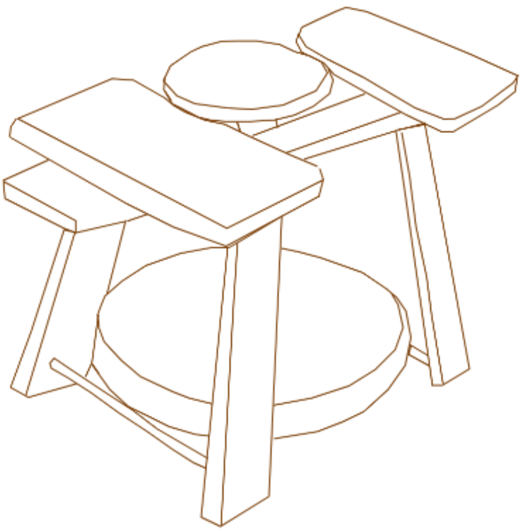
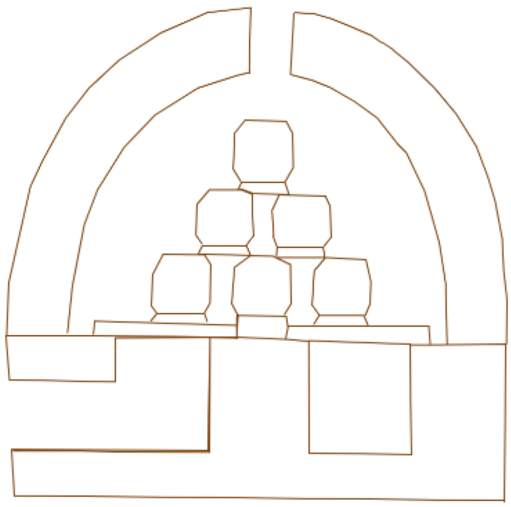
From clay to pot: A study on the production and provenance of Merovingian handmade and wheel-thrown ceramics from the settlement of Oegstgeest

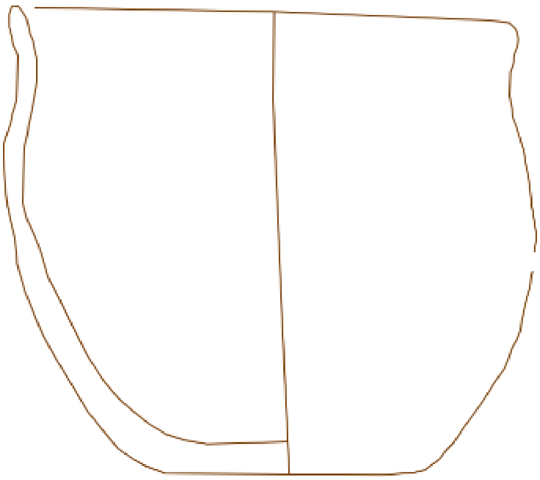
Smedema, Marit

From clay to pot

A study on the production and provenance of Merovingian handmade and wheel-thrown ceramics from the settlement of Oegstgeest







Marit Leonore Smedema

Frontpage: created by M.L. Smedema after De Bruin et al., 2021, p. 201; Marie, 2022; Sam, 2024

From clay to pot

A study on the production and provenance of Merovingian handmade and wheel-thrown ceramics from the settlement of Oegstgeest

Marit Leonore Smedema | S4491068

2425-HS Science Master Thesis Archaeology

Supervisor: Dr. D.J.G. Braekmans

Co-supervisor: Dr. M. Revello Lami

Co-supervisor: Prof. Dr. F.C.W.J. Theuws

Leiden University, Faculty of Archaeology

Zutphen

August 22, 2025

Final version

Acknowledgements

At this moment, you are reading the first page of my thesis about the production and provenance of Merovingian handmade and wheel-thrown ceramics from the settlement of Oegstgeest. This thesis has been written for the completion of the Archaeological Science Master's (MSc) at Leiden University. Already at a young age, I was always looking for little shards and finds I could find during hikes with my parents. I was always looking for treasures from the past, and loved visiting castles. It is therefore not surprising that I ended up choosing archaeology as my field of study. I earned my bachelor's degree in archaeology at Saxion University of Applied Sciences, and during my studies, I discovered my love for Medieval pottery. I chose to do my master's at the University of Leiden, which was quite far away, but I'm very happy that I did.

I would like to thank my supervisor, Dr. D.J.G. Braekmans and my co-supervisors, Dr. M. Revello Lami and Prof. Dr. F.C.W.J. Theuws, for all their help during the writing of my thesis. Thank you for the support, help and great advice! I would also like to thank Eric Mulder for his help in using the XRF and Esther de Kok from Archol for lending us the shards. Also, a big thanks to my parents, sisters, and friends who have supported me during this process and who have also provided me with fun and calm moments in between. Finally, I would especially like to thank my boyfriend, who has been by my side the whole time. Thank you for your love and support, and for motivating me to get out of bed and keep writing. I couldn't have done it without you!

Now I'm very happy to present to you my Master's thesis. I hope you enjoy reading it and that after you will have a different view of the Merovingian handmade ceramics. For after all, don't judge a book by its cover.

Table of contents

List of tables

List of figures

List of Appendices

1. Introduction

Within this thesis, the early medieval ceramics from the settlement of Oegstgeest are researched. This research goes further on the Master thesis of Sophie Vullings (2023) about the production, perception, and value of early medieval handmade ceramics in Northern Gaul. In her thesis, Sophie approaches early medieval handmade ceramics differently to gain new insights into their production, perception, and value in the Merovingian society of northern Gaul. It is an attempt to put these ceramics in a different light, and she encourages further research into this entire branch of material culture that is often underestimated, not well-researched, and misunderstood (p.9). This research will build upon her previous work and provide additional information about the production and provenance of Merovingian handmade ceramics.

