Harbours of Byzantium

The Archaeology of Coastal Infrastructures

Edited by

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Cover: Southwestern harbour of Byzantine Kassandreia in Chalkidiki, Greece (A. Ginalis)

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Editor's Preface

Christianity, Roman tradition and ideology, as well as Greek cultural heritage, have been labelled as the pillars of the Byzantine Empire. In fact, the real crux and enabler of power in an empire that combined the Occident with the Orient was its control over the seas. As such, seafaring constituted the formula of success for dominance of the Mediterranean, playing a key role in communication, military activities, and, especially, economic exchange. But how does one get from land to water? The linking gates are coastal installations, i.e. ports, harbours, and other infrastructures. These function as economic hubs, cultural and social meeting points, as well as gateways for communication and connection.

Even though the study of harbour sites and port networks of the Byzantine Empire constitutes a relatively new research field, it has nevertheless received significant attention over the last few years, as we can see from the instigation of various projects and the staging of conferences. However, attention is rarely paid to analyses of physical harbour remains and their impact on the general development of Late Antique and Medieval architecture, economy, or trade networks.

As such, in 2018, an international conference on the *Harbours of Byzantium* was organised at the Institute for Advanced Study of the Hanse-Wissenschaftskolleg in Delmenhorst, Germany. This event was intended to focus particularly on the archaeology of Byzantine coastal sites, including both harbour infrastructures *per se*, as well as associated facilities and affected landscapes. Leading scholars in the field from twelve different countries presented new material and data with which to understand the development of harbour architecture and coastal activities from Late Antiquity to the Middle Ages. The papers set out to cover sites from all provinces of the Byzantine Empire, stretching from Italy in the West to the Levantine coast in the East, and the Black Sea in the North to Egypt in the South. This allowed a general overview for comparative analyses and discussions on various aspects of Byzantine harbour networks and maritime connectivity.

Accordingly, the current volume provides a series of scientific papers deriving from presentations given at the conference. Beyond general approaches to the study of Byzantine harbour archaeology, the contributions offer a representative picture of harbour activities across the historical and geographical boundaries of the Byzantine Empire. Although it is impossible to reflect a comprehensive picture of the entire sweep of coastal landscapes, this work hopefully provides a basis for future comparative research in Byzantine harbour studies – on a local, regional, and supra-regional level.

The conference programme is included in the Appendices. The differences between the conference programme and the final version of this volume are explained by the fact that some scholars who submitted abstracts were ultimately unable to attend, and some who did attend and gave their papers did not submit them for publication. Fortunately, other colleagues agreed to contribute to this volume and I am most grateful to them for so doing.

I would like to express my deepest gratitude to all participants in the Delmenhorst Conference for presenting papers that provided unique insights, not just into ongoing excavations and investigations related to harbour installations, but also into hitherto understudied aspects of coastal infrastructures. It has been a considerable challenge to assemble this volume, and I am therefore particularly indebted to all authors who contributed and enriched this publication. Bearing in mind the time-consuming work of editing and unifying the papers, etc., as well as the difficulties brought on by the COVID pandemic, I have done my best to ensure as prompt a publication as possible.

Thanks must go here to Dr Susanne Fuchs and her team from the Institute for Advanced Study of the Hanse-Wissenschaftskolleg for their support in organising the conference in Delmenhorst. I am also sincerely grateful to David Davison and Mike Schurer from Archaeopress for agreeing to publish this volume and for guiding this work through to publication, their technical help, and the quick production of the printed version.

Alkiviadis Ginalis

2. Was Roman Marine Concrete Used in Byzantine Harbour Construction? An Unanswered Question

Robert L. Hohlfelder

In 1982, David Blackman published an article on ancient harbours in the Mediterranean Sea, the first substantive study of this topic since Lehmann-Hartleben's pioneering work *Die antiken Hafenanlagen des Mittelmeeres* appeared in 1923 (Lehmann-Hartleben 1923; Blackman 1982a-b). In turn, Blackman's work encouraged the late Professor Avner Raban to organise in 1983 what may have been the first international conference to focus specifically on this topic. (Raban 1985). It took place at Caesarea Maritima, known as *Caesarea Palaestinae* in antiquity, to distinguish it from other cities bearing the same name (hereafter as simply Caesarea), during a field season of underwater explorations conducted by the Caesarea Ancient Harbour Excavation Project (CAHEP), which I co-directed with Raban, along with John P. Oleson and R. Lindley Vann (Oleson 2014: 73).

