Heated crafts on the Roman shore. Revisiting the debate on the exploitation of coastal wetlands: the case of Roman Aardenburg (Zeeland, the Netherlands)

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Summary

In the past, coastal wetlands had a high potential for specific resource exploitation strategies like sheep husbandry, fishing and salt production. At Aardenburg (Zeeland, NL), multiple workshops and debris depositions point towards intense craft activities during Roman times. Yet, the nature of these heated crafts has long been debated (e.g. metallurgy, salt production or lime burning). After reviewing the evidence, we conclude that the workshops at Aardenburg were most likely related to salt production. Not only was the site well accessible, but the raw materials were readily available. Additionally, in the vicinity of Aardenburg, several salt production sites are known, and the debris depositions of all sites are highly comparable. Furthermore, the lack of suitable heating infrastructure, the absence of raw materials such as limestone and a relatively small local and regional market make it rather improbable that the workshops of Aardenburg produced lime.

1. Introduction[1]

From a Roman political and geographical point of view, the *ciuitas Menapiorum* situated on the northern fringe of *Gallia Belgica* (stretching northern France, Belgium, and the southern part of the Netherlands) was a rather 'marginal' territory on the outskirts of the Empire (fig. 1).[2] According to Groenewoudt,[3] a marginal landscape should be defined as an area of low agricultural productivity and low population density during a certain period of time.[4] Agriculturally speaking, coastal wetlands are viewed of 'marginal' importance as they are prone to environmental changes which limit the overall accessibility and thus impact the productivity and population density. However, as argued by Rippon[5] and De Clercq,[6] exactly the dynamic character transforms these wetland areas and their immediate Pleistocene borderlands into rich ecosystems with a high potential for specific, landscape-based resource exploitation strategies such as sheep husbandry, fishing and salt production. For these purposes, the coastal wetlands of northwest Europe have been more intensively exploited from

[1] This paper is part of the first author's PhD project: '*Salt of the north. An interdisciplinary study of Roman salt production, distribution and consumption in the civitas Menapiorum*'. The authors would like to thank dr. Sofie Vanhoutte for her comments and critical remarks on a first draft of this paper.

[2] DE CLERCQ (2011). The 'Roman perspective' on this remote part of the Empire can be found in historical sources describing the Menapian territory. For example, CAESAR (*Gal.* 3.28; 3.38; 6.5) repeatedly mentioned the continuous forests and vast marshes in which the Menapian forces retreated. TACTICUS (*Hist.* 4.28) used the term '*extrema Galliarum'*, the outer extremities of Gaul, to describe the Menapian territory which got looted by Julius Civilis' forces in 69 CE. VERGILIUS (*A.* 8.727) even called the Morini, the western neighbours of the Menapii, *extremi hominum*, which translates as the furthest of mankind.

[3] GROENEWOUDT (2009), on the concept of marginality, see also TURNER & YOUNG (2007)

[4] Nevertheless, marginality is rather relative concept influenced by varying economic, geographical, social and cognitive parameters, GROENEWOUDT (2009).

[5] RIPPON (2000)

[6] DE CLERCQ (2009; 2011)

Roman times onwards as indicated by recent studies on the Roman exploitation of the Somerset Levels[7] (GB) and the Fenlands[8] (GB).

In the 1970s, Thoen[9] published his seminal overview of the Roman Belgian coast arguing that the coastal wetlands of the Menapian territory were inhabited and exploited in Roman times. However, Ervynck et al.[10] interpreted and attributed these finds to seasonal off-site phenomena. Recent discoveries of habitation structures altered the perception of the Menapian coastal wetlands from a marginal, seasonally exploited landscape into an intensely exploited, permanently occupied landscape.[11] Nevertheless, high-resolution data regarding the diverse nature and the exact exploitation processes of the natural resources remained limited.[12] Indeed, multiple sites containing large debris layers, with or without heating structures, have been discovered at Koudekerke;[13] Leffinge;[14] 's-Heer Abtskerke;[15] Middelburg[16] and Aardenburg[17] (fig. 1). However, the interpretation of these sites has been a matter of debate for decades. Over time, a wide variety of heated crafts such as metallurgical activities, lime burning, pottery manufacturing and salt production were suggested, yet each hypothesis lacked solid argumentation.[18] In this paper, we address this long-lasting discussion by using Aardenburg as a case study. Aardenburg is exemplary for the wider region as the site contained multiple workshops as well as debris and ash layers. The nature of the workshops and the composition of the debris layers will be examined in detail to understand how they might relate to the specific craft activities suggested in previous literature. Deconstructing the old hypotheses is a necessary first step to wipe the slate clean and to provide a meaningful contribution to the debate based on new evidence. Furthermore, this will provide a solid basis for future research and will enable discussion on the economic integration and role of the Menapian *ciuitas* in provisioning the Rhine army or the civil hinterland with salt and derivative products.

[INSERT FIG. 1]

2. Situating the Roman settlement of Aardenburg

From the mid twentieth century onwards, archaeological research revealed a considerable number of structures and related debris of heated crafts near the Roman military *castellum* at Aardenburg (Zeeland, the Netherlands). The fort was positioned at the edge of the coastal plain, on the most seaward outcropping edges of a Pleistocene sand ridge.[19] This sandy elevation was cut by the Ee-river basin which flows into the North Sea (fig. 1). The channel infills found outside the settlement indicate a river basin running from south to north which widened towards the coastal plain in the north.[20]

[7] RIPPON (2000)
[8] LANE & MORRIS (2001); FINCHAM (2002)
[9] THOEN (1978a; 1987)
[10] ERVYNCK et al. (1999)
[11] DE CLERCQ (2009; 2011); VERWERFT et al. (2019)
[12] DE CLERCQ (2009; 2011)
[13] Situated five kilometres west of Middelburg, VAN DEN BERG & HENDRIKSE (1980)
[14] THOEN (1978a; 1978b; 1981; 1986)
[15] OVAA (1972; 1975)
[16] VAN DEN BERG (1988)
[17] VAN DIERENDONCK & VOS (2013)
[18] VAN DEN BERG & HENDRIKSE (1980); VAN HEERINGEN (1996); DE CLERCQ & VAN DIERENDONCK (2006); DE CLERCQ (2011); VAN DIERENDONCK & VOS (2013)
[19] OVAA (1958); VAN RUMMELEN (1965)
[20] OVAA (1957)

Channel infills found directly north,[21] west,[22] and south-east[23] of the *castellum* demonstrate that the river basin consisted of a dendritic system of waterways when crossing the sand ridge near the *castellum*. All of this suggests that the site was located at the most inland navigable section of the Ee, giving direct access to the North Sea. The Aardenburg *castellum* had a unique position at the end point of at least two main roads leading into the hinterland. One of the roads ran in western direction towards the Oudenburg *castellum* and the *ciuitas* capital (*Castellum Menapiorum*), and the other road ran in southern direction towards Bavay (*Bagacum Neruiorum*), connecting Aardenburg with the urbanized regions of central Gaul.[24] The combination of land-, and waterways on the edge of the Pleistocene sand ridge overlooking the coastal wetlands, gave Aardenburg a unique military and strategic economic position.

According to Van Dierendonck & Vos,[25] a civil settlement focused on the exploitation of marine resources was active at Aardenburg from the middle of the second century CE (phase I), followed by a first military occupation between 170-185/190 CE (phase II). However, after closely examining the evidence of the pre-*castellum* phase (phase I), it became apparent that all features attributed to phase I could just as well be part of phase II, casting doubt on the existence of a pre-military phase.[26] In any case, the fort was renovated or rebuilt (ca. 185/190 CE.) under emperor Commodus (phase III).[27] The construction of the Aardenburg fort, and by extension the fort at Oudenburg, might have been part of a larger military building program initiated by Commodus in which the coastal region of *Gallia Belgica* became militarised during the overall political-economic turmoil of northern Gaul in the late second century.[28] While the need for security and protection is evident in such period, the military presence might also have met more strategic goals such as the control of economic activities occurring in the coastal plain.[29] At Aardenburg, the destruction of several buildings and the silting up of the defence ditch marked a (temporary) end of the military occupation around 240/245 CE.[30] Under the usurper Postumus (260-269 CE), both the *castella* of Aardenburg (phase IV) and Oudenburg were rebuilt in

[21] HOEVENBERG & VAN SUIJLEKOM (2003); DIEPENDAELE (2013)
[22] JROB (1975; 1976); TRIMPE BURGER (1985); DIEPENDAELE (2009)
[23] VAN HEERINGEN (1989; 1992)
[24] VERBRUGGHE et al. (2017)
[25] VAN DIERENDONCK & VOS (2013)
[26] VAN DIERENDONCK & VOS (2013) suspected a pre-castellum phase (150-170 CE) based on the presence of two Samian ware fragments attributed to the potter Avitus from Blickweiler/Eschweilerhof (105-160 CE) in heating structure O-26, a drag. 33 with stamp MALLV[RO] in well W-10, the pottery found in the cart tracks, the pottery found in pit K-9 and an early date of building G13. However, regarding the stamp of Avitus, it should be noted that van Dierendonck & Vos do not mention the stamp type or the vessel type and do not refer to their source. As multiple potters by the name of Avitus are known, this information is crucial to correctly date the context, see HARTLEY et al. (2008). Additionally, Samian ware might be used for a longer period of time before it was broken and deposited. Next, the pottery of well W-10 was dated between 130-180 CE which partially overlaps with phase II. Furthermore, DHAEZE (2013) clearly stated that the pottery of the cart tracks and of pit K-9 should be dated after 160 CE and before 200 CE, and thus can belong to phase II. Finally, there are no solid arguments to date building G13 to phase I as it belongs to a military instead of the local native and civilian house-building tradition, DE CLERCQ (2009). As presented here, there are little arguments to exclusively date the aforementioned contexts to phase I (150-170 CE) as suggested by VAN DIERENDONCK & VOS (2013). On the contrary, there are several arguments to attribute the contexts to phase II (170-180/190 CE) instead or at least to let them overlap with phase II.
[27] VAN DIERENDONCK & VOS (2013)
[28] DE CLERCQ (2009); VANHOUTTE (*in press*)
[29] DE CLERCQ (2009; 2011)
[30] VAN DIERENDONCK & VOS (2013)

stone, probably again part of a larger building campaign.[31] After the Gallic Empire, both forts remained occupied for some time after which they got destroyed. Unfortunately, the precise end of both *castella* is difficult to define. Based on coin evidence, Chameroy[32] dated the definite end of Aardenburg's occupation in the 280s which he related to the campaigns of emperor Maximianus. Nevertheless, some pottery and coins point towards a small (Germanic?) reoccupation of the site during the fourth century.[33]

