of the 12 harbour sites of the island was conducted with a special focus on the documented sites (**Map 1**). This resulted in choosing Amathus's submerged Hellenistic harbour structures as the main case study, as they are the best preserved and best-documented structures to date. An aerial orthophoto was generously provided by Professor Dimitrios Skarlatos and Dr. Panagiotis Agrafiotis, which contributed to a more detailed study of the site[4]. A GIS database was also created, aiming to collate all the published data and site plans. This facilitated the identification of extant structures - now hidden under the *posidonia* seagrass. Finally, a survey on the site in the framework of the ANDIKAT project, carried out by members of the MARELab team and students from the University of Cyprus, was conducted in the summer of 2020-2021 to more closely observe the site.

The site was then compared with the architecture of harbour structures from the Aegean and the Levantine coast dating to the same periods. This was facilitated through the creation of an excel database that collected all the necessary information on the extant harbour structures. In total, 17 sites from the surrounding Aegean and eastern Mediterranean regions were consulted (**Map 2**); however, only some were used for the final comparison with Amathus. Finally, a glossary was also compiled to systematically address each structure from an architectural point of view, since harbour archaeology terminology[5] remains fluid in the bibliography (SPP 1630 Harbours, n.d.).

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[2] Original text in Greek: "Ο τοίχος του νότιου λιμανιού ήταν χτισμένος από ισοδομικούς ογκόλιθους... Οι Φοίνικες δεν χρησιμοποιούσαν τη κατασκευή αυτή... ήταν μια τεχνική καθαρά Ελληνική..."

[3] Original text in Greek: "Η, δε, παρακολούθηση των αιγαιακών προτύπων δεν θα πρέπει να αποδοθεί απαραίτητα στην «εθνική» συγγένεια, αλλά στον κοινό τρόπο πολιτειακής οργάνωσης σε πόλεις-κράτη ή πόλεις-βασίλεια στο Αιγαίο και την Κύπρο αντίστοιχα, χωρίς βεβαίως να αποκλείεται και η συμβολή της γενικής πολιτισμικής κατάστασης του νησιού."

[4] This orthophoto was produced after the SfM-MVS (Structure from Motion – Multiview Stereo) processing of UAV (Unmanned Aerial Vehicle) imagery to obtain a visual documentation of the terrestrial and underwater site, as well as its elevation. Concerning the extraction of the bathymetry from the submerged harbour, the issue of water refraction which affects depth estimation by leading to erroneous depths was considered. This was tackled through the creation of an algorithm that exploits structure from motion (SfM) and machine learning tools (such as DepthLearn (Agrafiotis *et al.*, 2019a, 2019b) to correct the refraction effect and create high resolution and accurate bathymetric maps, and then establish an image correction methodology (Skarlatos and Savvidou, 2015; Skarlatos and Agrafiotis, 2018; Agrafiotis *et al.*, 2020).

[5] Different terms are used in most publications to define the same structure, which renders the description incomprehensive from one publication to another (i.e., for Kourion, the same structure was addressed as a breakwater (Leonard 1995) and as mole (Leonard, 1997)). For this reason, it is important to address the same type of structure in a systematic way for all the harbour sites under study. Wherever a degree of uncertainty is identified, it needs to be clarified through further documentation in the field.

Limitations of research

A series of factors limited the full scope of this research. Published data on Cypriot harbour structures is not always accompanied by explanatory plans, sections, and photos. Many remain unexcavated and/or covered by modern harbourworks, as in the rest of the Aegean and eastern Mediterranean. During the period of British colonial rule (1878-1960) and in the immediate aftermath of the 1960s, important works were conducted on the island's modern maritime infrastructure, thus destroying or covering extant remains of the ancient harbours (e.g., Kyrenia) (Marangou, 1997; Panayiotou, 2013: 95-97).

Furthermore, a lack of systematic use of harbour terminology rendered the collection and interpretation of information difficult and oftentimes ambiguous (as in the case of Kyrenia). It was also complicated to differentiate between harbour construction techniques in the Classical and Hellenistic periods. Finally, it must be admitted that this study was mainly concentrated on the south coast of the island since archaeological research on the subject of research on the north coast has been severely limited after the events of 1974.

The harbour structures of Cyprus: An overview

Cyprus, the *Insulam Portuosam* as described by Ammianus Marcellinus (14.8.14) preserves a series of harbour structures that have been documented by various researchers in time. In total, 12 sites (**Map 1**) preserve harbour structure remains, almost all dating to the Classical and Hellenistic periods, a few to the Roman period and, surprisingly, for the time being at least, none to later periods. Before exploring the main case study, it is important to understand what other kinds of harbour structures were built around the island's coastline.

Nea Paphos

Nea Paphos is located on the southwest coast of Cyprus. The ancient harbour is located under the modern harbour of Nea Paphos and preserves several structures. The west breakwater-mole (?)[6] (**Fig.1**) has a curved shape with an orientation to the east. It is estimated to have been around 170 to 280 metres long by different researchers (Nicolaou 1966: 568; Daszweski 1981: 2; Leonard and Hohlfelder 1993: 374). It is difficult to document its exact length, due to the modern harbourworks that have been built on top of it. The width is thought to have been approximately 5 to 15 metres (Daszweski 1981: 3). In terms of its construction, a rubble foundation may have served as a base for the mole. Possible remains, including a series of headers, have been identified to the north of the medieval castle (Hohlfelder and Leonard 1993: 375; Theodoulou 2006: 133). Metallic cramps, noted by Hogarth (1889: 7), and mortar by Daszweski (1981: 3) have also been identified, although no further traces of metal cramps have been documented in more recent investigations (Nicolaou 1966: 568; Hohlfelder and Leonard 1993: 371).

At the curve of the west breakwater-mole (?), a concentration of blocks 50 to 70 metres long, called a spur, was identified (Daszewski 1981: 3-4; Leonard and Hohlfelder 1993: 376-378). The larger blocks

[6] According to Hohlfelder (1995), it is named as a breakwater. In this short report though it will be referred to as the west breakwater-mole (?).

range to 1.80-2.70 x 1.60-2.70 x 0.85-1.15m[7] and the smaller blocks 0.32-0.45 x 0.20-0.22 x 0.16-0.21m (Leonard and Hohlfelder 1993: 374).