The need for a corresponding study of Byzantine harbours did not immediately become apparent following Raban's initiative. In fact, this field remained a *terra incognita* for Byzantine scholars for years. When the magisterial three-volume *Oxford Dictionary of Byzantium* (*ODB*) appeared in 1991, the entry on Byzantine ports was extremely short and included only one reference to archaeological investigations at the early Byzantine site of Caesarea (Kazhdan 1991: 3, 1706-1707). Also, there was no corresponding entry specifically devoted exclusively to harbours. The author of the port entry and editor in chief of the *ODB*, Alexander Kazhdan, arguably one of the leading Byzantine scholars of the 20th century, had admitted to me that although his polymath interests did not include Byzantine maritime history or archaeology, and he could find no expert to undertake writing about this subject, so the task fell to him. He also said that he had been forced to rely on scanty textural evidence for his abbreviated note because no meaningful archaeological data existed, except an article of mine that related to Byzantine harbours or ports (pers. comm. 1992; Hohlfelder 1988: 54-62). I might also mention that Blackman himself had noted even earlier that we knew little about Byzantine harbours, except for repairs to Caesarea's maritime installations done by emperor Anastasius I in the late 5th or early 6th centuries AD (Blackman 1988: 15).

I include this encounter with Kazhdan to acknowledge the significance of this Volume by Dr Alkiviadis Ginalis. He has recognised the need to look carefully at Byzantine harbours and to better understand their role and importance in the maritime world of Byzantium. To that end, he organised a conference of international scholars who are actively engaged in archaeological fieldwork throughout the Byzantine world and who are starting to fill a *lacuna* in Byzantine studies recognised by Blackman three decades ago and then later by Kazhdan. This pioneering colloquium confirmed the need for the study of harbours as a vibrant field of Byzantine maritime history and archaeology, and for his efforts in this regard, all attendees thank him. As it was for ancient maritime history and archaeology, the investigations of Byzantine shipwrecks have led the way, for example the one found at Yassıada, and more recently the ones discovered at Yenikapı (Carlson *et al.* 2015), but now it is time for the study of Byzantine harbours and ports to follow.[1]

As I have already intimated, my own interest in Byzantine harbours and the topic of this contribution developed during my underwater investigations at Caesarea with Raban and others in the 1980s and early 1990s. (Oleson 2014: 313). It was there that the CAHEP team first encountered Roman marine concrete and later was able to precisely define its components and how it was employed in the construction of the two artificial enclosing arms or breakwaters that formed Caesarea's outer harbour (Fig. 2.1).

The underwater explorations in King Herod's harbour in the 1980's and 1990's did not focus on the status or nature of the Early Byzantine harbour facilities. Any information we recovered on the later years of Caesarea's harbours was almost incidental to our main goal. Our primary research objective then was to learn how Herodian builders, who had little if any experience working in a marine environment, could have constructed a large artificial harbour complex at a disadvantageous location along an exposed sandy coastline.

We realised quickly that technical help from Rome was the answer to that question. Roman builders

[1] For the distinction between port and harbour, see Rickman 1985: 105.

Figure 2.1: The main harbour of Caesarea. North is to the left. Remains of the Crusader city are visible on land (courtesy of CAHEP).

with experience in using concrete in the sea had been dispatched to Caesarea, most likely in response to an appeal from the king (Hohlfelder 2000a: 241-255). What was totally unexpected before our fieldwork began was the sophistication of their engineering expertise. We discovered that key elements of the two breakwaters that formed the outer basin were made of large Roman marine concrete blocks, or *pilae* as they were called. This unique concrete had been used for decades in the Bay of Naples area, but largely for the construction of private fishponds or *piscinae* associated with *Villae Maritimae* (Oleson 2014: 227). Before Caesarea, however, it had never been used outside of Italy for the construction of a large civic, artificial harbour complex.

Roman marine concrete consisted of a pumiceous pozzolanic mortar made from *pulvis puteolanus*, a volcanic ash or sand found only in the Bay of Naples region, that was exported in bulk from the Bay of Naples some 2000 km west of Caesarea. The long-distance maritime transport of this building material as a bulk commodity was heretofore unknown (Oleson 2014: 225). It is now estimated that *c.* 20,000 tons of *pulvis puteolanus* were imported to make all of the Roman marine concrete found thus far during the underwater investigations (Oleson 2014: 7, revised from Hohlfelder 2000: 251) (Fig. 2.2).

After this volcanic sand was mixed with quick lime and seawater to make a mortar, aggregate (*caementa*) was added to make the final concrete product (Oleson 2014: 2).[2] The unique chemical components of *pulvis puteolanus* – calcium, aluminium, silicates, and hydrates – are the key to understanding the amazing, demonstrable durability of Roman marine concrete. When mixed with quick lime and seawater to make the mortar used in making the Roman marine concrete, over time a rare element known as *Al-Tobermorite* crystallised within the concrete, a component that never appears naturally in conventional modern concrete (Oleson 2014: 141-145). In turn, it reduced the porosity of the exterior surfaces of the *pila*, eventually rendering the block itself waterproof and thus protected from the ravages of the sea. This process of crystallisation continued to harden the concrete block until it became like natural rock, incidentally, confirming an observation made by Seneca, a writer early in the Roman Empire (*Quaestiones Naturales* 3.20.3).[3] It also explains why the Caesarea *pilae* found beneath the sea have survived the ravages of nature for more than 2000 years, compared to an estimated survivability of 30-50 years for modern Portland cement concrete.