3. Archaeological traces of artisanal activity at Aardenburg

3.1. Potential workshops in the artisan quarter

The area approximately 400m south-east of the *castellum*'s eastern wall, along the main road leading south,[34] is characterised by an extensive 'industrial' or artisanal zone (fig. 1 no. 1-4 and 2). This area consists archaeologically of a complex sequence of multiple layers of brownish-red clay, with char inclusions, interspersed with large dumps of fired clay, indicative of numerous heating activities, next to multiple discrete features such as hearths and refuse pits.[35] No less than 27 hearth structures were uncovered during excavation campaigns between 1973 and 1991 (Oude Stad, Hof Buize I, Hof Buize II, Kamp Rodanborg I and Kamp Rodanborg II) (fig. 2). These digs covered an area of ca. 6500 m² in which several clusters of heating structures were discovered, indicating that the hearths were not part of one large workshop but instead might represent different smaller workshops, consisting of one or multiple working units, operating either simultaneously or consecutively. Most likely, these features only represent a fraction of the hearths once present as the debris layers also contained multiple fragments of dismantled heating structures. Unfortunately, during the initial excavations, these structures did not receive the necessary attention allowing a full comprehension of the nature and construction of the hearths. The features consisting of (burned) clay were only recorded in plan as a orange-red patch and no cross-sections were made to study the stratigraphical relation or the relative chronology of the hearths. Sometimes a clear distinction was made between the hearth filling, representing the combustion chamber, and the supposed hearth lining (fig. 3) but often these features were recorded as one structure. In addition, only a few photographs of the 'artisanal' zone were taken and no detailed photographs of the individual features were made or preserved (fig. 3). Furthermore, little is known about the find collection strategy during the different excavations and none of the publications nor the excavation archives mention any recovered hearth infrastructure.[36] Despite these difficulties, van

[31] On the Channel coast of Britain, several Shore forts were active or rebuilt during the Gallic Empire, see DRINKWATER (1983), DHAEZE (2011; 2019) and VANHOUTTE (*in press*).

[32] CHAMEROY (2013)

[33] VAN DIERENDONCK & VOS (2013), p. 331

,[34] VAN DIERENDONCK & VOS (2013) assume an eastern direction of the road for which there is no evidence. A southern direction for the roman road, as presented here, is more logical as the road follows the course of the main medieval road leading south (Zuidstraat-Hogeweg).

[35] VAN DIERENDONCK & VOS (2013), p. 168

[36] DE VISSER (2001) exhaustively studied all recovered material from the 1988 Hof Buize II excavation for her master dissertation. From this study it is clear that no hearth furniture was recovered (or perhaps discovered) in the 1988 excavation. VAN DIERENDONCK AND VOS (2013) performed a quick scan of the material from the other excavations to search for diagnostic elements to date the remaining hearths for publication of Roman Aardenburg. As they didn't mention any hearth furniture in their publication, the amount might have been minimal. Taking these studies into account, the decision was made not to (re-)examine the finds from the old excavations.

Dierendonck and Vos[37] attempted to date each feature based on the finds in and near the structures and to connect them to the different Roman occupation phases of Aardenburg (fig. 2).

One of the earliest workshops (phase II?), positioned east of the abovementioned road (fig. 2), consisted of two consecutive hearths (or hearth phases) with an external diameter of 1.5m and 1m. Both of the hearths were constructed on top of a small artificially raised work zone using sods.[38] Another workshop/unit with one hearth (external diameter 1-1.3m), south of the eastern road in the heart of the industrial zone, was assigned to phase II or phase III (fig. 2). Most of the securely dated hearths (eight in total) can be ascribed to phase III (fig. 2). As these hearths were spread out across the artisan quarter, they must represent different workshops which were active at different moments in time. Defining the number of workshops or the amount of heating structures per workshop, however, is hardly possible. Definitely, two of these hearths were simultaneously in use since they were internally connected with a flue. North of these hearths, another cluster of eight heating structures was situated closer to the road (fig. 3).[39] Only three of the hearths could be firmly attributed to phase III based on pottery fragments, but a contemporaneous or consecutive use of all eight hearths cannot be excluded. The dimensions of the supposed hearth lining/burned clay vary significantly, but the combustion chamber of six of the hearths is approximately 0.5-0.8m in diameter (fig. 3). In the southern part of the industrial zone, a cluster of three hearths might represent a single workshop with multiple working units active during the final occupation phase (phase IV) of Aardenburg.[40] The remaining thirteen hearths spread out across the debris zone lacked diagnostic material to attribute them with certainty to a specific occupation phase (fig. 2). Together with the remaining debris, they indicate more intense artisanal activities in some, if not all, occupation phases.

In all phases, the heating structures were remarkably similar. They were constructed from clay sods on a prepared slightly raised surface which was regularly reinforced with shells. Although the delineation was often not clear in plan, the external diameter of the features seems to have varied significantly which sometimes resulted in a broad 'hearth lining' compared to the actual size of the combustion chamber. Only taking into account the external dimensions would give false impressions regarding the usable workspace of each hearth. When recorded, the internal diameter of the hearths rarely exceeded 1m and was sometimes as small as 0.5m, indicating rather small heating structures.[41] Finally, during a more recent excavation at Aardenburg Draaibrugseweg (fig. 1 no. 11), a potential workshop was discovered north of the *castellum* at the west bank of the main waterway leading into the coastal plain. The feature itself was badly preserved, making interpretations hypothetical at best. Yet, the presence of vitrified clay elements and hammer scale might be an additional argument to assume artisanal activities in that area as well.[42]

[INSERT FIG. 2]

[INSERT FIG. 3]

3.2. Debris depositions at Aardenburg related to artisanal activities

[37] VAN DIERENDONCK & VOS (2013), p. 325
[38] VAN DIERENDONCK & VOS (2013), p. 179-180
[39] VAN HEERINGEN (1989); DE VISSER (2001); VAN DIERENDONCK & VOS (2013), p. 171-176; 325-329
[40] VAN HEERINGEN (1989); DE VISSER (2001); VAN DIERENDONCK & VOS (2013), p. 171-176; 330
[41] VAN DIERENDONCK & VOS (2013), p. 170-180
[42] WATTENBERGHE & VAN JOLE-DE VISSER (2012)

In addition to the extensive industrial zone with multiple heating structures *in situ*, there are several locations in and around the fort that provide indirect evidence for large-scale artisanal activities. Disregarded during the initial excavation and dismissed by van Dierendonck and Vos[43] are the ash-rich deposits found on top of the Pleistocene underneath the later *castellum* features. In 1961 and 1979, a 0.5m thick deposit of whitish, calcium rich ash was excavated at Tuin Ds. Vis in the northwestern part of the *castellum* (fig. 1 no. 6). The layers were found just outside, underneath and on the inside of the western *castellum* wall. In section (fig. 4), it became apparent that the V-shaped defensive ditch (phase III) and the foundation ditch of the stone *castellum* wall (phase IV) cut through the ash deposition providing a *terminus ante quem* for the layer's accumulation/deposition.[44]

[INSERT FIG. 4]

A similar ash-rich layer was found in the Tuimelsteenstraat (fig. 1 no. 7) underneath a stone building. Samian ware from the workshop of MAIIAAVS (Trier) and an *as* of emperor Trajanus date this ash deposition definitely before 190 CE.[45] In addition, ash layers on top of the (reworked) Pleistocene sand were observed in large areas of 'Weide Quataert' and 'Weide De Smet' (fig. 1 no. 8 and 9). One of these ash-layers was situated stratigraphically underneath the *principia* building of which the construction is dated at the end of the second century C.E. (phase III). According to van Dierendonck and Vos,[46] two early phase II buildings next to and underneath the later *principia* building were covered by an ash layer which they interpreted as a destruction layer, suggesting a violent end of the phase II occupation. If such a destruction event is accepted, the large quantities of ash underneath a substantial part of the later *castellum* would imply that quite a large phase II occupation, much larger than the currently accepted *castellum* area for which there are no indications, got destroyed. Additionally, the destruction of the wooden buildings cannot adequately explain the large calcium concentrations noted in the ash found at the site 'Tuin ds. Vis'. A far more likely scenario is that the ash originated from artisanal activities, conducted during the first military occupation (phase II), got dumped next to the early cart tracks running east-west through the later phase III fort area.

Next to ash layers, more general refuse dumps were also discovered. One of these refuse dumps was situated approximately 200m south of the 'industrial' zone, site Aardenburg Vestinggrachten (fig. 1 no. 5). Even though this dump could only be partially excavated, the presence of multiple vitrified clay elements suggests that debris from nearby artisanal activities was used to (partially) fill a depression in the landscape. The finds are dated between the end of the second and the third quarter of the third century CE which corresponds with the activity at the nearby artisan quarter.[47]

A recent excavation west of the *castellum* called Aardenburg Peurssensstraat (fig. 1 no. 10) provided opportunities to assess the nature and composition of a second debris zone on a gentle slope towards the Ee riverbed (fig. 5). This zone of approximately 500m² consisted of redbrown and darkbrown-greyish debris layers full of pottery, baked clay and vitrified clay elements. A geophysical (electromagnetic induction) survey was conducted north of the excavated area to determine the extent of the site. The results of this survey confirmed the presence of a tidal channel (fig. 1) but

[43] VAN DIERENDONCK & VOS (2013)
[44] JROB (1979)
[45] VAN DIERENDONCK & VOS (2013), p. 112
[46] VAN DIERENDONCK & VOS (2013), p. 115
[47] D'HONDT (2010)

disproved the existence of heating structures preserved *in situ*.[48] Unfortunately, no direct traces nor structures related to craft activities were found on site, suggesting that the craft activities took place elsewhere but that their waste was dumped here. In order to study the composition of the debris layer ten bulk samples (ca. 4600l) were sieved using a 2mm, 5mm and 10mm mesh. Only the > 10mm category contained diagnostic material which was further analysed.[49] Besides pottery, which dates the debris in the second half of the second century, the debris deposition contained two other large object categories: baked clay fragments (3680 pieces; 9,7kg) and sintered clay fragments (1825; 9,5 kg).