The east breakwater-mole (?)[8] had an east to west orientation. It is estimated to be about 350 to 600 metres long[9] and 5 to 10 metres wide (Daszweski 1981: 3; Nicolaou 1966: 568; Leonard and Hohlfelder 1993: 375-376). This structure is destroyed and is only preserved in segments. According to the PAHEP project, the western extremity of the east breakwater-mole (?) is around 20 to 25 metres wide (Hohlfelder 1995: 197). Several breach channels, (a result of intentional intervention or an outcome of damage caused by earthquakes) have been identified along the breakwater (Hohlfelder 1992: 255-256; Leonard and Hohlfelder 1993: 375-376; Hohlfelder 1995: 197-225). A rubble construction for the foundation level was also observed. Two types of rubble construction though were identified, one a simple spilt rubble, the other cemented, perhaps indicating two phases of construction (Hogarth 1889: 7; Leonard and Hohlfelder 1993: 331). On the landward side of the structure, ashlar blocks were observed of dimensions 0.57-1.80 x 0.45-0.65m (Leonard and Hohlfelder 1993: 373). Their configuration though remains unclear.

Parallel to the east breakwater-mole (?), 30 metres to the south, is a second breakwater 199 metres long with a width of 5 metres. This structure might have been a later addition in the Roman period, during the rebuilding of the harbour after the earthquake of 15 BC. It consists of a rubble construction with blocks of 1.80-2.70m x 0.90-1.40 x 0.70-1.00m (Leonard and Hohlfelder 1993: 375; Hohlfelder 1995: 201-202).

Based on the given descriptions of the harbour structures, as well as the dating of the foundation of the settlement of Nea Paphos, the first phase of construction of the harbour can be dated to the end of the 4th century BC (Nicolaou 1966: 564; Daszewski 1987: 173; Młynarczyk 1990: 23-25; Hohlfelder 1995: 194-195; Theodoulou 2006: 138-139, 237-238)[10]. Phases of repairs and renovation works after the earthquake of 15 BC are likely to have taken place (Hohlfelder 1996: 92-101), and it continued to be in use during the Roman and medieval periods up until today (Theodoulou 2006: 139).

Marion

The harbour of Marion lies approximately 4 km west of today's town of Polis, under the modern marina of Latsi. According to Nicolaou (1966: 97), a breakwater-mole (?)[11] was built of well-structured ashlar blocks. Following Raban and Linder's descriptions (see Raban, 1995: 165), there were two structures: a west mole with a north to south direction (40m long) and a north breakwater-mole with an east to west direction (**Fig. 2**). On the leeward side of the north breakwater a 2-metre-wide platform in two sections (30m and 58m in length respectively) was identified. These observations were subsequently contradicted by those of Theodoulou (2006: 107-108), who based his survey on an aerial photo taken in 1963 and a plan made in the 1960's by the Cyprus Department of Antiquities, created prior to the construction of the Marina of Latsi (**Fig. 2**). According to Theodoulou, the breakwater-mole (?) started

[7] Dimensions are presented in this manner: length x width x height.

[8] According to Hohlfelder (1995), it is a breakwater. In this short report though it will be referred to as the east breakwater-mole (?).

[9] Each researcher proposes a different length for the east breakwater-mole (?). This explains the difference between dimensions.

[10] For the complete discussion on the first phase of construction of the harbour basin, see Theodoulou's PhD thesis (Theodoulou 2006: 122-127).

[11] According to the publication the structure is referred to as a "mole" (Raban 1995). Based on the given descriptions (Nicolaou 1966; Theodoulou 2006) it is best described though as a breakwater-mole (?).

from the bay and extended to the north for 50 metres and then turned from a northwest to a southeast direction for 130 metres. The width of the structure was approximately 50 metres (Theodoulou, 2006: 107-108). The breakwater-mole (?) was built partially on a rocky foundation (reef) and a rubble foundation, while the upper structure seems to have been built with ashlar blocks. Concerning the rubble foundation, a recently cut section on the west modern breakwater-mole (?) built on top of the ancient remains has allowed a better understanding of the building technique of the rubble foundation. This indicated the application of two layers, the first (interior) one consisting of small stones while the second (exterior) boulders. Regarding the upper structure, according to the Department of Antiquities plan, alternating rows of headers and stretchers seem to have been in place. Metal and lead dovetail cramps were identified by Raban and Linder on some of the harbour's blocks (Raban, 1995: 165). Their typology remains unclear as no photos have been published.

This breakwater-mole (?) is thought to be dated to the Hellenistic period. In his PhD thesis, Theodoulou presented two arguments as to why this construction should be dated to this period: The use of metallic cramps and the fact that it seems to be an uncompleted project since the basin was not sufficiently protected from the northern winds, a fact that can be applied to other harbours on the island dated to this period (such as Amathus and Karpasia) (Theodoulou, 2006: 258, 260).

Karpasia

Karpasia's harbour is located 3 km north of Rizokarpaso village on the northeast coast of Cyprus. It is a natural open bay that preserves two ancient harbour structures: a quay and a mole. The North-east quay (?)[12] (**Fig. 3**) is located to the north-east of the basin, with an east to west direction. According to Taylor (1980: 155-156) its length is 78 metres and its width 2.5 metres, while according to Nicolaou (1976: 437) its length is 100 metres and its width 3metres. The different measurements are due to the lack of detailed, systematic documentation of the structure. Regarding its construction, there are two parallel walls, with the in-between space filled with rubble. This structure is built on natural bedrock. The walls are built with headers with an average dimension of 1x0.5x0.5m, connected with metallic cramps (dove-tail type) and mortar (**Fig. 4**) (Taylor 1980: 155-156). A phase of repair was identified in the middle of the quay (?) (Theodoulou 2006: 225-226). Hogarth (1889: 90) and Sakellarios (1890: 159) also refer to the use of spolia (repurposed building stone) in the construction of this quay (?).

On the southwest side of the bay lie the preserved remains of a 120-metre-long mole (**Fig. 3**)(Nicolaou 1976: 437), which stretches in a south to north direction from the beach towards an islet. The southern extremity of the mole is not well preserved. On the south side of the islet there are remains of fish tanks and a quarry (Theodoulou 2006: 226). The north extremity of the mole was built on a rocky foundation, while the southern extremity lies on man-made rubble (Theodoulou 2006: 226). A block (not in situ) preserves traces of ten dove-tail cramps, according to Theodoulou (2006: 226-227, fig. 212).

Furthermore, Pseudo-Skylax's reference (77.103) to Karpasia having a deserted harbour, the type of cramps based on Orlando's typology (1968: 102-105, fig. 113), and the fact that the basin's harbour structures were never completed due to insufficient protection from northerly winds (similar to Amathus and Marion), lead to a dating towards the Hellenistic period (Theodoulou (2006: 228-229). A similar dating was also given by Lehmann (1923: 257). However, J. du Taylor (1980: 199) dates the

[12] According to Taylor (1980) this structure is described as the east mole. Based on the terminology used in the framework of this research, the structure is addressed as a quay (?).

harbour structures to the Hellenistic-Roman times, specifically "phase IV" of the city, based on the pottery and the general construction works identified on the site.