[2] Also, for the distinction between Roman marine concrete and Roman hydraulic concrete.
[3] Oleson 2014: 26.

Figure 2.2: Pulvis Puteolanus from the Naples region (ROMACONS Archive, after Brandon *et al.* 2014: Fig. 1.1).

After the *pulvis puteolanus* mortar was mixed, either on shore or at sea, in special purpose barges, it was placed by a variety of means into wooden forms or *caissons* of various designs, to which aggregate, either imported Neapolitan tuff or local rocks, was added. These forms were either built in the sea, if the water depth permitted, or were constructed on shore and floated to their final destination, where the weight of the mortar and aggregate that filled them would result in their descent to the desired position (Fig. 2.3). Another unique feature of Roman marine concrete, a result of the chemical processes unleashed by its components, was that it did not need exposure to carbon dioxide in the air to set and cure, but rather would turn from a liquid to a solid state while submerged in the sea.

The discovery of so many of these concrete blocks and the logistical challenges their presence represented for the ancient harbour engineers raised many questions that could not be answered by investigations solely at Caesarea. Simply stated, was Herod's harbour a unique case, or did all harbours built or repaired from the Augustan Age on employ such massive amounts of Roman marine concrete?

This was the background for the Roman Maritime Concrete Study (ROMACONS) that began in 2002 at *Portus* in Italy, with subsequent fieldwork conducted elsewhere in Italy, Greece, Turkey, Israel, and Egypt. The intent of this research project was to collect concrete core samples from the interior of as many surviving blocks or *pilae* from as many ancient harbour sites throughout the Mediterranean that were accessible for our purposes (Fig. 2.4). These extracted cores were then shipped to research laboratories of the CTG Italcementi, the primary sponsor of ROMACONS, for exhaustive studies to learn as much as possible about

Figure 2.3: Roman marine concrete going into the wooden *caisson* using trip baskets (painting by Robert Teringo, courtesy of the National Geographic Society, used with permission, after Hohlfelder 1987: 264-265).

the nature of Roman marine concrete, and particularly to understand its confounding durability. It was vital for our study that all samples were collected the same way and analysed in the same fashion on the same machines in the same laboratory to guarantee the consistency and uniformity of our results (Fig. 2.5). The final report of the ROMACONS project appeared in 2014 as *Building for Eternity: The History and Technology of Roman Concrete Engineering in the Sea* (Oleson 2014). As the ROMACONS directors had hoped, its publication has generated considerable innovative research relating to marine concrete around the world.

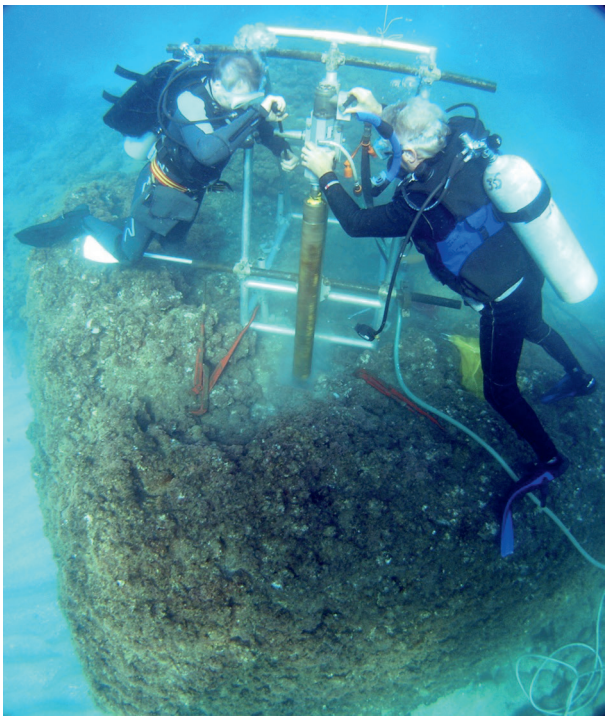

Figure 2.4: C.J. Brandon (left) and J.P. Oleson (right) coring a Roman *pila* at Caesarea (ROMACONS Archive).

There are valuable lessons for the modern world to be learned from ancient concrete engineering in the sea. It might be helpful to briefly summarise some of our data as they relate to the question posed by the title of this article. It seems that marine concrete was first developed in the late 2nd or early 1st century BC for use in fishponds of *villae maritimae* owned by the Roman elite (Oleson 2014: 227). During the reign of emperor Augustus, this material was used widely throughout the Mediterranean to construct an imperial maritime infrastructure befitting the new world order that Rome's first emperor was creating (Hohlfelder 2016: 91-104). Other emperors as well, including Nero,

Figure 2.5: A preliminary field analysis of a marine concrete core sample by J.P. Oleson. Large pieces of aggregate and lime are visible (ROMACONS Archive).