The soft fired, porous, purplish white to orange red clay fragments were found abundantly in the redbrown debris layers and to a lesser extent in the dark grey layers (fig. 5). These fragments are extremely weathered due to depositional (dumping, transport etc.) and post-depositional processes and pulverise easily. In this assemblage, only a few fragments can be recognised as salt container sherds. The remaining fragments were categorised as miscellaneous, amorphous, undiagnostic fired clay fragments. Although not quantified in detail, the categories 2-5 mm (19,8 kg) and 5-10 mm (18,3kg) largely consisted of baked clay pieces.

In the sintered clay category, several types could be distinguished: 1) smaller lightweight vesicular, highly porous, pale greenish-grey fragments that resemble fuel ash slag 2) larger, heavier and solid vitrified clay fragments and 3) small amorphous fragments that could not be assigned with certainty to either category. Fuel ash slag is the result of a high temperature reaction between alkali rich fuel ash from the fire and silica-rich material such as sand or clay.[50] As they can be formed in any sufficiently hot fire, they are not indicative of any specific craft activity and their presence has been attested on salt production sites[51] as well as at glass ateliers,[52] metallurgical workshops[53] and so on.

The amorphous greenish -grey objects are highly similar and vary considerably in form and size. In total, 231 fragments weighing 4,6 kg were retrieved from the bulk samples and 198 additional fragments (4,8 kg) were collected by hand across the debris zone during excavation. However, it should be noted that the collected fragments are only a fraction of the material present in the debris layers since the composition was studied through targeted bulk samples and the debris layers were not completely excavated to retrieve all finds. Quite often a thermal transition from highly vitrified inner surface to a slightly vitrified flat/slightly plano-convex clay bottom can be observed (fig. 6). Similar objects have been found in large quantities on other artisanal sites in the Menapian coastal plain as well, for example at Leffinge (> 6000 fragments weighing approximately 150kg).[54]

[INSERT FIG. 5]
[INSERT FIG. 6]

4. Identifying craft activities at Aardenburg: a heated debate

[48] Previous studies, e.g. LANE & MORRIS (2001); OLIVIER (2010); HATHAWAY (2013), have shown the potential of geophysical surveys to detect salt related heating structures.
[49] The results of the recent excavation of Aardenburg Peurssensstraat are part of a separate publication and will therefore not be discussed in detail here.
[50] BAYLEY (1985); BIEK & BAYLEY (1979)
[51] HATHAWAY (2013); BIDDULPH (2016)
[52] BIEK & BAYLEY (1979)
[53] BACHMANN (1982); HAUPTMANN (2020)
[54] Currently, an extensive archaeometric study is being conducted on the vitrified clay fragments from multiple artisanal sites, including Aardenburg, in the Menapian coastal plain. The aim is to determine their composition, how they formed and how they relate to the artisanal process occurring on the sites.

To this day, it remains an open question whether the craft activities at Aardenburg relate to salt production, metallurgy (iron and/or bronze), pottery production or lime burning.[55] The heated 'salt versus lime production' debate of artisanal sites in the North Menapian coastal plain (e.g. Leffinge, Koudekerke, Middelburg and 's-Heer Abtskerke) might have been a contributing factor to the overall caution regarding the interpretation of the artisanal activities at Aardenburg. While Leffinge was never contested as a salt production site,[56] the other sites were sometimes seen as salt production, then as lime production. The discussion peaked in the late 1980s - early 1990s with several small articles in which each side presented their arguments either in favour of salt production[57] or backing the lime production hypothesis.[58] The debate was never truly resolved and while salt production is often put on the forefront, the other possibilities always linger in the background as possible alternatives. The following section presents the expected archaeological evidence of each craft individually and verifies whether (some of) these elements relate to the archaeological evidence discovered at Aardenburg.

4.1. Metallurgy

Throughout history, metalworking has received ample attention which is not surprising given the importance of metal in all aspects of everyday life. Metals can be found in construction material, craft and agricultural tools, weapons, jewellery, domestic objects and so on. Without going into too much detail,[59] a clear distinction can be made between smelting and smithing activities. The former should be seen as the processing of raw ores into alloys (iron, bronze, brass etc.), while the latter is the fabrication and repair of metal objects by forging on an anvil or welding activities.[60] Both activities are well attested on Roman sites as they leave distinct imprints in the archaeological record. The remains of certain hearths and furnace constructions utilized for smelting and smithing can point to a specific craft (iron, bronze etc.), but more often simple, discrete structures were used. While the heating structures are less indicative, the surrounding debris and objects are very informative regarding the nature of the metalworking on site. Metalworking creates heaps of waste (different types of slags, moulds, crucibles, tools, semi-finished productions etc.) of which the type of craft can be derived from archaeological and (petro-)chemical analyses.[61]

At Aardenburg, a small zone (approximately 6 by 4m) south of the road in the artisan quarter (north-eastern corner of Hof Buize I) contained undiagnostic corroded iron scrap material, smithing slags[62] and hammer scale. The lack of smelting slags on site indicates smithing activities rather than iron ore smelting.[63] As these finds occur clustered within a well-defined area and no other traces related to metalworking were found in the 'industrial' zone, the metalworking seems to be limited to a single blacksmithing workshop while most (if not all) of the hearths are involved in other craft activities.

[55] DE VISSER (2001); DE CLERCQ & VAN DIERENDONCK (2006); DE CLERCQ (2011); VAN DIERENDONCK & VOS (2013)
[56] THOEN (1981; 1986; 1987)
[57] OVAA (1972; 1975; 1987; 1988)
[58] VAN DEN BERG & HENDRIKSE (1980); VAN DEN BERG (1988)
[59] For a detailed discussion of metalworking activities, see TYLECOTE (1987), REHREN (2020) and HAUPTMANN (2020).
[60] TYLECOTE (1987); REHREN (2020); HAUPTMANN (2020)
[61] TYLECOTE (1987); REHREN (2020)
[62] VAN DIERENDONCK AND VOS (2013) mention the presence of so-called 'hearth bottom slags' though this could not be verified.
[63] VAN DIERENDONCK & VOS (2013), p. 180

Hammer scale found during a recent excavation (Aardenburg Draaibrugseweg) might suggests the presence of another blacksmith working from a workshop north-west of the *castellum.*[64]

A certain amount of blacksmithing near a *castellum* is to be expected given the constant need to repair military gear and weaponry, the manufacturing of building material such as nails etc. Quite a few forts along the German and Raetian limes and Hadrian's Wall showed evidence of small workshops for metalworking activities.[65] These actions could be performed by soldiers inside the fort in (open) *fabrica* workshops but also by independent civilian contractors working from a workshop district in the *vici*.[66] Closer to home, the late third century hearths and furnaces inside the Oudenburg fort[67] pointed towards specialised bronze-alloy brooch production workshops in combination with iron working.[68] Even though the hearths from Oudenburg showed similarities to the Aardenburg examples, the lack of metallurgical slags, semi-finished goods and metal objects in most of the artisan quarter at Aardenburg indicate that other craft activities took place here.

4.2. Pottery production

Another example of high temperature artisanal activity is the manufacture of pottery. According to van Dierendonck and Vos[69] two moulds (one birdlike figure and one Eros-applique), found in the 'industrial zone', imply some form of pottery production at Aardenburg. Additionally, a production centre of North Menapian handmade ware, found in high quantities in the coastal plain, has been suspected in the vicinity of Aardenburg.[70] None of the heating structures at Aardenburg, however, resemble the known pottery kilns with separate combustion and firing chamber. In addition, near the hearths no misfired pottery was found which is quite common on pottery production sites. Overall, there are only a few indirect indications for pottery production in the vicinity of Aardenburg. In any case, the production of pottery cannot unambiguously be linked to the artisan quarter.

4.3. Lime burning

An older, widely supported, hypothesis stated that the artisan workshops at Aardenburg, and by extension the workshops situated in the North Menapian coastal wetlands, produced lime which was used locally for building activities.[71] To manufacture lime, a calcium carbonate ($CaCO_3$)-rich material (preferably a very pure limestone) was burned at temperatures above 900°C until it decomposed into carbon dioxide (CO_2) and calcium oxide (CaO). The calcium oxide, also known as quicklime, was then mixed with water, a process known as 'slaking', to produce hydrated or slaked lime (calcium hydroxide/portlandite). Once hydrated, the product could be stored for a long time if kept in suspension with water or in airtight containers. When exposed to air, which happened when the lime

[64] WATTENBERGHE & VAN JOLE-DE VISSER (2012)
[65] GRALFS (1994); ALLASON-JONES & DUNGWORTH (1997)
[66] REDDÉ (2006); KOLBECK (2018)
[67] In Oudenburg, 38 hearths representing 53 hearth levels, two furnaces and three hearth pits were discovered. These heating structures belonged to the first stone fort occupation (fort period 4) which is contemporary with the stone fort at Aardenburg (phase IV), VANHOUTTE (*in press*)
[68] VANHOUTTE (2009; *in press*)
[69] VAN DIERENDONCK & VOS (2013)
[70] DE CLERCQ (2009); VANHOUTTE et al. (2009)
[71] VAN DEN BERG & HENDRIKSE (1980); VAN DEN BERG (1988); DE CLERCQ & VAN DIERENDONCK (2006)

was used to create mortar or plaster,[72] it slowly hardened by storing carbon dioxide (CO_2) and releasing water, followed by the formation of calcium carbonate crystals ($CaCO_3$).[73]