Dreamer's Bay

Dreamer's Bay is located on the south-central coast of Cyprus, on the southernmost extremity of the Akrotiri Peninsula. The remains of a mole are situated between Cape Zevgari (west) and Cape Gata (east) (Heywood 1982: 162-164). Dreamer's Bay mole[13] is currently under study in the framework of the Dreamer's Bay project.

The mole (**Fig. 5**) has a north-west to south-east direction and is located 40 metres away from the current shoreline. The total length is about 135 metres. To the north it has a width of 4.75 metres, which widens towards the south to 8.5-9 metres. It was built to the north on a natural solid marl foundation, while to the south directly on the sandy seabed. Up to five courses have been preserved. The average size of the blocks used in the construction ranges to 0.90-1.3 metres in length, 0.4 metres in width and 0.3 metres in height. Two construction phases have been identified. From the north towards the south, for 80 metres, the use of headers on the exterior side of the mole and the use of stretchers in the center are observed. Beyond the 80-metre mark, towards the south, the structure continues to have headers on the outer sides, however, irregularly shaped blocks were used for its interior (Blue *et al*. 2018: 34-35; Blue *et al.* 2019: 19-20). Haggerty (1990: 27-28) also identified the use of spolia in the construction (Leonard & Demesticha 2003: 193-194; Theodoulou 2006: 217). Concentrations of fallen rubble have also been identified to the east and west of the structure (Blue *et al*. 2018 35-37; Blue *et al*. 2019: 12-19). The date of this structure has not been concluded yet, but it is estimated to date to the Hellenistic or Roman period (Theodoulou 2006: 218; Blue *et al*. 2018: 6; Blue *et al*. 2019: 8; James *et al*. 2019: 7).

Case study: The submerged harbour structures at Amathus

Amathus is located on the south-central coast of the island. It preserves three now submerged harbour structures (**Fig. 6**), two moles with a north to south direction, and one breakwater-mole[14] with a west to east direction that forms an artificial trapezoidal basin. These monumental structures were likely built during the Wars of the Successors (Diadochi), 322-281 BC (Empereur *et al.* 2017: 114). While the construction of the harbour appears to have remained incomplete (Empereur *et al.* 2017: 116), it remains the best site to study thanks to its recent publication.

Starting with the south breakwater-mole, to better understand it, it needs to be divided into three sections: the mole, the filling, and the breakwater. Studying sections of the breakwater generated by the QGIS terrain tool (Fig. 7) gave insight into the overall morphology of the structure. It is interesting to note that in sections 5 and 4, the breakwater seems to rise after the concentration of gravel and then gradually takes a tilting direction to the south, while in section 1 the breakwater has a gradual tilting position from the start. Focusing now on the breakwater, in the southwest corner the density of boulders is higher while along the rest of the breakwater the boulders are dispersed and mixed with amorphous

[13] According to the excavators this structure is characterized as a breakwater (Blue *et al.* 2018; Blue *et al.* 2019). Based on the terminology applied in the framework of this research it is described as a mole.

[14] According to the recent publication (Empereur *et al.* 2017), this is referred to as a mole. Based on the terminology applied in the framework of this research, it is described as a breakwater-mole.

stones of smaller size. The filling, which is a concentration of debris covered by a layer of pebbles and sand and fallen blocks that belong to the mole (Empereur *et al*. 2017:38), ranges between 5 and 20 metres in width (**Fig. 8**). Curiously, the southwest corner, the area most impacted by the prevailing winds, has the narrowest filling. The south mole along which the breakwater is located has a length of 180 metres (Empereur and Verlinden 1987: 8). Built with a single row of headers, while no solid natural or artificial foundation level has yet been identified (Empereur *et al*. 2017: 33-37), up to seven courses have been preserved (Empereur *et al*. 2017: 48). The width of this mole is around 2 to 2.50 metres. The alteration of headers and stretchers (**Fig. 9**) attested in the upper courses of the south corner of the harbour entrance (Empereur *et al*. 2017: 45) may be explained by the presence of a corner. The lack of traces of cramps on the blocks in this corner is likely due to the application of dry construction and an alteration of courses of stretchers and headers that would offer better resistance. In a similar case, an alteration of stretchers and headers can also be observed at the entrance bridge of Taposiris Magna's harbour in Egypt (Boussac 2009: 130, fig. 6) (**Fig. 10**).

The south breakwater-mole as an entity remains an exceptional structure. The highly concentrated filling likely explains the excellent preservation of the south mole, diffusing the energy that passes through the breakwater and therefore protecting its overall stability[15]. The only parallel to this construction is Caesaria Maritima's (Israel) western mole, which dates to the Roman Period and was built in a different manner (**Fig. 11**).

The east and west mole construction can both be described as construction techniques with core and facing (Ginouves 1992: 31), or *emplecton*[16]. The west is 130 metres long and 11 metres wide, while the east is 145 metres long and 11 metres wide (Empereur and Verlinden 1987: 8). In the west mole (sondage 8) (**Fig. 6**) this is not clear since the excavation trenches did not reveal two parallel walls of headers; however, from an aerial photo of the 1980s, this is visible at the northern extremity of the east mole (**Fig. 12**). This type of construction is identified in harbours along the Levantine coast and the Aegean, such as Thasos (Empereur *et al*. 1993: 647-648; Kozelj and Kozelj 2000: 33-34) and Mytilene (Theodoulou 2011: 95-97; Theodoulou and Kourtzelis 2011: 135; Theodoulou and Kourtzellis 2019: 88-100) in Greece, and Tyre (El amouri *et al.*, 2005: 115-126; Noureddine and Helou, 2005: 115-125 ; Noureddine and Mior, 2013; Noureddine and Sicre, 2018; Noureddine and Sicre, 2019) in Lebanon.

Finally, in terms of fastenings, traces of cramps on the moles have not been documented. The only evidence are two metal dove-tail cramps that were found during the excavation in the basin (Empereur *et al.*, 2017: 79) (**Fig. 13**). According to Orlandos (1968: 102-105, fig. 113), the typology demonstrates that this dovetail cramp could date to between the Classical and Hellenistic periods.

Preliminary conclusions

In terms of the harbour construction practices in Cyprus, which of the two traditions, Greek or Phoenician, is best represented? Having presented an overview of the preserved harbour remains on the island and analyzed the construction of the structures at Amathus, it has become evident that it is too early to answer this question with confidence. The first reason is that a single case study is not enough to be fully representative of all the harbour structures in Cyprus. The overview presented in this short report clearly indicates a lack of systematic documentation.

