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Edited by Simon Keay, Martin Millett,
Kristian Strutt and Paola Germoni

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With contributions by
Antonia Arnoldus-Huyzendveld†, Giulia Boetto, Paola Germoni, Alessandra Ghelli, Jean Philippe Goiran, Ludmilla Lebrun-Nesteroff, Simon Keay, Ilaria Mazzini, Martin Millett, Carlo Pavolini, Carlo Rosa, Férreol Salomon, Kristian Strutt, Cécile Vittori, Sabrina Zampini

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Preface

Carlo Pavolini

The survey that is published in this volume forms part of the Portus Project which is directed by Simon Keay. This initiative followed on from the overall 1998–2004 survey of Portus (Keay *et al.* 2005) and, since 2007, has produced several benchmark publications (eg. Keay and Paroli 2011).[1] It is an initiative conducted in close collaboration with the *Soprintendenza Archeologica di Ostia*, now the *Parco Archeologico di Ostia Antica*. The contribution of the latter to the publication is recognized by the presence of its archaeologist Paola Germoni, who is one of the four editors of the book, and who also co-signed the introduction, oversaw the preparation of other parts of the book, and took part in the drafting of its text (see below), along with Simon Keay, Martin Millett and Kristian Strutt.

In the first years of its activity, the Italian-British research programme was focused upon the imperial harbour basins to the north of the Tiber delta at the site of Portus and in its hinterland. They produced extraordinary results, for an idea of which one only needs to refer to the essential works mentioned in the previous paragraph. But in turning specifically to the Isola Sacra – where the results of the research are no less exceptional, as we shall see – the greater part of the work was undertaken between 2008 and 2012, with the collaboration (apart from the *Soprintendenza*, now the *Parco Archeologico di Ostia Antica* by virtue of its responsibilities to protect its cultural heritage) of such scientific institutions as the British School at Rome, the Universities of Southampton and Cambridge, and many other institutions and scholars of diverse origins and specialisms.

The difference between the survey of 1998–2004 (Keay *et al.* 2005) and that published here is fairly clear. The objective of the former was to study an area that had been built-up in antiquity, in some areas densely, while the latter is a landscape survey that has as its setting an area of *c.* 98 ha that we could define as 'free' of structures. However, this was only 'free' in a certain sense: the authors of the introduction make it clear that while the lands of the Isola Sacra are largely used for agricultural purposes today, there is also a large presence of houses, warehouses and other structures, as well as drainage channels relating to the *Bonifica* (drainage programme) of the early twentieth century and trenches for electric cables etc, all of which have inevitably conditioned a survey based upon geo-detection methodologies. While undertaking the survey, the archaeologists also had to take into account periods of time when fields were fallow or used for pasture.

A separate debate concerns the serious problem of illegal building. Nowadays, this is less prevalent and more controlled across the land area of the ancient Isola Sacra on account of various land protection measures; unfortunately, however, it is still widespread across the land which extends as far as the present-day coast of Fiumicino, and which corresponded to the sea in antiquity. It is also responsible for the current state of the banks of the watercourses which define the Isola to the north-east and to the north-west (in other words the Fiumicino Canal, or '*Fossa Traiana*', and the Tiber itself), which are cluttered with workshops for boat repairs and other often illegal installations. It is a situation that is lamented by the authors and which only leaves free the area of the Capo Due Rami, which corresponds to the north-easternern angle of the Isola.[2]

I will not detain myself on the numerous details provided in the text. This is the case of the 'traditional' sources discussed in Chapter 2, in which are included, for example, maps before and after the flood of 1557,[3] and aerial photographs from 1911 (Shepherd 2006) down to the Second World War (R.A.F. and *Aeronautica Militare Italiana*) and subsequently (*S.A.R.A.-Nistri*). Amongst these sources, those that derived from archaeological research undertaken before the start of the Portus Project stand out, and the description of them by the authors of this book forms a cohesive whole in the context of a review of the topography of the Isola as traditionally understood. Some of these are very well-known sites, such as the *Ponte di Matidia*, the *Basilica di S. Ippolito*, and the building identified as the *Isaeum* of Portus, a hypothesis which the authors support, to my mind correctly. Above all, the famous *Necropoli di Porto*, otherwise known as the Isola Sacra necropolis, which has been the object of excavations since the time of Guido Calza,[4] and which was given this name at a time before other burial areas, often of a similar size, had been uncovered in the vicinity. At this point, it is useful to mention the important Gazetteer of Sites, an appendix to the volume prepared by Paola Germoni, which lists discoveries of every kind from the Isola Sacra, collated not only from earlier publications, but also from official archives, including the old *Giornali di Scavo*, accounts sent to the *Ministero*, unpublished notes produced by members of the *Soprintendenza* etc. It consists of 52 sites that are distinguished with the symbol G (**G1**, **G2**, etc) that are located on the map Fig. 2.11.

I do not wish to reflect upon the methodologies used in the survey (Chapter 3, which like Chapters 6 and 7, was written by Keay, Millett and Strutt), not least because I do not feel sufficiently competent to do so. Correctly, this is a very technical account which will surely be of great value to experts who specialize in the application of non-destructive techniques to the study of ancient landscapes, an area of expertise which is going through a period of continual development. In the case of the Isola Sacra, therefore, the use of aerial photographs was accompanied by the study of satellite images and LiDAR data, the latter being a form of aerial laser scanning. I have already referred to the topographic survey undertaken between 2008 and 2012, and in Chapter 3 it is mentioned again, providing numerous technical details; the same is the case for the approach taken by the main form of geophysical survey undertaken in the Isola Sacra, namely magnetometry.

Up until this point, I have reflected upon the methods used in the survey. The following chapter, however, examines the results, which are presented on a method-by method basis: the results obtained from the gradiometry - effectively the interpretation of the geophysical anomalies, those from Ground-Penetrating Radar (G.P.R.), aerial photographic evidence and LiDAR coverage. The outcome of all of this fieldwork is provided by the splendid set of images, all of a high quality and definition, that are amongst the greatest merits of the book. It is logical that within its broader iconographic repertoire, and over and above the many photographs provided, the drawings should be of overall importance, particularly the plans. To give just one example to illustrate my point, the plan in Fig. 4.2 reproduces the general 'mosaic' of the 33 rectangular areas in which the area covered by the Roman Isola Sacra was divided in order to present the results of the survey. Area by area, the successive figures present the results obtained by means of the different (and integrated) techniques that I briefly describe above. Thus, for instance, Fig. 4.4 (which corresponds to Area 1, which represents the northern sector of the Isola Sacra between the *Basilica di S. Ippolito*, the '*Fossa Traiana*', and the *Ponte* and *Terme di Matidia*) synthesizes the results from the gradiometry and the discoveries made before the survey, which are superimposed upon the layout of the modern landscape, which is represented in a lighter colour.

In any event, the author of the preface to a book does not need to describe the results point by point, as this would be both repetitive and boring. For a book as rich and complex as this one, it was necessary to try and understand its overall structure and to focus upon specific issues. Now that I have done this, I would like to concentrate upon several specific points about which it seems to me possible to put forward some personal reflections, in some cases. There are also the issues relating to the most 'revolutionary' discoveries provided by the Portus Project in relation to the historical and archaeological study of the Isola Sacra in recent years.

Pride of place amongst these goes to the discovery of the canal which crossed the whole of the island from north-west to south-east: this had already been reported in previous years,[5] but is only described in detail and with the benefit of full documentation in this volume. Thus, the Portus to Ostia Canal not only occupies the whole of Chapter 5 in this book, but also acts as one of the key factors underlying the new interpretation of the topography of the ancient island. In the conclusions, the authors define it as the most ambitious work of infrastructure and engineering documented on the Isola Sacra, with evident implications for the history of the entire port and urban system that had the mouth of the Tiber as its fulcrum. And it is right that the editors refer to it as the Portus to Ostia Canal, and not *vice versa*; this might seem to be purely a question of terminology but for them, however, it confirms the absolute centrality of the creation of the Claudian and Trajanic basins (and the settlement which developed around them) within the context of the transformations of the entire coastline which they brought about during the first and second centuries AD.

The mouth of the northern end of the canal was cut into the southern quay of the '*Fossa Traiana*'. Significantly, this point lay opposite the mouth of the *Canale Romano* on the northern side, a canal which ran eastwards in an arc in the direction of the Tiber (see the topography of this in Fig. 1.2). The Portus to Ostia Canal was the widest[6] of all those that have been located so far at Portus and in its vicinity since the publication of the 1998–2004 geophysical survey. It is not worth going into detail here about the geological and geoarchaeological research that has defined its characteristics, and which has been the result of work of experts on the prehistoric and protohistoric phases of the fluvial and coastal phases of the Tiber delta, such as F. Salomon, J.-Ph. Goiran, A. Arnoldus-Huyzendveld† amongst others. The boreholes, already published in part and now interpreted as part of a stratigraphic sequence in their broader context, were drilled in part between 2011 and 2013, and completed in 2017.

Turning attention to the historical aspects, and in particular hypotheses about ship draught and navigability, it is very interesting to learn that the canal could have been used at least in part by commercial ships of considerable tonnage equivalent to, for example, the 150-ton vessel on display in the splendid museum of the *Bourse* at Marseille. While it is true that this water route seems to have been crossed by a road and thus a bridge at a certain point, it is possible that this may have been a mobile installation. Moreover, the question as to whether the Portus to Ostia Canal was used for navigation alone or whether it also served to relieve Tiber flood waters, remains open.[7] Another major problem to confront us concerns the southern end of the canal. One cannot state with certainty that it flowed into the Tiber opposite Ostia, or directly into the sea; the various possibilities can be seen in Figs 5.1, 5.2 and 5.7. The writers would seem to favour the first possibility, not unreasonably. This issue is so important that it recurs several times, as well as in Chapters 6 and 7, where it is noted that in all the hypotheses noted above, the interplay of currents and the silt transported by the canal would have created difficulties for manoeuvring ships and made it difficult to establish a river port in this sector.

Nevertheless, a first conclusion concerning such a new and unexpected feature of the topography of the Isola is its chronology. In the volume it is argued that the watercourse was created between the end of the first and the beginning of the second century AD, an obvious coincidence with the grandiose Trajanic engineering enterprise at Portus; in the conclusions of the book, the dating is further refined to a date of somewhere between AD 110–120, with a final completion during the reign of Hadrian. Its disuse, however, would have begun between the late second and the beginning of the third century AD: this is an interesting suggestion which could be taken to support those arguments which have suggested that the first signs of the decline of the port system at the mouth of the Tiber - referring to Ostia, however, and not Portus - were already becoming manifest in the Severan period (see below). This therefore means that the canal would have been in full use for a relatively short period of time, perhaps a century or so; in the conclusions, it is argued that after this, the authorities were clearly not able to manage dredging operations, and the canal silted up, perhaps in the course of the fourth century AD, as the 1998–2004 survey has shown to have been the case with other watercourses around Portus.

There are several indicators that help us to better define this chronology, such as the function of the watercourse as interpreted from another sensational discovery. This concerns two shipwrecks from the Isola Sacra (Figs 5.9–13), whose relationship to the canal is stated as probable rather than certain.[8] The section of text that discusses these benefitted from an expert in the archaeology of ships, Giulia Boetto, as well as Alexandra Ghelli and Paola Germoni. Wreck no. 1 was discovered in 2011, *c.* 300m to the north of the north bank of the Tiber, in the course of works for the new *Ponte della Scafa*; Wreck no. 2 (arranged perpendicularly to Wreck 1) was found a little later, but while the remains of the former were completely recovered,[9] the latter has not yet been completely excavated (the known section is 14m long). Apart from presenting very interesting details about process of excavation, restoration and conservation, and the types of wood used in Wreck no. 1, there is a discussion of its chronology, with a *terminus ante quem* of the third century AD proposed on the basis of stratigraphic evidence.[10] On the other hand, the relatively small size of the boats supports the idea – proposed by the writers in the preceding pages – that this watercourse may have also been used by boats of small and medium capacity, with a draught of 2.5m: in other words, *naves caudicariae* or boats of a similar typology used for local commercial cabotage and, above all else, in connecting Portus with Ostia.

Overall, therefore, the Isola Sacra canal would not have constituted port infrastructure in the strict sense, as was indeed the case of the *Canale Romano* or the '*Fossa Traiana*' itself; nor were warehouses or analogous installations documented along its banks. It must, therefore, have served more for transit (and occasionally for mooring[11]) than for the unloading and storage of merchandise.

In the final part of the book (Chapters 6 and 7), Keay, Millett and Strutt present a holistic synthesis of everything presented up to this point. For ease of reference, I have alluded to many of their conclusions in my preceding pages. For what remains, I will omit much information that was known prior to the survey. However, it is important to note that the writers take a stand on the respective roles of Claudius and Trajan in the complex process of the port system as we understand it today. The impact of the interventions undertaken under the first of the two emperors is reinforced: while the Fiumicino Canal was thought to have been excavated in the Trajanic period until recently, the 1998–2005 survey has confirmed that it must have already existed under Claudius.[12] A not unimportant consequence of this was that the Isola Sacra could be considered to have been an island by the middle of the first century AD,[13] even though it did not have the epithet 'Sacra'; the chapter also discusses the Late Antique name for this strip of land and its possible explanation, an issue upon which I will not dwell.

The frequent floods which would have affected the Isola, also explain the rarity of ancient rural settlements, a fact confirmed by the survey. The excavation of canals clearly improved the situation, as we have seen, but the impression that the Isola had a limited population is also true of subsequent periods, with one exception. It is at this point that a highly relevant issue, that of the so-called *Trastevere Ostiense*, makes its first appearance in the book. It has only been in the last decades that it has begun to receive the attention that it deserves, owing to discoveries on the ground and numerous publications. One should not forget that the Isola Sacra in the Roman period was very different to what it is today, not only because it was 'narrower' on the coastal side, but also because to the east, the ancient course of the Tiber incorporated the extensive meander that was subsequently cut and isolated by the sixteenth century flood mentioned earlier. They are very well-known issues, but not everyone realizes that the part of the Isola which corresponded to the spur of land within the meander was relatively heavily urbanized down to at least the first century AD.[14]

In terms of terrestrial communications, the principal ancient road on the Isola was the via Flavia, as is well known; but also of importance here, was its connection with Portus (and thus its crossing of the '*Fossa Traiana*'). The authors argue in favour of a Flavian date for the origin of the *Ponte di Matidia*, which would have then been repaired – by Matidia – in the Trajanic period. In short, the Flavian interventions in the Isola would have been considerable, and are also attested (as is discussed in another part of the text) by both the building of the first *mausolea* at the *Necropoli di Porto* at the end of the first century AD, and the fact – noted by P. Pensabene – that 15 percent of the documented marble blocks from the *statio marmorum* on the south side of the '*Fossa Traiana*' are also attributable to the Flavian period.

The line of the via Flavia in the southern part of our territory is uncertain, and its relationship to that of the Portus to Ostia Canal cannot be defined with certainty; neither are we in a position to document in detail and with certainty the route by which, in the opposite sense, it entered Ostia from the south and left it again by the north in order to reach the river, and in the end to cross the Isola itself and arrive at Portus.[15] As for the means by which the road crossed the Tiber, the location and configuration of the bridge whose piers were seen in 1879, are not precisely known (Site **G50** of the Gazetteer). Several suggestions, however, are possible. The text provides reasons for thinking that in origin, the via Flavia would have followed a straight line, from its origin in the north-west down to the right bank of the river. This would support an argument in favour of a bridge at the position of site **G50** (Fig. 2.10), and thus a road access into Ostia at a point at or near Tor Boacciana. The creation of the canal on the Isola under Trajan would have thus led to a change in the line of the via Flavia and the creation of a bridge on the canal itself (see above), which should not be confused with the archaeologically attested structure crossing the Tiber to the south. All of these topographic details are illustrated on Figs 5.1, 5.7 and various others.

The survey has also documented – and this is another significant novelty – the division of the land on the Isola into lots (Fig. 6.4), by ditches of substantial width that could also have been navigated by small boats, as well as being used for drainage. Leaving details of them aside, there are several important aspects worth noting. In some parts of the Isola one glimpses the existence of rectangular allotments oriented east–west, following a modular length equivalent to 50m or multiples of 50m (100m, 150m) that are difficult to relate to the customary system of Roman land divisions; nor are the productive uses of the allotments easy to identify. As regards their chronology, there are reasons for thinking that the sub-divisions of the land into allotments occurred after the establishment of the via Flavia, which then came to constitute the western, or rather the north-western, margin of the land scheme, and was subsequently cut by the Portus to Ostia Canal. Did this belong to a formal *limitatio*? The authors leave this question open, while recalling that in one passage (222.6) the *Liber Coloniarum* speaks of lands around Portus being assigned to *coloni* by Vespasian, Trajan and Hadrian, and to single individuals by Lucius Verus, Marcus Aurelius and Commodus. Certainly, none of these sources explicitly mention the Isola Sacra, although in theory, the term *strigae* could correspond to these lots.

