



# *Portus*, New Contributions to its Research: Construction Systems and Dating of the East–West Docks

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## Abstract

The archaeological site of *Portus* (Ostia Antica), is a most important ports of the ancient world. Since 2017, the University of Huelva, in collaboration with the Archaeological Park of Ostia Antica, has been developing a research project on one of its interior piers, the so-called lantern. Said east–west structure or pier is the best example of its category in the port complex. With a length of about 150 m. the latest research has provided numerous and interesting data on its architecture and diachrony, highlighting significant phases in its evolution from its construction to its final abandonment in the beginnings of the Middle Ages. Therefore, the results presented here represent a significant novelty in the general knowledge of *Portus* and in that of its docks in particular.

**Keywords** Piers · Docks · Navigation · *Portus* · *Ostia Antica*

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## Portus and its Docks, Location, and Research History

The area of the called imperial ports is located in the vicinity of the current Tiber mouth, in the town of Fiumicino, 23 kms west of Rome. Nowadays, the remains of the ancient harbours of Claudius and Trajan, as well as the docks and warehouses, make up the archaeological area of *Portus*, part of the Parco Archeologico di Ostia Antica, about three kilometres from it (Fig. 1).

*Portus* is one of the most important and widest port environments of the ancient world. It was built on the right bank of the Tiber by the emperors Claudius and Trajan, and it was created to strengthen the supply system in Rome, considering that *Ostia*, due in part to the environmental and geomorphological determinants that were ruining its port, could not supply adequately. Indeed, the most recent research confirms that a series of extreme flood events and alluvial deposits of the Tiber with a high sedimentation rate between the second century B.C. and the early first century A.D. negatively affected the river port of *Ostia* (Goiran et al. 2014). This new port, partially situated in coastal ridges of dunes and ancient marshy lagoons, soon proved to be inadequate to protect ships efficiently against storms, as Tacitus said (*Annales XV*, 18.3). This led to the excavation by Trajan at the beginning of the second century A.D. of an additional inner hexagonal basin surrounded by warehouses and official buildings, his *portus traiani felicis*. The sedimentation of the Tiber delta was probably also the main reason why Emperor Claudius built an artificial canal called *Fossa Traiana*, the current Fiumicino canal which connects the port to the Tiber, to reduce the vulnerability of the Roman capital to flood risks (Mazzini et al. 2011).

From the middle of the first century A.D. until the beginning of the Early Middle Ages, the *Portus* complex was the main port of Rome. Its location, next to the Tyrrhenian, produced a decisive and fast environmental change that, together with some historical vicissitudes, largely determined the final purpose of the port. In fact, with the passage of time,



**Fig. 1** Location of the archaeological area of Portus next to the Tiber mouth (prepared by the authors based on data from *geoportale nazionale*)

the successive Tiber floods ended up covering the port structures, which made it difficult to read the palaeo-landscape (Goiran et al. 2010, 2011, p. 31). From a geomorphological point of view the Tiber delta can be divided into two areas: on the one hand, the inner zone in the east, related to the ancient lagoons of Maccarese in the north and *Ostia* in the south (Bellotti et al. 2007), and on the other, the outer area in the west, where the landscape is composed of dune barriers (Delile et al. 2014, p. 35).

## Port Infrastructures: The East–West Quay and its Predecessors

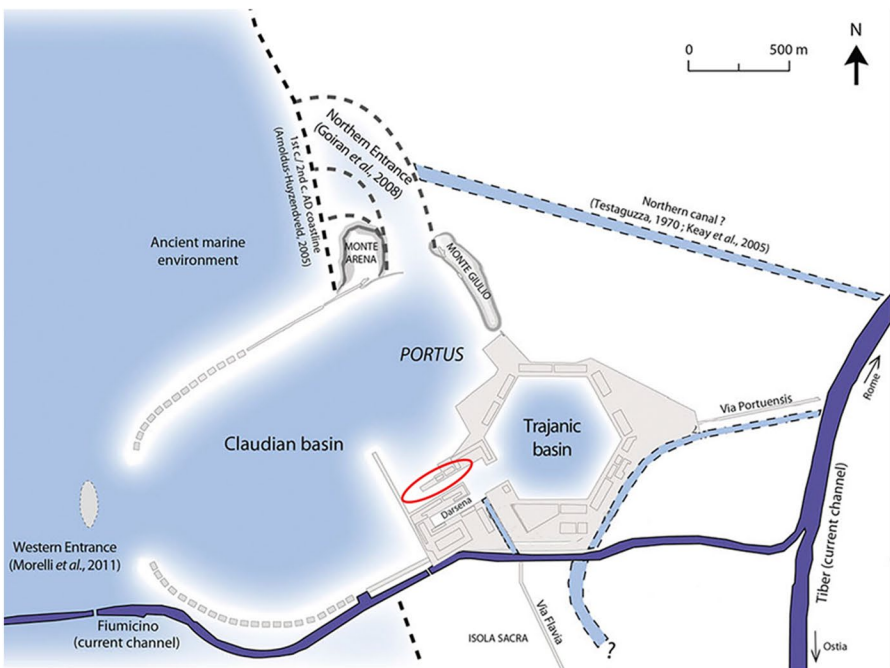
In the port of Claudius, the inner part was protected by two large straight piers arranged respectively in a north–south and east–west direction, which define the western and northern sides of the entrance canal to the hexagonal or Trajan’s harbour (Fig. 2). The east–west dock, also known as the lantern quay, measures 150 m long by 8 m wide with several buildings and structures on its upper part corresponding to numerous building phases that, diachronically, follow one another from the foundational period until the abandonment of the structure at the dawn of the Middle Ages.