To produce lime, two types of lime kilns can be distinguished: 'clamp kilns' and 'flare kilns'. In the former type, alternating layers of fuel and limestone were stacked into a pit or built into a mound which was then covered with clay or turf.[74] As the lime was inevitably mixed with the fuel ash, the end product was of lesser quality. Besides a heating area of varying dimensions and the remains of unburned (or partly burned) limestone, these features left few archaeological traces.[75] The 'flare kilns' were much more common in Antiquity and their construction has been described in detail by Cato.[76] Even though details of the individual lime kilns such as size, shape and construction method slightly differ, the archaeological examples largely match Cato's description. Overall, the lime kilns, approximately 1.5-4m in diameter, consist of a 'calcination chamber' constructed on top of a hearth with a combustion chamber connected to a stoking-pit using a firebox.[77] Preferably, the Romans integrated their lime-kilns in a natural slope which not only thermally insulated the kiln walls but also facilitated the loading and unloading as both needed to be done from the top of the kiln (fig. 7).[78]

[INSERT FIG. 7]

To cut transport costs, these lime kilns were located either near limestone and fuel sources or near the construction sites (e.g. *villae*, towns, forts etc.). Nevertheless, both Demarez[79] and Lavergne & Suméra[80] have suggested that the production predominantly occurred near the raw materials after which the quicklime was transported to the construction sites where it was slaked. Arguments in favour of such a lime trade are the lack of lime quenching pits on the production sites, but also the production capacity of the lime kilns which by far exceeded local needs, for example lime kiln battery at Iversheim (fig. 7) and at Kempraten.[81] In these lime kilns, the stokehole and combustion chamber were situated either at the same level creating a bottom/low-level draft[82] or slightly offset generating a mid-level draft which changed the air-flow and in turn caused the temperature to rise faster. The latter method appears to have been developed from the second or third century CE onwards and was used for example in the lime kiln battery at Iversheim (fig. 7).[83] In any case, kilns with mid-level draft did not replace the bottom/low-level draft kilns as both techniques continued to be used side by side throughout the Roman period. Overall, lime burning was a slow process that could take up to several weeks and consisted of several sequential phases such as loading of the kiln with limestone, the firing

[72] Besides the production of mortar and plaster, lime could also be used in tanning processes or as a soil improver in agriculture (DIX (1982)).
[73] DIX (1982); DEMAREZ (2014); ACKERMANN & KOCH (2015)
[74] DIX (1982); ACKERMANN & KOCH (2015)
[75] DIX (1982)
[76] CATO *Agr*. 38.1-8
[77] DIX (1982); DEMAREZ (2014); ACKERMANN & KOCH (2015)
[78] DEMAREZ (2014), p. 127-130
[79] DEMAREZ (2014)
[80] LAVERGNE & SUMERA (2000)
[81] SÖLTER (1970); LAVERGNE & SUMÉRA (2000); DEMAREZ (2014)
[82] This type was fairly common, see e.g. the lime kilns from Kempraten (CH), ACKERMANN & KOCH (2015), in the Ajoie-area (CH), DEMAREZ (2014), at Sivry-Courtry (FR), SUMÉRA & VEYRAT (1997), at Ghislenghien (BE), DANESE & AUTHOM (2015), etc.
[83] SÖLTER (1970); DEMAREZ (2014), p. 127-29

sequence, the cooling down period and the retrieval of the produced lime.[84] For insulation purposes, the loaded 'calcination chamber' was covered with a clay mantle which, consequently, had to be removed to retrieve the lime. Together with fuel ash, the remains of this clay mantle, unburned or partially burned limestone and lime residue largely make up the debris layers surrounding the lime kilns. As the kilns needed to be dismantled to retrieve the lime, only the lower part of the structure (e.g. combustion chamber, hearth and flue) remains preserved *in situ.*[85]

Taking the construction of 'flared lime kilns' into account, the heating structures discovered at Aardenburg clearly differ in several ways. Firstly, the heating structures were much smaller with a maximum external diameter of a few meters and an internal diameter rarely exceeding 1m which is significantly smaller than the dimensions of the archaeologically attested lime kilns in the Roman world. Secondly, the level topography of the 'industrial' zone of Aardenburg excluded the use of natural slopes for the construction. Thirdly, a flue was only recorded in a few structures while this should be an essential, well-constructed element of flared lime kilns. Theoretically, the heating structures could function as small stacked 'clamp kilns' as described by Dix,[86] but again the dimensions do not fit the known examples and the external kiln walls should be made of stone or brick for which there are no indications on site.[87] And finally, large amounts of unburned or partially burned limestone and lime residue are lacking from both the artisan quarter as well as the debris layers at Aardenburg.

Next to the archaeological evidence, there are several additional arguments disproving the lime burning hypothesis at Aardenburg. First of all, there is the absence of suitable raw material as raw limestone does not naturally occur in the vicinity of Aardenburg. The closest available limestone source can be found in the area of Tournai (Tournai limestone). As Tournai limestone was used as a building material at Aardenburg, the limestone was definitely imported in phase III. Over land, the distance between Aardenburg and Tournai is approximately 75km, but to save costs the stones would have been transported by ship using the river Scheldt and the North Sea. However, several of the workshops predate the earliest Tournai limestone buildings at Aardenburg (the *principia* and baths).[88] In other words, the phase II workshops were active at a time when no limestone was present on site and lime was not needed. Even in phase III, an earth-and-timber fort with a stone *principia* was constructed rather than a stone *castellum* for obvious economic reasons. The large-scale transport of Tournai limestone was too expensive when wood, clay and peat were readily available. As the import of limestone was considered a too costly building material, why would they spend this precious resource as raw material in lime kilns? If this argument already applies to Aardenburg, then imagine the use of limestone as raw materials on all artisanal sites in the Menapian coastal plain (e.g. Middelburg, Koudekerke and 's-Heer Abtskerke) where no stone constructions occur.[89]

Alternatively, van den Berg[90] and van Dierendonck and Vos[91] have suggested the use of shells (mussels, cockles, oysters etc.) as a raw material since they occur in relatively large quantities at Aardenburg and on the other artisanal sites. Little is known about shell lime production during Roman times in northwestern Europe, but for the medieval period shell lime production is certainly attested

[84] ACKERMANN & KOCH (2015)
[85] DEMAREZ (2014), p. 127-139; ACKERMANN & KOCH (2015)
[86] DIX (1982)
[87] Clamp kilns could also be constructed underground in large pits, but there are no indications that this was the case at Aardenburg
[88] VAN DIERENDONCK & VOS (2013)
[89] DE CLERCQ (2009; 2011)
[90] VAN DEN BERG & HENDRIKSE (1980); VAN DEN BERG (1988)
[91] VAN DIERENDONCK & VOS (2013)

in the Netherlands.[92] However, in Roman times, the presence of shells could easily denote consumption practices or shell processing activities, as large concentrations of shells were frequently found on regional non-artisanal habitation sites in the coastal plain as well, for example at Serooskerke[93] and Ramskapelle.[94] Also, in the case of lime production, one would not expect to find such large quantities of shells on the habitation sites. Since the lime burning process would require a large amount of shells, these shells would have been a valuable resource and would simply not have been thrown away. Even if the shell lime hypothesis holds true, the question remains what lime was used for. The number of workshops at Aardenburg (27 hearths in total) combined with the artisanal sites Middelburg and 's-Heer Abtskerke would have produced a significant lime output for which there was only a small local and regional market.[95] Except the military infrastructure at Aardenburg, no stone buildings occur near the artisan quarter.[96] In addition, the local building traditions (wooden farmsteads) in the Menapian sandy hinterland would have prevented export to regional markets as well.[97]

4.4. Salt production

Given Aardenburg's location at the edge of the coastal plain, suggestions have been made that the hearths were involved in the production of salt and derivative products such as fish sauce.[98] The Menapian coastal wetlands have a long tradition of salt production dating back to the middle Iron Age and in the vicinity of Aardenburg several Roman salt production sites are known.[99] These production sites were situated in the vicinity (side-branches) of tidal inlets which supplied the necessary saltwater for the production. The salt marsh vegetation such as samphire, saltmarsh rush, sea lavender, etc. provided ways to improve the brine production efficiency, while the omnipresent peat was exploited as a fuel source and the clay was used to construct the hearths. Similarly, at Aardenburg, the artisan quarter was located in a soggy area close to the Ee river basin connecting Aardenburg with the salt marshes and the North Sea. A macrobotanical analysis[100] of a water well on the outskirts of the industrial zone indicated a freshwater environment on site with nearby a brackish/saltwater environment.[101] Unfortunately, no water management infrastructure was found near the hearths which would unambiguously have pointed towards salt production as was the case in Leffinge.

While lime and pottery production required an enclosed kiln with separate combustion and firing chamber, salt production called for open hearths with accessible salt containers or pans. In these

[92] JANSE (1981)
[93] DIJKSTRA & ZUIDHOFF (2011)
[94] VERWERFT et al. (2019)
[95] A certain amount of lime might have been required to produce mortar and plaster for stone buildings in military *castella* (e.g. Aardenburg, Oranjezon and Roompot) and central places (Wenduine, Colijnsplaat and Domburg). Still, this would not explain why these large production sites occurred isolated far from the raw materials and the supposed consumption sites. Since the production conditions near the consumption sites in the coastal plain would have been practically the same, there are no advantages to producing lime in isolated sites far from both the required resources and the consumers.
[96] VAN DIERENDONCK & VOS (2013)
[97] DE CLERCQ (2009; 2011)
[98] DE VISSER (2001); DE CLERCQ & VAN DIERENDONCK (2006); VAN DIERENDONCK & VOS (2013)
[99] DEKONINCK & DE CLERCQ (*in press*)
[100] These results are briefly mentioned in a few publications but a report of the analysis is lacking. A pollen and diatom study on samples from recent excavations is currently being undertaken which could shed new light on the environment and vegetation surrounding the waterways
[101] VAN HEERINGEN (1989), p. 133-34; VAN DIERENDONCK & VOS (2013), p. 38-9

hearths, the salt containers were placed above the fire using so-called briquetage elements (e.g. pedestals, stabilisers, pinch-props, slabs etc.). The hearths of Aardenburg could have easily functioned in this regard as they were simply constructed with an inner diameter rarely exceeding 1m. However, both in the artisan quarter as well as in the debris depositions, salt container fragments and diagnostic briquetage elements were lacking. Instead, only large amounts of miscellaneous, undiagnostic fired clay fragments were present, a phenomenon often encountered on salt production sites due to the destruction and disintegration of clay built heating structures, work floors etc.[102] The absence of both salt containers and briquetage elements is often considered problematic for the identification of salt production. Yet, this could also signify changing production mechanisms as observed in Roman Britain.