In terms of the areas of burial, the survey confirms the existence of a burial area along the via

Redipuglia (**G17–G19**) that largely represented a continuation of the *Necropoli di Porto* par excellence, which is situated along the via Flavia, and its offshoots (viz. the burials of the *Opera Nazionale Combattenti*, site **G20**). There were also other groups of tombs, and for an overall evaluation of this phenomenon and the observations that follow, the general plans on Figs 6.4–6.5 prove useful.

It is interesting to note that, amongst other things, the tombs located to the north-east of the via Flavia, which are difficult to identify from geophysical evidence alone, do not seem to have included standing *mausolea*, with a few exceptions. Moreover, the strange structures identified along the west bank of the Tiber on the eastern side of the Isola, could also be evidence of *mausolea*, although this would need to be confirmed with excavation.

With good reason, the authors pose the question: since fairly large cemeteries have been documented on the Isola, where did the people reside when they were alive? There was a settlement near the southern bridgehead of the *Ponte di Matidia*, to be sure, but this was not very dense and was for the most part occupied by public buildings.[16] There is a lack of evidence for *domus*, *insulae* and similar buildings on the Isola, and this is also in large measure the situation at Portus. This is at least what is understood from the current state of research.

This is a major issue that is not easily interpreted. As the geophysical survey proceeded and subsequent open area excavations of certain areas were undertaken, it has intrigued members of the Portus Project and caused them to pose questions about the 'urban' character of Portus. In his publications and in conference presentations, Simon Keay has put forward the suggestive hypothesis that there existed a substantial degree of commuting between Ostia and Portus: that is that many individuals involved in the loading and unloading of merchandise at the imperial harbour basins, and in storing it in the warehouses etc, would have lived in the old *colonia* and travelled to their 'place of work' daily, either by road (along the via Flavia), or by boat – in which case they would have used the Isola Sacra canal, or directly by sea. Boats for local cabotage, such as the *caudicariae* or the *lyntres*, would have also been used for this. This is what is left to be guessed at in another passage of the text, where it is argued that thanks to the transport infrastructure that we now understand better, Portus could be reached from Ostia (and *vice versa*) in as little as an hour on foot or by boat. Another hypothesis that is suggested in addition, or as an alternative, is that some of the port workers could have resided in lodgings situated on the now lost upper storeys of the *horrea* at Portus.

Returning to the funerary landscape of the Isola Sacra, the authors suggest, if I understand them correctly, that the *mausolea* on the north side of the Isola were destined for the inhabitants along the southern bank of the '*Fossa Traiana*' and the *Portuenses*, and that the tombs along the via Flavia (including the so-called *Necropoli di Porto*), as well as those situated along the banks of the Tiber, would have served the needs of the *Ostienses*. This is an interpretation about which I would be cautious, and indeed the conclusions warn against overly simplistic hypotheses about 'spatial segregation' and instead suggest the existence of 'mixed' funerary situations; in relation to this, they cite inscriptions from the *Necropoli di Porto* recording individuals who were active in both port cities,[17] both of which were characterised by having societies that were both complex and mobile. All of this is true, although in my opinion, the main argument is a topographic one: in fact, if one examines plans like Figs 6.4–5 (and others), one cannot not help but notice the fact that the tombs along the via Flavia only become dense along the northern stretch of the route, suggesting or confirming the idea that this cemetery had mainly comprised just one of the '*necropolis di Porto*'.[18] When (and if) the funerary panorama of the north-east bank of the Isola along the Tiber are better known, it will perhaps be possible to know whether this sector really was a burial space shared by the residents of Ostia and Portus.

The settlement which, thanks to the survey, has been identified along the southern bank of the Isola Sacra, and thus the right bank of the Tiber, constitutes a reality that is so new and important, as well as having so many implications, that it is justly assigned ample space in the concluding chapters of the book, and inevitably I will do the same here. The discovery, even if only by means of geophysical survey and without verification by means of excavation, had already caused a major sensation (and not just in the scientific community) at the time when Simon Keay made it the object of a press conference held in Rome in April of 2014, that was broadly taken up by the mass media. Following that public presentation, the coordinators of the survey published a report on the discovery that was synthetic, but also exhaustive (Germoni *et al.* 2019). I also attempted to formulate some personal reflections on the matter that were published in the same collection of papers (Pavolini 2019).

The settlement of which we are speaking covers *c.* 4 ha, and is comprised – overall or in large part – by a group of warehouses that were aligned along the southern bank of the Isola. This excluded the area lying between the presumed course of the canal and the route of the via Flavia to the west, which is understandable because between both of these only a narrow tongue of land would have remained available, and it would have been unsuitable for these kinds of construction. On the eastern side, the complex of buildings that have been identified could be seen to represent a continuation of the collection of buildings that had already been identified in the spur of land within the ancient meander of the Tiber (see in particular, Fig. 6.2). However, it is unclear whether or not there was a gap between both groups of buildings at its narrowest point.

In summary, therefore, five buildings have been revealed to date by the geophysics (the essential details are summarized in Table 6.1 of the book), of which four were definitely warehouses,[19] while the interpretation of the fifth remains more uncertain. In terms of the typology, three of the *horrea* belong to the courtyard type,[20] for which the authors cite Ostian parallels. The fourth is also a probable warehouse although it may perhaps have had a different function and is without any strict parallels on the other side of the river. The fifth building is decisively different, as it seems to consist of a large enclosed quadrangular area and subdivided by lines of internal pilasters[21] (a space for unloading cargoes prior to their storage in warehouses?). In terms of the chronology of this quarter, settlement evidence prior to the late first century AD is rare, perhaps on account of the frequent Tiber floods, while the excavations of the last century indicate that the earliest structures were built from *opus reticulatum* (see Note 21), which can be generically dated to the first–second century AD.

An equally relevant structure that has been revealed by the non-destructive survey in this southern sector of the Isola, is the probable defensive wall that shuts off the 'warehouse quarter' to the north (Fig. 6.6), whose chronology is far from clear. It is significant that, as its discoverers note, it respects the orientation of the system of landscape division that has been discovered to the north: but does that mean that we ought to necessarily attribute it to the same period, that is the late first century AD, or ought we think instead of a more recent date which is not in itself identifiable? To answer this is challenging: as we will see, the authors incline towards the second hypothesis, but in the meantime discount the idea that this defensive circuit could be considered to have been some kind of continuation, on the other side of the river, of the walls of Ostia that are dated by Fausto Zevi on the basis of epigraphic evidence to 63–58 BC. They do this because it is logical to do so (the Isola defensive circuit was clearly destined to protect a complex of vital importance such as the series of *horrea*, and these are much later than the Ciceronian period, as we know), as well as for a whole series of issues. In effect, the defensive wall has a width of 3–5m and has square external towers (not on the angles) of *c.* 6–8m: these are characteristics that – without going into too much detail – differ significantly from those of the late Republican wall circuit of Ostia.

In terms of its circuit, once the Isola Sacra wall reached its western limit, it turned sharply south in the direction of the northern wall of Building 1. The relative chronology of both structures will only be resolved by excavation; however, there are indications from the magnetometry to make one think that the defences were later than the outer wall of the warehouse and that this was incorporated into them in order to consolidate the defensive system. Towards the east, albeit without proof, the authors argue that the wall continued in a straight line as far as the inner (west) bank of the meander (as the above cited plans might be taken to suggest). If this is the case, it would have ensured that the southern and eastern arms of the Tiber would have been provided with an adequate degree of protection against any assailants.

Turning now to the crucial question of its chronology, one point of great importance is the fact that if on the one hand the Isola Sacra wall circuit is significantly different from that of Ostia, on the other it has characteristics that are remarkably similar to those of late antique date that were built at Portus,[22] as the authors argue. Fundamental to understanding the chronology of these are the results of the sondage, albeit of limited scope, undertaken at the so-called '*Antemurale*' of Portus. The stratigraphic sequence here has made it possible to push the date of the fortifications of Portus back from both the traditional Constantinian period, and the late fourth to early fifth century AD date that had been attributed to them at one stage. It is now argued that the fortification could have been completed around AD 470–80, and that it could have been undertaken by a *praefectus Urbi* of Odovacar (Keay and Paroli 2011, 7, notes 22, 82 and 141).

It is clear, then, that if the fortification running along the northern side of the *horrea* on the southern side of the Isola Sacra should also be attributed to a late date on the grounds of similarity, and that if a future stratigraphic excavation should confirm this, then it would raise interesting questions about the last stages of the history of Ostia. These are issues that I have raised in the article mentioned above (Pavolini 2019), which is also cited by the authors of this volume who tend to agree with the hypotheses formulated there. They thus espouse the vision of an Ostia in which the underlying rationale for its earlier floruit had already begun to fade from the third century AD onwards, and which in the middle of the fifth century AD was heading towards its definitive crisis as an urban institution. There is far too much to say about this issue, but it has already been done on numerous occasions and not only by me.

And still, given the context of our discussion, we can do no less than remember a key fact which is that after the end of the Republic, let alone during Late Antiquity by which time they had largely fallen into disuse, the fortifications of Ostia were never reconstructed. At Portus, as we have just seen, matters played out differently, something which makes one think that in the last period of its use, the warehouse quarter of the *Trastevere Ostiense*[23] with its protective wall, and I would say the Isola Sacra as a whole, was by now under the administrative jurisdiction of Portus[24] rather than Ostia, and therefore under its economic and political control as well. The historical implications would have been evidently highly significant, and need to be further explored.

The final paragraphs of Chapter 7 are dense with final observations and important questions. For the large scale building projects undertaken at both Ostia and at Portus at different times in their histories, particularly those completed for the *annona*, should one think of them in terms of public or private initiatives, or perhaps as combined operations, and in what proportions? As regards Ostia, Janet Delaine (2002) has suggested that in many cases, the investment would have come from private sources (from members of the urban ordo or from *collegia*, freedmen of the *colonia* etc), but it is then worth posing the same question about land ownership, as the authors of the book do, where there are similar problems. In the case of Portus, one can probably attribute it to imperial property, which would have been acquired through inheritance: but what about the lands of the Isola Sacra? Here the question seems to be more complex: the directors of the survey tend to distinguish between the lots, which in the central and northern sectors of the Isola came to be divided up and distributed to *coloni* or those to whom it had been assigned – perhaps as a result of imperial intervention, and those along the southern strip, which at least from the second half of the first century AD when the *horrea* began to appear, could have been in private hands.

The definitive conclusions to the volume do no more than expand upon the contents of Chapters 6 and 7 (which are in themselves conclusive as we have seen), but do so in terms of a broader context. One aspect perhaps prevails above all others: for any future study of Ostia, the change in our perception of its history as a result of the survey results is, and will remain, fundamental. This is because from now on, we need to envisage Ostia as no longer being just the settlement on the left bank of the river as we have traditionally known it, with the *Trastevere* as a poorly studied appendage, but as a great commercial river port (a 'commercial corridor' is the textual definition), or a port cut in two by a river ('a port bisected by a river' as described in the book). And here, a comparison with the Urbs itself becomes inevitable, since studies in recent decades (it is not necessary to provide references, but sufficient to think of the contributions by C. Mocchegiani Carpano, E. Rodríguez Almeida and F. De Caprariis, amongst others) have given the impression of a Rome served commercially by quays and landing stages – with their ensemble of storage buildings – not just concentrated around the *Emporium* and the northern river port of *Tor di Nona*, but spread out along the whole length of the urban stretch of the Tiber.

Consequently, our image of Ostia should also change in respect of its demographic profile. Even though calculations concerning this have always been somewhat random, for obvious reasons, and it seems appropriate to retain the same note of caution from now onwards, it is clear that we cannot still think – for this Ostia as broadly understood – of a population equivalent to the figure of 30,000–40,000 that is usually cited; there would have been many more. The text states this, as well as alluding to another element that, in the context of needing to re-examine the size of the population, is particularly relevant: I am alluding to the large urban expansion of Ostia to the south-east of the Republican walls that would have been documented by another programme of non-destructive survey, namely the geophysical survey directed years ago by Michael Heinzelmann, which remains almost completely unpublished, as our authors lament. In any event, if there is a confirmation of this and add this possible 'Ostia outside the walls' to a *Trastevere* that is otherwise somewhat more densely occupied than previously thought, in schematic terms Ostia would pass from the status of a small to medium sized centre to one of a middle to large size. So many aspects of its history (its relations with Rome and Portus itself), will have to be radically reviewed, while in terms of didactic communication to the non-specialist public, someone would need to re-write the popular guides as well.

The conclusions to the volume speak of the beginnings of the first century AD as the possible initial establishment phase of the commercial infrastructure to the north of the Tiber, with everything that this implies. Without prejudice to excavation controls, this dating could be considered to be too high, since in some parts of the text, the second half of the first century AD had been suggested as the period that marked the first appearance of the *horrea*, which would have developed above all in the course of the second century AD. In any case, even if it is admitted that a true flourishing of the '*Trastevere*' had begun between AD 50 and 100, in the analysis of the authors this would suggest that the commercial and urban revitalization of the old colony of Ostia was essentially determined by the establishment of the Claudian basin at Portus, rather than as a result of the Trajanic basin, and we have already seen some possible reasons for this.

This picture is completed by the reflections that appear in the final paragraphs of the chapter, and which encompass the broader geographical context of the port system created by the Romans along the central stretch of the Tyrrhenian coast (with Trajan as the protagonist in some of the decisive interventions), and which ranged from Centumcellae in the north to Terracina to the south, if not beyond, since further south lie Pozzuoli and Naples. At the 'heart' of this system lay the Ostia/Portus conurbation, and the 'heart of the heart' was the Isola Sacra, for the understanding of which this book accomplishes a gigantic breakthrough. Notwithstanding its length and completeness and the fact that the present contribution stands out as an essential point of departure, it is not necessarily one of arrival (and I believe that the authors can agree with this). So, the wish – that can perhaps seem to be customary but which has rarely been so justified – is that the Portus Project and the Italian-British surveys of the Isola Sacra around the imperial harbour basins and in its hinterland continue, using both non-destructive and traditional archaeological methodologies, so that they can provide us with further new and unexpected discoveries for historical reflection.

Notes

1 In relation to this Pavolini 2013.

2 Many programmes of urban and landscape replanning along the modern Roman coastline have been drawn up in recent years, with few practical outcomes up until now. Nevertheless, interesting ideas relating to these – with projects in which the archaeological context based upon Ostia and Portus (with the Isola Sacra at their heart) assumes crucial importance – are to be found, for example, in two recent volumes produced by the *Dipartimento di Architettura e Progetto dell'Universita di Roma La Sapienza*, with a contribution by this writer. (Pavolini 2015); see also Pavolini 2019.

3 This is the date which is usually attributed to the moment when the meander formed by the Tiber close to Ostia is cut, remains isolated and silts up, creating the so-called Fiume Morto, although it has been argued that this was a gradual process lasting several years and was not complete until 1562: see amongst others Pannuzi and Rosa 2017.

4 The book cites works down to and including the most recent contribution by Olivanti and Spanu 2019, although it omits the matching article in the same *Atti del Terzo Seminario ostiense* (Baldassarre *et al.* 2019) which integrates and replaces earlier publications by Baldassarre and her collaborators.

5 It was first presented publicly by Germoni *et al.* 2011: figs 1.3–4, although at this stage it was only possible to provide an illustration of the first stretch of the canal.

6 The writers estimate its width at *c.* 35m.

7 In effect, given the general topography, a double function would seem the most probable, and this would not only be the case with the Portus to Ostia Canal, but also those that have been identified, or better interpreted, as a result of recent fieldwork (the *Canale Romano*) mentioned above, the northern canal and the '*Fossa Traiana*' itself: see Keay and Paroli 2011: Figs 1.3–4.

8 Further on, the editors of the volume put forward the hypothesis that the vessels were found in what was the final stretch of the canal which, in nearing the bank of the Tiber, would have turned gently to the west, as seems to be suggested by aerial photographs, coinciding with the route taken by the via Flavia.

9 Length of *c.* 12m x width of 4.88m.

10 This is the rationale for suggesting that the canal was not abandoned later than the Severan period.

11 This may have been the context of the Isola Sacra wrecks.

12 This is probably one of the canals referred to in the well-known inscription (CIL XIV, 85) that records the decision of the central power to create canals that aimed to resolve at least in part the problems of the Tiber floods. It dates to AD 46, and such a chronology confirms (something implicit in the analysis of the authors) that the excavation of the first harbour basin and its canal lying to the south of it must have been planned together. However, the fact that the *statio marmorum* along the line of the '*Fossa Traiana*' was active during the final decades of the first century AD (see below), is a fact that speaks for itself.

13 Which implies that it is only from this point that we can speak of a Tiber delta.

14 All of the relevant bibliography for this, with studies by A. Arnoldus-Huyzendveld, L. Paroli, A. Pellegrino and others, is cited in the volume.

15 In respect to the solution adopted in this book, the question is perhaps rather more complex. I simply refer the reader to Pavolini 2018 which discusses hypotheses relating to the final stretch of the coastal *via Severiana*, which ran from southern Lazio, and after entering Ostia from the south probably, at least to my mind, coincided with the southern stretch of the Decumanus Maximus and the *Via della Foce* as far as the Tiber. There must have been, therefore, stretches of coastal roads that existed prior to the Severan re-organization of the road, and hypothetically the via Flavia could thus be considered to represent their continuation on the Isola Sacra.