[15] This interpretation was formed with the insightful observations and comments of Mauro Frontini Miguel.
[16] This term is used after Vitruvius (II,8,7) (see Orlandos 1968: 125).

While the south breakwater-mole of Amathus appears to be a unique construction for its time, we need to search for further examples on the island. Parallel to that, the terms used to describe the Greek and Phoenician traditions generate preconceived ideas that overlook interesting observations, such as those made at Amathus. Nevertheless, if these innovative practices cannot be defined as either Greek or Phoenician, how can we address them? Could we consider these practices as local innovations? This is a question that cannot be answered without considering the historical context of the period. Can we consider this as a project of the Amathusians or an idea of one of the military architects who accompanied the Diadochi, Antigonus and his son Demetrios Poliorketes ("the Besieger"), to the island in the late 4th century BC? Perhaps we will not know until we identify similar examples of local "innovation" on the island.

Future Perspectives

As stated above, further documentation is needed to perform a more thorough analysis of the harbour structures on the island. It is also important to extend the comparative study to sites on the south coast of Turkey and even more from the Levantine coast. Another issue that needs further discussion is that of dating. Distinguishing a Classical from a Hellenistic harbour structure remains, for the time being, a complicated task. Finally, harbour structures form an integral part of the cultural history of the coastline and its associated settlement, and thus to further understand their construction practices one needs to understand the surrounding environment and architectural trends in the area.

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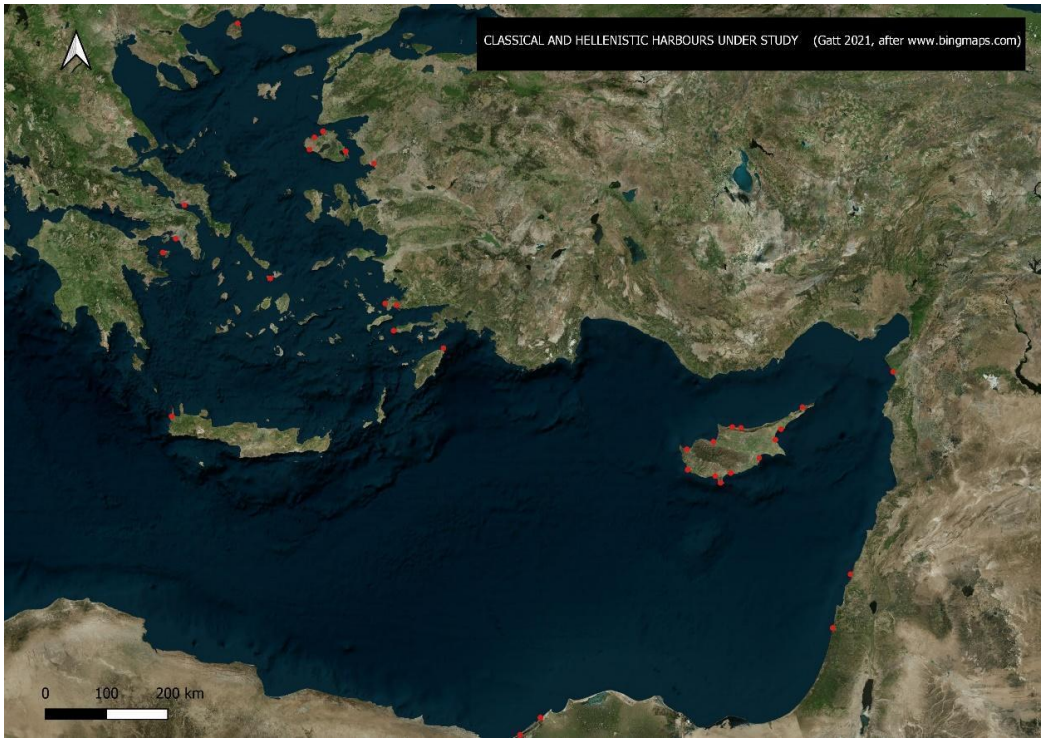
Figures

Map 1: Coastal settlements of Cyprus that preserve Classical and Hellenistic harbour remains (after www.bingmaps.com Gatt 2021)



Map 2: Location of all harbours considered in the framework of this study (after www.bingmaps.com Gatt 2021)

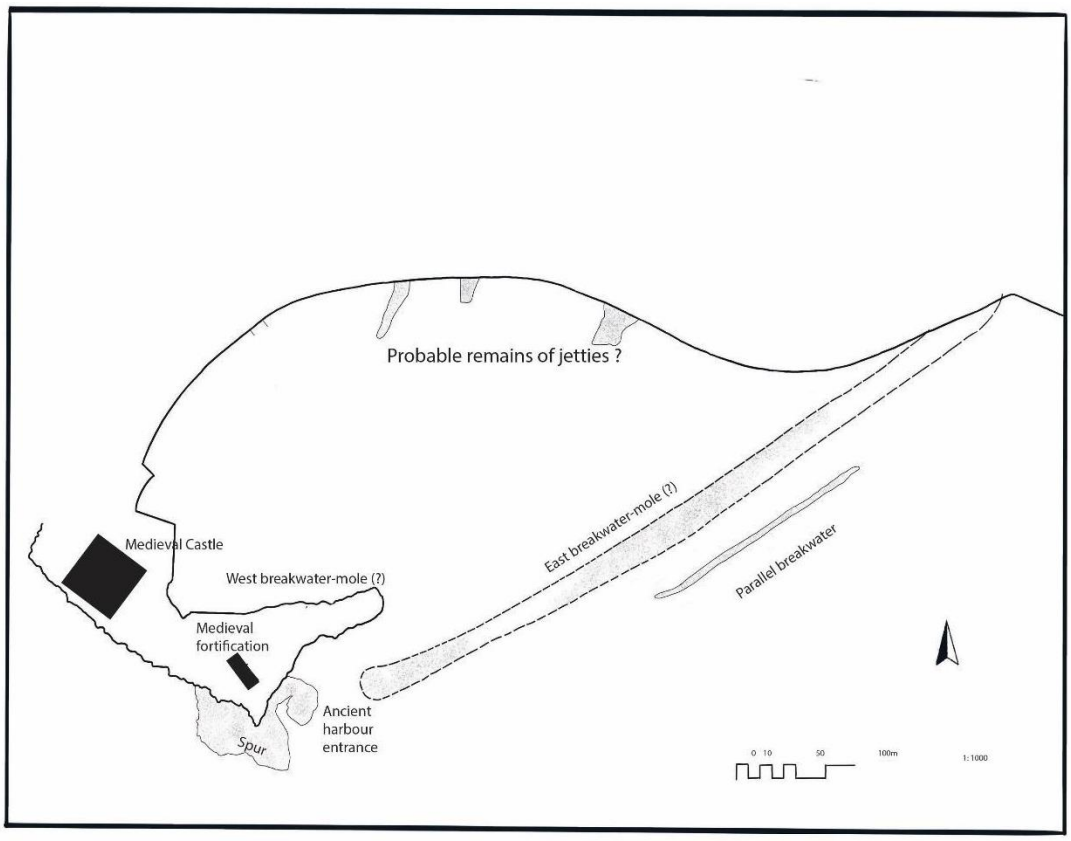


Fig. 1: Plan of the ancient harbour at Nea Paphos (A. Gatt, after Leonard *et al*., 1998: 151, fig. 4).