In Droitwich (Worcestershire, GB), Hurst[103] observed a significant increase in production capacity from the second century onwards which he connected to technological improvements. Arrowsmith and Power[104] noted a similar evolution in Nantwich (Cheshire, GB) where they also found fragments of lead sheeting indicating the use of lead evaporation pans from the middle of the second century onwards. Similar fragments dated to the end of the second century were also found in Middlewich (Cheshire, GB), confirming the transition from clay to lead evaporation vessels in a specific salt production area.[105] According to Zant,[106] this improved evaporation technique using lead evaporation vessels was well established in Cheshire by the end of the second century at the latest. In the North Menapian territory, the lack of salt containers on the production sites and the introduction of hearth batteries (e.g. Leffinge, 's-Heer Abtskerke and Middelburg) suggests a similar technological innovation taking place roughly at the same time. Instead of lead, which was not as readily available as in Britain, iron vessels could have been introduced.[107] As both the lead and iron were very valuable in Roman times, they would have been recycled leaving little archaeological trace on site. As these metal vessels probably required different support mechanisms, it might explain as to why no briquetage elements were recovered at Aardenburg, except large amounts of undiagnostic fired clay fragments.

Similar to Roman Britain, this transition from clay to metal evaporation pans could have been a way to increase production to meet an increased demand. However, this transition could not be observed on all production sites in the Menapian *ciuitas* and ceramic containers continued to be used well into the third century alongside metal evaporation pans. For example, in the southern part of the Menapian *ciuitas* along the French coast, multiple sites such as Looberghe (late second, early third century CE), Pitgam (first – early third century CE) and Steene (first – early third century CE) contained large amounts of ceramic salt containers and small circular pillar fragments used to support the containers above the hearth.[108] Unfortunately, no heating structures preserved in situ on these sites making it impossible to reconstruct the hearth dimensions and to determine how these heating structures functioned exactly.

In addition, the 0.5m thick debris layer found at the site 'Tuin Ds. Vis' consisted primarily of calcium-rich ash.[109] As noted above (cfr. 3.2.), this ash-rich debris layer might have been present underneath a large part of the later *castellum*. Large ash deposits are not uncommon on artisanal sites and similar

[102] LANE & MORRIS (2001); HATHAWAY (2013)
[103] HURST (1997), p. 149
[104] ARROWSMITH & POWER (2012)
[105] ZANT (2016)
[106] ZANT (2016), p. 142
[107] The use of large iron salt pans has been attested in the area during medieval times LEENDERS (2007).
[108] HANNOIS (1999); DONNADIEU & WILLEMS (2015); FAUPIN (2017); TEYSSEIRE (2020).
[109] JROB (1979)

calcium-rich ash layers were noted at Koudekerke,[110] Middelburg,[111] 's Heer-Abtskerke and Leffinge.[112] Analyses of comparable ash layer from medieval salt production centres such as Steenbergen (NL), Hulst (NL) and Tholen (NL) also revealed large calcium concentrations.[113] According to Leenders,[114] the high calcium content in the debris might be the result of removing calcium-rich salts, naturally present in the brine,[115] during the evaporation process. Similarly, in Roman times these calcium-rich salts could have been removed resulting in calcium-rich debris layers on site.

Furthermore, the composition of the debris depositions discovered at Aardenburg (e.g. Aardenburg Peurssensstraat and Aardenburg Vestinggrachten) is highly similar to the debris layers of the known salt production site discovered at Leffinge. On both sites, the redbrown and darkbrown-greyish debris layers largely consisted of fired clay fragments, vitrified clay fragments and fuel ash slag. The high amount of vitrified clay elements[116] recovered on both sites was rather surprising as vitrification is indicative of high temperature activities (ca. 900°C) and traditionally salt production has been interpreted as a long-lasting process occurring at relatively low to medium temperatures. A detailed discussion of these vitrified clay fragments falls out of the scope of this paper,[117] but the transition from clay to metal evaporation vessels and the introduction of a new type of heating structure (hearth batteries) might have changed the salt production mechanisms and the way in which the heating structures functioned. Although these vitrified fragments are not indicative of a specific craft and can be found for instance on archaeometallurgical and glass production sites, the fact that these fragments occur both on the known salt production site of Leffinge and at Aardenburg might be additional indirect argument to suspect salt production activities at Aardenburg as well.

Overall, the known presence of nearby salt production sites, the availability of natural resources, the presence of suitable hearth infrastructure, and the similarities between the debris depositions at Aardenburg and other known salt production sites, make it rather likely that at least some (if not all) of the hearths at Aardenburg were involved in salt production.

5. Economic implications of salt production at Aardenburg and the north Menapian territory

In the late second century, the military occupation shifted from the more inland oriented fort of Maldegem towards Aardenburg, located at the mouth of the river Ee and the edge of the coastal plain.[118] A *castellum* was built (ca. 170-185/190) at a strategic position on the intersection of terrestrial and maritime connections and was favourably positioned to control the flow of goods and people.

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[110] VAN DEN BERG & HENDRIKSE (1980)

[111] VAN DEN BERG (1988)

[112] Similar to the vitrified clay fragments, an extensive archaeometric study is currently being conducted on the ash layers discovered on the artisanal sites in the Menapian coastal plain.

[113] LEENDERS (2007); MIENTJES (2015)

[114] LEENDERS (2007)

[115] Next to sodium chloride, the brine always contains a set of other salts (calcium carbonate, calcium sulphate, magnesium chloride etc.) naturally present in seawater. As these salts have a different solubility, they will crystalize at a different moment during the evaporation process, MCCAFFREY et al. (1987); BABEL & SCHREIBER (2014).

[116] Aardenburg: 429 pieces weighing 9,4 kg. Leffinge: > 6000 fragments weighing ca. 150 kg (cfr. section 3.2). However, comparing these numbers is difficult as the material was collecting using different excavation strategies.

[117] See note 54 for the extensive archaeometric study that is currently being conducted on the vitrified clay fragments.

[118] THOEN (1991); DE CLERCQ (2009); DHAEZE (2011)

Additionally, the military presence stimulated the local salt production whether for military use or for trade. Several debris depositions, ash layers and hearths dated to this earliest military occupation are known. The lack of civil occupation traces near the artisan quarter and the simultaneous start of the artisanal activity and the military occupation, implies some form of active military involvement in the local salt exploitation. Positioning salt exploitation sites near the fort ensured the military apparatus of a constant supply of a vital commodity which was used to preserve and prepare provisions, tanning etc.[119] A relationship between the Menapian *ciuitas* and the Roman army was already well established in the second half of the first century CE as evidenced by the *salinatores*-inscriptions.[120] In these inscriptions the *salinatores* of the *ciuitas Menapiorum* and *Morinorum* honoured *Lucius Lepidius Proculus*, a centurion of *legio VI Victrix* stationed at *Novaesium* (Neuss) who was a provisions officer responsible for the legion's salt supply.[121]

Next to a local military supply, salt was also an integral part of larger regional military (and civilian) supply networks. In Britain, next to providing salt to the local residents, several salt producing areas have been closely linked to military supply networks.[122] The fact that these supply systems could be quite extensive has been suggested by Gerrard,[123] who demonstrated that the Dorset Black Burnished 1 pottery industry might in fact be an army-controlled supply line of pottery and salt(ed products) stretching from south-west Britain to the northern frontier (Hadrian's Wall). In *Gallia Belgica*, the *Nehalennia* altars found at Domburg and Colijnsplaat, mentioning four times a *negotiator salarius* (salt merchant) and three times a *negotiator allecarius* (trader in salted fish sauce), provide evidence for a thriving salt trade from the late second century onwards. The provenance of these merchants[124] and the origin of the stones suggest strong connections between the Rhineland, the North Menapian territory and *Britannia* for salt and fish sauce.[125] The consumption of fish sauce has been attested at Aardenburg by a dolium rim fragment bearing the scratch mark ALIIC XI S, indicating that this storage vessel was filled with 11,5 *amphorae* of *allec*.[126] Through private contracts with garrisons stationed at the Rhine limes or contracts with the Roman administration of *Germania Inferior*, these *negotiatores* might have been used to supply the Roman army stationed at the Rhine with salt and fish sauce.[127]

Changing supply mechanisms and/or an increased demand stimulated production and, in addition to the Aardenburg workshops, multiple salt production sites from this period (e.g. Leffinge, 's-Heer Abtskerke and Middelburg) are known. Just as at Aardenburg, these workshops are characterised by a lack of briquetage elements and the omnipresence of vitrified clay fragments which might represent technological improvements of an ancient technique. The introduction of iron evaporation vessels and of the linear succession of heating structures (so-called hearth batteries), present at Leffinge, 's-Heer Abtskerke and Middelburg, would have pushed the production capacity of the area to unprecedented

[119] TSIGARIDA (2012; 2014a; b); DEKONINCK & DE CLERCQ (*in press*)
[120] CIL 11.390; 11.391
[121] THOEN (1986); DEKONINCK & DE CLERCQ (*in press*)
[122] For several salt production regions in Britain a connection to the Roman military supply network has been assumed. For example, the salt production in Central Somerset has been linked to the supply of the Roman legion stationed at Caerleon, HATHAWAY (2013). Also, the 'industrial salt production centres' in Cheshire county (e.g. Nantwich) have been connected to the salt supply of the Roman troops stationed at Hadrian's Wall, ARROWSMITH & POWER (2012), p. 179-82. FINCHAM (2002) even interpretated the Fenlands as a specific taskscape aimed at the production of salt and salted meat for the Roman army.
[123] GERRARD (2008)
[124] Most of the merchants came from Cologne, STUART & BOGAERS (2001)
[125] STUART & BOGAERS (2001); DE CLERCQ (2011)
[126] DE CLERCQ & VAN DIERENDONCK (2006); VAN DIERENDONCK & VOS (2013)
[127] TSIGARIDA (2014a; b)

levels with major economic implications.[128] As suggested by De Clercq[129] and Dekoninck & De Clercq,[130] the Menapian coastal wetlands were intensively exploited in Roman times as a specific taskscape or a productive landscape, focused on the exploitation of salt, to meet the increasing local and (supra) regional salt demand.