16 I note in passing some hypotheses that appear later in the text (in other words, the conclusions), that suggest

the possibility that both here and in the *statio marmorum* further to the east were situated offices – used by imperial officials – charged with collecting customs on merchandise that being transported from the ports to Rome (and in lesser quantity to Ostia).

17 Also, in another passage which refers to epigraphic and juridical documentation, it is noted how many *navicularii* and other members of associations connected with commerce supply and port activities, would have carried out their work both in the old *colonia* and the imperial harbours.

18 And to my mind it is significant that the 'decline' of the cemetery dateable only by its *mausolea* can only be detected from *c*. the first half of the third century AD, as has always been understood. This is perhaps a confirmation of the fact that the importance of Ostia was gradually decreasing and that, as a consequence, the intensity of fluvial and terrestrial connections between Ostia and Portus was also diminishing. While all of this was occurring, Portus obviously continued to be inhabited and flourished, although its inhabitants came to be buried elsewhere. This is, therefore, a complex issue that clearly cannot be developed here.

19 A small part of Building 1 was discovered during an excavation in 1968 (Zevi 1972 and **G41**).

20 I would like to draw attention in this note to many issues relating to such warehouses and related problems that are all very well documented in Chapters 6 and 7 of the book. For example, the probability that the principal product stored in them was grain; the possibility that there were auctions or similar activities in their courtyards, as Janet DeLaine (2005) has suggested in relation to some Ostian buildings; finally, calculation of storage capacity, not only that of the 'warehouse quarter' but also of the urban area of both Portus and Ostia as a whole, a subject about the authors themselves stress prudence.

21 This Building 5 had been observed in the sondages dug in the 1960s (the circumstances of the find and the publication by Zevi and others appears in the entry **G44** in the Gazetteer), and to it perhaps belonged the mosaics located immediately to the east of the limits of the survey, **G45**-**G46**. This was a built-up area, the characteristics of which are for the moment less clear, which extended to the south-west of the sites listed and included structures built from *opus reticulatum* (of the first century AD) that were observed in the same sondages.

22 In making all of these observations, I take as read the fact they all derive from magnetometry results. I have pointed this out on various occasions, and the authors themselves also have this in mind; however, this does not prevent us from reasoning and formulating hypotheses from this kind of evidence.

23 The date of whose abandonment is unknown; in the conclusion, reference is made only to the existence of an undated tomb 'a cappuccina' which was discovered in the old excavations at **G43**.

24 As is well known, the first source that defines Portus as a *civitas* dates to AD 313. The change in its administrative status could have thus occurred earlier, we do not know when, and it could have involved the 'annexation' of the Isola Sacra to the new territory administered by the new *civitas*. Rather broader considerations related to the continued flourishing of Portus in Late Antiquity are discussed in Pavolini 2019.

Acknowledgements

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Note regarding the Gazetteer

Information about previously explored sites on Isola Sacra is summarized in the Gazetteer (see pp. 173–85). Throughout the text and on the illustrations, references to these sites in text uses the abbreviated form (**G1**), meaning Gazetteer site 1.

Note

1 It was directed by Simon Keay; Grant numbers AH/1004483/1 and AHE509517/1.

Chapter 5

The Portus to Ostia Canal

Abstract

This chapter builds upon the results of the previous chapter and provides additional evidence for the Portus to Ostia Canal. It first presents a detailed analysis of the sediments in the geoarchaeological boreholes drilled at three different points along the line of the canal and its immediate vicinity. These confirm its identification as a navigable watercourse, even though there remains some uncertainty as to whether the Isola Sacra 1 and 2 shipwrecks were deposited in the canal or in an associated palaeo-lagoon close to the ancient coastline. The study suggests that the canal was probably dug in the Trajanic period, had various phases of use, and that it was abandoned in the early third century AD. *The second part of the chapter comprises a study of these two shipwrecks.*

Introduction
Simon Keay

One of the most significant discoveries made by the survey on the Isola Sacra was the Portus to Ostia Canal, a key element of infrastructure that helped convert the island into a landscape that integrated the functions of both ports. The previous chapter documented the geophysical evidence for its path southwards from the south bank of the '*Fossa Traiana*' opposite the *Canale Romano*, and left open the question of its southernmost stretch, which either met the Tiber opposite Ostia, or veered south-westwards into the Tyrrhenian sea north of the Tiber mouth. The canal is on a greater scale than any of the other canals detected at Portus and it also displays some differences in terms of its morphology. Furthermore, there are important questions to be answered relating to its chronology and function. This chapter addresses these questions with two studies. The first analyses the canal from a geoarchaeological perspective and also attempts to understand its potential as a navigable watercourse; the second complements this with a preliminary discussion of two ships that sank in the canal in antiquity. Issues raised in the chapter are incorporated into the overall discussion presented in Chapters 6 and 7.

A multi-proxy analysis of the evolution of the Portus to Ostia Canal
Ferréol Salomon, Ludmilla Lebrun-Nesteroff, Jean-Philippe Goiran, Giulia Boetto, Antonia Arnoldus-Huyzendveld†, Paola Germoni, Alessandra Ghelli, Illaria Mazzini, Cécile Vittori, Sabrina Zampini and Carlo Rosa

The study of the Portus to Ostia Canal has been conducted in three phases. A first traverse of boreholes was drilled during the excavation of the boats Isola Sacra 1 and 2 in 2011, and was followed by a second in 2013 in the segment of the canal east of the *Necropoli di Porto* (***G35***) at the point where the canal seems to divide into two different branches. A preliminary study of this latter cross-section was published in 2016 and brought together Electrical Resistance Tomography data and core stratigraphy (Salomon *et al*. 2016b) (Figs 5.1, 5.2 and 5.3). Finally, between June and December 2017, 270 core sequences were obtained from boreholes drilled as part of preliminary planning for a new bridge close to the existing Ponte della Scafa, which crosses the Tiber between the Isola Sacra and Ostia (Figs 5.2 and 5.3). They were situated within the line of the Portus to Ostia Canal and the palaeo-river mouth of the Tiber. This chapter provides a detailed analysis of the chrono-stratigraphic sequences of the cores drilled across north and south of the Portus to Ostia Canal, with new palaeo-environmental data, radiocarbon dates and archaeological dates, and summarises results from the 2017 cores. In the light of this information, the chapter aims to understand the sedimentological and palaeo-environmental characteristics of this canal, how long it remained in use, the characteristics of its

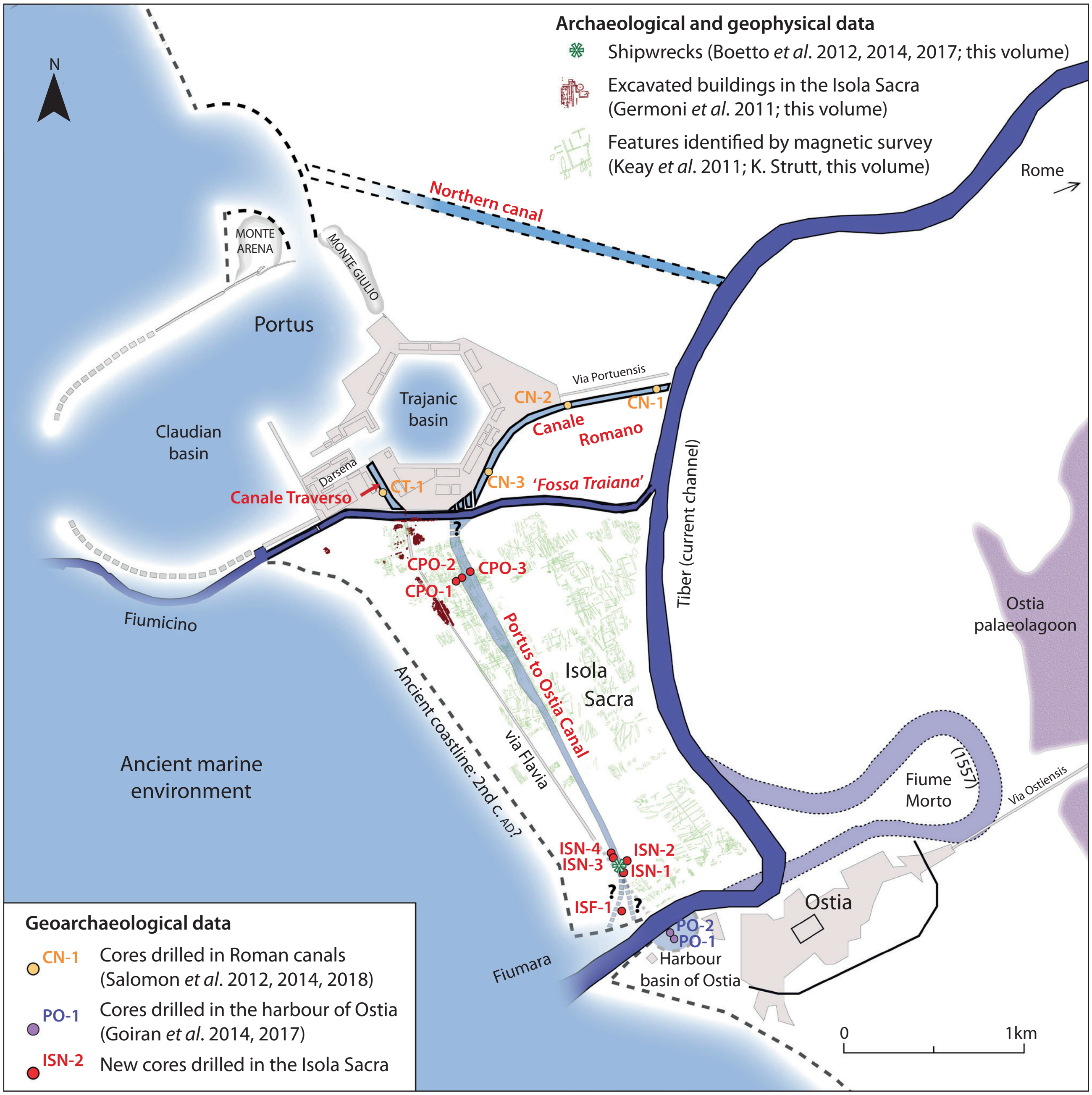


Figure 5.1 *(above). General location of the Ostia-Portus system and the Isola Sacra in the Tiber delta. (Drawing: Ferréol Salomon.)*

Figure 5.2 *(opposite). Detailed map of the two areas studied: north of the Isola Sacra (top) and south of the Isola Sacra (bottom), with key below. (Drawing: Ferréol Salomon.)*

Features identified by magnetic survey (Keay *et al.* 2011; K. Strutt, this volume)

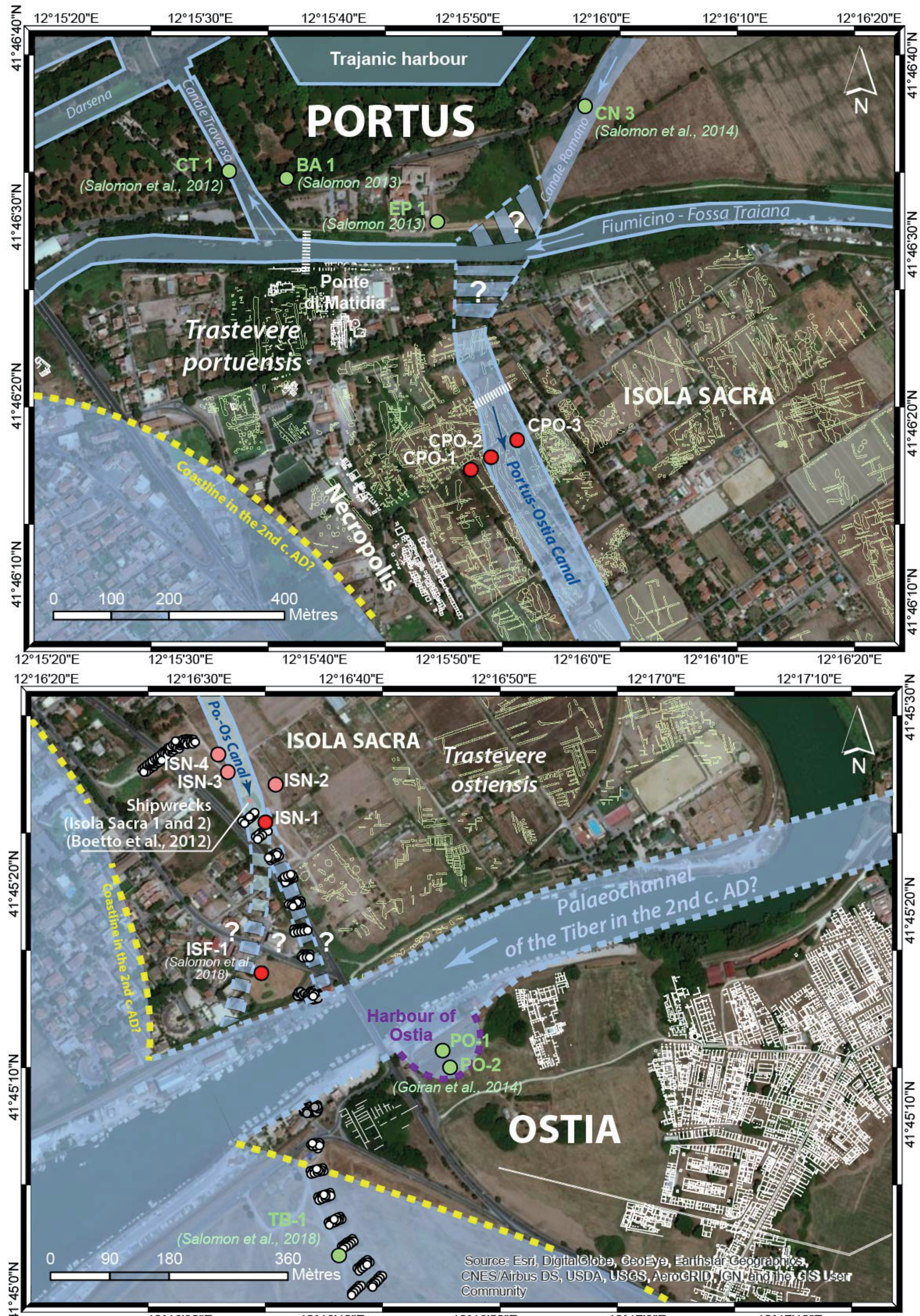
Bridges

New studied cores drilled in the Isola Sacra

Other cores drilled in the Isola Sacra

Cores from C. Rosa / Soprintendenza di Ostia/Roma

Published cores drilled at Portus and Ostia


12°15'20"E
12°15'30"E
12°15'40"E
12°15'50"E
12°16'0"E
12°16'10"E
12°16'20"E
41°46'40"N
41°46'30"N
41°46'20"N
41°46'10"N
Trajanic harbour
PORTUS
Darsena
Canale Traverso
Canale Romano
N
CN 3
(Salomon et al., 2014)
CT 1
(Salomon et al., 2012)
BA 1
(Salomon 2013)
EP 1
(Salomon 2013)
?
Fiumicino - Fossa Traiana
Ponte di Matidia
Trastevere portuensis
ISOLA SACRA
CPO-3
CPO-2
CPO-1
Portus-Ostia Canal
Coastline in the 2nd c. AD?
Necropolis
0
100
200
400
Mètres
12°16'20"E
12°16'30"E
12°16'40"E
12°16'50"E
12°17'0"E
12°17'10"E
41°45'30"N
41°45'20"N
41°45'10"N
41°45'0"N
Po.-Os Canal
ISOLA SACRA
Trastevere ostiensis
ISN-4
ISN-3
ISN-2
ISN-1
Shipwrecks
(Isola Sacra 1 and 2)
(Boetto et al., 2012)
Palaeochannel of the Tiber in the 2nd c. AD?
Coastline in the 2nd c. AD?
ISF-1
(Salomon et al. 2018)
Harbour of Ostia
PO-1
PO-2
(Goiran et al., 2014)
OSTIA
TB-1
(Salomon et al., 2018)
0
90
180
360
Mètres
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