At the base of this quay there are interesting constructive elements corresponding to its foundations’ systems, likewise, in the upper zone of the western side of it, the research of the early twentieth century suggested the existence of a lighthouse or *lanterna*, being henceforth known by that nickname (Lugli and Filibeck 1935, p. 81). This wharf and its lighthouse were part of the internal circulation system of *Portus*; specifically, it indicated the entrance to the hexagonal dock. Furthermore, this structure protected the inner part of *Portus* from the rough water, where the *grandi magazzini di Traiano*, the canal leading to the inner dock and the *canale trasverso di collegamento* were located.

In short, it is an inner east–west quay which allowed the entry and exit of boats from the outer dock of the Claudius port to the Trajan’s hexagonal dock, protecting the area of the inner dock from the tides. From an architectural and archaeological point of view, this structure has a lower level of knowledge compared to other structures such as the Imperial Palace area, *horrea severiani*, *magazzini di traiano*, etc.

Previously to the start of research in 2017, in the framework of collaboration between the University of Huelva and the Parco Archeologico di Ostia Antica, the preceding interventions on the quay were scarce. Over the last centuries, the news of its work, details and elements went unnoticed in favour of other more significant and monumental areas or structures of this great port. The first information about the thermal baths located at the dock’s entry came to light in the 1920s. They were visible at the beginning of this century and unleashed several excavations from which a significant group of marbles was recovered. The work directed by Canina, and Garraz made it possible to discover its remains, as well as the first planimetry of this complex (Canina 1830, p. 2), and more recently, new research has allowed a better and greater knowledge of that structure (Panzieri et al. 2016).

Regarding this wharf, we will not have news of it until the end of the nineteenth century when during the prince Torlonia excavations Lanciani notifies the appearance, at the end of the head or *testata*, of a column with the inscription of the *magister militum* F. Stilicoïn (Lanciani 1868, p. 168). It was not until the beginning of the twentieth century that the first detailed descriptions of the quay were found. The work carried out by Lugli and Filibeck (1935) provided information about the condition of the structure and the most important elements. They even provided some graphic material that shows a completely different image to the current one, before the transformation of *Portus* into a natural park,



**Fig. 2** Above, indication of the east–west dock location on an orthophoto; below, on a planimetry of the old port (Salomon et al. 2014)

free of vegetation and with filler tells that show that there were structures in the upper part. The information transmitted by these authors represents the bulk of the current knowledge about this structure. In their description, we can find the existence of a staircase (3×3 m) leading to a tower, interpreted as a lighthouse or *lanterna*, which will name the quay from this time onwards, as well as various features of the construction of its head with a series of phases that would modify its original appearance at the time of Diocletian or Constantine (Lugli and Filibeck 1935, pp. 81–82).

The most recent research has generated an interesting debate on the chronological aspects of the construction of this inner dock. On the one hand, research carried out by Verduchi in a sector of the quay near the *Casale*—nowadays the future visitor reception centre—dates the construction of the establishment to the Trajan period (Verduchi 2004, pp. 237–241). Nevertheless, on the other hand, the research carried out by Paroli, Panziere and Ricci in the easternmost part—in the thermal bath area—has been able to identify an area that seems to have been built in an early period of *Portus*' life, probably in the Claudian-Neronian period. The research led by Keay and the British School seems to be along the same lines, which means, based on various archaeological testimonies, an assignment for the so-called *molo della lanterna* and other facilities firstly attributed to Trajan such as the dock or the mouth canal, or the *trasverso* communication canal, as components of the original Claudian port scheme (Keay et al. 2005, p. 275). Finally, and as we will explain later, the research carried out in recent years in the area near the end of the wharf seems to point to a much later chronology than initially was established, at least for this sector.

## The East–West Quay: Construction System, Dating and Diachrony

Regarding the dock background, the activities at the dock began within the framework of an extensive DEATLANTIR project, consisting of annual excavation campaigns, and geophysical and wall faces analysis, developed from 2017 to the present day. The data obtained related to its fabric, occupation or surrounding palaeo-environment now make up the bulk of the knowledge about this port structure (Bermejo et al. 2021a; b, c, d; Muñoz et al. 2021; Marín et al. 2021).

Specifically, relevant work has been carried out on a sector of the wharf's north side, as well as on its head, where different exploratory drillings, rotary explorations, building analysis, laser photogrammetry, geophysical prospecting, cleaning and consolidation of the existing structures have been proposed. In conclusion, a broad combination of methodologies that, added to the multidisciplinary nature of the project itself, have laid the foundations for creating a solid discourse on the different constructions that took place in this infrastructure from its founding moment until its definitive abandonment or deterioration.

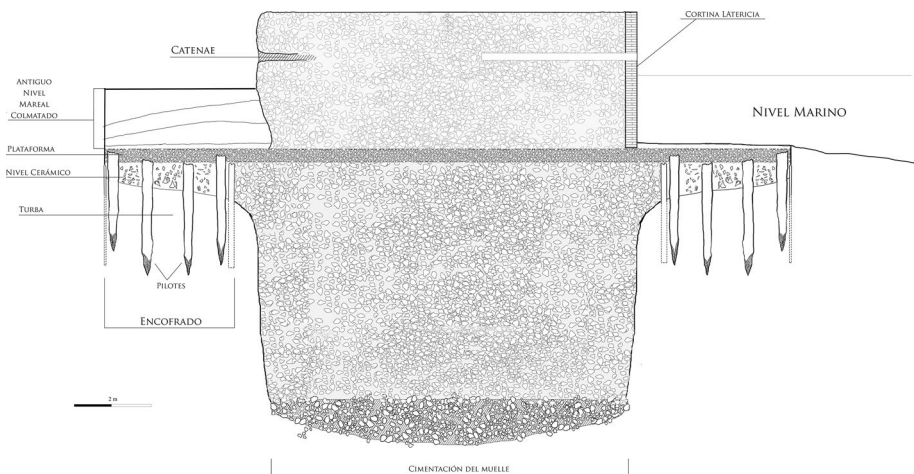
Precisely, the geoarchaeological data obtained—some of them still being studied—talks about an extremely dynamic port infrastructure in its configuration, with numerous construction stages associated with a progressive loss of depth regarding the silting of the old port cove in the period between the third century A.D. and the beginning of the sixteenth century A.D. (Bermejo et al. 2021c). The first of these phases corresponds to the time of the wharf construction, at least for the last 25 m, thanks to the excavations carried out in its foundations and the surface explorations, which have made it possible to determine its constructive potential.