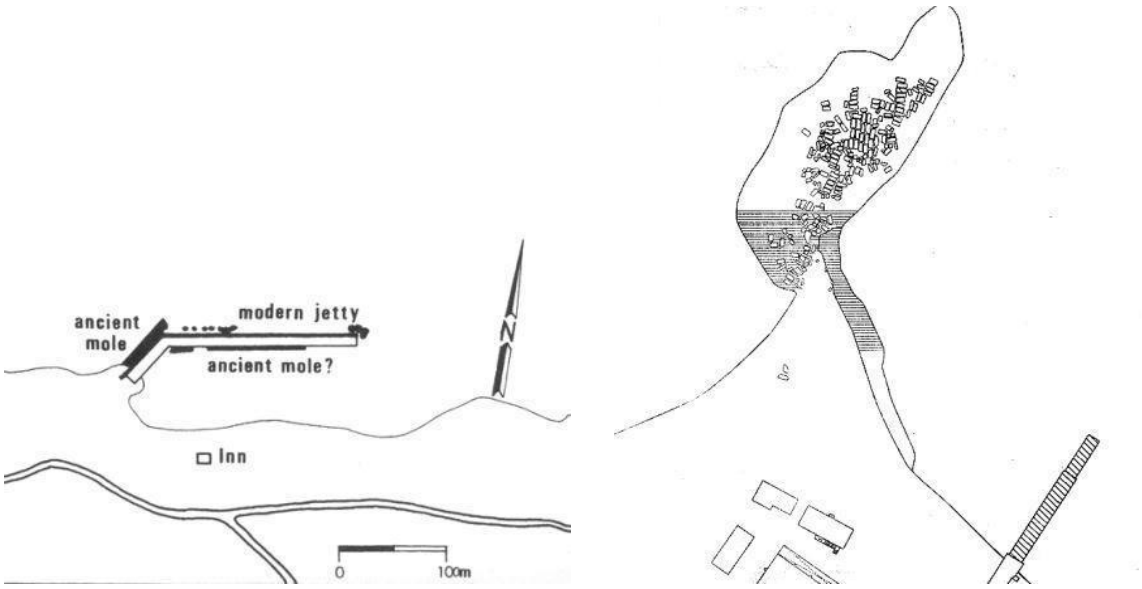


Fig. 2: (Left) Plan of Marion's harbour structures (Raban, 1995: 164, fig.38). (Right) Plan of the ancient remains, produced by the Cyprus Department of Antiquities in 1960 (Theodoulou, 2006: fig.8).

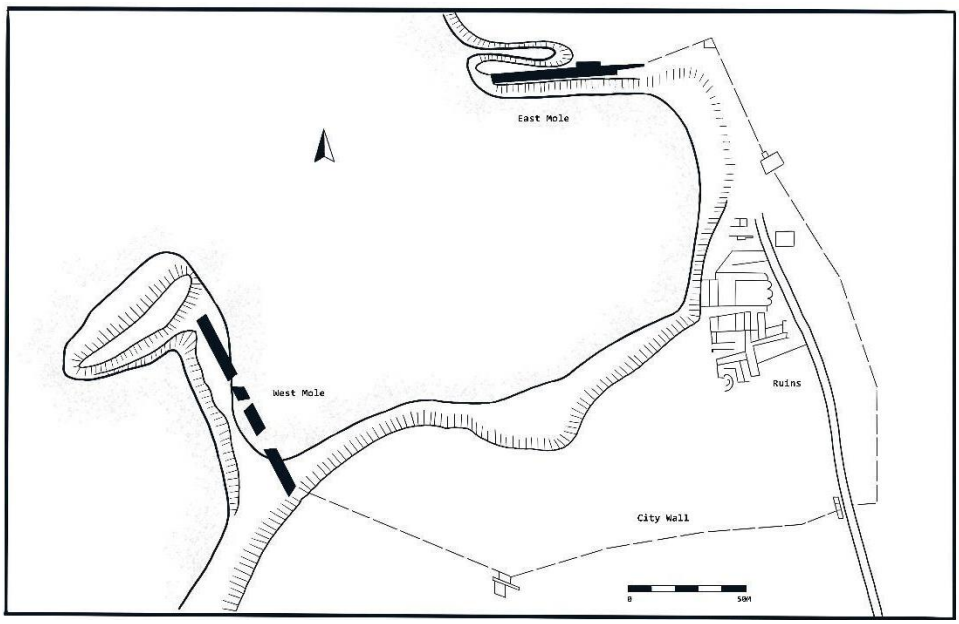


Fig. 3: Plan of Karpasia's harbour basin (A. Gatt, 2021; after Taylor du Plat, 1980: fig.2).

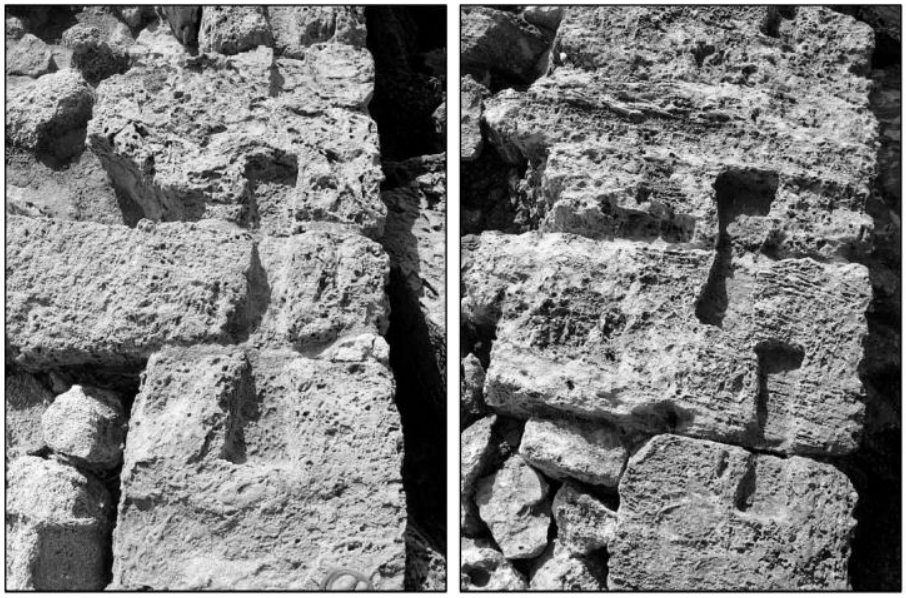


Fig. 4: Traces of dovetail cramps on the blocks of the north-east quay (?) of Karpasia (Theodoulou 2006: fig. 213 a, b).