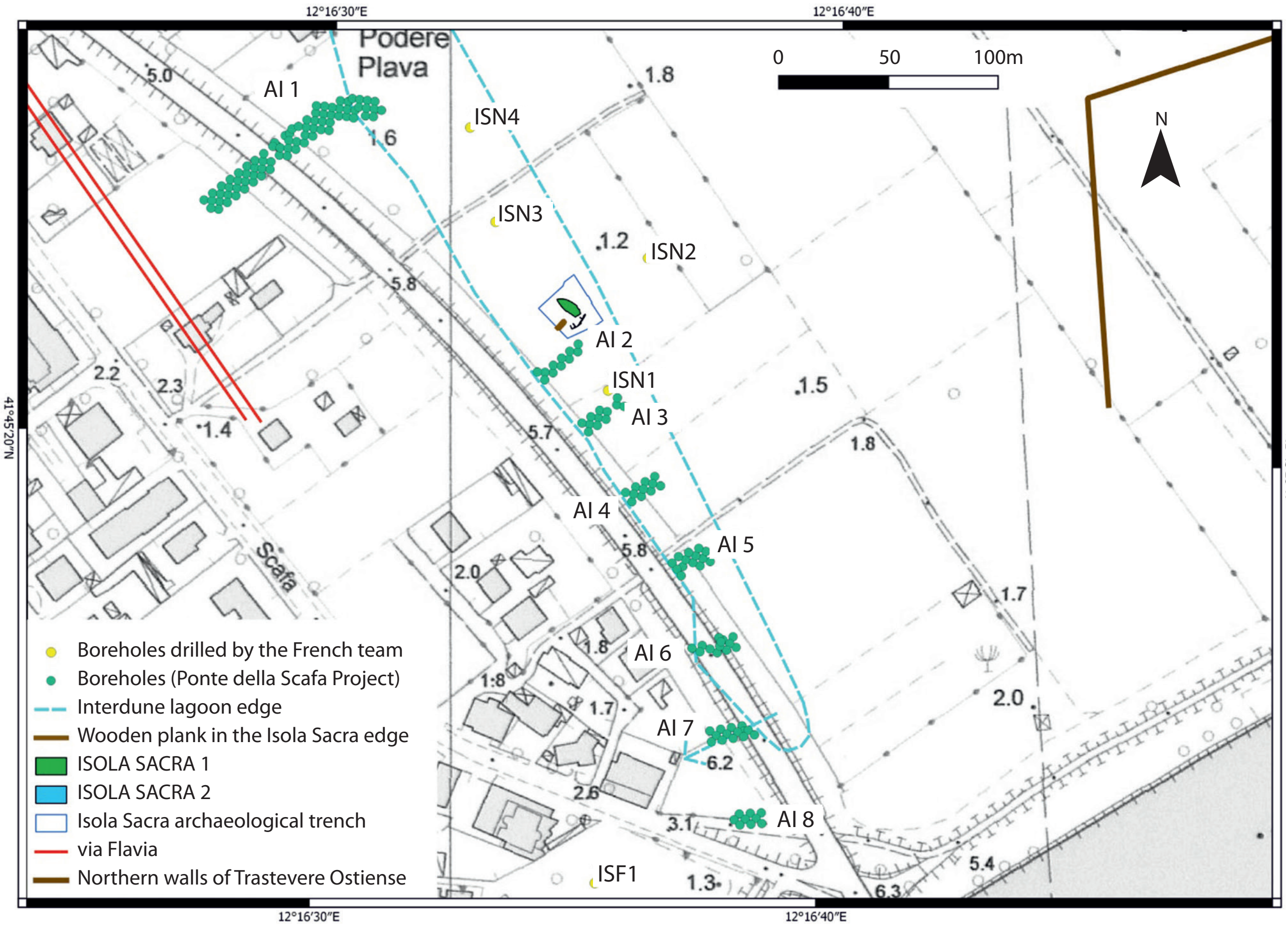


Figure 5.3. *Detailed map of the area investigated in 2017 by 160 geotechnical boreholes in anticipation of the construction of the new Ponte della Scafa. (Drawing: Carlo Rosa and Alessandra Ghelli.)*

navigability through time, and the nature of its connections to the Tiber and the broader canal system of Portus.

The geological and geoarchaeological context

The Tiber delta was formed in the Late Pleistocene/Early Holocene era during a general period of rapid sea level rise and coastal transgression. The morphology of the Tiber mouth at that time is often associated with a delta within a semi-protected bay (Bellotti *et al.* 1995; Marra *et al*. 2013; Milli *et al.* 2013; 2016). From 7000–6500 yr. cal. BP, the sea level rose slowly and the current delta with a prograded plain started to build up (above, Fig. 2.1). Today, the subaerial plain of the Tiber delta is divided into two parts: the inner and outer Tiber delta. The inner delta in the east corresponds to the area of the palaeo-lagoons that were reclaimed at the end of the nineteenth and beginning of the twentieth centuries. In the west, the outer delta corresponds to the prograded deltaic plain. Detailed analyses of the different phases of coastal progradation have been proposed by Giraudi (2004), Bicket *et al.* (2009) and Salomon (2013).

Geoarchaeological studies in the Tiber delta have been conducted over the last twenty years, focusing mainly on the Roman period. The maritime harbour of Portus (Giraudi *et al*. 2009; Goiran *et al*. 2010; Sadori *et al.* 2010; Mazzini *et al.* 2011; Bellotti *et al*. 2009; Delile *et al.* 2014b; Salomon *et al.* 2016a) and the fluvial harbour of Ostia (Goiran *et al.* 2014; Hadler *et al.* 2015; Sadori *et al.* 2016; Salomon *et al.* 2016a; Delile *et al.* 2018) have been the main foci of interest. Parallel to this, the Roman canal network at Portus has also been studied through geoarchaeological methods (Salomon *et al.* 2012; 2014; 2017a; Lisé-Pronovost *et al.* 2018). Studies relating to the canals have mainly focused on the instability of the bedload across time, the processes leading to their abandonment, their navigability, the dredging phases, and the possible existence of locks. An extensive range of techniques has been applied to the analysis of the sediment trapped in the canals in order to reconstruct the hydrodynamics of their differing environments (sedimentology, geochemical indicators, palaeo-magnetism), the freshwater-marine balance (bioindicators such as malacofauna, ostracods, foraminiferae and geochemical indicators), the vegetation (macro-vegetal remains, pollen - *Canale Traverso* in Sadori *et al.* 2010), palaeo-pollution using geochemical analyses (*Canale Romano* in Delile *et al.* 2014a), and chronology largely derived from an analysis of radiocarbon dates.

Methodology[1]

Northern and southern sections across the canal

Three cores were drilled into the northern part of the Portus to Ostia Canal to the east of the *Necropoli di Porto* (CPO-1; CPO-2; CPO-3) (Figs 5.1 and 5.2). The magnetometry results suggest that what appears to be a small island within the northern stretch of the canal was created by two channels flowing around it simultaneously or in succession. Additionally, five cores were drilled around the Roman ships excavated in the southern part of the Isola Sacra 2011 (ISN-1; ISN-2; ISN-3; ISN-4) and along the river Tiber (ISF-1) (Table 5.1).

The stratigraphic units within the core sequences were defined by the visual recognition of colour, texture and structure combined with magnetic susceptibility measurements (Dearing 1999; Salomon *et al.* 2012). Magnetic susceptibility measurements were taken every centimetre using a Bartington MS2E1 high-resolution surface sensor and are expressed in x 10^{-6} CGS (SI = CGS value × 0.4). Sediments from each stratigraphic unit were sampled, and wet sieving was performed in order to measure the relative content of the coarse fraction (> 2 mm), sand (2 mm at 63 µm) and silt/clay (< 63 µm). Further detailed grain-size measurements were obtained using a Malvern Mastersizer 2000 laser grain-size indicator, which expressed the hydrodynamic context of the samples during deposition (Folk and Ward 1957; Cailleux and Tricart 1959). Complementary information about the palaeo-environmental context was obtained from a dry 10 g sub-sampled sediment, which was heated at 375°C for sixteen hours to measure the organic content (Ball 1964). In the wet sieved sediments (fraction< 1mm), all ostracods (small bivalved crustaceans) were collected, normalised to 10g of sediment weight, and identified in order to deduce the characteristics of their original environments, being particularly indicative of freshwater and marine influences (Carbonel 1988; Frenzel and Boomer 2005; Ruiz *et al*. 2005; Mazzini *et al*. 2011; Vittori *et al.* 2015). The ceramics discovered in the core samples were identified and dated (Table 5.3).[2] Different organic materials were dated by Accelerator Mass Spectrometry (AMS), obtained from the linear accelerator of Saclay (Artemis - University Lyon 1), while calibration of the dates was performed using an existing published curve (Reimer *et al.* 2013) and processed with the software OxCal, with all dates cited at 2 sigma (https://c14.arch.ox.ac.uk/oxcal/OxCal.html) (Table 5.2).

Finally, a Palaeoenvironmental Age-Depth Model chart (PADM) was created for Cores ISN-1 and ISF-1 (Salomon *et al.* 2016a) (Fig. 5.6). Six radiocarbon dates and four dated ceramic fragments provided a reliable sedimentation curve in the age-depth model. The Roman sea level was reconstructed based on the upper limit of barnacles (*biological sea level*) found attached to the northern mole of the Claudian basin at Portus. Barnacles were dated using the radiocarbon technique (2115±30 BP, = 230–450 cal AD – Goiran *et al.* 2009). The different reconstructed draughts of the ships that may have been used in the canal are reported on the right-hand side of the PADM (Boetto 2010). Additionally, the depths of the bottom of the Roman ship Isola Sacra 1 and its date of sinking were included in the chart. This ship probably sank prior to the first half of the third century AD, according to the dating of archaeological evidence found during its excavation (pp. 139–45; Boetto *et al.* 2012a; 2012b; 2017) (Tables 5.2 and 5.3).

Table 5.1. *Location and heights of the cores drilled.*

Core	X	Y	Z
CPO-1	272620.534	4628000.206	+1.31m
CPO-2	272648.789	4628019.725	+0.68m
CPO-3	272700.925	4628051.561	+0.26m
ISN-1	273569.512	4626325.030	+1.27m
ISN-2	273585.149	4626382.897	+1.29m
ISN-3	273512.658	4626401.853	+1.29m
ISN-4	273497.753	4626428.264	+1.12m
ISF-1	273563.491	4626096.872	+ 2.24m

Coordinate reference system (CRS): EPSG: 32633, WGS 84 / UTM zone 33N
Heights: In reference to the to the national tide gauge from Genoa, Italy (s.l.m.) – Corrected values from Salomon *et al*., 2016b for CPO-1, 2 and 3 (calibration of the LiDAR data)

Section across the river mouth and the western end of the canal

In 2017, 270 new cores were drilled near the Roman palaeo-river mouth of the Tiber near Ostia and in the Portus to Ostia Canal. This work was conducted for geotechnical purposes in preparation for the construction of the new *Ponte della Scafa* bridge,[3] and the boreholes were situated on the sites of planned

Table 5.2. *Radiocarbon dates. (*= Calibrated using the Marine13 curve; **= heights in relation to modern sea level are given with reference to the national tide gauge at Genoa).*

Core	Samples	Depth below surface (m)	Depth below current sea level**	Laboratory samples	Dating support	Radiocarbon age: 14C yr BP	±	Age calibrated BC-AD (Reimer et al., 2013) - 2σ	Comments
ISN-1 (+1.27m)	ISN-1 / 324	3.24	1.97	Lyon-10126 (SacA-32778)	Wood	1850	30	cal AD 80–240	-
ISN-1	ISN-1 / 365	3.65	2.38	Lyon-10129 (SacA-32780)	Charcoal	1835	30	cal AD 85–245	-
ISN-1	ISN-1 / 443	4.43	3.16	Lyon-10128 (SacA-32795)	Shell	11 710	45	11,730–11,485 cal BC	Rejected
ISN-1	ISN-1 / 516	5.16	3.89	Lyon-10133 (SacA-32796)	Shell	11 830	50	11,835–11,645 cal BC	Rejected
ISN-1	ISN-1 / 552	5.52	4.25	Lyon-10131 (SacA-32782)	Vegetal matter	1835	30	cal AD 85–245	-
ISN-1	ISN-1 / 610	6.10	4.83	Lyon-10130 (SacA-32781)	Charcoal	1865	30	cal AD 75–235	-
ISN-1	ISN-1 / 722	7.22	5.95	Lyon-10127 (SacA-32779)	Vegetal matter	2585	30	805–675 cal BC	-
ISN-1	ISN-1 / 809	8.09	6.82	Lyon-10132 (SacA-32783)	Vegetal matter	2660	30	840–795 cal BC	-
CPO-1 (+1.31m)	CPO-1 / 797	7.97	6.66	Lyon-11787 (SacA40134)	Organic matter	3390	30	1,750–1,620 cal BC	-
CPO-2 (+0.68m)	CPO-2 / 525	5.25	4.57	Lyon-11788 (SacA40135)	Wood	2055	30	170 cal BC– cal AD 15	-
CPO-2	CPO-2 / 870	8.70	8.02	Lyon-11789 (SacA40136)	Wood	3865	30	2,465–2,210 cal BC	-
CPO-3 (+0.26m)	CPO-3 / 284	2.84	2.58	Lyon-11790 (SacA40137)	Wood	1965	30	45 cal BC– cal AD 115	-
ISF-1 (+2.24m)	ISF-1 / 606–609	6.08	3.84	Lyon-11216 (SacA37194)	Charcoal	2110	30	205–45 cal BC	-
ISF-1	ISF-1 / 693–697	6.95	4.71	Lyon-11217 (SacA37195)	Wood	2245	30	395–205 cal BC	-
ISF-1	ISF-1 / 734–737	7.36	5.12	Lyon-11218 (SacA37196)	Posidonia*	2560	30	365–190 cal BC	-
ISF-1	ISF-1 / 785	7.85	5.61	Lyon-9322	Posidonia*	2620	35	455–220 cal BC	-
ISF-1	ISF-1 / 879–882	8.81	6.57	Lyon-11219 (SacA37197)	Charcoal	41500	1500	-	-
ISF-1	ISF-1 / 910	9.10	6.86	Lyon-11220 (SacA37219)	Shell*	37040	840	40,265–37,695 cal BC	Rejected
ISF-1	ISF-1 / 1298	12.98	10.74	Lyon-11221 (SacA37220)	Shell*	3195	30	1,160–930 cal BC	-
ISF-1	ISF-1 / 1330–1335	13.33	11.09	Lyon-11222 (SacA37221)	Shell*	3145	30	1,090–880 cal BC	-

bridge piers and approach ramps. This exceptional opportunity generated a considerable amount of new stratigraphic data relating to the southern part of the Isola Sacra and in the north-west sector of Ostia. The cores were between 15m and 20m deep and spaced out along a north–south cross-section on both sides of the river. More than 160 boreholes were drilled within nine sectors across an area of 2,600 square meters across the southern part of the Isola Sacra (Figs 5.2 and 5.3).

The large amount of stratigraphic data generated for processing, the absence of a budget for palaeo-environmental analyses and the limited time available for producing a final report, meant that effort was focused upon studying the complex context of the river mouth.[4] The amount of stratigraphic data obtained in

Table 5.3. *Archaeological dates – Identification by S. Zampini (* heights in relation to modern sea level are given with reference to the national tide gauge at Genoa).*

Core	Sample	Depth below surface	Depth below modern sea level*	Sample description	Age estimation
ISN-1 (+1.27m)	ISN-1 / 659–666	659–666	532–539	Two body sherds of *sigillata italica*, and two body sherds, possibly thin-walled ware.	30 BC–AD 150
ISN-1	ISN-1 / 600–609	600–609	473–482	A body sherd of Baetican amphora, probably a Dressel 20.	AD 1–300
ISN-1	ISN-1 / 595–575	595–575	468–448	A body sherd of African amphora.	AD 100–700
ISN-1	ISN-1 / 559–563	559–563	432–436	Four fragments of brick; two body sherds of African amphora (form not identifiable).	AD 100–700
ISN-1	ISN-1 / 609–614	609–614	482–487	A rim from a closed cooking vessel in common ware.	AD 1–300
ISN-1	ISN-1 / 600–607	6,00–607	473–480	A handle attachment from a Baetican Dressel 20 amphora.	AD 1–300
ISN-1	ISN-1 / 908–905	908–905	781–778	A body sherd of common ware or amphora.	Not dateable
ISN-1	ISN-1 / 917–921	917–921	790–794	Unidentifiable pottery chips and a fragment of red painted wall-plaster.	Not dateable

doing this combined with the extensive knowledge of the territory and scientific experience of the team in charge of the analyses, made it possible to carry out a detailed reconstruction of the paleogeographic evolution of this part of the Isola Sacra. The data have been entered and processed in a G.I.S. (made with QGIS open source) to reconstruct the principal phases in the geomorphological evolution of the area.

Analysis of the northern cross-section

Cores CPO-2 and CPO-3 were drilled within the Portus to Ostia Canal, while Core CPO-1 was drilled in the beach-ridge plain to the west of it (Fig. 5.4). Core CPO-1 exhibits a stratigraphic sequence composed mainly of well-sorted sand (Unit A to D) with a silty layer on top of it (Unit E). The bottom layer (Unit A) is composed of finely laminated sand (75%) and silty sand (25%), with few coarser particles (0.11%). No shells were identified within it. Unit B exhibits a wide range of different environments and hydrodynamic contexts. It is composed of bedded grey silty clay (up to 47% of silts and clay), well sorted fine sand (up to 98%), but coarse sand is also present on top of this unit. Organic matter trapped in the deposits was dated to 3390±30 BP (Lyon-11787, = 1750–1620 cal BC). Unit C corresponds to a more homogeneous deposit composed of yellow well-sorted medium sand (82 to 93% of sands – 125 to 500 μm), better sorted at towards the top, and is generally laminated. Above this is Unit D, which consists of well-sorted medium to coarse yellow and black sands. Finally, this stratigraphic sequence is covered by 2m of laminated silty deposits, with a colour gradient ranging from light brown at the bottom to dark brown at the top. Furthermore, the grain-size decreases from silty sand (60% of sand for 40% of silts and clay) to sandy silt deposits (80% of silts and clay for 20% of sand). Ceramics were found at 0.5m, 0.8m, 1.80m and 1.95m below the topographic level but were not sufficiently well preserved to be identified or dated.