Trajan, Hadrian, and Antoninus Pius, used Roman marine concrete made with *pulvis puteolanus* in their harbour projects. Everywhere throughout the first two centuries there seems to have been a remarkably consistent protocol for mixing and employing this concrete throughout the Mediterranean world, both in large projects, e.g. the building of *Portus Julius* in the Bay of Naples, at Caesarea Maritima, Soli/Pompeiopolis, and Alexandria, as well as in smaller projects at Cosa, Egnatia in Italy, and Chersonesos in Crete. It also seems that the Roman marine concrete appeared beyond the Mediterranean – in fishponds in Portugal and perhaps even in India. Thus far, everywhere this protocol was followed *pulvis puteolanus* was used to make the pumiceous pozzolanic mortar.

The reasons for this seem to be lessons learned early on by Roman builders as their engineering experience using concrete in the sea advanced. Our analyses of various pumiceous volcanic sands from other Mediterranean sources, like the island of Santorini, that would have been available to them, have indicated that they all have their own unique chemical composition. Obviously, they could not have duplicated our modern analyses. But somehow, probably through trial, error, and observation, they realised that *pulvis puteolanus* from the Naples region produced the best marine concrete. While this was a constant, a variety of formworks or *caissons* were employed to hold the resulting liquid concrete until it had set and cured. They were not always uniform in shape or construction techniques. Nor was the aggregate added to the mortar to make Roman marine concrete always the same. Tuff from the Naples region seemed to be the best choice, but local limestone or sandstone sufficed as well, thus reducing the costs and time necessary to import tuff as well as *pulvis puteolanus* from the Bay of Naples.

As regards the use of Roman marine concrete in the Early Byzantine era (4th through 6th centuries) and beyond, none of the harbours visited by ROMACONS investigators that were known to be in use then – Lechaion, Anthedon, Yenikapı, Portus, Alexandria, and Caesarea – appear to have employed Roman marine concrete to repair or expand existing maritime installations at any point beyond the end of the 2nd century AD. Beyond that date, we have no solid evidence to offer of its use, hence the title of this present contribution 'Was Roman Marine Concrete used in Byzantine Harbours?'.

Three decades ago, however, I thought I had an affirmative answer to this question. In 1988, I published an article where I suggested that some maritime

building techniques just revealed by excavators at Caesarea, namely the use of Roman marine concrete placed in wooden forms to set and cure, may have been employed, *mutatis mutandis*, in the construction of harbour facilities near Constantinople during the reign of emperor Justinian that were discussed in *De Aedificiis* by Procopius of Caesarea (Hohlfelder 1988: 54-62). At the time of that publication, the study of both ancient and Byzantine harbours, as a field of interest to maritime historians and archaeologists, was in its infancy, while the underwater excavations at Caesarea were also still in progress with years of fieldwork and more remarkable discoveries ahead. I had no idea then how much Roman marine concrete was actually used at Caesarea or elsewhere, the precise nature of this building material, which I erroneously described as hydraulic concrete, or how common the use of barges or wooden formwork was throughout the Mediterranean basin in harbour construction or repairs. Now, after so much harbour research has occurred, some aspects of my article now need re-examination.

What is certain is that the Procopius text does confirm that the Roman maritime engineering technology of using wooden *caissons* or cribs (*kibotois* according to Procopius) in the construction of harbours did continue into the 6th century AD, but that alone does not prove that these forms were filled with Roman marine concrete (Gertwagen 1988: 149). Research since 1988 has shown that wooden forms or barges were used in a variety of ways over the centuries separating King Herod's harbour and the one discussed by Procopius. Sometimes they were filled with a less durable mortar mix, rubble and broken ceramic vessels, or rocks alone (Schläger *et al.* 1968; Oleson 2014: 189-222).

It still may be possible, oweverr, that the *caissons* mentioned by Procopius did contain Roman marine concrete, but since this harbour has not yet been discovered, and possibly is now immured in some modern coastal installation never to be found, one will never know for certain. The survival of one aspect of Roman harbour engineering, the use of *caissons*, alludes to the possibility that the recipe for Roman marine concrete may have survived as well (Ousterhout 1999: 133-134).

To date, only a small sample of known harbours in the Byzantine era, plus those not yet discovered, have been surveyed or excavated, so at this state of our collective knowledge of Byzantine harbour construction we must remember the aphorism – absence of evidence does not mean evidence of absence. Since scholarly interest in Byzantine harbours is just beginning, we may expect this *lacuna* to be filled by new studies. As data mount, we may well be better prepared to answer my article's titular question, but an answer is not yet possible. A major reason for this article is to appeal to scholars, who are or will be studying construction of Byzantine harbours, to be attentive to the engineering techniques at play and particularly to ensure that any mortar-aggregate fill discovered in a purpose-built barge, *caisson*, or any type of wooden formwork, box, crib, or in a derelict ship's hull, should be carefully analysed in an appropriate state-of-the-art laboratory. These results should be compared to the data published in *Building for Eternity* to see if *pulvis puteonalus* was still in use in concrete mortar during any period of Byzantine history.