The goal of the research is to get a better understanding of the Merovingian handmade ceramics. They are usually overlooked and less researched compared to the Merovingian wheel-thrown ceramics. The wheel-thrown ceramics were produced in specialised large-scale production centres, while the handmade ceramics were produced locally on a household scale. It is therefore often assumed that the handmade ceramics were poorly produced by unskilled potters. The handmade ceramics are, however, far less studied than the wheel-thrown ceramics and the conclusions about them are often drawn too quickly. Within this thesis, the handmade ceramics from Oegstgeest are analysed with a different approach, because they could be more than meets the eye.

During this research, a selection of the ceramics is analysed using a chemical and macroscopic analysis. Also, a literature review is carried out about the Merovingian pottery and the settlement of Oegstgeest. For the chemical and macroscopic analysis, only a selection of the wheel-thrown and handmade ceramics is analysed due to the large quantity of shards. During the macroscopic analysis, the ceramics are examined with the naked eye and a binocular magnifying glass in order to identify, describe and interpret the ceramics and fabric groups. During the chemical analysis, the ceramics are analysed with a handheld XRF (HH-XRF) to assess the chemical composition of the ceramics. The results are compared with the chemical data of Dutch sediments from DINOloket to establish the provenance of the ceramics. For the literature study, peer-reviewed and reliable sources are used to gather information about the settlement of Oegstgeest, the pottery assemblage of Oegstgeest, the production of handmade and wheel-thrown Merovingian pottery, and the provenance of handmade and wheel-thrown Merovingian pottery. Within this study, the handmade ceramics are also compared to the wheel-thrown ceramics from Oegstgeest to see the difference in production and provenance.

During the research, the integrated database of all the ceramics from Oegstgeest made by E.J. Bult is used. Access to this database was obtained through Archol. The integrated database contains the determination of all ceramics from Oegstgeest, which was compiled based on research and determinations by M.E.P. Dijkstra, E.J. Bult, and students within the framework of the Medieval Pottery Lab under the supervision of E.J. Bult.

The research question that will be answered is as follows:

What new insights on the production and provenance of Merovingian handmade and wheel-thrown ceramics can be gained based on a macroscopic and chemical analysis of the ceramics from the Merovingian settlement of Oegstgeest?

The research question will be answered based on five sub-questions. The sub-questions are about the appearance of the Merovingian settlement of Oegstgeest, what is currently known about the production and provenance of the early medieval ceramics, the description of the Merovingian ceramics from Oegstgeest, the chemical composition of the Merovingian ceramics found at the settlement of Oegstgeest, and the difference between the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest based on the macroscopical and chemical analysis.

1.1 Chapter overview

In Chapter 2, an introduction to the Merovingian wheel-thrown and handmade ceramics is given. The different types of wheel-thrown and handmade ceramics found within the pottery assemblage of Oegstgeest are introduced, together with the chronology and production of the handmade and wheel-thrown Merovingian ceramics. In Chapter 3, an overview is given of the landscape, site, structures and pottery found at the Merovingian settlement of Oegstgeest, to give an idea of the context in which the ceramics have been discovered. In Chapter 4, the methodology chosen for this research is given. The research question, sub-questions, sampling strategy and the three research methodologies used are presented. In Chapter 5, the results from the macroscopic and chemical analysis are presented. At the end of the chapter, a summary of the results is given. In Chapter 6, the results are analysed and presented. Chapter 7 holds the conclusion. Based on the results and interpretation of the literature study, chemical analysis and macroscopic analysis, the sub-questions are answered. The main question is then answered based on the sub-questions. In Chapter 8, the interpretation of the results is discussed, and recommendations for future research are given.

2. Merovingian pottery

2.1 Introduction

This chapter provides background information on Merovingian wheel-thrown and handmade ceramics from Europe. Firstly, an introduction to Merovingian wheel-thrown and handmade pottery will be given. The various types of wheel-thrown and handmade pottery identified within the assemblage, along with their distribution, will be discussed. Secondly, the chronology of the handmade and wheel-thrown Merovingian pottery will be outlined. Finally, the production processes of the handmade and wheel-thrown Merovingian pottery will be explained.

2.1 The pottery assemblage

The Merovingian pottery assemblage from the settlement of Oegstgeest includes various types of pottery, both handmade and wheel-thrown. The wheel-thrown ceramics refer to ceramics crafted using a potter's wheel. The wheel-thrown ceramics can be split into red wares, fine wares, and coarse wares. The fine and coarse wares can be further split into oxidised and reduced fired ceramics. The handmade ceramics can be split into Anglo-Saxon wares, late Anglo-Saxon wares, and Hessens-Schortens wares. All these types of ceramics will be introduced in this part of the chapter.

2.1.1 Wheel-thrown ceramics

Rotgestrichen wares/ Red wares

Rotgestrichen ware, also known as red ware, is produced in Mayen and Trier. The Rotgestrichen ware imitates the Late Sigillata wares made in the Argonne region, following the Roman tradition. The two types of earthenware look very similar and are difficult to tell apart (Vullings, 2023, p.13). Rotgestrichen ware is a fine-to-coarse earthenware with red glossy engobe. The ware is connected to 'Pseudo-sigillata' and is mainly shaped as a bowl. The earthenware can also be shaped as plates, dishes, cups, and terrines. This type of pottery is only represented at the settlement of Oegstgeest by one or possibly two shards (Hemminga & Hamburg, 2006, pp.53-54).