On this matter, the results have led us to think about the possibility that we are dealing with a quay of very late chronology; or, alternatively—what seems more feasible—that is a dock where the gradual process of silting up meant planning periodic expansions of it as the harbour area filled up. This also seems to be the development of the north–south quay, in which there are several diachronic extensions, although it is true that its stages have been dated exclusively through wall face examinations and construction techniques, with no excavations in its foundations (Bucowiecki and Mimmo 2021).

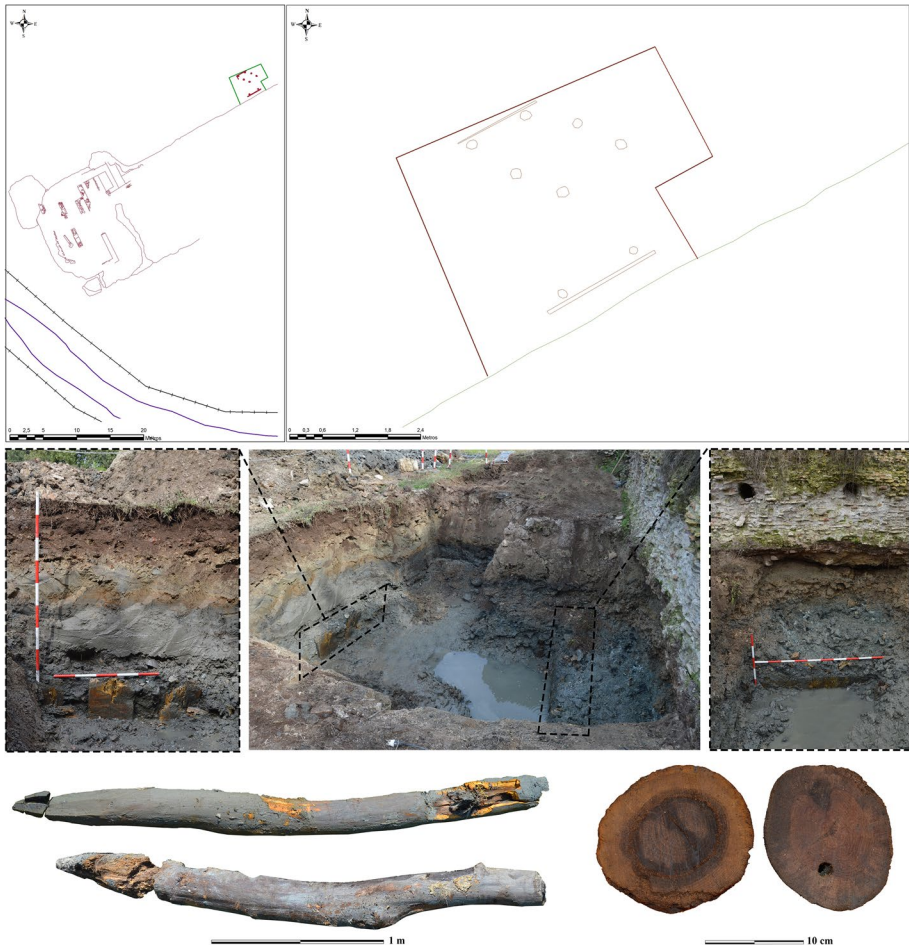
From the construction point of view, it is possible to establish the use of an architectural system that is known because of the descriptions made at the time by Vitruvius (V, 13). For the construction, a wide trench was prepared with dimensions of approximately 19 m wide and a variable depth until reaching the seven metres, which is known thanks to the evidence extracted from the surface of the quay, that allows a section of it to be restored with complete accuracy (Fig. 3).

This impressive trench was used to prepare the foundations for the quay. Therefore, its edges were made with a double wooden formwork with different thicknesses on the inside (15 cm) and the outside (5 cm). These formworks were utilised to support the construction from the outside inward, as they were employed as platforms from which to pour the different levels of *caementa* that formed the foundations. The inner walls of the formwork, made with vertical strips, were held with horizontal strips and, although it has not been possible to document them, must have had the same type of wall-to-wall shoring. This system was completed with the driving of wooden piles into the peat substrate of the old riverbed, with an approximate length of 3 m and the tip hardened by burning (Fig. 4). This framework was then filled by a strong pouring made of waste ceramic material, with a significant presence of transport materials as well as tableware ceramics that provided a clear drainage function to the formwork foundation. Finally, on top of this, there was another pouring made of different sized rocky material that sealed the whole area and provided a regularised platform.