6. Conclusion

From the 1970s onwards, multiple artisanal sites have been discovered in and on the edge of the North Menapian coastal wetlands suggesting an intense exploitation during Roman times. The nature of these heated crafts has been a matter of debate for decades and over the years metallurgical activities, pottery manufacturing, lime burning and salt production have been suggested as interpretation. The ambiguous position towards these craft activities slightly downplayed the significance of the area in the wider economic network of northern Gaul.

In this paper, we have attempted to attach the evidence of artisanal activity at Aardenburg to certain craft activities. Situated at the outcropping edges of a Pleistocene sand ridge overlooking the coastal plain and after reviewing the available evidence from archaeological structures and debris layers, we conclude that the workshops at Aardenburg were probably related to salt production. From a landscape-based point of view the site is well-positioned to produce salt as the raw materials were readily available and the location very well accessible to the transport network –both maritime and terrestrial. Already from the middle Iron age onwards, salt has been produced along the southern North Sea basin and in the vicinity of Aardenburg multiple Roman salt production sites are known. Furthermore, as the composition of debris depositions discovered at Aardenburg are highly similar to the debris layers of known salt production sites in the area, for instance at Leffinge, similar crafts activities might have taken place on both sites. The lack of clay salt containers and briquetage elements, one of the major arguments against salt production, might represent technological innovations as seen in Cheshire, Britain. The Roman drive for technological optimalisation might have replaced the small individual clay vessel in favour of larger, better heat-conducting materials such as lead or perhaps even iron evaporation pans. Nevertheless, ceramic containers continued to be used well into the third century alongside metal evaporation pans as exemplified by salt production sites in northern France. While a multifaceted use of the heating structures cannot be excluded, all evidence suggests that at least some (if not all) the workshops at Aardenburg were involved in salt production and that the 'marginal' coastal wetlands surrounding Aardenburg were intensively exploited in Roman times as a specific taskscape or productive landscape focused on the exploitation of salt. As was to be expected in the vicinity of a Roman *castellum,* metallurgical activities occurred in a specific zone in the artisan quarter, but evidence suggest this would have been of minor importance at Aardenburg.

[128] DEKONINCK & DE CLERCQ (*in press*)
[129] DE CLERCQ (2011)
[130] DEKONINCK & DE CLERCQ (*in press*)

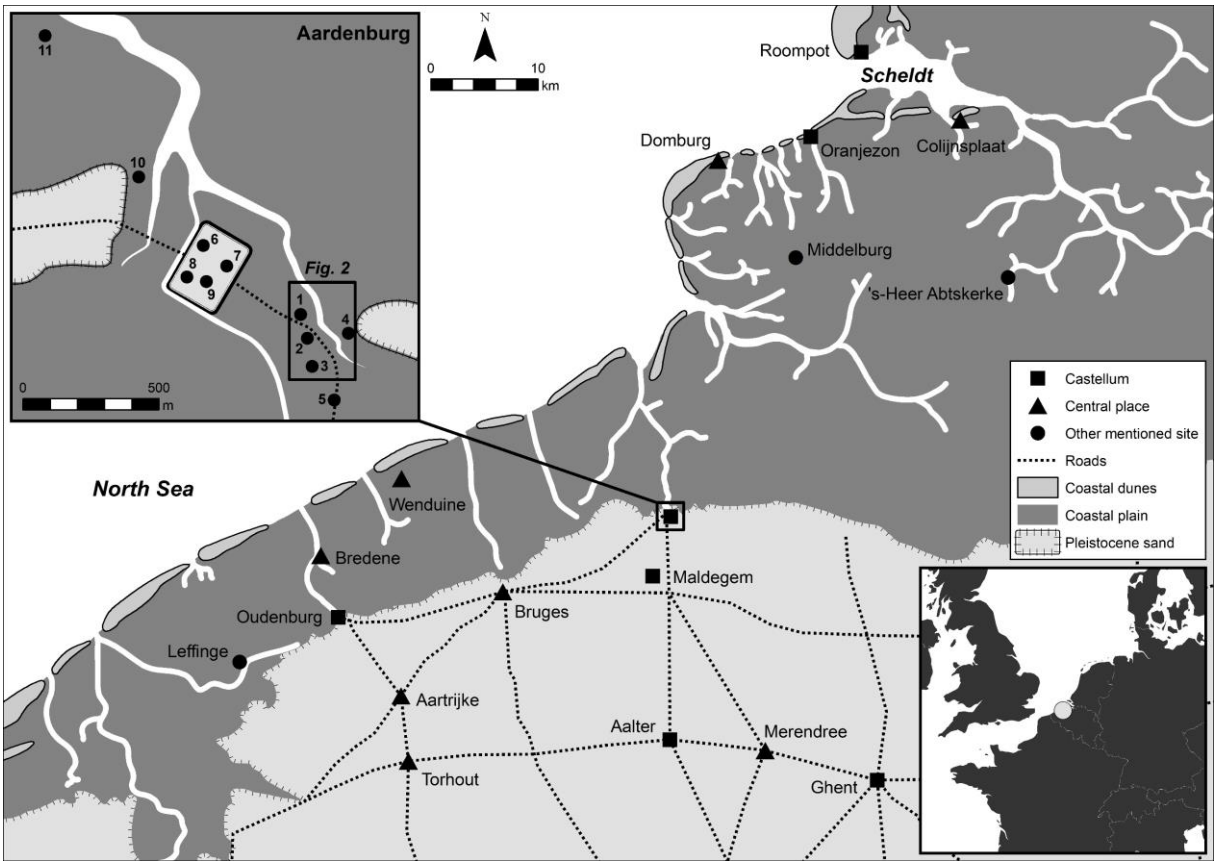

Figure 1. Simplified map of the most important sites in the North Menapian territory in the late second, early third century CE with a detailed map of the Aardenburg area with the sites 1) Oude Stad 2) Hof Buize I 3) Hof Buize II 4) Kamp Rodanborg 5) Vestinggrachten 6) Tuin Ds. Vis 7) Tuimelsteenstraat 8) Weide De Smet 9) Weide Quataert 10) Peurssensstraat 11) Draaibrugseweg.

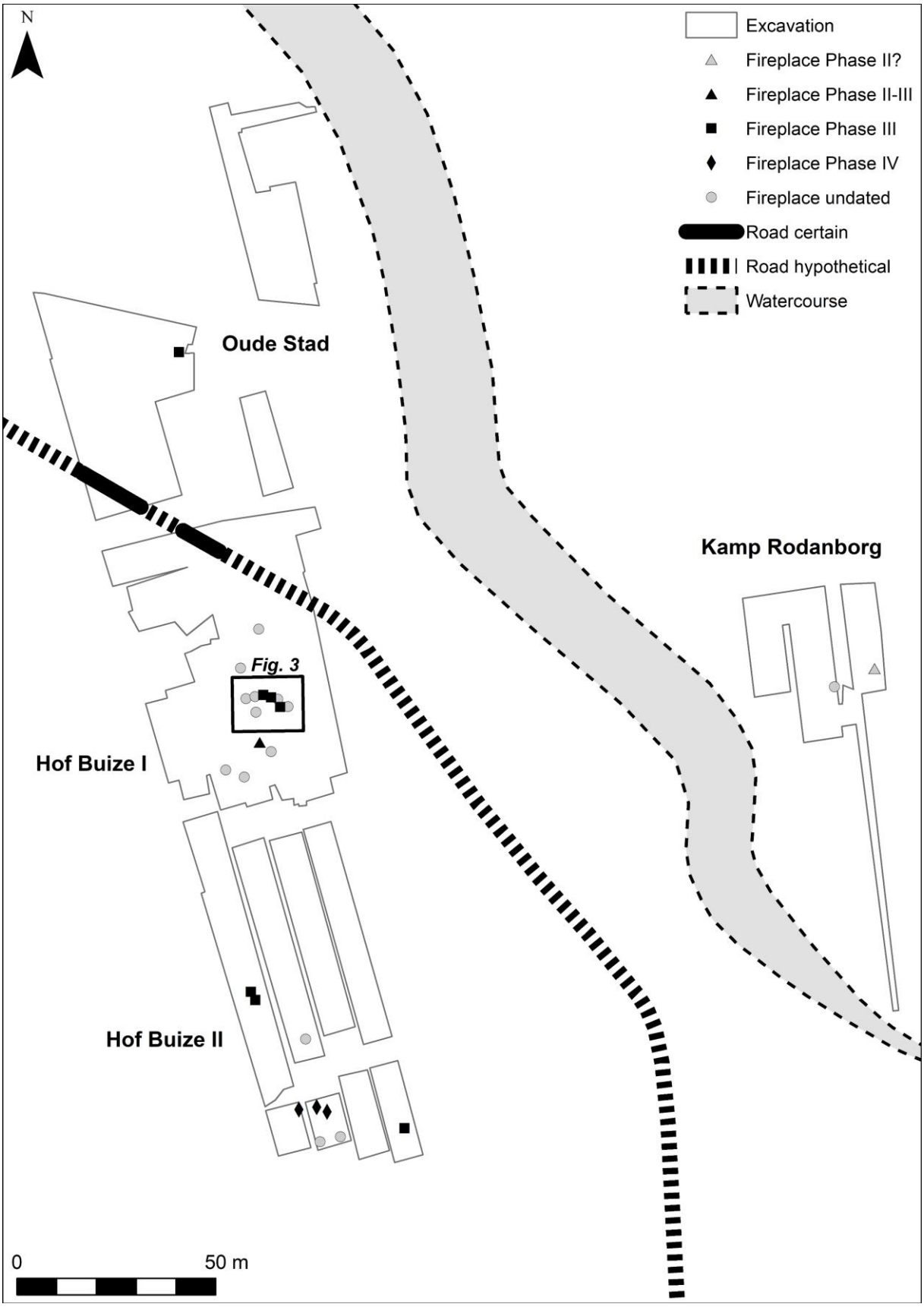

Figure 2. Simplified map of the artisan quarter east of the *castellum* of Aardenburg (supplemented and modified after VAN DIERENDONCK & VOS 2013, fig. 8.21).