Fine wares

Merovingian fine wares are often produced locally, in the German Eifel region, or small production centres alongside the Meuse and Rhine (Verhoeven, 2016, pp. 158-159). In the Netherlands, fine ware production centres include Maastricht and Cuijk. Fine ware vessels are mostly common in burial grounds, but they can be found in lesser amounts in settlements (de Koning et al., 2020A, p.128).

Fine ware mostly has a very fine temper and is medium-hard fired (Verhoeven, 2016, pp.158-159). The earthenware has a smooth wall, which is, in most cases, burnished, making the surface seem shiny (de Koning et al., 2020A, p.128). The colour of the vessels is usually grey or black due to reduced firing, but red exceptions occur that are oxidised-fired. Sometimes, both firing methods can be seen on the same sherd, which is connected to the fluctuation of the amount of oxygen during firing. In those cases, the colour on the outside of the earthenware is leading when identifying the sherd (Hemminga & Hamburg, 2006, pp.53-54). Decorations may include impressions of roller stamps, individual stamps, and straight or wavy incised lines on the upper wall of the vessel. Most of the fine earthenware found in the North of the Netherlands has a narrow opening; however, variations with a wide mouth do occur (Knol, E., 1993, p.64). Most of the fine ware ceramics are biconical pots. As the name suggests, the vessels have a biconical shape. The pots have a carination in the wall, a flat bottom, and a sharp transition to the lower wall (see Figure 2.1) (De Bruin et al., 2021, pp.163-164). For the biconical pots, a total of five basic shapes were identified by Siegmund (1998). The first basic shape (Kwt1) can be identified by a concave upper part of the body. The second basic shape (Kwt2) includes a biconical pot characterised by a straight upper body, a sharp transition between the upper and lower sections of the body, no shoulder ridge, and only a single stamp decoration. The third basic shape (Kwt3) is, for the most part, the same as the second basic shape, except it has a shoulder ridge and/or a roller stamp decoration. The fourth basic shape includes biconical pots that don't fit the other shapes, like coarse biconical pots. The fifth basic shape includes a biconical pot characterised by a straight upper part. A sixth basic shape was later added for vessels with two shoulder ridges (de Koning et al., 2020A, pp.128-129). Jugs, bowls, and spout pots can also be made of fine earthenware, but these occur in lesser amounts (Verhoeven, 2016, pp.158-159).

In the Lower Rhine area, the biconical pots date from 530-640 A.D., but a broader date range from 500-700 A.D. has been applied for this type. From Rhenen, Dokkum-Berg Sion Rothem, and from England, small pots with a round bottom made out of fine earthenware are also known. These pots are dated in the seventh century based, among others, on Dutch parallels. Related Merovingian fine ware with a convex base has also been found in the grave fields of Rill and Eick in the Rhineland (Knol, 1993, p.64).

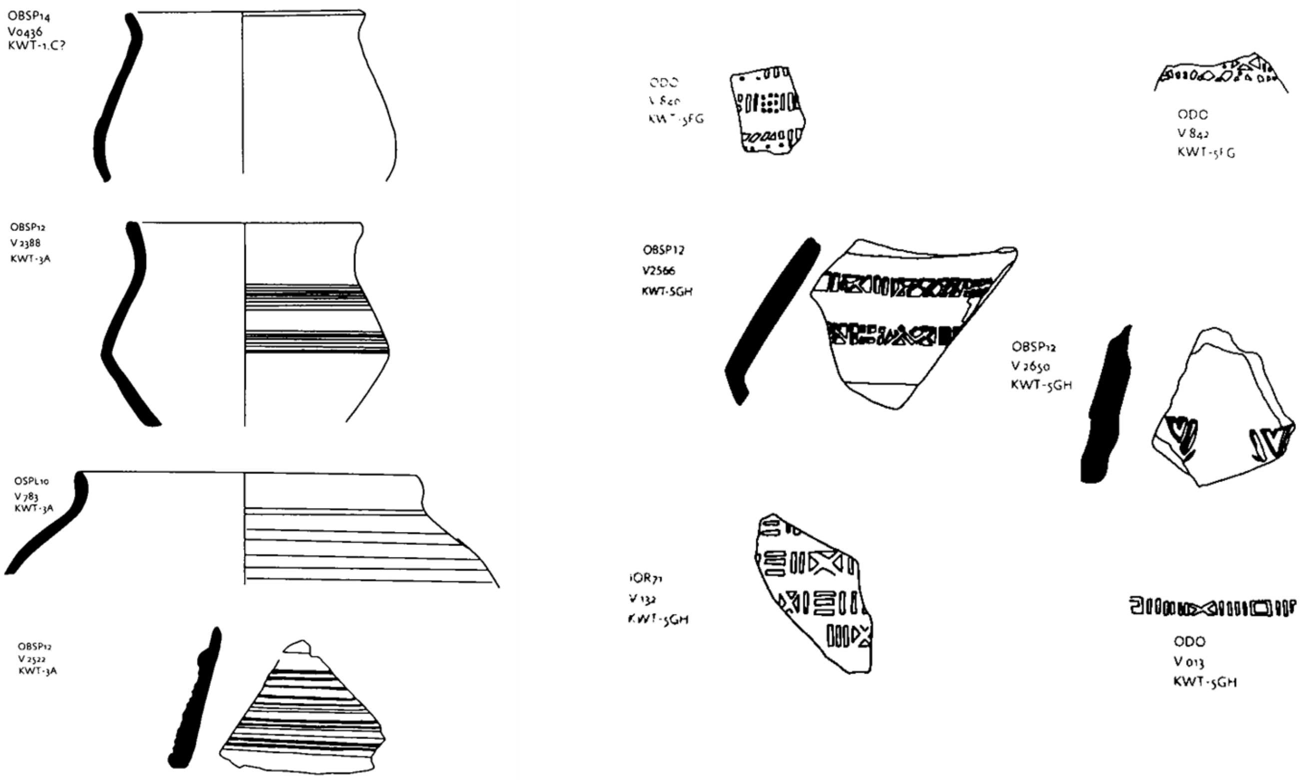


Figure 2.1: Fragments of Biconical vessels from Oegstgeest (De Bruin et al., 2021, p. 166)