The ceramic material recovered from the pouring of the formwork is represented by a list of numerous transport containers identified as Keay types VI, VII.3, LII, XXIV, as well as fine African silverware types C and D in Hayes forms 27, 50, 182, and common kitchen



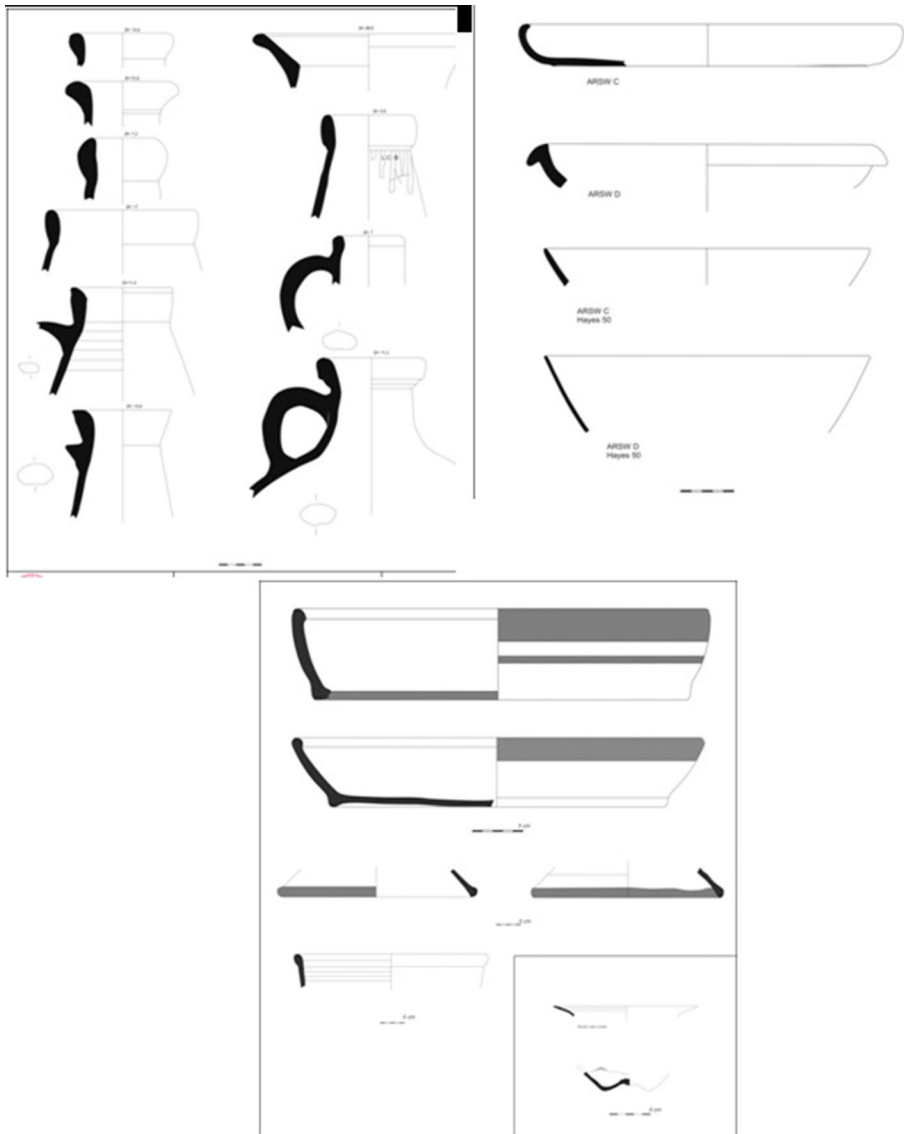
**Fig. 3** North–south section of the quay



**Fig. 4** Position and detail of the formwork and the pilings that formed it

ceramic in Hayes forms 196A and 197. In short, a collection that refers to a chronology from the first half of the third century A.D. onwards (Fig. 5).

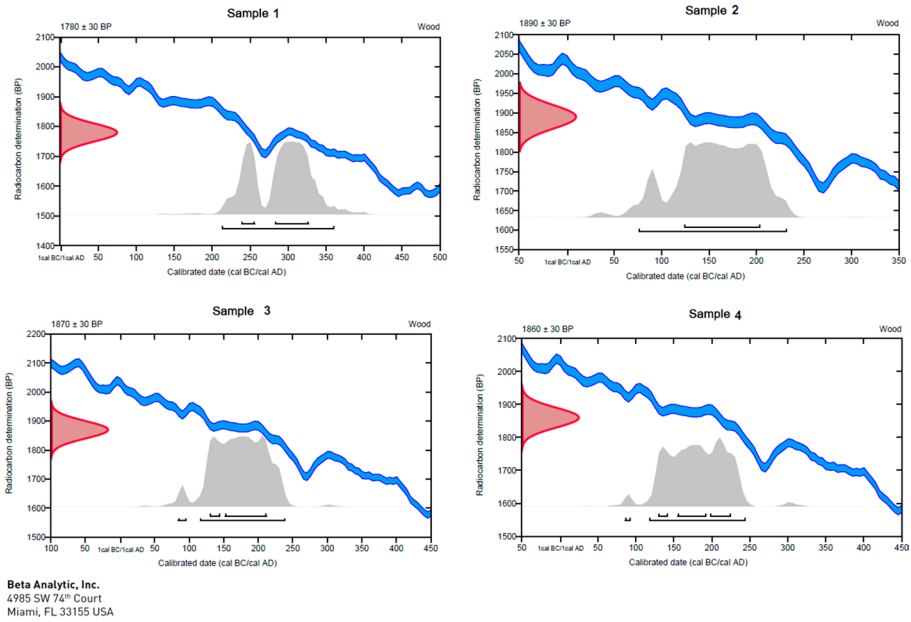
The palaeobotany study of the wood samples taken from the formwork confirms the utilisation of species such as *pinus* and *quercus* that are around fifty years old. The C14 dating of four wood samples obtained from different parts of the formwork has provided an absolute calibrated dating ranging from 213 to 361, 76–232, 116–239 and 118–244, with all the samples sharing the range corresponding to the period between 213 and 244, within the first half of the third century A.D. (Table 1, Fig. 6). This formwork system must have been widely used in *Portus*, although it is true that not many examples have been found to date. In this regard, in the excavations carried out between 1999 and 2000 in the Darsena area, in the southwest corner, the upper part of the planks row that formed a wooden formwork wall, probably of cypress or alder species, was laid bare (Morelli et al. 2005, p. 257). Despite this, nothing is known about its dating or species with certainty, nor whether it formed a double wall as in the case of the east–west quay.