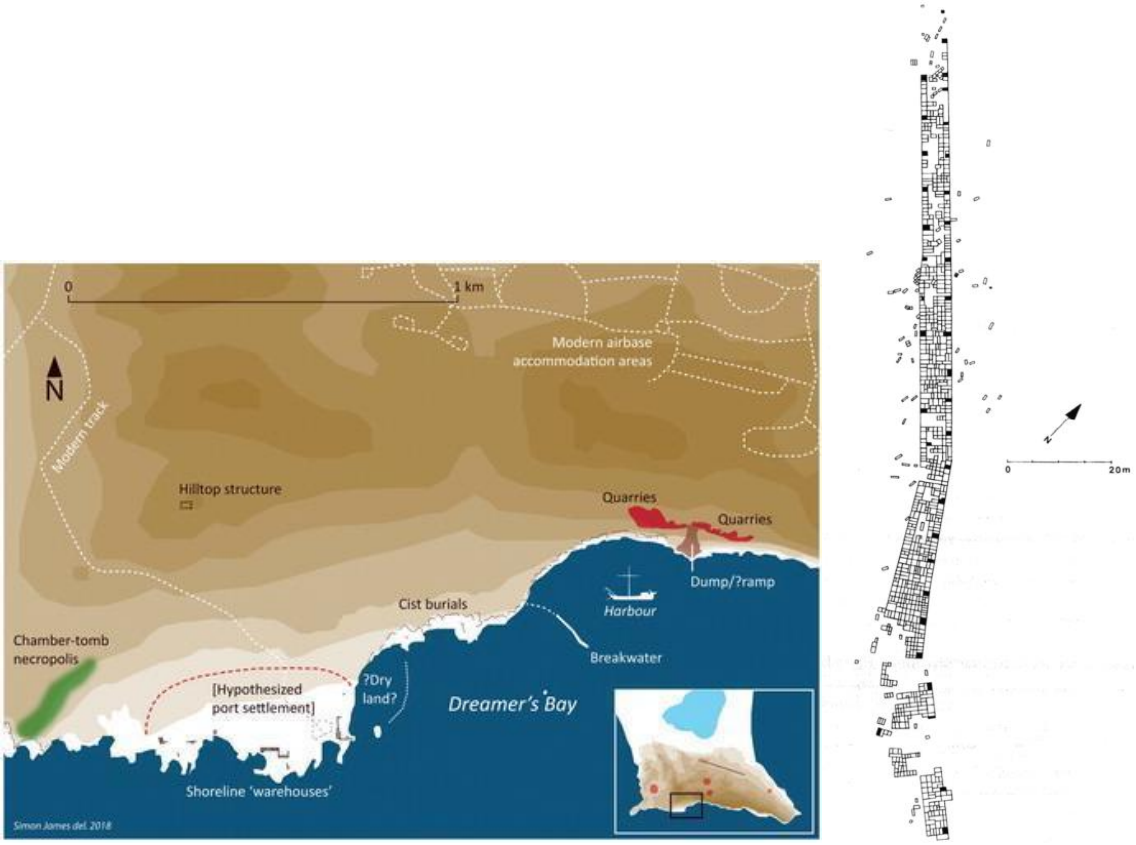


Fig. 5: (Left) Location of the mole at Dreamer's Bay (James *et al.*, 2021: fig.3). (Right) Plan of the mole by Haggerty (1990).

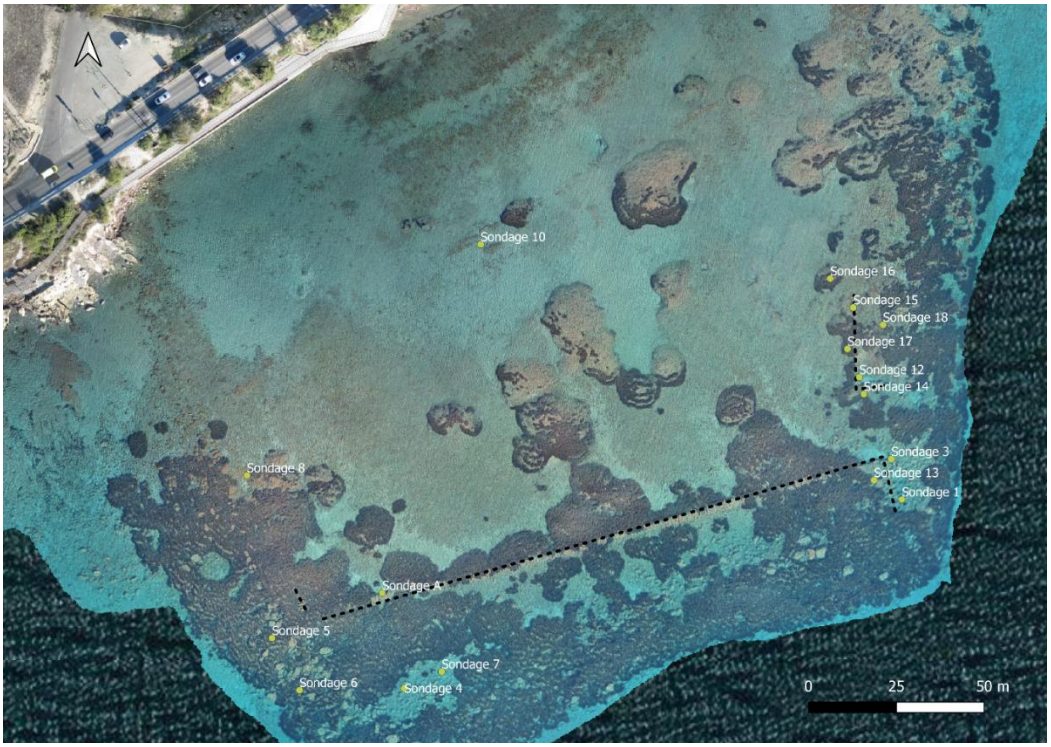


Fig. 6: Plan of Amathus with the location of sondages and the visible remains of the moles (black dotted line) (J.Gatt 2021, after Orthophoto of Amathus generated after refraction correction using Agrafiotis *et al.*, 2020 method. Image courtesy: Cyprus Univ. of Technology, Photogrammetric Vision Lab and Empereur *et al*., 2017).