Coarse wares

Merovingian coarse ware found in the Netherlands is often produced in the German Eifel region, particularly from the area around the city of Mayen. That's why the earthenware is also called Merovingian Mayen. Aside from that, there were smaller production centres alongside the Meuse and Rhine, which mostly produced for the local market (Verhoeven, 2016, pp. 160-162).

Coarse ware is medium-hard to hard fired, and the temper consists of medium coarse sand and distinctive, angular black particles. The ware is usually oxidised fired, which results in a red or orange colour, but sometimes the ware can be grey or yellow. The yellow coarse ware is made out of a tertiary clay that isn't used in Dutch production centres (Verhoeven, 2016, pp. 160-162). Coarse ware can be identified through the characteristic medium coarse temper that can be felt on the surface. The temper can range from coarsely tempered shards to shards with a fine temper that can just about be felt on the surface (Hemminga & Hamburg, 2006, pp. 53-54). There seems to be a gradual change within the shape spectrum of the coarse ceramics from the late third century up to the Early Middle Ages (De Koning, 2023, p.655).

Most of the coarse earthenware are ovoid pots, which are also called Wolbwandtopfe. These pots can vary in size and rim shape, and are sometimes decorated with lines. The pots can have one or two ears, and they are sometimes shaped like Late-Roman earthenware (Knol, 1993, pp.64-65). Usually, the pots are big and round, and the shards are often very thick and easy to recognise because of the distinct turning ridges on the inside (Verhoeven, 2016, pp. 160-162).

They have a flat to slightly hollow bottom, and the rim can take on a variety of forms (De Bruin et al., 2021, pp. 168-169). The ovoid pots are most likely produced in the German Rhineland. It is assumed that some of the production centres from the Roman period kept producing pottery until the Merovingian or even the Carolingian period. Mayen is one of the most important production centres, where the production continued until the late Middle Ages. Badorf and Walberberg also played an important role in the production of ceramics in the Merovingian period (Van Spelde, 2012, p.21). The spread of the ovoid pots made in Mayen is mostly focused on the areas along the big rivers, notably the Rhine. The Moselle also plays a small role in the spread of the ovoid pots. The Mayen ovoid pots were also recovered at a couple of sites in the Frisian mound area. They were possibly brought via the former Zuiderzee and indicate trade contact beyond the Frisian-Franconian borders (Van Spelde, 2012, p.24).

Two main groups of ovoid pots have been defined, which can be further split into subgroups. The first group (Wwt 1) can be identified by a wide mouth and a narrow base. The three subtypes within this group are not chronologically significant. The second group (Wwt 2), which dates later than the first, consists of higher and more slender pots, which are barrel-shaped. The subtypes within this group are chronologically significant. The type Wwt 2.1 (590-670 A.D.) is wider and less tall, and the type Wwt. 2.2 (670-740 A.D.) is more slender and taller. In summary, the pots go from rather small and wide pots in the sixth century to broader and larger pots in the seventh century (de Koning et al., 2020A, pp.102-103). Throughout the Netherlands, two different types of Merovingian coarse ovoid pots are well represented: Alzey 27 and Alzey 33. Type Alzey 27 has a narrow mouth with a gallery on the inside of the rim (see Figure 2.2). Type 33 has a wide mouth with a shoulder ridge (see Figure 2.3). Both types develop continuously throughout the Merovingian period. During the fifth to seventh centuries, the same shapes were made with almost no alterations, only the fabric changed (de Koning et al., 2020A, p.101). The coarse ovoid pots were most likely used for cooking and storage (de Koning et al., 2020A, p. 102). Jugs and bowls made out of coarse ware also occur (Verhoeven, 2016, p. 160).

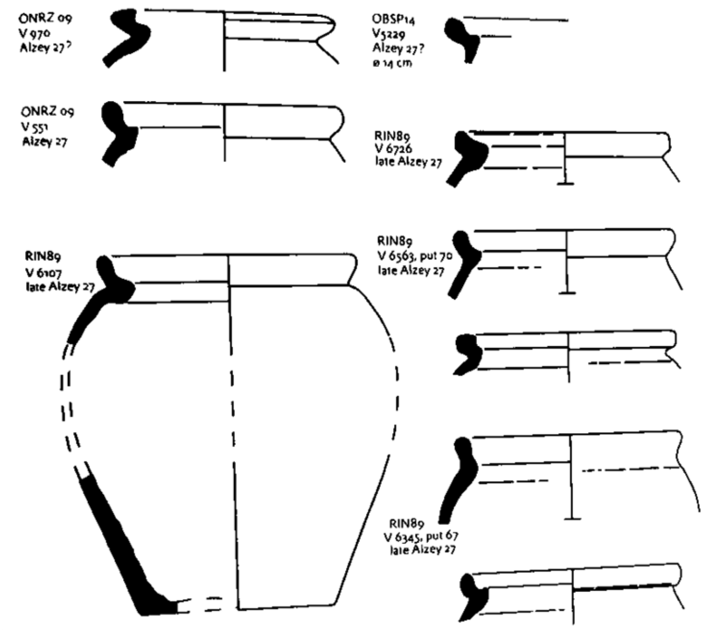


Figure 2.2: Rim fragments of ovoid vessels type Alzey 27 from Oegstgeest (De Bruin et al., 2021, p. 169)