**Fig. 5** Ceramic material recovered from the framework pouring

**Table 1** Dates obtained from the timber samples from the formwork

Wood sample	
Sample 1	(95.4%) 213–361 cal AD
Sample 2	(95.4%) 76–232 cal AD
Sample 3	(92.8%) 116–239 cal AD
Sample 4	(94.4%) 118–244 cal AD



**Fig. 6** Results of the radiocarbon dating (Beta Analytic)

Once this formwork has been secured with its pouring, its surface can be used as a service platform from which the actual construction of the quay foundations can begin. From there, we can pour the different levels of *caementa* until it reaches the same level of the platform, and then build the body of the quay itself, both the infra-tidal and supratidal parts (Fig. 3).

The construction system followed for the upper part of the pier was based on formworks systems, the imprints of which are still visible in the negatives of the *catenae* system. Finally, once the formwork was removed, it was covered with *opus testaceum* (Fig. 7).

**Fig. 7** Detail of the quay wall

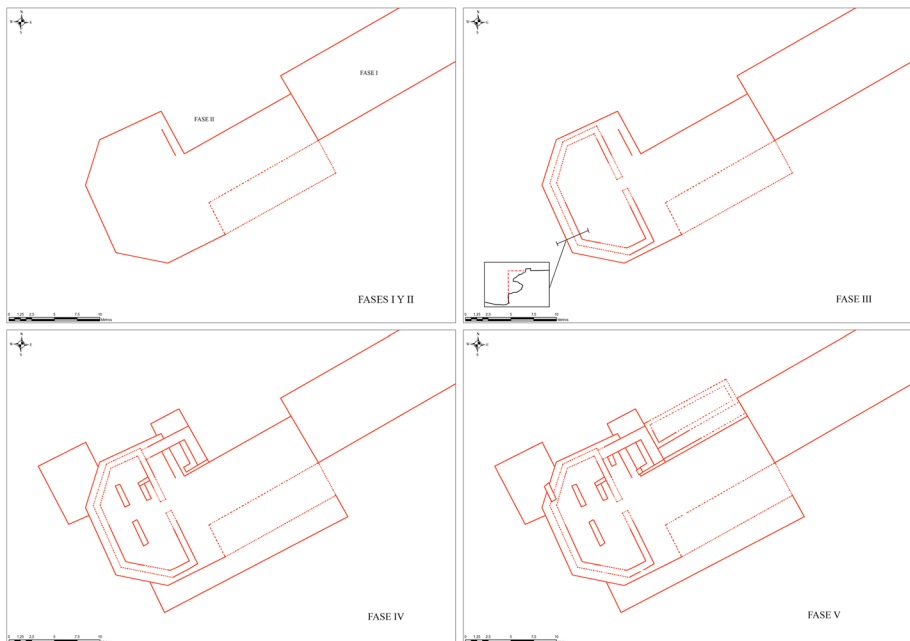


In the final part of the quay (Fig. 8), then, the different archaeological interventions carried out so far (Bermejo et al. 2021a, b), have made it possible to corroborate some details that allow us to consider the possibility of a later construction for this last section. This idea is based on several aspects. Firstly, the constructive power of the quay in its final part (last two metres) is considerably lower than in its previous development, being 5.50 m in the first one as opposed to 9.6 m in the second one.

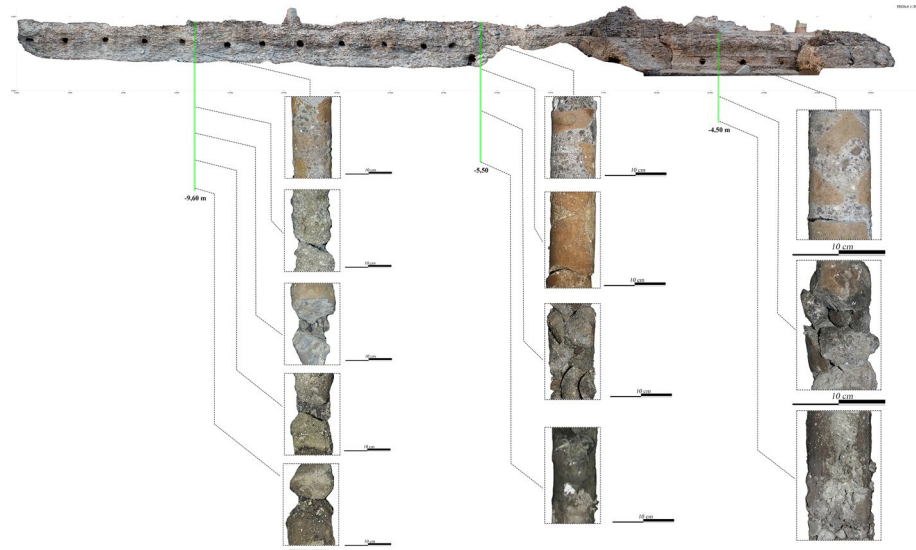
Indeed, the rotating explorations of its surface at some points of the structure reveal foundations of different depths (Fig. 9).