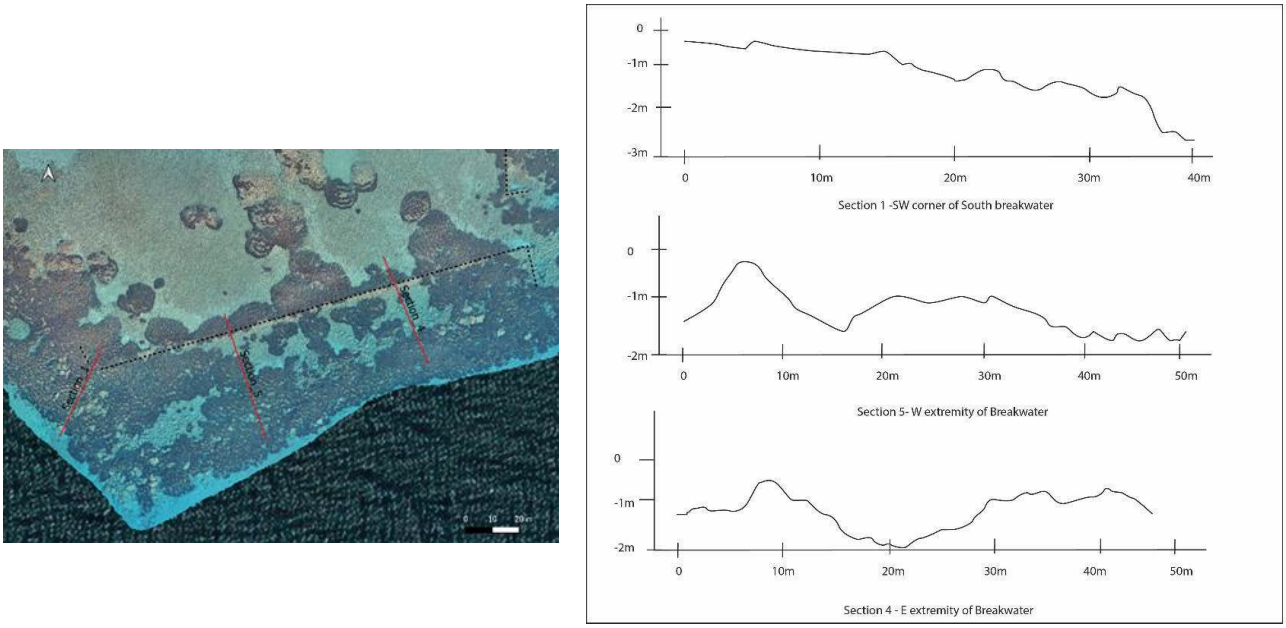


Fig. 7: Sections of the south breakwaters-mole profile (from top, Sections 1,5,4) (Gatt 2021, following orthophoto of Amathus, generated after refraction correction using Agrafiotis *et al*., 2020 method. Image courtesy of the Cyprus University of Technology, Photogrammetric Vision Lab).

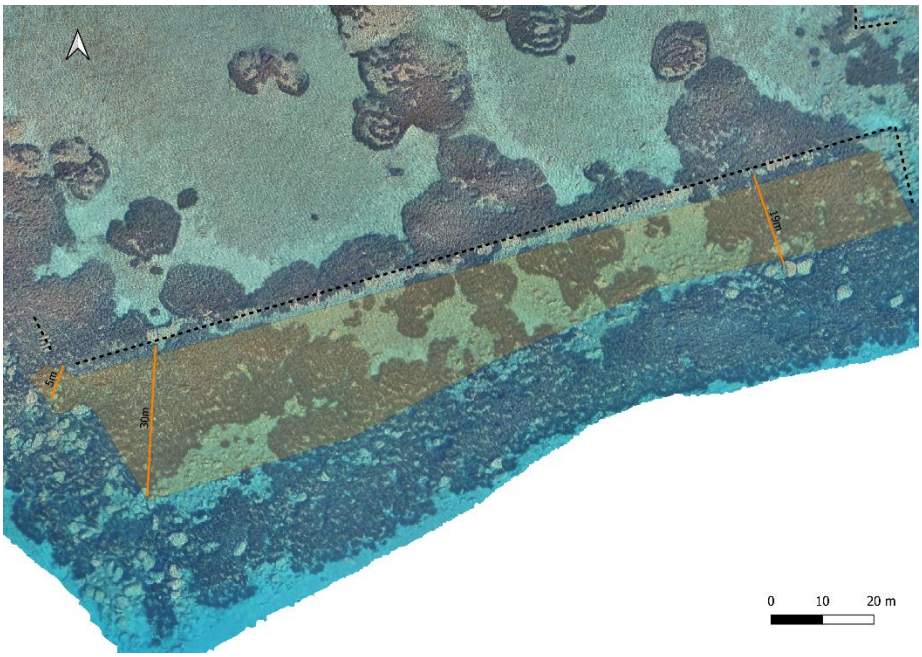


Fig. 8: The width of filling along the south mole (red line) (J. Gatt 2021, following orthophoto of Amathus, generated after refraction correction using Agrafiotis *et al*., 2020 method. Image courtesy of Cyprus University of Technology, Photogrammetric Vision Lab).