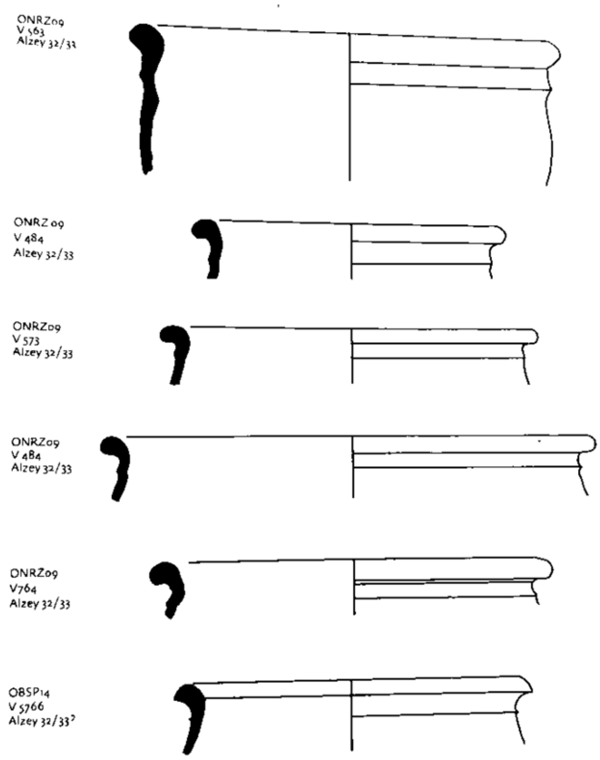


Figure 2.3: Rim fragments of ovoid vessels type Alzey 32/33 from Oegstgeest (De Bruin et al., 2021, p. 169)

2.1.2 Handmade wares

There is no standardised typology for describing handmade Merovingian pottery, due to the lack of closed grave finds and stratigraphic gathered material. The pottery types are mostly identified by surface treatment and inclusions, because these seem to change the most over time rather than shape or decoration (Hemminga & Hamburg, 2006, pp. 66-69). Within a type, a distinction can be made based on decoration or shape. Most of the handmade pots have a three-part shape, which means a pot with a wall, shoulder, and neck (Knol, 1993, p.53).

Anglo-Saxon wares

The group of handmade pottery named Anglo-Saxon ware is, in decoration and shape, closely related to the Anglo-Saxon pottery production, hence the name (Soulat et al., 2012, p.215). Anglo-Saxon wares are known from the Flemish and Dutch coastal areas, the Dutch inlands, and Anglo-Saxon England (Dijkstra, 2011, pp. 352-354). Anglo-Saxon ware is a distinctive style of pottery that originated in Jutland and Schleswig-Holstein. In the fourth and fifth centuries, the Anglo-Saxon wares spread to Lower Saxony (De Bruin et al., 2021, p.197). The earliest Anglo-Saxon pots that are dated by radiocarbon dating are from the fourth century (Lanting & Van der Plicht, 2010, P.142).

Anglo-Saxon ware was most likely made by women on a household scale. There are hardly any pots that are the same due to local preferences. The fact that the shapes and decorations of the

Anglo-Saxon wares are very similar in Northwest Europe can be explained through the exchange of gifts and family ties. There are two types of Anglo-Saxon Earthenware: decorated and undecorated. Both come from Northwest Europe (Dijkstra, 2011, pp. 352-354). The early Anglo-Saxon wares are characterised by an S-shaped rim and typical Anglo-Saxon decorations (see Figure 2.4). Anglo-Saxon ware is mostly black in colour, but can also be brown, red, or yellow. The earthenware is sometimes polished and often has a grit temper (Krol, 2006, pp.10-11).

Decorated Anglo-Saxon earthenware has a temper of fine granite, coarse sand, or sometimes crushed seashells, a black- or brown-spotted smooth surface, and is mostly heavily decorated (Knol, 1993, pp.53-54). The decorations may consist of vertical, slanting, horizontal, and curved grooves, horizontal ridges, chevrons, regular impressions, bumps, stamps, round or oval impressions, rosettes, and even pictures of men and animals. There are two dominant shapes within the decorated variant: a biconical form with a wide mouth opening, called the *Schalenurne*, and a similar biconical form with a narrow mouth opening. Sometimes the pots have dents and bumps, and they rarely have ears. The bottom of the pots developed over time from angular to more rounded; however, there are also pots with a rounded foot/pedestal base (Nieuwhof, 2013, pp.60-61; Knol, 1993, pp.53-54).

The undecorated Anglo-Saxon earthenware has been tempered with fine granite and often has a shiny surface (Knol, 1993, pp.53-54). The shapes are often bionic, sometimes pouch-shaped, or wide-mouthed with a short neck. The pots sometimes have small pinched ears, which can be seen as a form of decoration. Sherds are often mistaken for earthenware from the Iron Age or Roman times. Some shapes are already present in the third century, but this earthenware is mostly present in the fourth to sixth centuries. This earthenware later goes over in Hessens-Schortens (Knol, 1993, pp.53-54).