The stratigraphic sequences of cores CPO-2 and CPO-3 (Fig. 5.4) reveal three major depositional phases: (1) yellow laminated well sorted sand (Unit A); (2) coarse deposits (Units B, C and D); and (3) overlying fine deposits (Units E, F and G in Core CPO-2 and Unit E in Core CPO-3). Units A in Cores CPO-2 and CPO-3 exhibit facies of laminated sandy deposits that are distinct to that in Core CPO-1. The average sandy content varies between 68% and 78%. The higher content of silt and clay is observable at the bottom of core CPO-3, with 46% of the total dry sediment. The upper part of the Unit A in Core CPO-3 comprises 93% of sand and 7% of silt and clay. None of the units in cores CPO-2 and 3 resembles Unit B in Core CPO-1 with a wide range of hydrodynamic contexts. Units A in Core CPO-2 and 3 had been cut by the Portus to Ostia Canal at different depths. Unit A in cores CPO-2 and CPO-3 ends at a depth of 3.5m below the Roman sea level (Ro.s.l.) of the third to fifth century AD. The radiocarbon date obtained from a fragment of wood in Core CPO-2/Unit A provided an older date than another sample in Core CPO-1/Unit B, with 3865±30 BP (Lyon-11789, = 2465–2210 cal BC). Unit B in Core CPO-3 has a thickness of around 2.5m, from -2 m Ro.s.l. to +0.5 m Ro.s.l. Sediment is composed mainly by medium to

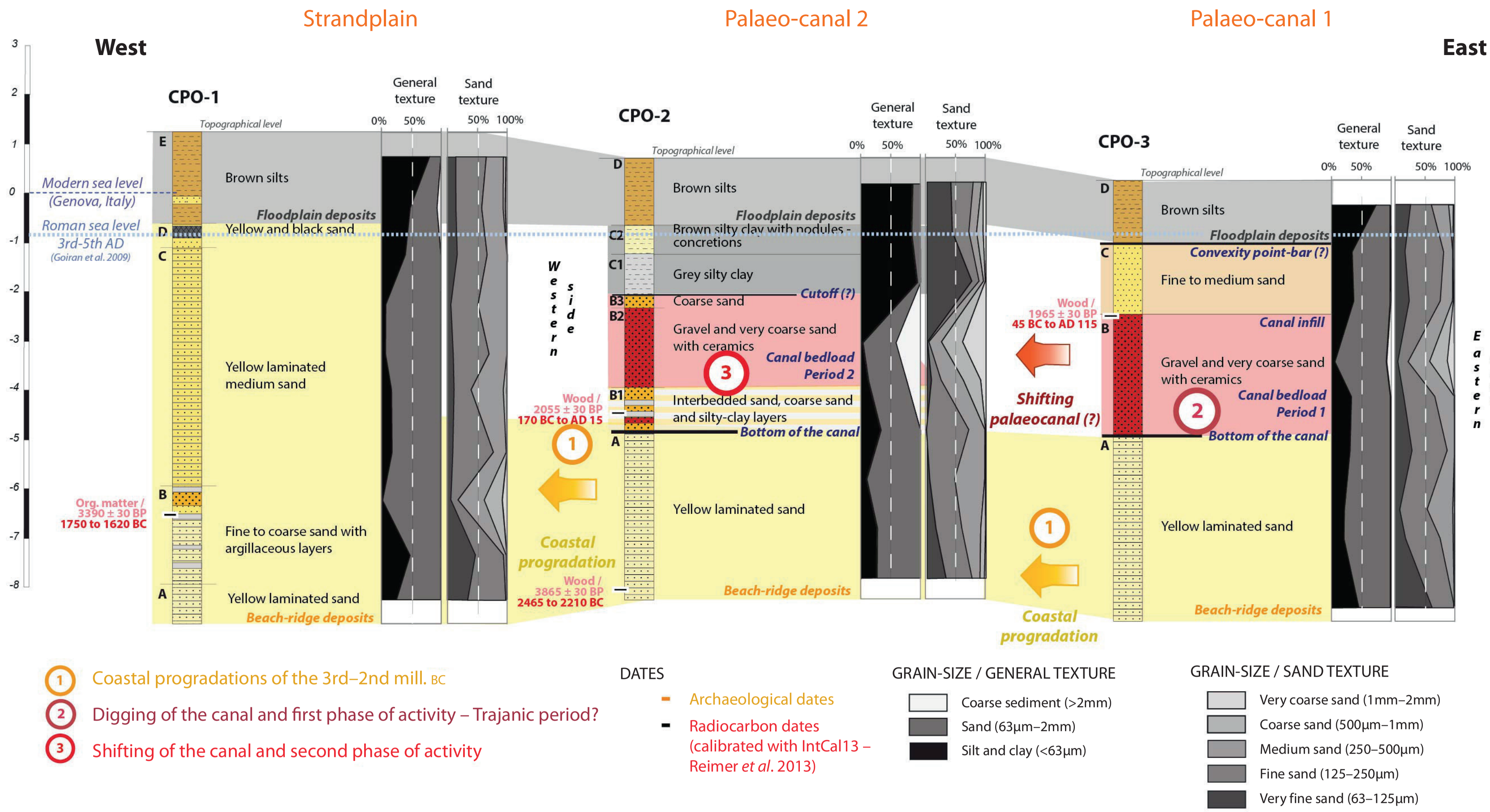


Figure 5.4. *Cross-section of sedimentary cores from the boreholes drilled in the northern part of the Portus to Ostia Canal. (Drawing: Ferréol Salomon.)*

very coarse sand with a coarse fraction above 2mm. Fragments of ceramics were also observed in this layer. This unit was dated to 1965±30 BP (Lyon-11790) calibrated to 45 cal BC–cal AD 115. Unit C is a silty sand deposit composed of 35% of silt and clay and 65% of sand. The sand fraction contained between 46% and 60% of fine sand. It is important to note that this 1.5m thick unit was deposited above the Roman sea level. Unit D on top of Core CPO-3 is a brown sandy silt deposit was composed of 75% of silt and clay, 24.5% of sand and 0.5% of coarse fraction.

The upper units of Core CPO-2 reveal different deposits to those recorded for Core CPO-3. Unit B starts at a depth of around -3.50 m Ro.s.l. At the bottom, sub-unit B1 is composed of interbedded sand, coarse sand and silty-clay layers revealing unstable hydrodynamic depositional conditions. A piece of wood uncovered in a clayey-silt layer had a radiocarbon date of 2055±30 BP (Lyon-11788) calibrated to 168 cal BC – cal AD 16. Sub-units B2 and B3 are indicative of high energy depositional contexts that contain ceramic fragments. The coarse fraction corresponds to between 22 and 45% of the total dry fraction of the sediments, with 55 to 67% of sand and 1 to 30% of silt and clay. No dates were obtained for this layer. Unit C is a silty-clay deposit subdivided into two sub-layers. Sub-unit C1 is a grey silty clay deposit composed of 95% of silts and clay, and sub-unit C2 is a brown silty clay layer in a lower proportion (85%). The distinction between the two sub-units is also related to the concretion observed in the coarse fraction of sub-unit C2, but not in C1. Finally, the top of Core CPO-2 is composed of brown silty clay (87%), which is a facies similar to Unit D in Core CPO-3.

Analysis of Cores ISN-1 and ISF-1 in the southern cross-section

Five cores were drilled in a southern section of the Portus to Ostia Canal. Here are presented details relating to Core ISN-1, which was drilled within the line of the canal, and Core ISF-1 which was drilled further south on the right-hand side of the current Tiber river course (Fig. 5.5). No detailed analyses have yet been conducted on Cores ISN-2, 3 and 4.

Analysis of Core ISF-1

Core ISF-1 reveals six stratigraphic units, whose deposits are characterized by their poor sorting index (Figs 5.5–5.6).

At a depth of between 12.00m to 7.50m below sea level (b.s.l.), Unit A was a grey-beige deposit composed of medium sand with silty sand layers. The sand fraction is around 78% of the total dry weighted samples for 22% of the silt and clay. Medium, coarse to very coarse sand each represented 25% of the total sand fraction present. This deposit is well sorted. Two shells were dated by radiocarbon, providing a date at the end of the second millennium BC/beginning of the first millennium BC (Lyon-11222, 3145±30 BP = 1091–881 cal BC; and Lyon-1122, 3195±30 BP = 1160–930 cal BC). Magnetic susceptibility values were between 18 and 192 CGS for a median of 192 CGS.

Between 7.50m and 5.70m b.s.l., Unit B is a rather complex grey to dark grey and mainly sandy (74%) deposit. Very coarse sands represent an average of 30% of the total sand fraction present. However, the unit is composed of a succession of different layers. Sub-unit B1 is composed of 40% silt-clay and 60% sand. Samples analysed in sub-units B2 and B3 comprise as much as 88% sand. Gravels also appeared in these two sub-units (<8mm B-axis). The Trask sorting index is relatively poor at between 1.6 and 6. Magnetic susceptibility from 7.50m b.s.l. through to the top of the stratigraphy has a high variability between 12 and 6027 CGS with a median of 252 CGS. No ostracods were found in these unstable and high energy environments. Posidiona fibres were also observed in this unit and some were dated to 2620±35 BP (Lyon-9322, = 455–220 cal BC). Two radiocarbon dates of 37,040 840 BP (Lyon-11220) and 41,500±1500 BP (Lyon-11219) derived from shell and charcoal were rejected on the grounds of being too old and suggest that the material had been re-deposited.

Unit C is composed of eight sub-units between 5.70m to 1.10m b.s.l., which reveal a very unstable environment. The colour of individual deposits ranges between mainly grey to dark grey at the bottom of the unit to beige towards the top. The texture is generally sandy (67%), although coarse particle inputs were sometimes detected, especially in the sub-units C2, C4 and C5. Thin deposit laminations were observed in sub-units C1 and C7 (with 70% to 85% of silt and clay). The particles reached a diameter of 8mm in C4 and C5 (B-axis). The median grain has an average of 170 μm within a range from 14 to 380 μm. The overall sorting index was medium to poor. Three dates were obtained in the lower part of this unit, from both abundant ceramics and from radiocarbon dates derived from charcoal and wood in the lower part of Unit C. The dates range between the fourth and first centuries BC (Lyon-11218, 2560±30 BP = 365–190 cal BC; Lyon-11217, 2245 ±30 BP = 395–205 cal BC; Lyon-11216, 2110±30 BP = 205–45 cal BC).

Unit D is a small unit of less than 1m-thick (1.10m to 0.25m b.s.l.) composed of yellow to medium sand. The sand fraction is 86% of the total dry weighted samples. Silt and clay are 16%, while the coarse fraction is no longer present. Unit E is made of brown to orange fine sand. The percentage of silt and clay rises

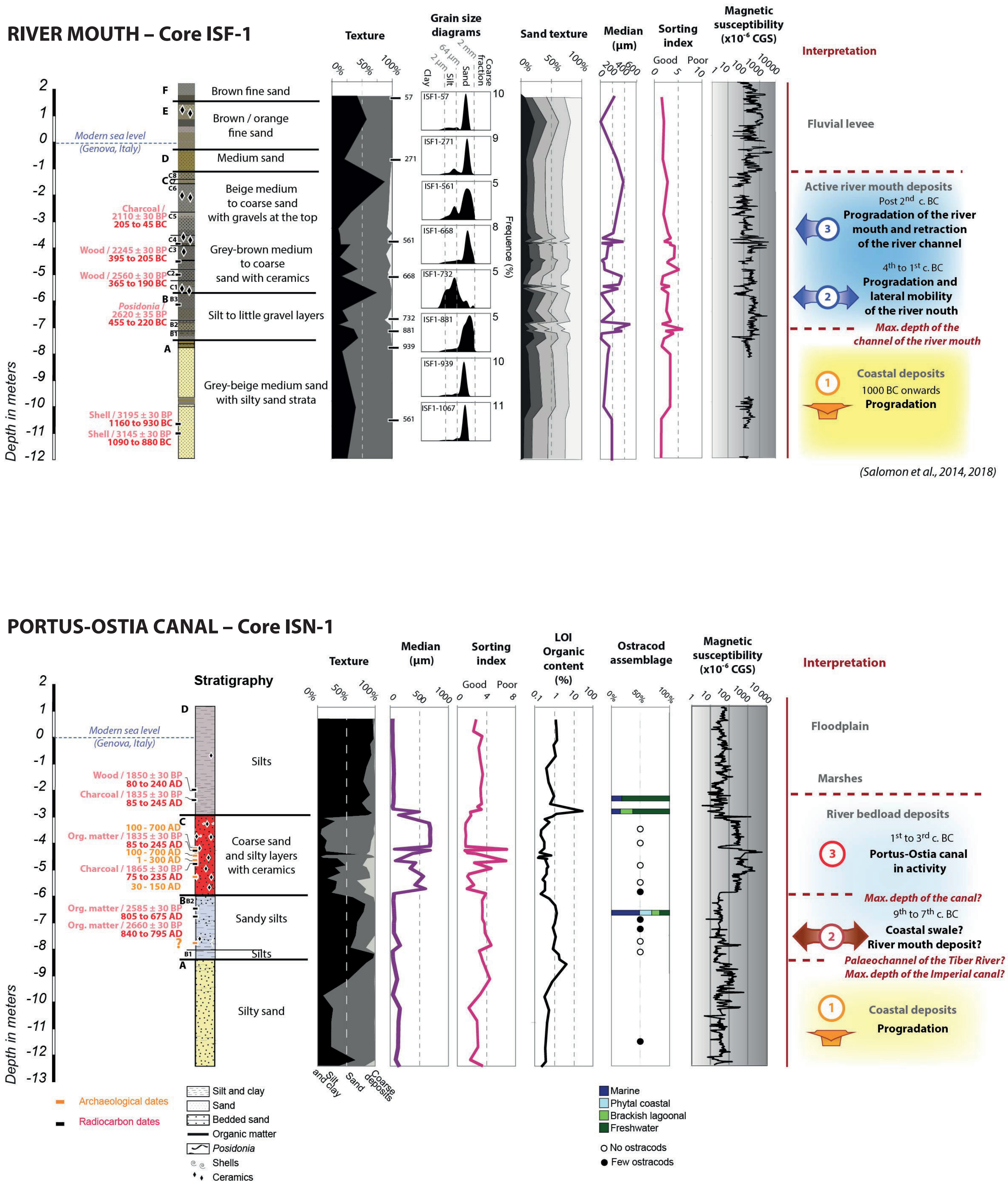


Figure 5.5. *Detailed palaeoenvironmental analyses of Cores ISF-1 and ISN-1. (Drawing: Ferréol Salomon.)*

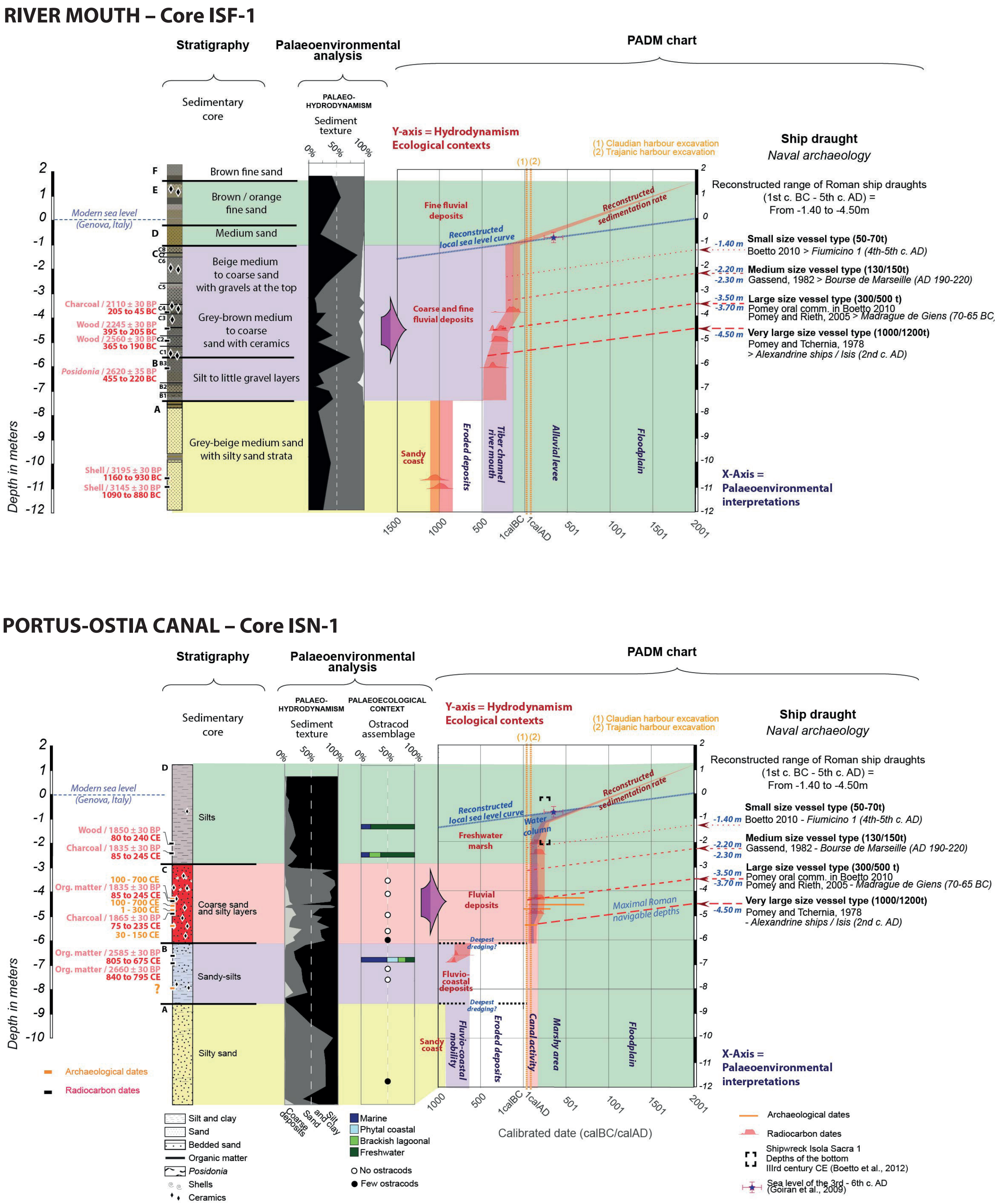


Figure 5.6. Palaeoenvironmental Age-Depth Model *(PADM Chart) of Cores ISF-1 and ISN-1. (Drawing: Ferréol Salomon.)*

to 40–55%, while sand remains an important fraction (45 to 60%). Few ceramics were identified at the top of this unit. Finally, Unit F consisted of brown fine sand and sandy-silt. No radiocarbon dates are available for these three units.