If marine concrete is discovered, a range of new questions will need answers. For example, how would *pulvis puteolanus* have been transported as a bulk commodity to the Byzantine harbour(s) where it had been discovered? We think we know how such bulk transport occurred in Roman times (Oleson 2014: 223-226), but how would this trade have been conducted after the fall of Rome in the West and the survival of Byzantium in the East, or how had the knowledge of the composition and use of marine concrete become so common that it survived over the centuries, particularly if we discover evidence for its use well after the traditional ancient maritime trading corridors had been lost to, or endangered by the Arab maritime onslaughts?

Acknowledging that Roman marine concrete has not yet been discovered at Caesarea in the surviving maritime infrastructure from its Byzantine history, it is appropriate to discuss what we do know about its harbour during the Early Byzantine period in keeping with the focus of our present conference. By the beginning of the 4th century AD, it had, not surprisingly, undergone significant changes since its construction by Herod the Great in the late 1st century BC, and no longer retained the monumental grandeur of its predecessor. Nor were its once majestic adornments necessary for the harbour to function (Flemming 1996: 37).

In this regard, it is important to remember that all harbours exist in a challenging natural environment at the interface of land and sea. Their survival depends on the needs and available resources of the societies that they serve and that maintain them. If their maintenance is neglected or deferred too long, the sea will challenge their very survival. If there is too much neglect, the sea will obliterate them. Also, as the economic needs or political realities of the port cities of which they are an integral part change, so will their character change. A harbour complex that served a long-lived city like Caesarea underwent many rebuilding phases, each dictated by the needs, circumstances, and resources of the moment.

To better understand the face and nature of Caesarea's harbour in the Justinianic era, a brief background can

be presented ,covering the life and times of its earlier predecessor harbours, excluding adjoining unprotected bays that were part of the harbour system but were only useable when weather conditions were appropriate. Such opportunistic anchorages would also have existed in the 6th century AD and the proceeding centuries. Their existence and use are also part of the larger story of maritime trade throughout the Mediterranean, both in antiquity and during the Byzantine era.

When Herod decided to build his new port city on the ruins of a much smaller Hellenistic settlement (Hohlfelder 1987; Holum *et al.* 1988: 72), he was faced with daunting problems, not the least of which being that the site he selected was on a exposed coast where storm seas with 5-10 m waves were not uncommon.[4] For his new port city to flourish and fulfil his dreams, it required a massive artificial harbour that could survive all natural challenges. Caesarea would be a gateway terminus for both a vast system of roads extending throughout his possessions and beyond and for the maritime corridors that connected his kingdom to the rest of the Mediterranean world (Patrich 2011: figs 1 and 25 for this road network).

The construction of his vast harbour installations into an open sea, where the fetch length of waves that struck the shore was over 1000 km, was something never before attempted. His harbour, as I have suggested elsewhere (Hohlfelder 1987: 260-279: Holum *et al.* 1988: 105 and *passim*), was an engineering *tour de force* that both served the interests of Herod's port city well but also was another architectural monument that heralded his prestige and celebrity throughout the world of his time.

Since its construction required engineering skills and experience beyond the competence of his own builders, the king turned to Rome. Fortunately, his close ties with Augustus and with his second-in-command when the project started, Marcus Agrippa, gave him access to what he required (Hohlfelder 2000a). Fortunately for Herod, his intentions to construct an all-weather harbour along a virtually straight section of the Levantine coast where none then existed were congruent with Augustus's own efforts to construct a maritime infrastructure that would be a nexus for the new world order Rome's first emperor envisioned (Hohlfelder 2016: 101-102).

The Herodian harbour installations remained an important cog in Rome's maritime network for centuries, although their physical character changed. The king's harbour had redundant and ornate structures dangerously built on the breakwaters themselves, all intended to make a personal statement to his own majesty. After his death, Caesarea eventually became the capital of Roman Judaea. When the city became a Roman colony sometime under Vespasian (AD 69-79), the ostentatious architectural display of a deceased ruler's importance became superfluous. Its earlier grandeur apparently fell victim to a massive tsunami that struck the harbour complex in AD 115, one of three such events mentioned in historic sources (the other two occurred in AD 551 and AD 747), each of these natural catastrophes diminished the existing facilities and would have required some engineering response to restore the functionality of this most important Levantine harbour, although the nature and extent of such repairs after each of these disasters remains unclear (Goodman-Tchernov and Austin 2015). The 2nd-century tsunami appears to have severely damaged the Herodian/Early Roman superstructures on the breakwaters. They were never fully repaired because in some ways they were redundant to similar buildings (e.g. *horrea*) on shore that were far less vulnerable to the forces of nature. What is certain is that whatever the nature or scope of the restorations that took place after this tsunami, they were sufficient for this capital city to continue to be the gateway for commerce to and from Judaea and lands beyond. It is equally likely that *spolia* from the earlier monumental structures were most likely used for breakwater repairs and reused elsewhere in Caesarea, a process that continued in a similar way into the late 19th and early 20th centuries, when a small settlement of Bosnians who lived within the ruins of the ancient city sold ancient stones pillaged from the site (Holum *et al.* 1988: 238). It is also likely that the ruins of Caesarea had provided a convenient 'quarry' for the building of the Suez Canal in the mid 19th century, as had been the case for another Roman capital port city on Cyprus, Paphos.[5]