It is difficult to determine the exact dating of the Early Anglo-Saxon wares. Taayke (2020) prefers a date around the sixth century based on the association with rough-walled imported ware. Knol (1993) states that a connection exists with the local Roman pottery tradition and tends toward an initial dating in the late fourth and fifth centuries. He states that the Anglo-Saxon earthenware can be dated from the fourth century based on North German parallels. It is believed that the Anglo-Saxon pottery from the Netherlands was still in use in the sixth century, based on English Anglo-Saxon pottery. This theory is confirmed based on 14C dating of charcoal from Frisian urns (Knol, 1993, pp.53-54). In Wijnaldum-Tjitsma, the earthenware was introduced in the fifth century and is most characteristic of the sixth century. In the grave field of Rijnsburg-de Horn, it occurs along with other handmade pottery and seems to date to the sixth and seventh centuries (Hemminga & Hamburg, 2006, pp.66-69).

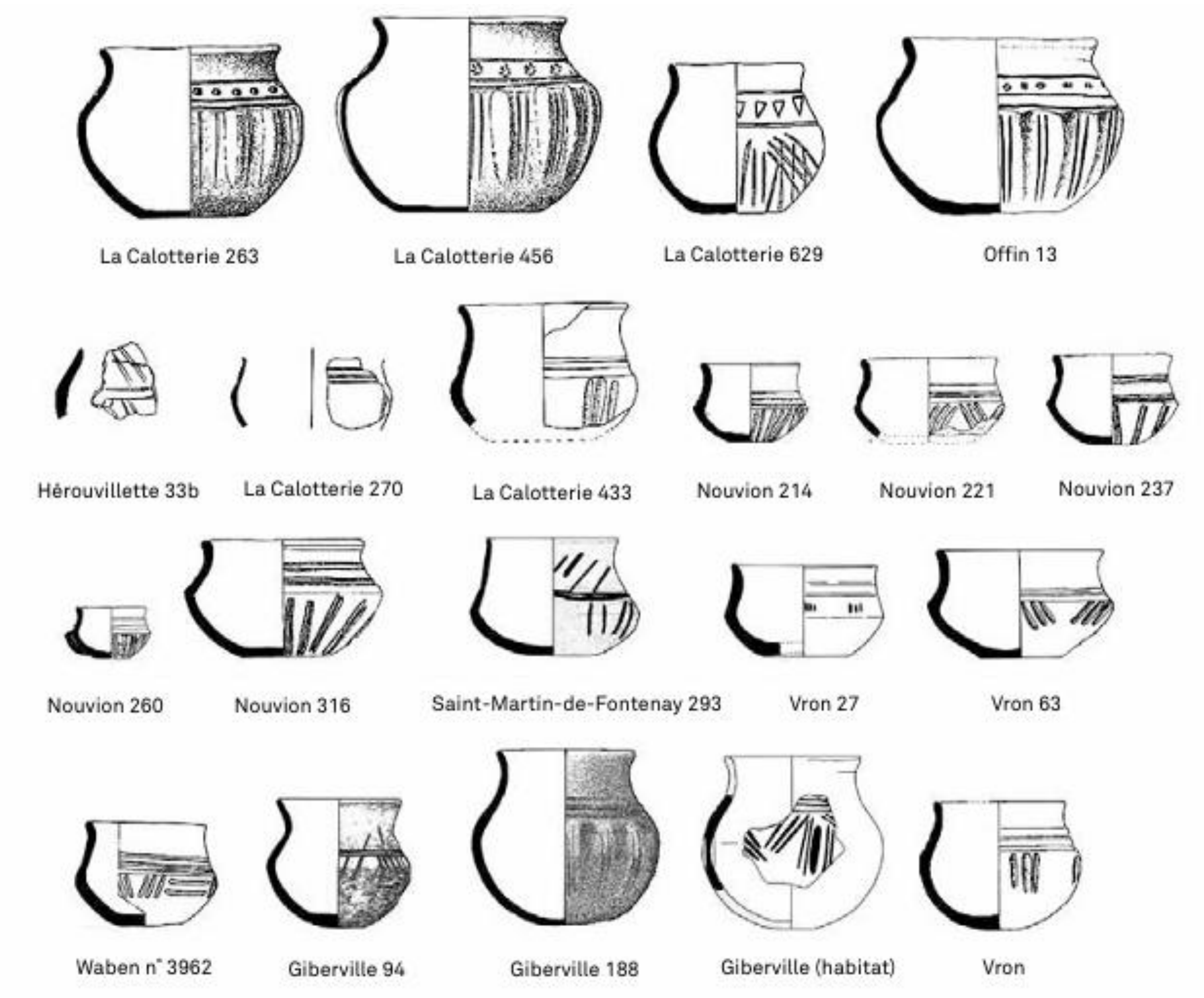


Figure 2.4: Anglo-Saxon pottery from northern Gaul (Soulat et al., 2012, p.217)

Hessens-Schortens wares

The Hessens-Schortens ware, also known as 'Odoorn-Godlinze' or Eitöpfe, is the precursor of the Carolingian *Kugeltopf* (Hemminga & Hamburg, 2006, pp.66-69). This ware is only produced on a household scale and is made for personal use. It is assumed that most of the pottery was locally produced (de Koning et al., 2020B, p.14). There are a lot of variations in fabric and temper. The earthenware is often soft to medium hard, and the temper can vary from fine sand and sometimes coarse seashells to coarse stone dust, which can peek through the surface. Hessens-Schortens is mostly made with a coarse granite dust temper and has a smooth or semi-rough surface (Knol, 1993, pp.55-56). It is, however, unclear if Anglo-Saxon pots that are undecorated and have coarse sand/ fine rubble inclusions, and pots with inclusions of plant remains, also fall under the type Hessens-Schortens. They could belong to the same type because they have, for the most part, the same shapes (Hemminga & Hamburg, 2006, pp. 66-69).