Analysis of Core ISN-1

Core ISN-1 is composed of four stratigraphic units (Figs 5.5–5.6).

Unit A is between 12.43m and 8.53m b.s.l., mainly sands with some sandy-silt layers at the bottom. Sand represented an average of 65% of the total weighted samples, with 25% silts and 10% of clay, with very fine sandy laminated silts (25% to 75% of silt and clay). Organic matter is relatively low in this layer with a value lower than 1%. Its content rises towards the top of the unit, reaching 4%. The lower part of the Unit is lower than 100 CGS in the two bottom metres but rises to an average of around 100 CGS in the upper two metres. No dates are available for this unit. The ostracod content of one sample was analysed at 11.73m–11.70m b.s.l. Only twenty-one ostracods were observed in the sample and seven species identified (*Cyprideis torosa* – brackish water, and *Cytheridea neapolitana*, *Leptocythere* sp., *Palmoconcha* sp., *Paradoxostoma* sp., *Carino cythereis*, *Semicytherura* sp. – Marine water), mainly adults (62%).

Unit B was situated at between 8.53m and 5.98m b.s.l., and was mainly composed of silts (Sub-unit B1 – 75% with 4.4% of organic matter) or sandy silts (Sub-unit B2 – 55 to 67% of silt with organic matter content around 1). Small fragments of ceramics were observed but not identifiable. From 7.90m to 7.94m b.s.l., there was a layer composed of sand (62%), silt (32%) and clay (6%) with small fragments of ceramics present. Out of the 34 ceramic fragments found, nineteen were rounded and fifteen had sharp edges. None of them could be identified or dated. Magnetic susceptibility was generally at around 50 CGS but rose above 100 CGS in the layer with ceramics (7.90m to 7.94m b.s.l.). No ostracods were found in the silty Unit B. Few ostacods were found at between 7.44m–7.47m, while two *Candona* sp. were identified, suggesting that this had been deposited in a freshwater palaeo-environment. At 7.09m–7.12m b.s.l., fragmented ostracods were observed but were not identifiable. Finally, some twenty-three ostracods were observed at 6.24m–6.27m b.s.l., of which 40% were freshwater species (*Candona* sp., *Limnocythere imopinate* and *Cyprideis* sp. from a brackish environment), 34% were marine species (*Leptocythere* sp., *Xestoleberis* sp., *Henryhowella* sp., *Cytheridea* sp.) and 26% were coastal species (*Paradoxostoma* sp.; *Procytheideis* sp.). Two radiocarbon dates obtained from organic matter in this unit revealed similar dates of the first half of the first millennium BC (Lyon-10132, 2660±30 BP = 840–795 cal BC and Lyon-10127, 2585±30 BP = 805–675 cal BC).

Unit C lay between 5.98m and 2.97m b.s.l. (or -5.18m and -2.17 Ro.s.l.) and was mainly composed of coarse to very coarse sand (80 to 95 % of the total weighed dry samples). No ostracods were observed in this unit, probably on account of the high energy deposition. However, many small shells were observed between 4.24m and 3.09m b.s.l. mixed in with a very coarse sand. From 6.00m to 5.03m b.s.l., the sediments were composed mainly of coarse sand (81–92% of sand), silt (6–15%) and clay (1–2%) with many ceramics (69 fragments: 28 rounded and 41 with sharp edges). Above this, from 5.03m to 4.82m b.s.l., the deposit was sandy (70–78%) with more silt (18–24%) and clay (4–7%). Fifty-one ceramic fragments were found in this unit (60% rounded and 40% with sharp edges). Between 4.82m and 4.68m b.s.l., the content of sand continued to decrease (51%), while that of the silt (41%) and clay (8%) increased. Ceramics were also observed, with amphora sherds appearing at the bottom of the subunit at 4.82m–4.73m b.s.l. The sandy content increased again at 4.68m b.s.l. until 2.97m b.s.l, together with many ceramic fragments. Some layers show a higher tenor of finer deposits, such as those at 4.36m–4.24m b.s.l. where they were 45% silt. Two radiocarbon dates were taken in this layer, ranging between AD 70 (post-Claudian) and the earlier third century AD (Lyon-10130, 1865±30 BP = 75–235 cal AD (Charcoal); Lyon-10131, 1835±30 BP = 85–245 cal AD (Organic matter)). Ceramics found in this unit dated to between AD 1 and 700.

Unit D lies between 2.97m b.s.l. (-2.17 Ro.s.l.) and the topographic surface at 1.27m a.s.l., and is mainly composed of compact silts (60–75%), clay (10–18%) and local sand (6–20%/30%). A single ceramic sherd was found at 0.53m b.s.l. Magnetic susceptibility values were low (< $100x10^6$ CGS) for the whole unit. Organic matter was also rare but peaked at 32% at the bottom of the unit at 2.63m b.s.l. (-1.83m Ro.s.l.). At 2.84m–2.86m b.s.l., ostracods are mainly indicative of freshwater influence (13 ostracods - *Candona* sp., *Limnocythere* sp., *Cypria ophtalmica*) although some marine species are also present (3 ostracods - *Aurila* sp., *Xestoleberis* sp. - 2.84m–2.86m b.s.l.). More freshwater influence is observed in the ostracod assemblage of sample 2.39m–2.36m b.s.l. (*Candona* sp., *Heterocypris salina*, *Darwinula stevensoni*, *Limnocythere* sp., *Cyprideis torosa* for freshwater species, *Ilyocypris* sp. living in freshwater to brackish environments, and *Aurila* sp. living in a marine environment). In a manner akin to Unit C, Unit D is dated to sometime between the end of the first and the middle of the third centuries AD on the basis of radiocarbon evidence (Lyon-10129, 1835±30 BP = 85–245 cal AD (Charcoal); Lyon-10126, 1850±30 BP = 80–240 cal AD (wood)).

Preliminary results from the north–south cross-section in the southern part of the Isola Sacra

In the set of 160 core stratigraphies obtained from the boreholes drilled on the north side of the Tiber in 2017 (Figs 5.2 and 5.3), the stratigraphies generally begin with a grey silt sediment at 20m or 15m b.s.l. and continue upwards to an average depth of 11m b.s.l with a grey silty-clay sediment. This layer is interpreted as having been deposited in the pro-delta. From *c*. 11m b.s.l. upwards, there follow a couple of meters of a laminated sandy-silty deposit, which hints at the presence of the approaching delta front and the coastline. In the remaining 10m, the cores exhibit a gradual increase in the sand content and coarser grain-size, due to the gradual decrease in depth of the seabed and up to the submerged beach or emerged beach facies. Overall, this kind of stratigraphic succession would appear to be typical of a deltaic progradational coast. However, differences in stratigraphic successions from 7m to 8m b.s.l. up to the modern ground level have been observed across the study area. Descriptions and preliminary interpretations of these follow here (Fig. 5.3).

In Areas AI8 and AI1, there was a complex sandy beach facies that was covered by silty alluvial sediments derived from Tiber activity. These younger deposits are yellow-beige silts and partially pedogenised. In Area AI7, the stratigraphy is complex, probably on account of an association between the palaeolagoon and the sea. At the top, yellow-beige alluvial silts are partly affected by pedogenic processes; these deposits are interpreted as floodplain deposits. In Areas AI6 and AI5 areas, a five to seven metre thick grey silty-clay deposit was observed between 10m and 0m b.s.l., and can be interpreted as a palaeolagoon that had formed between two ridges. On top of this, the same yellow-beige alluvial silts were deposited and related to the Tiber flood activity. Two different types of stratigraphic successions can be observed in area AI4. The cores drilled to the west displayed facies similar to AI6 and AI5, with a thick greyish-green silty-clay deposit. The cores drilled on the east comprise a 0.60m thick layer of coarse sand with ceramic fragments from -3.20m to -3.80m a.s.l. followed by fine palaeolagoon sediments. The uppermost part of the stratigraphy comprises yellow-beige alluvial silts. In Areas AI3 and AI2, layers of silty-clay are interbedded with sand or coarse sand deposits with ceramic fragments. The stratigraphy is similar to that in Core ISN-1 and to the stratigraphy observed in the archaeological trenches where the Isola Sacra 1 and 2 shipwrecks were found. Wood fragments are present in the two cores closest to the excavation trench. Yellow-beige alluvial silts were again observed in the uppermost part of the cores.

Discussion

The Isola Sacra prior to the establishment of Portus

Coastal progradation

The Isola Sacra is a key area for understanding the evolution of the Tiber delta during the late Holocene. More specifically, the survey results presented in previous chapters and the new sedimentary cores presented in this chapter shed new light on the extent and the chronology of fluvial and coastal mobility during the third to first millennia BC (Fig. 5.7).

Core CPO-1 reveals deposits characteristic of a sandy shore of the Tiber delta (Salomon 2013; Salomon *et al*. In press 2021). At the bottom, Unit A is composed mainly of a very fine sand that was deposited below the fair weather wave base (FWWB) or the outer line of offshore breakers. Unit B reveals different layers of fine and coarse sand that probably settled in the longshore trough, which lies behind the longshore bars and the shore breaker zone. The very well sorted yellow laminated fine to medium sand of Unit C originates from the shore breaker zone. Finally, Unit D reveals bedded yellow and black sand deposits characteristic of the upper part of the wash zone. The black sand layers are placer formations issued from a selective sorting of the particles driven by their density as well as their size. The final and uppermost layer (Unit E) was composed of brown silts and corresponds to floodplain deposits settled after the formation of the beach ridge.

Coastal sands were also noted in Cores CPO-2 / Unit A and CPO-3 / Unit A. The bottom of these sandy units was composed of a higher tenor of very fine sand that might have been deposited close to the fair weather wave base (FWWB), while the upper part of the units comprised medium sand that is related to the shore breaker zone. The upper part of the sandy shore stratigraphic succession was removed by the construction and the evolution of the Roman Portus to Ostia Canal (Units B). Surprisingly, no facies can be clearly related to longshore trough deposits in the lower part of Cores CPO-2 and -3. The piece of wood in CPO-2 / Unit A is dated to the end of the third millennium BC, earlier than the date obtained from core CPO-1.

Similar coastal facies have been observed from deposits underlying Portus (Salomon 2013; Salomon *et*

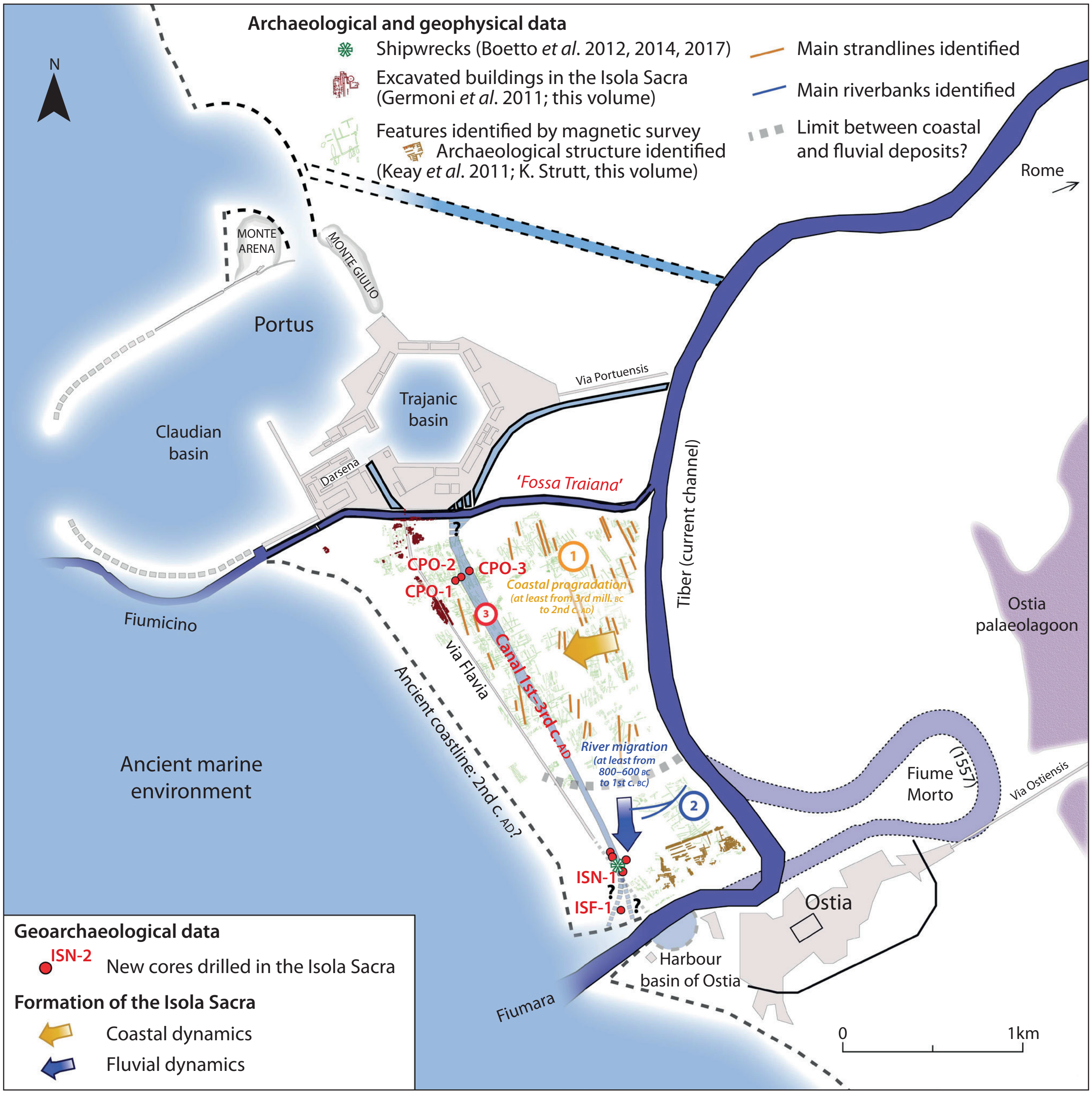


Figure 5.7. *Main phases in the formation of the Isola Sacra. (Drawing: Ferréol Salomon.)*

al. In press 2021) and Ostia (Goiran *et al.* 2014; Salomon *et al.* 2018). Dates from the sandy shore stratigraphic succession analysed in Cores CPO-1 and CPO-2 suggest that the northern part of the Portus to Ostia Canal was excavated in one or several progradational phases dated between the end of the third (2465 to 2210 cal BC in Core CPO-2, Lyon-11789) and the beginning of the second millennia BC (1750 to 1620 cal BC in Core CPO-1, Lyon-11787). Later progradational phases on the southern side of Portus, north of the Ponte di Matidia, were dated to the first millennium BC (Cores BA-1 and EP-1 in Salomon 2013).