A more functional harbour, probably limited to the area within the two breakwaters, with necessary maintenance funded by emperors and/or local elite attempting to curry favour with Rome (Oleson 2014: 80), existed throughout the 2nd and into the 3rd century AD, even as international maritime trade seems to have diminished throughout the Mediterranean (Parker 1996: 108). There may have been several navigational hazards, ruins that had fallen into the sea that required ship captains to take extra precautions when entering or leaving the harbour. But these would soon have become known, and their avoidance became routine. They would have not been a cause for maritime commerce to flee Caesarea for other nearby Levantine ports, for none existed. Owing to the importance of this harbour to the port city it served in the 2nd century AD, there is certainty that necessary repairs were made, as Caesarea had been of prosperity and growing imperial importance – particularly after AD 135, when it had

[4] Personal observations.

[5] Personal conversation with the late Aaron Wegman of Kibbutz Sdot Yam.

Figure 2.6: Portus Augusti coin issued at the Caesarea mint during the reign of Trajan Decius (AD 249-251).

become the capital of the Roman province of Syria/Palaestina.

A coin issued In the Caesarea mint during the reign of the Trajan Decius (AD 249-251), bearing the reverse legend of *PORTUS AUGUSTI*, may well have been struck to commemorate the beginning of a renovation of the harbour installations, which had been allowed to decline in the ubiquitous imperial chaos of the early 3rd century AD (Fig. 2.6). It may have been struck to honour direct imperial involvement or by some member of the local elite attempting to gain favour with the emperor, who may or may not have planned a visit that never materialised. The important point is that *PORTUS AUGUSTI*, the official name of the main harbour that had replaced the earlier name of *SEBASTOS*, still existed in some manner. It would not have been struck to honour an installation that no longer functioned and had disappeared beneath the sea sometime in the past, or to express the hope that the emperor might renew a submerged harbour, as some scholars have maintained (Gertwagen 1988: 149; Raban 1992: 119; Reinhardt and Raban 1999). Their hypothesis of an early submergence of the Herodian breakwaters was based on alleged tectonic activity caused by a series of fault lines that ran parallel to Caesarea's coastline. One purportedly ran beneath the North Breakwater and the second was adjacent to the outer face of the South Breakwater. Purported tectonic activity was believed to have caused the submergence of both structures sometime after the 1st century. Recent scholarship, however, has disproved the existence of these fault lines and established the current Israeli coast has been tectonically stabile for at least the last 2500 years (Marriner and Morhange 2007: 162; Gill 1999: 24; Sneh 2000: 27 contra Gertwagen 1988: 149; Raban 1992: 119; Reinhardt and Raban 1999: 811). Moreover, rabbinical texts speak about a functioning harbour in Caesarea in the 3rd century AD, including one that mentions an Alexandrian grain ship that anchored in the harbour to sell its wares (Ringel 1988: 69). We know now that whatever the damage that befell the Herodian harbour in AD 115 was the result of the tsunami occurrence and that whatever the negative impact of this disaster might have been, it was overcome and the harbour functioned in some fashion throughout the remainder of the 2nd, and possibly into the early 3rd century AD.

There seems to have been a revival of the city's fortunes in the 4th century AD as the Christianising Roman world turned its attention to the Holy Land. Caesarea may have reached a second apogee of prosperity and wealth then as the provincial capital of Syria/Palaestina (Patrich 2011: 113; Ratzlaft *et al.* 2017: 142), which itself had grown in stature because of its importance in the Christian narrative. Caesarea's harbour, whatever its configuration, clearly was an entry point to the Holy Land, a factor that contributed to its wealth and prosperity. It was precisely at the end of the 4th century AD (AD 394) that Porphyry, Bishop of Gaza, sailed with his entourage from Caesarea to Constantinople (Ringel 1988: 72, citing Mark the Deacon's Life of Porphyry 33-34, 37). Apparently, even at the end of the 4th century AD harbour facilities were functioning sufficiently to accommodate international maritime travel, as one would expect for a capital that was a port city for a major province (Reinhardt and Raban 1999: 811 contra Raban 1992; Hohlfelder 2000b; Yule and Barham 1999: 278).