This earthenware is usually dark grey, but sometimes reddish, brown, or black (Knol, 1993, pp.55-56). In opposite to Anglo-Saxon wares, Hessens-Schortens is shapeless, often messy, and most of the time poorly finished and thick-walled. The biconical shapes of the Anglo-Saxon earthenware have disappeared, and the pots are often somewhat irregular, relatively small to large 'bag-shaped' (see Figure 2.5) (Boon, 2011, p.4). The most occurring type consists of egg- or pouch-shaped pots with simple, short, non-thickened edges, a light constriction at the neck, and a flat bottom (Hemminga & Hamburg, 2006, pp. 66-69). Among the three-part forms, a narrow-mouth and a wide-mouth variant can be distinguished. Both have a flat base and an upright or slightly outward curving rim. This rim sometimes tapers on cross-section, and a third form is a neckless, wide-mouth bowl. Small pots with the same surface treatment sometimes already have a round bottom. This also occurs, rarely, with the Wheel-thrown Merovingian earthenware. (Knol, 1993, pp.55-56).

The pots are sparsely decorated. There are sometimes decorations under the rim or on the shoulder, like stripes/scratches, simple line decorations, fingerprints, or stamps. Also, the wall of the pot can be polished (Boon, 2011, p.4). Incidentally, the wide-mouth pots have a small ear on the side or the bottom of the belly (Knol, 1993, pp.55-56). At first, the Hessens-Schortens wares were dated from 450/500-700, but later this was extended to 450/500-800/850 (Nieuwhof, 2008, p.287). The narrow-mouth pots are dated in the sixth and seventh centuries based on finds from the grave field at Schortens in Ostfriesland. In Oosterbeintum and Dokkum-Berg, Sion urns and pots have been found together with objects dating from the sixth and seventh centuries (Knol, 1993, pp.55-56).

At the end of the seventh century, the temper became more coarse and the surface less smooth, because the temper peeked through the surface. The Hessens-Schortens earthenware found in Odoorn could be divided into a quality group with a fine grit and thin wall (quality A) and a quality group with more coarse grit and thicker walls (quality B). The earthenware from Odoorn has been dated from 450/500 to 800/850 A.D., where quality group A is most common with the older forms and quality group B is only present in the possible *Kugeltopf*. There were also pots in Odoorn that had both qualities. This is an indication of the existence of transitional forms between the Hessens-Schortens earthenware and the *Kugeltopf* (Knol, 1993, pp.55-56). It isn't clear when the Anglo-Saxon ware ends and Hessens-Schortens begins, or when Hessens-Schortens ends and the *Kugeltopf* begins. The development of Anglo-Saxon ware to Hessens-Schortens to *Kugeltopf* is seamless and doesn't occur simultaneously everywhere in the Netherlands. Partly because these wares have few typical features and similarities with each other, they are difficult for archaeologists to recognise, especially if only wall sherds remain (Boon, 2011, p.4).

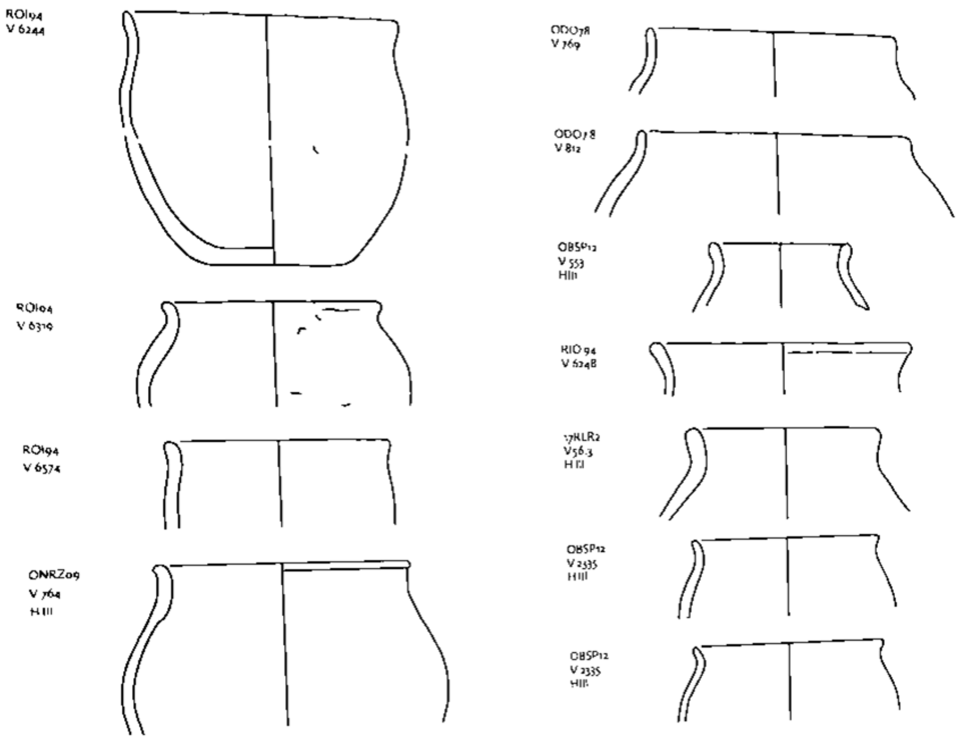


Figure 2.5: Hessens-Schrortens ware from Oegstgeest (De Bruin et al., 2021, p. 201)