Fluvial mobility

North–south strandlines identified in the survey results in the northern part of the Isola Sacra, curve toward the east while continuing south (Fig. 5.7). These correspond to beach-ridges, and the dating evidence from Cores CPO-1 and 2 and suggests that there was already a cuspidate Tiber river mouth in the southern part of the Isola Sacra during the third to second millennia BC. Although none of the radiocarbon dates from fluvial deposits confirm directly the presence of a palaeochannel in the south of the Isola Sacra at this date, first millennium BC river mouth deposits were identified in Cores ISF-1 and ISN-1.

At the bottom of Cores ISN-1 and ISF-1 (Units A), very well sorted silty-sands were interpreted as shoreface deposits. In the latter they were dated to the beginning of the first millennium BC (1160–930 cal BC, Lyon-11221; 1090–880 cal BC, Lyon 11222), and formed part of a prograding coast. This would have been offshore and below the contemporaneous sea level, and which would then then have been covered, and probably partially eroded, by fluvio-coastal deposits. In the same core, Units B and C clearly exhibit the characteristics of fluvio-coastal facies deposited in the inner part of a river mouth: these two units are a complex intercalation of gravels, coarse and finer sands with layers of clayey-silts. The presence of many ceramic fragments in these layers is indicative of the proximity of Ostia. Posidonia fibres, fragments of wood and small pieces of charcoal provided a radiocarbon date of between the fifth and first centuries BC (455–220 cal BC, Lyon 9322; 365–190 cal BC, Lyon 11218; 395–205 cal BC, Lyon 11217; 205–45 cal BC, Lyon 11216). Unit B in Core ISN-1 corresponds to a fluvio-coastal deposit of fine sediments either laid down in a deep swale between two ridges, or as a result of flocculation in a palaeochannel (Salomon *et al.* 2017b). These fine deposits were dated to between the ninth and sixth centuries BC. Taken together with the geophysical evidence, this palaeo-environmental analysis suggests that the beach ridges observed in the north of the Isola Sacra and deposited during the third to second millennium BC were eroded by river mouth dynamics in the south part of the Isola Sacra during the first millennia BC.

Reconstruction of the fluvio-coastal landscape dynamics

The new palaeo-environmental data from Cores CPO-1, 2, 3, ISN-1 and ISF-1, together with the survey results discussed in Chapter 4, help provide us with a better understanding of the evolution of the Tiber delta from the third to the first millennia BC. Five clear steps in this process can be summarised as follows. First, coastal progradation occurred across the Isola Sacra between the third and first millennia BC, based on Cores CPO-1, 2 and 3 and additional dates from Portus (Salomon 2013: EP-1 and BA-1; see Fig. 5.2). Second, there was a high degree of fluvial mobility in the southern part of the Isola Sacra in the first millennium BC, eroding the earlier prograded plain of the third–second millennium that still existed in the north of the Isola Sacra (Units A in Cores CPO-1, 2, and 3), and generating new coastal progradation toward the north (Salomon 2013: EP-1 and BA-1) and the south below Ostia (Salomon *et al.* 2018: CAT-2; Hadler *et al.* 2015: OST-4). Third, the river channel migrated from the central part of the Isola Sacra to the south between the eighth and sixth centuries BC; Unit B in Core ISN-2 can be related to the fluvial mobility at this period or to the formation of beach ridges following the migration of the river mouth southwards. Fourth and finally, the river mouth stopped migrating south of the Isola Sacra (Salomon *et al.* 2018); Core ISF-1 deposits of the fourth to first centuries BC can either date the last stage in the migration of the river mouth toward the south, or a reduction of the width of the river mouth of the palaeochannel.

Palaeoenvironments of the canal

In the cores CPO-2 and CPO-3 derived from the Portus to Ostia Canal, Units B reveal high energy deposits with a facies similar to the fluvial bedload observed in the *Canale Romano* on the north side of the '*Fossa Traiana*' (Core CN-1/Unit C, CN-2/Unit D and CN-3/Unit C in Salomon *et al.* 2014). Interbedded layers of fine and coarse deposits in Unit B1 correspond to an instability similar to that observed in the *Canale Romano* (Core CN-3/Unit B in Salomon *et al*. 2014). Fine deposits were interpreted as resulting from flocculation, on account of the influence of the salt-water edge extending inland through the mouth of the '*Fossa Traiana*'. These phases of flocculation would have been regularly interrupted by the higher energy of Tiber flood waters flowing into the Portus to Ostia Canal.

Surprisingly, the record of the infilling of the canal that is evident in Core CPO-2 differs from the stratigraphy recorded in CPO-3. The former reveals the classic sequence of a cut-off channel, with coarse bedload at the bottom (Unit B) and finer deposit for the filling (Unit C). A similar stratigraphic succession was observed in the *Canale Romano* (Salomon *et al.* 2014) and in the palaeomeander of Ostia (Salomon *et al.* 2017b: Cores MO-1 and MO-2). The full canal sequence of Core CPO-3 is composed of gravel and sands (Unit B). Part of this coarse facies is deposited above the reconstructed height of the Roman sea level of the third to fifth centuries AD (Goiran *et al.* 2009), and is overlaid by 1.5m of fine to medium sand. These deposits could be interpreted as corresponding to a point bar derived from a lateral movement of the canal during one or several flood event(s), as the survey results from northern part of the island demonstrate the canal was wider in this area (Chapter 4). Since the Tiber was a meandering river within the delta during the Roman period (Salomon *et al.* 2017b; 2018), similar processes could have been active along the canal itself after its excavation. In the light of this, the stratigraphic evidence that we have suggests that there was a migration of the canal from the position of Core CPO-3 to that of Core CPO-2. The piece of wood in Core CPO-2 / Unit B dates to 170 cal BC–cal AD 15 (Lyon-11788), prior to the establishment of Portus. Although this fragment may have been residual in this canal context, as is often the case in such contexts, the radiocarbon date obtained from Core CPO-3 (45 cal BC–cal AD 115, Lyon-11790) is interpreted here as corresponding to the primary phase of canal use. It is a date which suggests that the canal moved laterally quickly after its excavation; it also fits with the archaeological and historical dates for the construction of Portus and its canal, and corresponds to the dates of the canal sediments and the boats in the south of the Isola Sacra.

Navigability

The Portus to Ostia Canal measures between *c.* 90 m in the north and *c.* 40m further south. Due to lateral mobility (see above), the width of the northern part of the canal is most probably over-estimated. Additionally, the lack of magnetometry coverage in some areas may lead us to under-estimate of its downstream width. The actual width before and after lateral migration of the canal is also difficult to reconstruct with certainty. The minimum width is broadly similar to the 35m widths of the '*Fossa Traiana*' and the *Canale Romano*, but wider than the 25m of the *Canale Traverso*. In terms of comparative scale, the Isola Sacra 1 ship is 12m long and 4.88m wide (Boetto *et al.* 2017; see below), meaning that there would have been sufficient space for it to turn and manoeuvre within the canal.

The PADM chart created for the canal presents data in such a way as to allow its changing water-depth to be more easily understood (Salomon *et al*. 2016a) (Fig. 5.6). In contrast to enclosed harbour environments, the depth of canals can change in response to flood events. In other words, the bottom of a canal sequence can either be explained in terms of the deepest point reached in dredging, or by hydrodynamic conditions. Additionally, the stratigraphy in a core from a borehole drilled at one side of the canal may not represent its deepest part. However, Electrical Resistivity Tomography undertaken across the line of the canal in the context of the geoarchaeological fieldwork confirmed the observations made in relation to the two cores (Salomon *et al.* 2016b).

In accordance with our hypothesis, Cores CPO-2 and 3 provide a record of the two phases of activity within the canal, with a water depth of -2m Ro.s.l. This means that a ship with 2.20m–2.30m of loaded draught, such as the 150 ton vessel from the Bourse de Marseille, could have used this part of the canal (Gassend 1982; Pomey and Rieth 2005; Boetto 2010). It is possible, however, that the bridge identified in the geophysical survey (Chapter 4: Area 6, **G33** and **m6.6**) could have presented an obstacle to them. The piers (*c.* 5m by 9m) in this stretch of the canal are spaced at *c.* 6m apart and the roadway carried along them would have been an obstacle to their masts unless they could be temporarily taken down. Core ISN-1, which was extracted from the southern part of the canal near the excavation of the ships, reveals a maximum water depth of -5m Ro.s.l. Although the draught of a fully loaded Isola Sacra 1 has yet to be calculated, most sizes of Roman ships could have been accommodated in this part of the waterway (Boetto 2010; Pomey and Tchernia 1978).

Connectivity of the canal within the Portus system and in relation to the Tiber river mouth

Connnectivity is of primary importance in considering whether the Portus to Ostia Canal was built for navigation or for flood relief. How was it integrated into the canal system of Portus? What role did it play in relation to the river-mouth system of Ostia, which included the fluvial harbour basin of Ostia?

In contrast to the *Canale Romano*, the '*Fossa Traiana*' and the *Canale Traverso* but similar to the *Northern Canal*, the riverbanks of the Portus to Ostia Canal do not seem have been built with reinforced banks, and appear instead to have been cut directly into coastal deposits in the north and fluvial deposits in the south. It was precisely these loose riverbanks that led to the lateral mobility of the canal. According to the magnetometry results presented in Chapter 4, the orientation of the northern stretch of the canal is not aligned on beach-ridges, although its eastern banks indicate that the erosion of some sections might have been constrained by the beach-ridge system. More investigation will be necessary to attest whether or not the southern sector of the canal followed any pre-existing natural feature.

Ostian side

It is still difficult to establish whether the canal was connected to the Tiber opposite Ostia, to the river channel downstream of the curve initiated by the canal near the excavation of the shipwrecks, or directly into the sea in the west. The old aerial photographs presented in Chapter 4 (Figs 4.71–4.72) are not as clear as one would like, and do not provide any evidence for any canal-related features, except perhaps for a small westward curve. Furthermore, it has not been possible to undertake any geophysical survey downstream to the west in the area which is now heavily built-up. However, it is worth pointing out that the river mouth is the most morphologically active part of a delta. Consequently, a direct connection to the Tyrrhenian sea would have led to the rapid sedimentation of the mouth of the canal. The littoral drift on the north side of the river mouth is oriented to the north and would have easily created beach ridges after flood events. Even if there was lateral mobility of the palaeochannel, the connection of the canal to the channel close to the Tiber mouth would have probably lasted longer.

The north–south cross-section of cores drilled by Ghelli, Rosa and Germoni suggests that there was coarse and sandy sedimentation between 2m and 8m b.s.l. in the area of Core ISN-1 (Areas AI2 and AI3) that was associated with the Portus to Ostia Canal, and mostly fine deposits toward the south (AI6, AI5) which are identified as a palaeolagoon between two sandy coastal ridges. Absolute dates would be necessary to confirm whether this palaeolagoon existed during the period of use of the canal and whether it could have been used as a waterway. Figs 5.1, 5.2 and 5.7 show different hypotheses for the connection of the Portus to Ostia Canal with the Tiber near Ostia.

Portus side

It is possible that the junction of the Portus to Ostia Canal and the '*Fossa Traiana*' may have been bordered by an embankment since not doing so would probably have led to destabilisation of the riverbanks. The banks of the latter comprised solid structures that are discussed in Chapter 2, and furthermore there is north–south anomaly (**m5.5**) in Area 5 which could indeed mark the line of such an embankment. In the light of this, Figs 5.1 and 5.2 present a hypothetical interpretation of the possible morphology of the intersection between the *Canale Romano*, the Portus to Ostia Canal and the '*Fossa Traiana*'. It is based in part upon the better-known junction between the '*Fossa Traiana*' and the *Canale Traverso*.

It is also possible that the canal could have been used for flood management in the same way as the *fossis* mentioned in the famous Claudian inscription of AD 46 from Portus (CIL XIV, 85 – Keay *et al.* 2005: 315, A1, fig. 9.1). The coarse sediments in CPO-2 and 3/Units B are similar to the bedload found in the *Canale Romano* and suggest that floods passed through the Portus to Ostia Canal. Sediment transfer continuity is then attested with the '*Fossa Traiana*' and the *Canale Romano*, ultimately to the river Tiber upstream.

Conclusion

The Isola Sacra provides the 'missing piece' for reconstructing the Tiber delta dynamics before the Roman Imperial period, and for better understanding the broader harbour system of Portus and Ostia. In particular, the two cross-sections of cores drilled in the northern part of the Portus to Ostia Canal (CPO-1, 2, and 3) and its southern part (ISN-1, 2, 3, 4 and ISF-1) shed new light on these two issues.

The new geophysical and sedimentary data show firstly that the Tiber mouth lay in the area that later formed the south of the Isola Sacra as early as the third to second millennia BC, and secondly that there was no sudden or catastrophic defluviation of the river channel southwards from the area later occupied by Portus in the eighth to sixth centuries BC (Segre 1986; Giraudi *et al.* 2009). It suggests instead that there was a progressive southwards migration of the mouth of the river channel in the southern area of the Isola Sacra from the latter date onwards (Bellotti *et al.* 2011; Salomon *et al.* 2018).

In terms of chronology, combined archaeological and radiocarbon dates relating to the cores are consistent. The Portus to Ostia Canal was built between the end of the first century AD and the beginning of the second century AD and was abandoned between the late second and early third centuries AD. The waterway could have been used for navigation by small to medium size boats and ships with water depths of between 2m and 5m, and perhaps also as a flood-relief canal. The absence of constructed riverbanks in conjunction with the lateral mobility of the canal suggests that the waterway was not designed to be a harbour-canal in the same way as the *Canale Romano*, the '*Fossa Traiana*' or the *Canale Traverso*. The dissociation of the southern stretch of the canal with the newly discovered northern extension of Ostia in the *Trastevere Ostiensis* and the bridgehead settlement on the north side of the Isola Sacra are possible arguments in favour of this.

The Isola Sacra shipwrecks

Giulia Boetto, Alessandra Ghelli and Paola Germoni

The Isola Sacra 1 shipwreck (**G52**) was discovered at the beginning of February 2011 during archaeological excavations undertaken on behalf of the City of Rome and by the Soprintendenza Speciale per i Beni Archeologici di Roma (present-day Parco Archeologico di Ostia Antica), *c.* 300m to the north of the north bank of the Tiber, in advance of the construction of a replacement for the Ponte della Scafa. The excavation, study and documentation of the find lasted for about five months, during which time a second shipwreck, the Isola Sacra 2, was discovered lying perpendicular to the Isola Sacra 1 and partially covered by it (Fig. 5.8); only the southern side of this shipwreck could

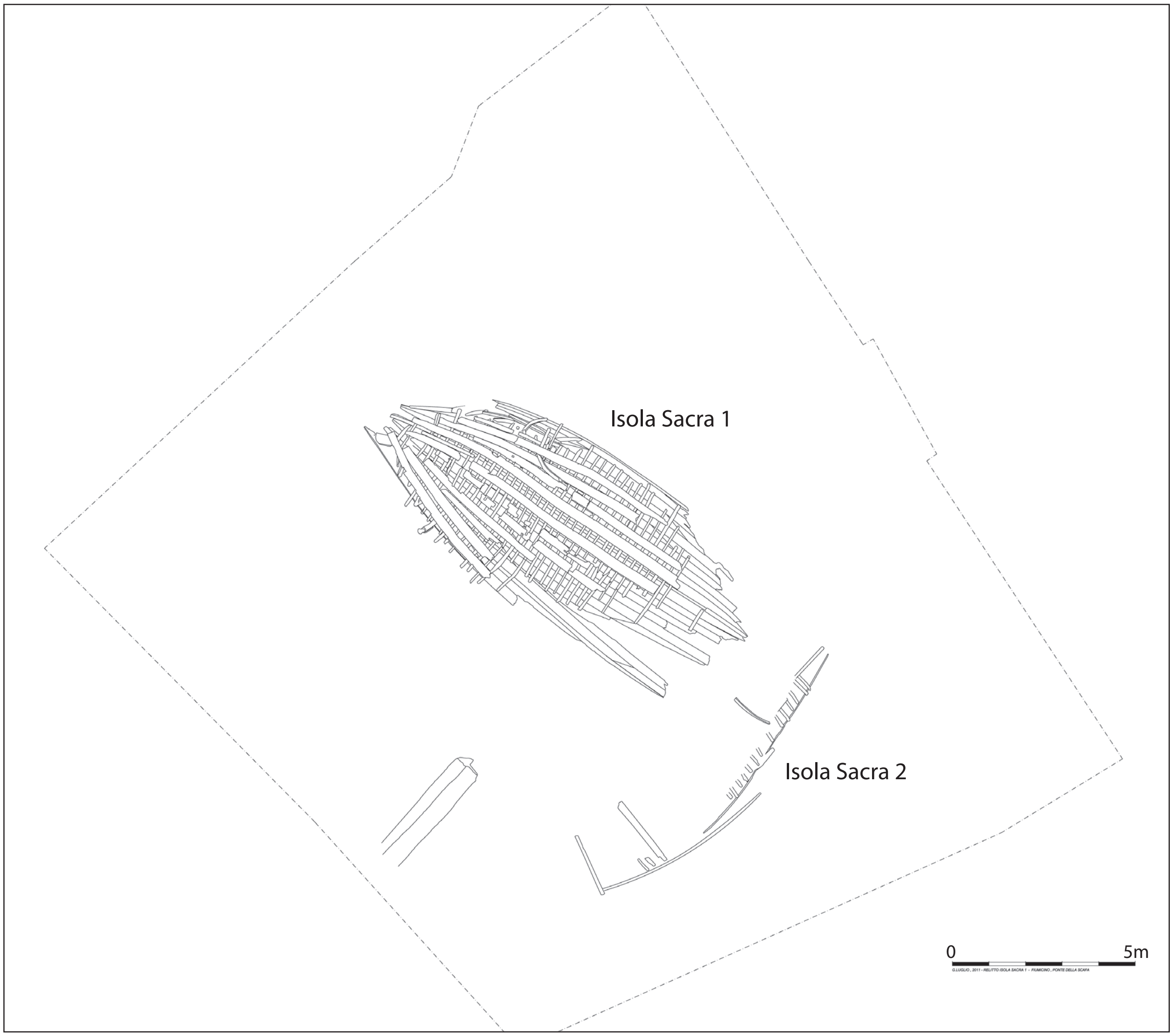


Figure 5.8. *The excavation area with the position of the Isola Sacra l and 2 shipwrecks, and the timber. (Survey and Drawing: G. Luglio.)*

be investigated and documented (Boetto *at al*. 2012a; 2012b; 2017; Fiore *et al.* 2015).