This detail is very significant because if it had been built at a single moment this difference in its constructive power would not be understandable, even more so when it is assumed that an architectural programme of a certain magnitude was used on top of the head. Secondly, in the head's walls, we can observe the use of *caementa* with the introduction of tegula to regularise the pouring (Fig. 10A and B). This fact, together with a totally different arrangement and sizes for the trunks that formed the *catenae* of the formwork, reveal constructive particularities that could be due to successive constructive moments. Finally, in the final development of the quay body, the remains of a union between different parts can be seen; that is, a constructive relationship that shows a latter add-on. In fact, the analysis of the laser scanning of the *catenae* imprints in this junction area reveals an oblique arrangement, an unmistakable symptom of a foundation finishing in the work. As we can see, there are a series of construction data that point to the possibility of a pier to which a wider head or strut was added later (Fig. 10C).

These details make it possible to identify a second construction stage, represented by the attachment or construction immediately at the end of the quay body of a polygonal head or strut with a surface area of approximately 290 m<sup>2</sup> (Fig. 8). Perhaps the most outstanding architectural element was the angle of junction between the corner and the dock



**Fig. 8** Construction phases of the quay in its westernmost area

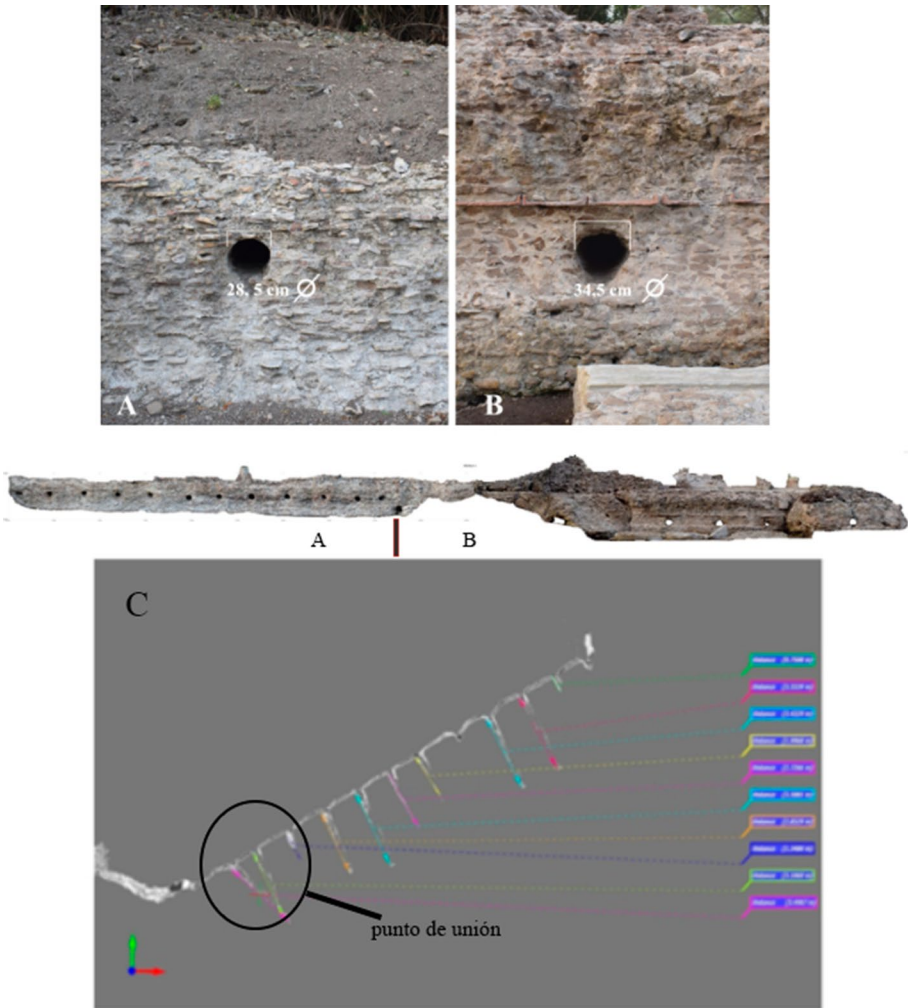


**Fig. 9** Section of the east–west quay with signs of the foundation’s depth and samples of *caementa*

because a system of brick unloading arches was chosen. This system may have been conceived to distribute the pressures and impact of the structures developed above the head. Indeed, its surface was prepared for an important construction but later degraded. Despite this, the remains of its foundations, which were still visible in the excavation, allow us to theorise about the existence of big construction, with 0.90 m wide *opus testaceum* walls, very possibly decorated with an architectural-decorative set of marble. This information is supported by the remains found at the foot of the head on its northern side, belonging to marble columns, as well as remains of *opera musivaria*, that fell vertically in the dock riverbed with some parts of the wall and the quay claddings.