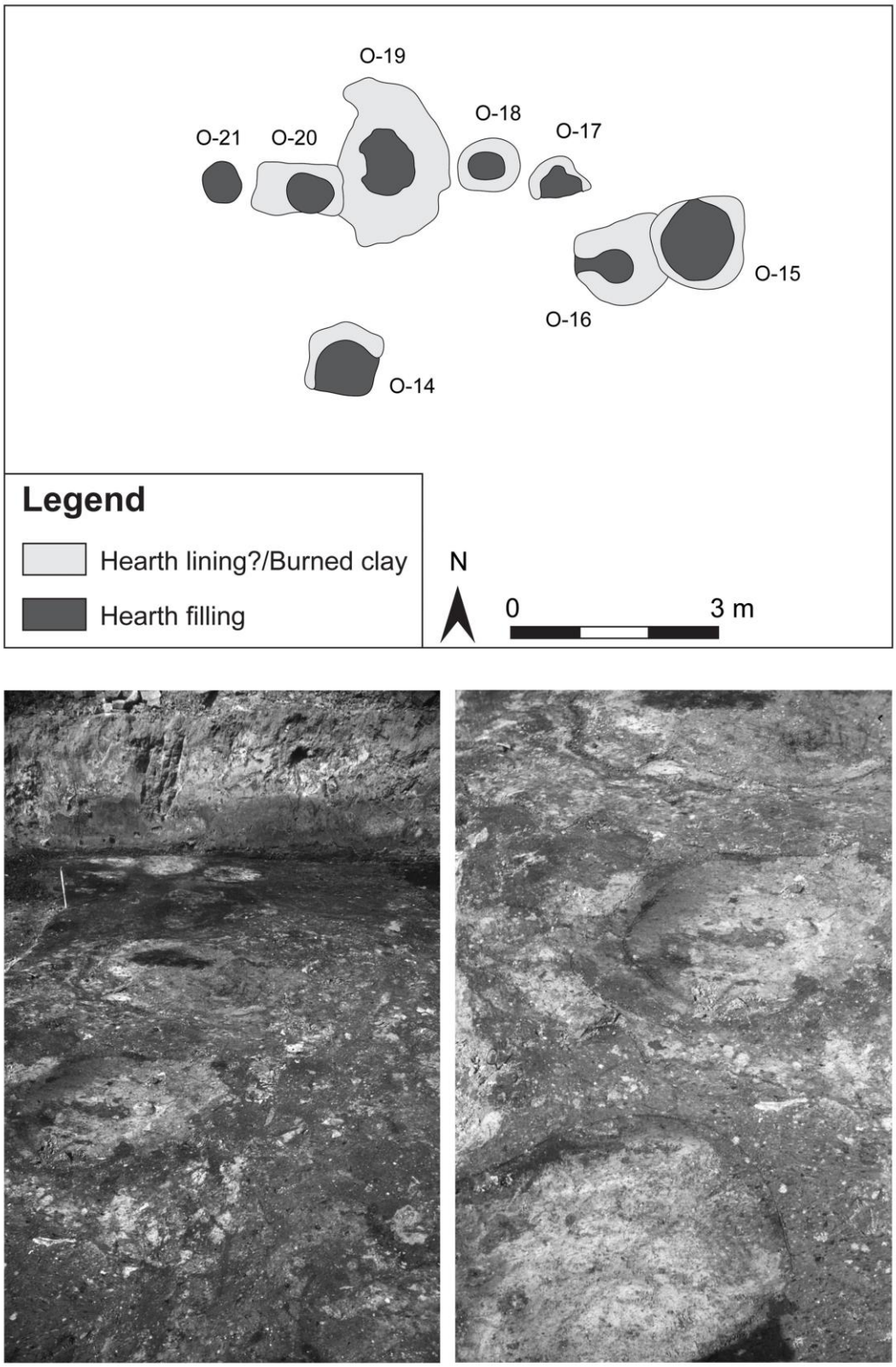

Figure 3. Excavation plan and photographs of the heating structures O14-O21 discovered during the excavation of Hof Buize I in 1976/78. Heating structure O16, O18 and O19 could be attributed to phase III, but the remaining hearths lacked diagnostic material to date them to a specific occupation phase (excavation plan modified after the unpublished excavation archive and VAN DIERENDONCK & VOS 2013, fig. 6.59; the unpublished photographs were made available by Erfgoed Zeeland).

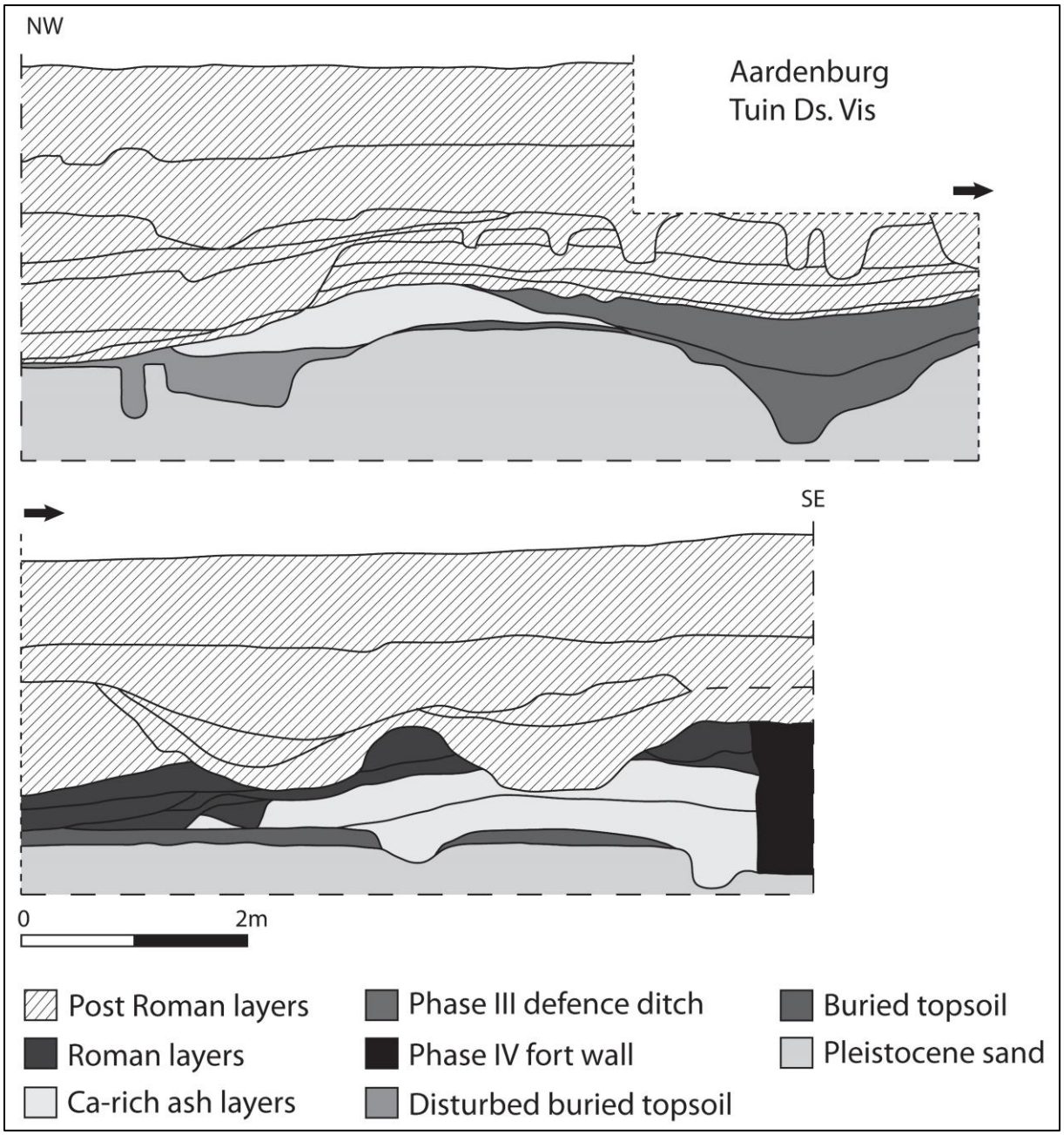

Figure 4. North-west -– south-east profile of excavation 'Tuin ds. Vis' with calcium rich ash layers on top of the Pleistocene subsoil (unpublished excavation archive made available by Erfgoed Zeeland).