The very end of the 4th century AD saw a provincial reorganisation that reduced Caesarea's importance. It lost its lofty status as the capital of Syria/Palaestina and entered the next century as the provincial capital of a much smaller region called *Palaestina Prima*. The 5th century AD was a tumultuous one throughout the Mediterranean world, and Caesarea was not immune to the various centrifugal forces that began to bifurcate the empire and that played havoc with international and local trade. There is literary testimony (Procopius of Gaza, *Panegyricus in Imperatorem Anastasium* 19) that the harbour at some point in the 5th century had ceased to be a safe haven for ships. There are no data available to indicate when in the 5th century this extreme deterioration had occurred or why it been allowed to happen. But the old dictum that when coastal installations are not sufficiently maintained, the sea will recover them, may explain what had happened. Even if Procopius of Gaza was correct and did not exaggerate the state of destruction to amplify Anastasius' later beneficence, one can be sure ingenuity borne of necessity would have prevailed, perhaps in the off-loading of cargo and passengers from larger merchantmen that stood at anchor in areas free of submerged hazards to smaller boats.

In spite of the uncertain nature of damage or functionality to its harbour in the 5th century, Caesarea continued to play an important role in the Byzantine Levant, serving as a gateway port city where the life of the province it administered and the Byzantine world beyond conjoined (Patrich 2011: 121, n. 24).[6] There simply were no viable alternatives. Whether it was the capital of Syria/Palaestina in the 4th century or *Palaestina Prima* in the 5th and 6th centuries AD, Caesarea was always the terminus of a vast road network that linked the city and Roman territories throughout the region, and even to lands beyond Rome's reach. As a gateway city with a functioning harbour, whatever its configuration might have been, it served as the node for both maritime corridors that spanned the entire Byzantine Empire and for smaller, regional opportunistic anchorages that used Caesarea as a hub for access to international markets. Joseph Patrich, an archaeologist who co-directed the most recent extensive excavations at Caesarea, and who has authored the most comprehensive up-to-date study of the capital city, states: 'Throughout the Roman and Byzantine periods, it was the best harbour of Judaea/Palaestina' (Patrich 2011: 120). While agreeing with his general assessment, it does not mean that the nature of the harbour installations had remained constant during this entire period or that they had not endured significant changes. Perhaps the functionality of Caesarea's harbour might best be seen as a double-dipped or w-shaped curve. At an apex when first constructed by Herod, it seems to have slowly lost its monumentality during the early 3rd century AD, although still serving the city's needs in some fashion. After the start of a major restoration announced on the coin series of Trajan Decius, it began a rise to another apogee in the 4th century (Patrich 2011: 113), only to gradually decline again during the course of the tumultuous 5th century AD, either through conscious neglect or adverse natural conditions, or a combination of both. Procopius of Gaza, writing in AD 502, said that the harbour had previously fallen into such disrepair that imperial intervention was necessary. Due to the benefactions of Anastasius I, he stated that '...the city is rejuvenated, boldly receives ships and is full of supplies' (Procopius of Gaza, *Panegyricus in Imperatorem Anastasium* 19).[7] His account does not indicate the nature or extent of the repairs to the harbour, but any renewal would have required more than simply restoring the North Breakwater (Hohlfelder 2000b contra Gertwagen 1988: 149). There would have been a 'large-scale reconstruction' involving both breakwaters (Patrich 2011: 99, contra Reinhardt and Raban 1999: 813). How this renewal was accomplished is unclear from Procopius' text or from the underwater excavations conducted over the years, except that we surmise Roman marine concrete seems not to have been used. Its absence in this one project, however, does not mean that the Early Byzantine world had lost the recipe for this building material. Rather, the most expedient way to effect repairs of Caesarea's breakwaters would have been to dump rubble from barges on any submerged sections until their surfaces were above water, and they once again provided a safe anchorage for incoming and outgoing ships. It is reasonable to assume that any restoration of harbour works in antiquity would optimise existing ruinous structures as much as possible (Oleson 2014: 26), particularly if functionality not grandeur was the ultimate objective. Moreover, a restoration of only the North Breakwater would not have provided a safe harbour for the city, since the heaviest seas primarily were from the west/southwest.[8] With only a limited renewal of a breakwater that ran east/west and perpendicular to the coastline, Procopius of Gaza's comment about the city safely receiving ships and all necessities would not apply.

With these extensive restorations, Caesarea once again had a working harbour that could serve the needs of the capital of *Palaestina Prima* (Hohlfelder 2000b). Certainly, it no longer reflected the impressiveness of its Herodian predecessor, a requirement that had long since come to an end with its refounding as a Roman colony. But whatever the character of its maritime installations

[6] Much of the imported goods to Judaea/Palaestina seem to have passed through the harbour of Caesarea.

[7] Transl. by J.P. Oleson: Oleson *et al.* 1984: 294, n. 20.

[8] Personal observation.

after their revitalisation, they met the needs of the Early Byzantine port city.