At the end of the excavation, in October 2011, the drainage pumps were stopped so the groundwater could rise and completely fill the trench with water. By flooding the shipwrecks in this way, it was possible to keep the wooden structures waterlogged and preserved in good condition. Considering the importance of the discovery and the need to also investigate the second shipwreck before starting the construction of the replacement bridge, it was decided to remove and restore Isola Sacra 1 for eventual display (Fig. 5.9). Meanwhile, the specialist in dendrochronology, Stéphanie Wicha, identified all the wood types used in the construction of the ships and all the documentation was processed. It was only three years later, between July and September 2015, that the recovery of Isola Sacra 1 could begin. After the installation of a well-point system in the 2011 trench, the groundwater was pumped out, the geotextile and protective sandbags that had been used to cover the wreck were removed and the ancient wooden structures were cleaned. The salvage started with the ceiling, continued with the frames, and ended with the planking and keel of the ship. Because of the high degree of distortion of the wooden structures, both in terms of their longitudinal keel profile and the cross sections along their frames, it was decided to dismantle the shipwreck (Fig. 5.10). This was undertaken after Giampaolo Luglio performed an accurate digital photogrammetry survey of each stage of the process.

As far as possible, the wooden structures were kept intact or recovered in pieces which followed existing breaks. The internal assemblies (tenons) connecting the strakes of the planking and the keel were cut off. The strakes and the keel were cut into several sections since they reached up to 12m in length. The most important elements, such as the transom and the bollards, were also digitally surveyed separately after they were removed from the shipwreck. Finally, all the pieces of the shipwreck were transported to the Parco Archeologico of Ostia Antica where they are kept in a structure especially built to conserve the waterlogged wood (Fig. 5.11) (Germoni *et al.* 2017: 1349–50).

Figure 5.9. *The Isola Sacra 1 shipwreck. In the background, lies the southern side of the Isola Sacra 2, and in the side of the trench to the right, the timber. (Photograph: G. Luglio.)*

Figure 5.10. *View from the south-west of Isola Sacra 1: the distortion of the shipwreck is fully visible. In the foreground can be seen the timber protruding from the southern side of the trench and, on the right, the southern side of Isola Sacra 2. (Photograph: G. Luglio.)*

Figure 5.11. *The pieces of the strakes on the stainless supports within the storage facility at Ostia. The wood is conserved with a high degree of humidity on account of an irroration system. (Photograph: L. Damelet, Aix Marseille University, CNRS, Centre Camille Jullian.)*

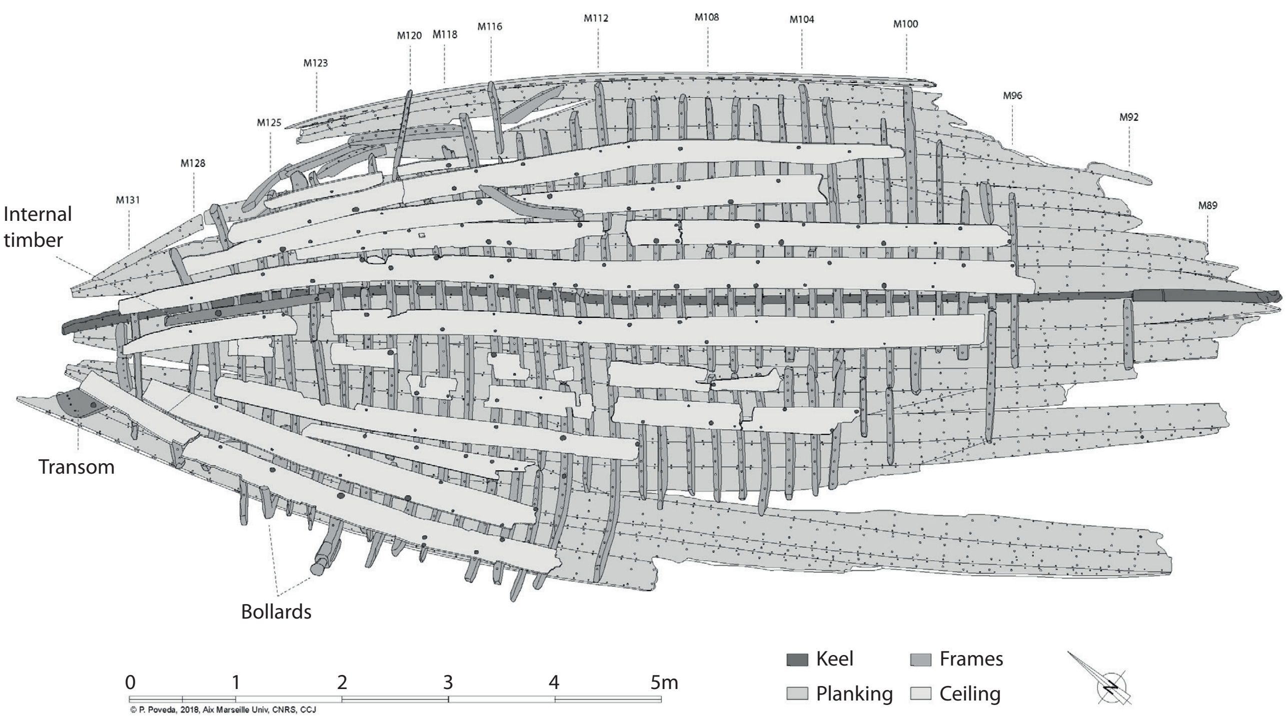


Figure 5.12. *Plan of Isola Sacra 1. (Survey: G. Luglio; Drawing: P. Poveda, Aix Marseille University, CNRS, Centre Camille Jullian.)*

Figure 5.13. *The port side of Isola Sacra 1 preserved up to the gunwale showing the two bollards and, on the right, the transom lying under the upper stringer. (Photograph: G. Luglio.)*

Isola Sacra 1

The remains of the Isola Sacra 1 wreck (Figs 5.9, 5.10 and 5.12) are about 12m long and 4.88m wide, covering a total surface of 60 m^2. The shipwreck was oriented north-west to south-east but, to simplify the fieldwork and the documentation process, the orientation has been treated as north–south. The western side, which was identified as the port side, lay at a lower level than the eastern side, with a difference in height of about 1m. The upper strake of the eastern side (the lower wale) appeared at a depth of 1.40m b.s.l. The upper strake of the western side was at a depth of 2.09m b.s.l. Between the stern (south) and the stem (north) the difference in height was important too. The stern was at a depth of between 1.58m and 2.37m b.s.l.; the stem lay at a depth of 3.17m b.s.l. The significance of the difference between the stems is not clear.

Despite significant post-depositional deformation in the shape of the vessel, it is clear that the transverse section at the main frame had a flat frame with a hard chine at the turn of the bilge and was thus comparatively flat-bottomed. Given the preservation of the port side up to the height of the gunwale, it has been possible to estimate the amidships inner hull depth at *c.* 1m. The longitudinal section shows that the ship had an impressive deformation and an S-shaped keel (Fig. 5.10).

The keel, which was made of evergreen oak (*Quercus ilex* L.), is 11.5m long, 0.06–0.08m wide amidships and 0.10m in width and 0.11–0.12m high forward. The keel is connected with a scarf joint to the transitional stern timber, which is 1.40m long and 0.10–0.11m wide. This timber, made from a walnut tree (*Juglans regia* L.), with triangular rabbets for the garboards and the strake ends, is higher than the keel. The difference in height is visible at the level of the scarf, since the transitional timber protrudes out of the flat inner face of the keel. The transom, a single piece of sycamore (*Acer pseudoplatanus*), was not found in its original position but had shifted under a stringer, forward. The transom is semi-circular in shape, 0.585m wide, 0.30m high and 0.095m–0.115m thick. It is chamfered to allocate the keel and strake ends. The transom is fastened to the keel by an oblique nail driven from its inner surface, while the planks are fastened with nails driven from the outer surface of the hull.

Hull planks are 0.18m to 0.29m wide and 27.5mm thick and are homogenously built using stone pine (*Pinus pinea* L.). They are edge-joined by a close setting of pegged mortise-and-tenon joints. The pegs affixing the tenons are spaced 0.156m centre-to-centre, while mortises are spaced 0.108m. The tenons are made of evergreen oak while the pegs are made from olive wood (*Olea europea* L.). The general planking-pattern consists of ten strakes on the starboard side and twelve on the port side. The tenth strake, situated at turn of the bilge, is the lower wale on both sides and is built from cypress wood (*Cupressus sempervirens* L.).

Thirty-seven frames survived, while the position of seven additional frames is detectable thanks to the fastening visible on the planking. Most of them are made of oak (*Quercus* sp.) with some elements in evergreen oak (*Quercus ilex* L.), ash (*Fraxinus excelsior* L.) and olive wood (*Olea europea* L.). The general framing-pattern comprises alternating floor-timbers and half-frames with some of the half-frame's branches overlapping the keel. The frames are on average 0.064m wide and 0.092m high, with room-and-space of 0.177m, and they are connected to the planking by olive wood (*Olea europea* L.) treenails and copper alloy nails. There is no evidence of bolts or nails for the assemblage of some of the floor-timbers with the keel. Two of the conserved futtocks have the upper ends shaped for tying rope rigging. One has a very complex shape and a lateral groove to wedge in one or two toe-rails to raise the level of planking above the sheerstrake, while the second bollard has an arm 90° bent inside the vessel (Fig. 5.13).

The inner structure of the ship is formed by a timber of evergreen oak (*Quercus ilex* L.), set parallel to the keel and connected with the hanging system of the transom, and stringers made of stone pine/maritime pine (*Pinus pinea* L./*Pinus pinaster*). All of these elements are attached to the frames with iron nails. The upper stringer at portside had, along the upper edge, three notches where transverse thwarts were inserted. Finally, the hull was made watertight by an internal and external coat of pitch.

Isola Sacra 2

The second shipwreck, Isola Sacra 2, lay perpendicular to the Isola Sacra 1 and was partially covered by it (Figs 5.8– 5.10). As its stern and stem extremities continued beyond the sides of the trench, only the upper part of its southern side could be examined for a total length of 14 m. The excavation revealed the presence of two transverse beams, which suggest that the vessel is particularly well preserved. The planking of Isola Sacra 2 is edge-joined by a close setting of pegged mortise-and-tenons joints, but differs from Isola Sacra 1 in showing evidence of repairs. The frames are 0.074m wide and 0.103m high, spaced on average at 0.172m. An internal reinforcement, rectangular in shape and with smoothed angles, is nailed to the planking and may be connected with repair work on the vessel. The remains of three stringers are nailed to the frames and the hull is covered by pitch.

Discussion

As Isola Sacra 2 was not fully excavated, it is not possible to advance hypotheses about its structural system, shape, propulsion and original function. In the case of Isola Sacra 1, however, it is clear that the hull structure and the shape are based on a longitudinal strake-oriented concept while the building process is shell-first (Pomey 1998; 2004; Pomey and Rieth 2005; Pomey *et al.* 2012). The presence of the transom indicates that this vessel belonged to the *horeia*-type vessel family, which comprised service boats or fishing boats, especially the smaller ones (Boetto 2009). There was great variability amongst boats of this kind, with examples known from contemporary nautical iconography and from first century AD shipwrecks found in the silted harbours of Toulon (shipwrecks Toulon 1 and 2 – Brun 1999) and Naples (shipwreck Napoli C – Boetto 2005; Boetto and Poveda 2014).

Conclusion

Archaeological excavation of the Isola Sacra site produced a stratigraphic sequence of about 3m between the modern ground level and the ancient sediment upon which lay the Isola Sacra 1 vessel. The stratigraphy consisted of layers of silted mud (yellow in the upper part and grey in the lower part), alternating with grey sand of different grain sizes. The different finds (ceramics, amphorae, coins and organic materials) covering the ship's timbers were chronologically homogeneous, fixing the *terminus ante quem* for the wreckage to the third century AD.

This evidence could be taken to suggest that the two vessels may have sunk during a flooding episode of the Tiber, which lay some way to the south. Unfortunately, however, owing to the limited area (*c.* 500 m^2 area) excavated, it was not possible to find evidence for any associated structures such as river quays or other kinds of infrastructure. It is worth noting, though, that a very large timber protruded obliquely from the south-western side of the trench in 2011. This was made of oak (*Quercus* sp.), was at least 4.2m in length and pentagonal in section (*c.* 0.50m by 0.35m). An alternative explanation can be made on the basis of the geophysical and geomorphological research discussed above and in Chapter 4. This would see the ships and the timber lying within with Portus to Ostia Canal, or in an area closely associated with it, such as an inlet or some kind of dock. The excavation of the second shipwreck may well produce new data that would make it possible to better define the chronological sequence of the events that led to the sinking of these two vessels in this part of the Isola Sacra.

General conclusions

Simon Keay

The analyses presented in this chapter provide a clear demonstration of the importance of adopting an interdisciplinary approach to the study of major landscape features, such as the Portus to Ostia Canal. The geoarchaeology clearly confirms the existence of the canal, the fourth known at, or in, the vicinity of Portus; it also suggests that it was created at some time the end of the first and beginning of the second century AD, and that it had a short life that may have ended at some time in the early third century AD. The geoarchaeological analyses also reveal the potential of the canal as both a navigable watercourse, and as a channel to divert Tiber flood waters away from the '*Fossa Traiana*'. This dual role resembles that of the '*Fossa Traiana*' itself, which is of Claudian date, and also the *Canale Romano* of Trajanic date, both of which were established to enable ships to move between the Tiber and Portus, and to divert flood waters coming downriver from Rome.

The two ships raise important questions. Their proximity to the course of the Portus to Ostia Canal very strongly suggests that they may have sunk in the canal at some time in the early third century AD, although this cannot be confirmed, since the mouth of the watercourse has still to be identified with certainty. Furthermore, their size would tend to tend to support the geoarchaeological arguments that the canal was navigable, and that it could have been used by ships with a minimum loaded draught of above 2.20m–2.30m in the north, and deeper draught ships further south. All of these issues will be explored further in Chapters 6 and 7.

Notes

1 Throughout the text cores are referred to by their abbreviated core numbers prefixed by a code that relates to the different sub-projects (eg. CAT-1, ISN-1 etc), with their locations shown on the appropriate maps in Chapter 4 and in this Chapter.
2 This work was undertaken by Sabrina Zampini
3 The work was directed by A. Ghelli, C. Rosa and P. Germoni and was co-financed by the Municipality of Rome and the Lazio Region and under the supervision of the Parco Archeologico di Ostia Antica.
4 The stratigraphic units were defined by visual recognition by C. Rosa (colour, texture, structure, presence of organic material, presence and nature of lithic material), while the ceramics and wood fragments were identified by A. Ghelli.

The Isola Sacra Survey

The Isola Sacra occupies the land between Ostia and Portus at the mouth of the Tiber, and thus lies at the centre of the massive port complex that served Imperial Rome. This volume focuses on the results of a survey of the island completed as part of the Portus Project, complementing the previously published survey of Portus (2005) and the forthcoming publication of the German Archaeological Institute's survey of Ostia. The survey is framed by an analysis of the geomorphology of the delta, and integrated with information from past excavations. It is complemented by a programme of geoarchaeological coring and a short account of the ships excavated on the Isola Sacra in 2011.

The results make an important contribution to the understanding of the landscape of both Portus and Ostia, offering new information about the development of the delta, and the changing use of the Isola Sacra. They also provide evidence for the buildings along Isola Sacra's northern shore and the cemeteries that flank this settlement and the via Flavia (which runs between Portus and Ostia across the centre of the island). Most significantly, three completely new sets of features were revealed: a major canal that ran north–south across the island; a system of land divisions, which created blocks of fields; and a suburb of Ostia on the island's southern flank. These results are key for understanding the development of the Portus–Ostia complex, and hence the economy of the City of Rome itself.

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