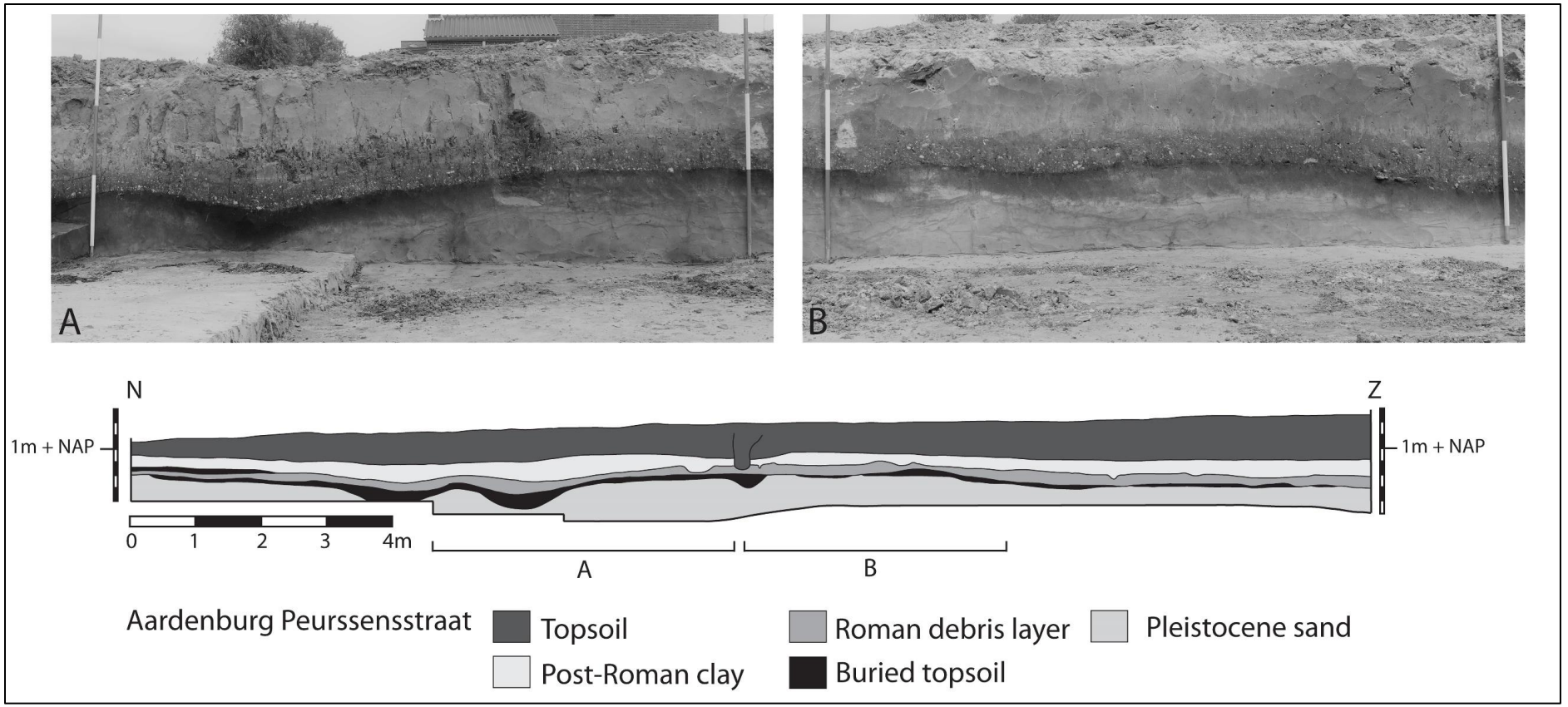

Figure 5. North-south profile of the debris layer found at 'Aardenburg Peurssensstraat' (unpublished data of Bodac and UGent).

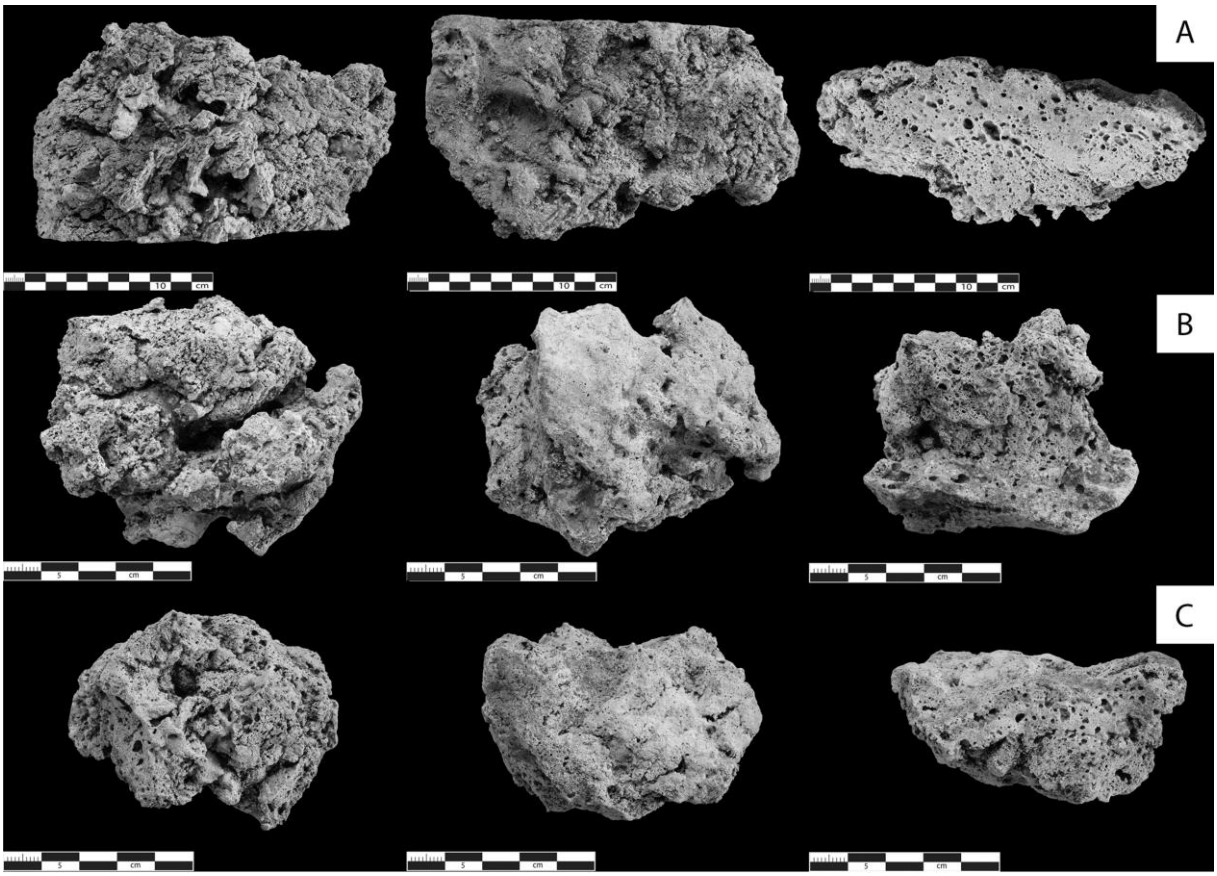

Figure 6. Examples of vitrified clay fragments discovered at Aardenburg Peurssensstraat with the slightly vitrified flat/slightly plano-convex clay bottom on the left, the highly vitrified/glassy inner surface in the middle, and the cross section showing the gradual thermal transition on the right (© C. Verhelst and UGent)

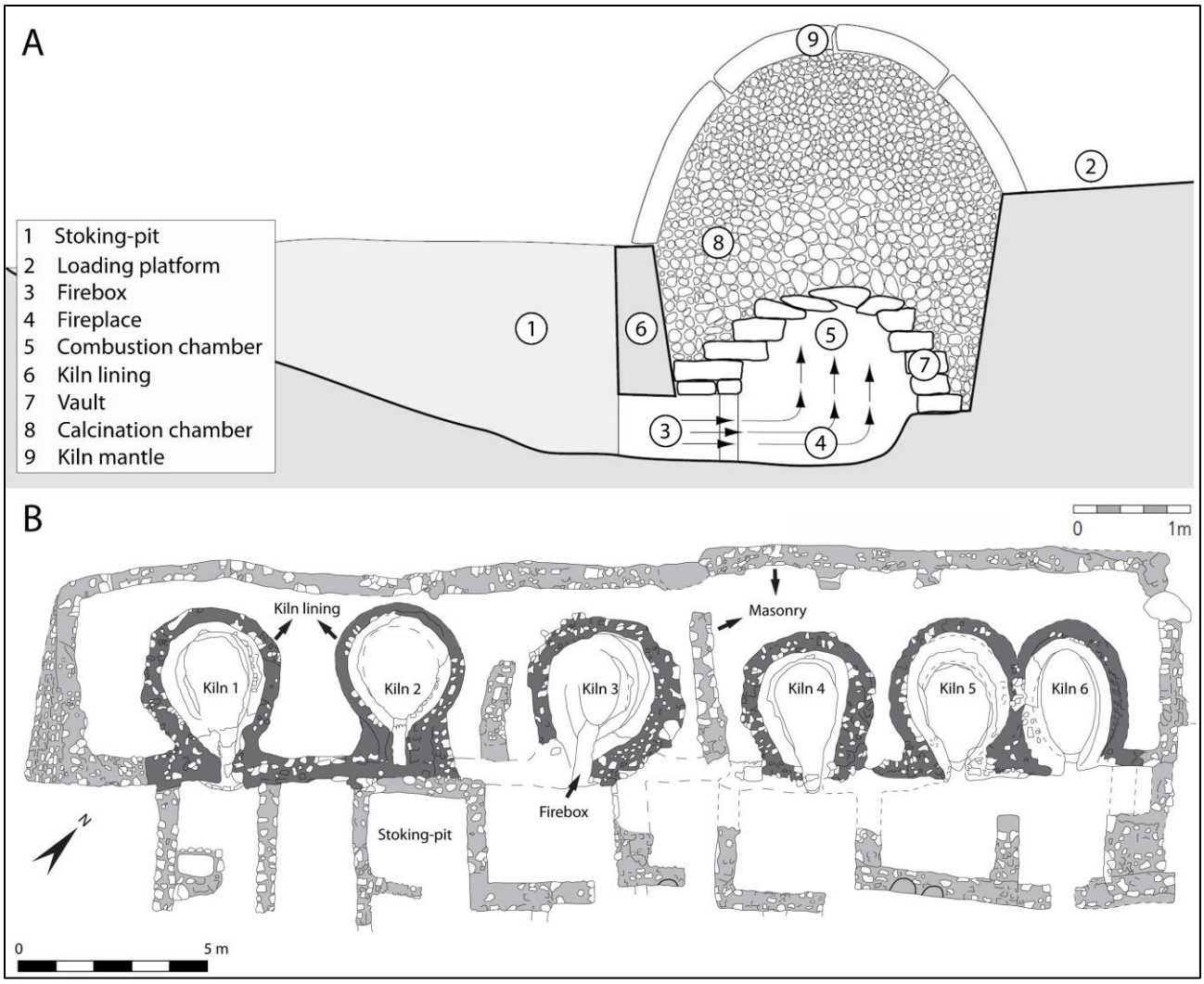

Figure 7. A: schematic reconstruction of a Roman lime kiln (after DEMAREZ 2014, fig. 141-42) and B: excavation plan of the Roman lime kiln battery discovered at Iversheim (DE) (modified after SÖLTER 1970).

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