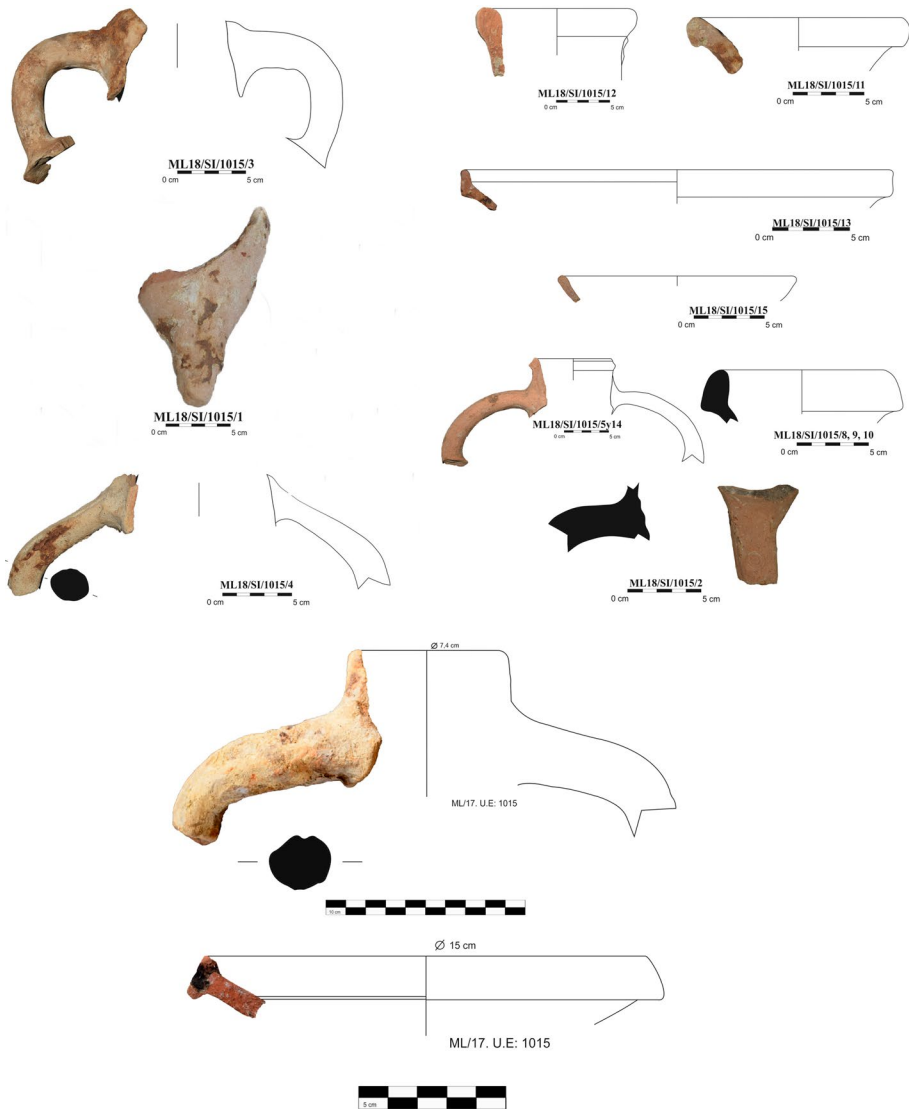
As regards the chronology of this stage, we do not know when it was built, but it was obviously raised after the development of the quay’s last part. Hence, it dated to after the mid-third century A.D. The ruination moment is better dated, as the remains of the columns and walls belonging to this structure fell to a receding seabed; a level from which various transport materials and *amphorae* LRA1, LRA2, were recovered (Peacock and Williams 1986; Bonifay and Villedieu 1989; Bonifay and Piéri 1995), as well as models of Keay 36a, Almagro 51c and tableware ceramics in ARSW type D in Hayes forms 61B, 78, 94b and 101. This suggests a *post quem* date of the first half of the fifth century A.D. for the demolition time and thus for the beginning of the third phase (Fig. 11).

Regarding its function, and despite the scarce remains, it is believed that the monumentality of the remains may back the hypothesis that a large tower-shaped structure was erected on the head, very possibly a signalling element that would articulate—like a lantern or interior lighthouse—the transit and navigability from the outer dock or Claudio’s dock and *the canale di collegamento*. This idea had already been suggested in the 1930s based on the remains visible on its surface at that time (Lugli and Filibeck 1935, p. 81). Subsequently, the area excavating has allowed to identify a new construction stage at the head of the quay. A third building phase that would lead to the deterioration of the previous great construction. During this period, the pier head saw how its *platea* went through



**Fig. 10** Details and laser scanning of the north side of the quay, with signs of the *catenae* point cloud

an important spatial and functional restructuring; where a large structure was once visible, a new 78 m<sup>2</sup> *opus testaceum* building was constructed (Fig. 8). From the functional point of view, the material record is mostly composed of transport elements as well as common ceramics, which leads us to consider a storage function. It is quite possible that by this time the most extreme area of the quay would have been used for berthing, unloading and storage. The construction of this area and, therefore, the change in the functionality of the pier head took place after the deterioration of the previous phase. It must therefore have been built after the middle of the fifth century A.D., the date of the end of the tower or *lanterna*. Afterwards, a significant change in the configuration not only of the head but also of the final part of the quay was again documented. This process seems to be due to a new construction stage that will lead to the enlargement of the useful surface area and new constructions. From a chronological point of view, the lack of material culture because of them and their foundations means that we must theorise about the moment of their construction,



**Fig. 11** Ceramic material recovered from the level of tide silting

although it must have taken place in the second half of the fifth century or the beginning of the sixth century A.D. Of this great reform programme, maybe the most remarkable is the construction of two platforms attached to the quay and its head on the north side—probably also on the south side—intending to provide it with more surface area. These platforms or small docks made up of poured *caementa* meant the expansion of the space by 4.20 m in length 5.60 m in width and 1.50 m in height. A new building with a tower-shaped plan of at least 13 m<sup>2</sup> (Fig. 8), with walls 1.20 m wide, was planned to be built on top of this platform. There is no material evidence to support its functionality, but the warlike environment of *Portus* at this date, with constructions that indicate a tendency towards fortification

(Keay and Paroli 2011, pp. 7–10), suggests that it must have been a new tower, in this case, conceived with a clear defensive and control function. Indeed, the construction dynamic in the Late Antique centuries was hectic in other areas of Porto, so that by the fifth and sixth centuries there was a fortification of the port (Paroli 2004, pp. 257–258) in which the east–west quay shows precisely this process, with successive constructions that make the quay more solid and make it more difficult to cross.