During the early 6th century AD, Caesarea was rejuvenated (Hohlfelder 1992: 78). Major terrestrial building projects were completed, including a huge octagon church that commanded the harbour itself, a *kastron*, a refurbishing of one of its aqueducts, the construction of many new *horrea*, and the expansion of the city well beyond the Byzantine walls, all reflecting the city's wealth and importance during this short period of 6th-century florescence (Patrich 2011: 101-116). In fact, the population of Caesarea during the reign of Justinian may have been as great as 100,000 (Patrich 2011: 94, n.10). If so, it would have been one of the largest cities in the Byzantine Empire, with an importance that transcended the province it served. Every aspect of the city's growth, enhancement, and prosperity provides proxy evidence that it had a functioning harbour. Otherwise, how else would such a renaissance have occurred? The linkage between a functioning harbour and Caesarea's prosperity was constant throughout its existence up to and including this last chapter of the city's Early Byzantine history. This last *floruit* may well have begun to erode after the great plague struck in AD 542, followed by the tsunami of AD 551. These two natural disasters, along with changing geopolitical conditions in the world beyond its immediate environs, may have debilitated Caesarea to a point where it no longer had the resources or communal will to strive to recover its earlier 6th-century prosperity. It did survive the end of the 6th century AD, but its heady role as one of the great port cities of the eastern Mediterranean Roman and Early Byzantine world was nearing an end.

It is very surprising that Procopius of Caesarea, whose unique work *De Aedificiis* (perhaps published posthumously in the AD 550s) details so many building projects elsewhere in the empire during the Justinianic era, did not mention anything about his home city. He had stated in section V of this work that he would cover all the emperor's building projects in Asia and Africa broadly defined (*De Aedificiis*, V. i. 1-3), but in fact he only discussed events involving the Samaritans in Neapolis (modern Nablus) in Palestine, before moving on to a brief discussion of monasteries in Arabia (*De Aedificiis*, V. vii and viii). Such a limited selectivity, excluding Jerusalem along with Caesarea, speaks clearly to an unfinished work, an opinion long held by numerous scholars (Cameron 1985: 84; Evans 1972: 81). Perhaps he had been saving a more detailed discussion of Palestine (including Caesarea) to the last, since he knew this region so well, but his death came before that aspect of his work was completed. We can only imagine what he might have said about Caesarea's terrestrial buildings and harbour complex, its role in the world of Justinian, and perhaps even the maritime commerce that moved into or out of its harbours.

Joseph Patrich began his comprehensive study of the archaeology and history of Caesarea with the following concise but accurate assessment: 'Its [Caesarea] prosperity continued as long as it served as a provincial capital and its harbour functioned, serving the international trade' (Patrich 2011: 1). It is appropriate to end this discussion of the evolution of its harbour from Roman to Byzantine times by citing it as a summation statement. The fortunes of Caesarea were inexorably linked to its harbour installations. When *c.* 7000 soldiers fled by ship in AD 640/641 to escape the Arab conquerors, who had just broken the city's terrestrial defences, the Roman and Byzantine chapters of Caesarea's history ended. This dramatic fight for survival shows that even in its last moment, its harbour, however damaged it might have been in AD 551, had recovered somewhat and was still functioning. Because it was, the last Caesarea Byzantines had been able to endure a seven-year siege, obviously receiving supplies and troops from elsewhere along the maritime corridors of the empire. Herod's harbour had heralded the city's entry into the Roman world. Its 7th-century AD configuration, whatever form that might have taken, was the stage for the final moment of Byzantine control, although it would continue to be a possible maritime frontier in the continuing Arab-Byzantine struggle.

In the centuries that followed, the historical and archaeological evidence regarding the fortunes of Caesarea's harbours is less certain.[9] There is a huge body of unpublished artefacts excavated by Raban in the 1990s that may possibly be relevant to our understanding of Caesarea's harbours in the Early Byzantine era (Patrich 2011: 92, n. 3). These data may also provide more information on the fate of the harbour during the Arab occupation. But as regards Byzantine ports in general, Kazhdan noted: 'After the 7th c. there are few references to harbor construction' (*ODB* 3: 1706, where makes no distinction between ports and harbours). Our future understanding of the role of harbours in the maritime world of Byzantium will be enhanced only by the archaeological investigations now underway and by those that will occur in the years ahead.

I end my comments by once again thanking Dr Alkiviadis Ginalis for opening a door to the future of Byzantine harbour studies with a pioneering conference. We can all hope that the publication of its proceedings

[9] For a suggestion that the harbour still functioned during the Persian occupation in the early 7th century AD to accommodate the continuation of silk trading, see Patrich 2011: 149, n. 24; for a functioning harbour after the Arab conquest, see Hohlfelder 2000b: 58.

spurs scholarly interest in our subject the same way D. Blackman's article on ancient harbours did in the 1980s (Blackman 1982a-b).

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