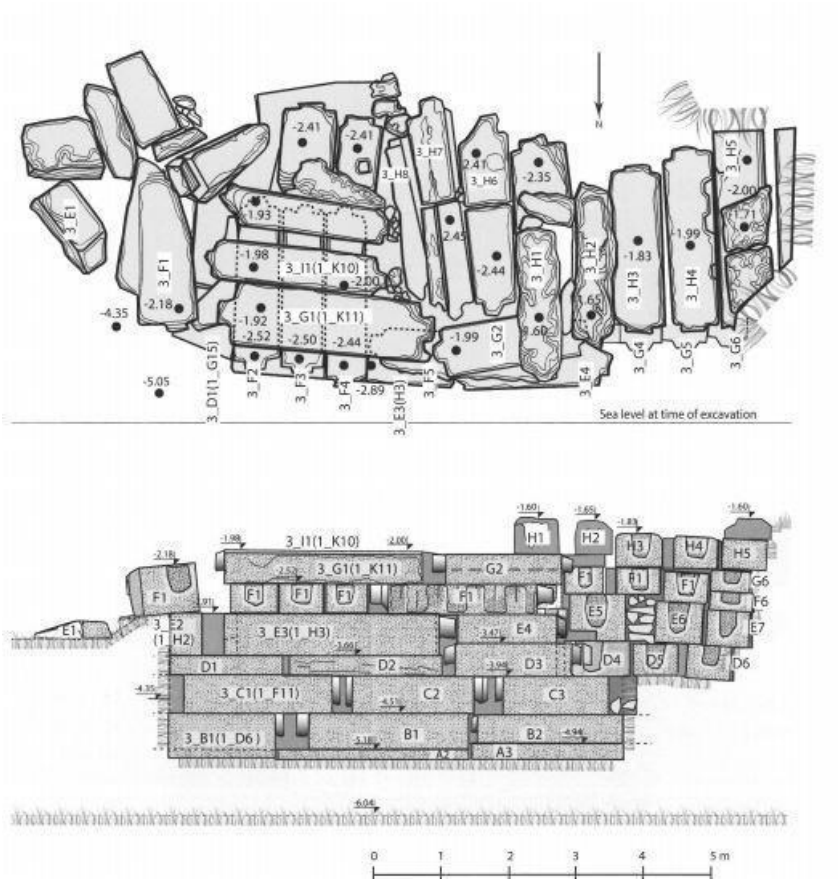


Fig. 9: Plan of the eastern extremity of the south mole at Amathus (sondage 1,3,13); and the north lateral side of the same mole (Emperuer *et al.* 2018: 46, fig.16).

Fig. 10: Photo of the entrance bridge of Taposiris Magna basin, northern Egypt (Boussac 2009: 130, fig.6).

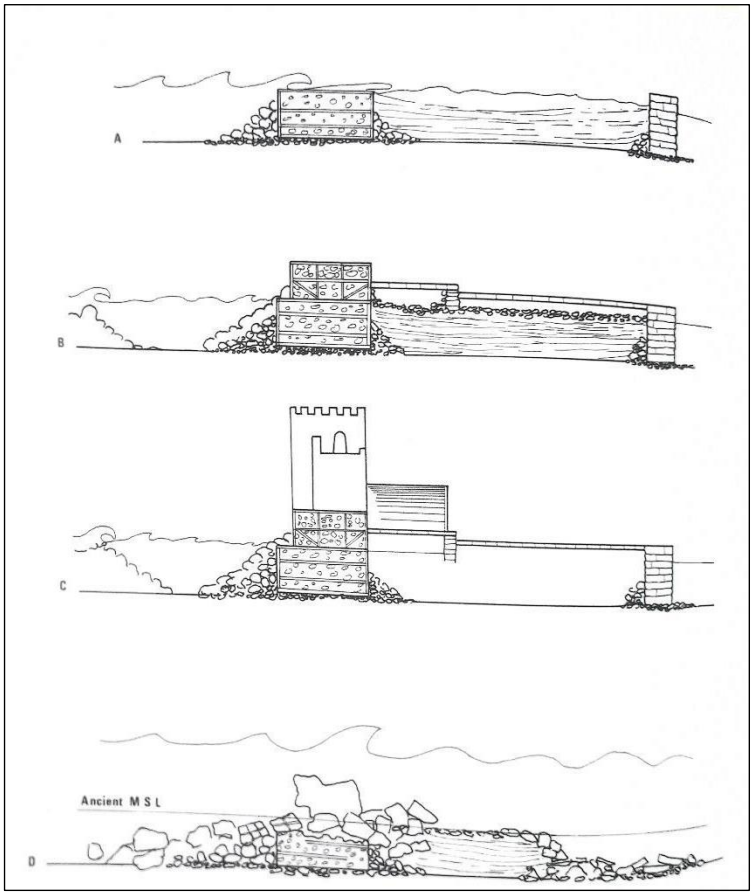


Fig. 11: Schematic representation of the section of the west mole of Roman Caesaria Maritima, Lebanon (Raban *et al*., 2009: 96, fig.5.35).

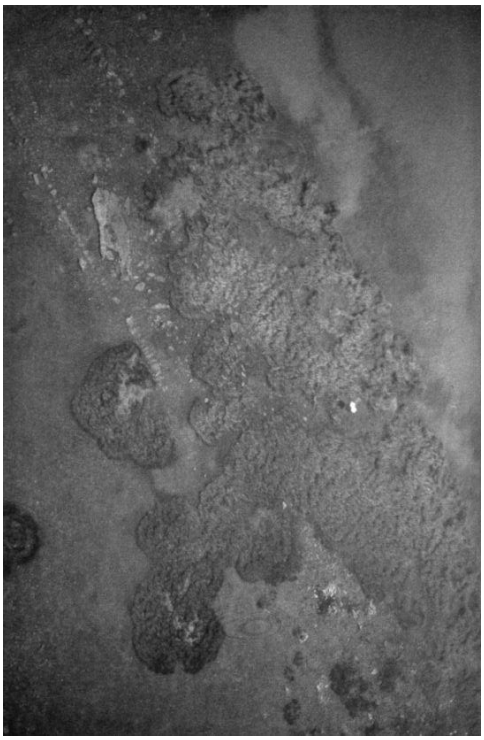


Fig. 12: Aerial view of the northern extremity of the east mole at Amathus (Empereur *et al*., 2017: 12, Fig.2).

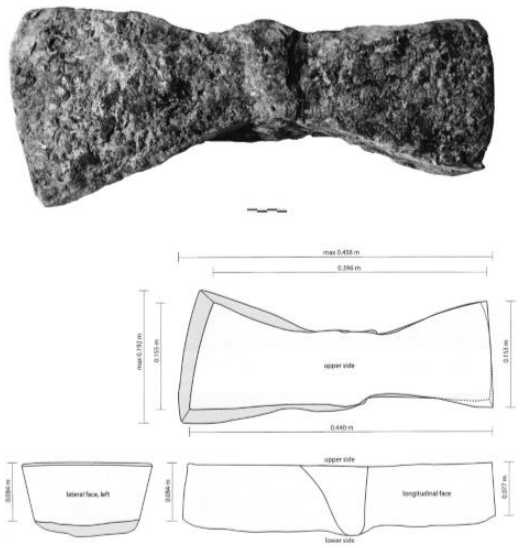


Fig. 13: Lead dove-tail cramp identified in sondage 2 (Empereur *et al.* 2017: 81, fig. 41a-b).

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