Concerning this constructive impulse, but at an immediately later time, the quay would have new extensions with the addition of new platforms, specifically on the north-eastern area, in this case attached to that of the previous page (Fig. 8). This new platform has dimensions of 9.70 m by 4.80 m. Although there has not been a lot of action in this area, it is sure that immediately after the foundation was made, a rectangular structure was raised on top of it. Its construction is rather irregular due to the utilisation of reused materials and its function seems to be related to providing more usable space for the quay. For its chronology, it is completely unknown, although it is true that its construction took place after the attachment of the previous platforms, perhaps in the beginning or first half of the sixth century A.D., in that Gothic war environment and coinciding with the time when the *Darsena* warehouses were being sealed and their levels of use were being refilled (Morelli et al. 2005, pp. 251–252; Bucowiecki and Mimmo 2021). In this period, we must also include various reforms carried out in the rest of the infrastructures of the quay. These encompass the internal restructuring and the creation of a stairway in the port environment of the second phase, as well as the internal remodelling of the second tower-shaped structure. All these new constructions are characterised by the poverty and poor workmanship of their walls, evidence of the crisis of *Portus* at this time. This would be the last constructive impulse that took place on the pier head since among its last evidence of use there are only some deterioration episodes that clog the entire area, a process that could be associated with the general decline of all the infrastructures in this sector of *Portus* around the sixth century A.D., now that the early medieval port was located on the *Fossa Traiana* at its connection with the ancient canal of communication.

## Final Considerations: A New Chronological Proposal for the East–West Quay of *Portus*

The various interventions carried out on the east–west quay of *Portus* have contributed a considerable corpus of data throughout some excavations and research, thanks to which, from an interdisciplinary methodological point of view, it has been possible to synthesise an initial diachronic proposal for it. According to our argument, previous research on the quay had been scarce, with only the interventions in the area of the thermal baths, as well as those that highlighted in the 1930s the importance of a possible *lanterna* or lighthouse. Against his background, a comprehensive study was made of the last metres of the dock, and numerous aspects of its fabric, construction systems, the functionality of spaces and diachrony were dealt with, which can be summarised in a series of phases:

*Phase I.* This stage is represented by the construction of the pier through an important trench excavation with wooden formworks filled with ceramic material with a draining function and the piling driving. These foundations had a double function: on the one hand, to give greater solidity to the construction of the quay on its flanks and, on the other hand, to favour—as working platforms, the *caementa* effluents that formed

the foundations of the quay and the raising of the visible part of the dock, which was covered with a brick wall.

From a chronological point of view, the dating of this first phase corresponding to the construction of the dock has been possible thanks to the combination of different data. On one hand, the C14 dating of several samples of wood from the formwork provides a coinciding chronology for all of them of the first half of the third century A.D. On the other hand, the study of the ceramic material recovered from the fill of the formwork points to a chronology of the first half of the third century A.D. This is one of the main contributions of our work since the traditional proposal, which considered this quay to be either from the original plan of Claudius' design or immediately after or from the Trajan period, corresponds to work from the Severan dynasty. At this point we must be cautious because the excavations have been focused on the last 30 m of the quay, so the results relating to its chronology should not be extrapolated to the whole wharf. That is, we should not rule out the possibility of a wharf that progressively advanced as the old Claudius dock was filled in; rather, different construction phases and the last one being the one detected in our research. This idea could be related to the research carried out in the starting area of the wharf, where levels from the Claudian period associated with its construction were documented.

*Phase II.* The next stage of the construction seems to be related to the attachment of an imposing head or prop to the end of the quay. The construction of a structure of a certain magnitude seems to have been planned on top of it, as revealed by the remains of its foundations and the architectural and decorative materials fallen at the foot of the structure, on the old seabed. This head, with a polygonal shape, has a series of construction and masonry features that differentiate it from the body of the pier. Firstly, the difference in the depth of the foundations, without being a conclusive argument, at least shows a significant difference which must be considered. Secondly, its construction shows differentiating elements, the use of tegula to level the *caementa* pouring, as well as the use of larger diameter *catenae*, reveal the use of modules in its unequal formwork. Finally, there is a relationship of attachment between the pier body and its head, a connection in its fabric that is clearly visible on its north side. All these details, in the absence of excavations going deeper into the foundations of the head that allow us to obtain other data, lead us to consider the possibility of a different phase. As for its chronology, we do not know much about its construction, although it was obviously built in the middle of the third century A.D.

*Phase III.* A third episode in the quay life and its prop was then confirmed, represented by a moment of ruin and deterioration of the pier head. This process, dated by the level of collapse documented at the foot of the structure around the first half of the fifth century A.D., meant a complete change in the appearance of the structure. Using the remains of the previous phase, the space is now configured as a storage environment.

*Phase IV.* Shortly afterwards, various structures were attached to the sides of the quay as small docks, that allowed the structure at the head to be provided with a larger useful surface area. These extensions allowed the raising, on the north side, of a great tower-shaped structure, perhaps with signalling and sighting functions. At this time, dating to the second half of the fifth century A.D., a big transformation of the entire Portus was taking place, with a clear search for the defence of the port which led to the remodelling of old storage buildings, docking structures, etc.

*Phase V.* Immediately after the previous phase, a final construction process was carried out on the quay, represented by a new platform on the north side on which new structures were built. The fact that so little has been preserved prevents any approximation to its

functionality and chronology, although it must indeed have been created at least between the fifth and sixth centuries A.D.

After this last episode, the quay and its head will never again show signs of occupation or structural alterations that would suggest a use beyond the sixth century A.D. It is for this reason that the area will be abandoned, and it will become a host of ruins and a quarry of materials.

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## Declarations

**Conflict of interest** The authors declare no competing interests.

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