Late Anglo-Saxon wares

Late Anglo-Saxon ware has a reddish, grey colour, and the surface feels like fine sandpaper. The shape is often irregular, and the decoration is sloppily finished and fairly sober (Krol, 2006, p.16). This earthenware has a fine temper of granite, and the pots often have a rounded foot/ pedestal base. These types of decorated pots often have dents, and line- or stamp-decorations. Because of the surface treatment, this ware is different from the classical Anglo-Saxon earthenware. Based on finds from graves in Rijnsburg, Wageningen, and Garderen-Beumelerberg, the late Anglo-Saxon ware has been dated to the sixth or seventh century. Parallels for the forms and decorations used in this pottery have been found in England, dating from the sixth century. However, it's not clear if these parallels have the same surface treatment. In South Germany, similar handmade earthenware occurs, which has been dated in the fifth, sixth, and seventh centuries and is known as 'Almannische Rippengefasse'. It is assumed that this earthenware tradition comes from the Elbe area. In southern Germany, as well as in England and the Netherlands, Anglo-Saxon ware developed into the same forms (Knol, 1993, pp. 54-55).

2.2 Chronology

In order to understand how the handmade and wheel-thrown Merovingian ceramics changed over time, an introduction to their chronology will be given here.

2.2.1 Wheel-thrown

Around 460/470, biconical pots are introduced. A concave upper wall identifies the first biconical pots. The later pots feature a straight upper wall and evolve from wide to high, slender vessels. The decoration on the shoulder also evolves, which can indicate the date of the pot. First, the decoration consists of single stamps, which are later replaced by linear or wavy grooves and ribbed patterns. These decorations are also later replaced by rouletting, and composite rouletting was used as decoration in the seventh century. The biconical pots are used in the Netherlands up to the middle of the eighth century (De Bruin et al., 2021, p.164).

Ovoid pots were probably first introduced around 400/450. They were in use together with Carolingian ware, handmade globular pots, and imported wheel-thrown wares in the eighth century. Ovoid pots were in use up to the ninth century in Germany. In the Netherlands, the ovoid pots were replaced by globular pots at the beginning of the ninth century (De Koning et al., 2020B, pp. 167-168). The chronology of ovoid pots is difficult to establish. Van Spelde developed a typochronology based on the comparison and dating of rim types. However, this method has not been tested, so it can't be used with certainty (De Bruin et al., 2021, p.184).

2.2.2 Handmade

Anglo-Saxon pottery first appeared in the Netherlands during the Migration Period, in the fourth and fifth centuries (Krol et al., 2020, p. 410). Early Anglo-Saxon pottery occurs in the coastal areas of the northern Netherlands and is likely produced until the end of the fifth century or the early sixth century. Later Anglo-Saxon pottery has been dated to the late fifth century and early sixth century in the Netherlands. A more uniform decoration distinguishes the later Anglo-Saxon pottery. The decoration consists of groups of vertical lines and long, vertical lugs and indentations or rows of stamps. The late pottery has a protruding foot, a rounded or biconical body, and a high neck. Around the end of the fifth century, the Anglo-Saxon pottery was slowly replaced by Hessens-Schortens ware in most of north-west Europe. Hessens-Schortens ware is coarser and often undecorated. It is assumed that around 525/550 Anglo-Saxon pottery fell completely out of use in the Netherlands (Krol et al., 2020, pp.412-413).

Hessens-Schortens ware replaced the Anglo-Saxon ware around 450 in the northeast of the Netherlands. It is difficult to make a clear chronological development for this earthenware (Krol et al., 2020, p.437). Hessens-Schortens vessels with a tapered lip on the inside date back to the third quarter of the seventh century. In Saxony and Salland, the neckless bowls date back to the fifth and sixth centuries and possibly continue into the seventh and eighth centuries (De Bruin et al., 2021, pp. 202-204). The narrow-mouth pots date back to the sixth and seventh centuries

(Knol, E., 1993, pp.55-56). At the end of the seventh century, the temper became coarser and peeked through the surface. There seems to be transitional forms between the Hessens-Schortens earthenware and the *Kugeltopf* (Knol, E., 1993, pp.55-56). It is, however, not clear when exactly the Hessens-Schortens ends and the Kugeltopf begins. The transition is seamless and doesn't occur at the same time everywhere. Both the wares also share a lot of similarities, which makes it difficult to tell them apart (Boon, 2011, p.4). Around the third quarter of the eighth century, the Hessens-Schortens ware was replaced by the kugeltopfen. In the German coastal area, Hessens-Schortens stayed in use up until the ninth century, next to the Kugeltopf. In Drenthe, this earthenware is also found next to the Kugeltopf until the early ninth century. And in Salland, the earthenware completely disappears at the beginning of the tenth century (De Bruin et al., 2021, p. 202).

2.3 Production

In order to understand how the handmade and wheel-thrown Merovingian ceramics were produced, an introduction to their production from collecting raw materials to firing will be given here. The production of the pottery will be described according to the steps in the chaîne opératoire. The chaîne opératoire can be defined as: ''it describes the whole manufacturing process defined as a series of operations that transform raw material into finished product, either consumption object or tool.'' (Roux, 2017, p.102).

2.3.1 Collecting raw material

The raw material that is used for all types of ceramics is clay (Mittendorff & Berends, 2018, p.5). It is indicated that the selection of clay is closely related to other practices. Through experience, the potters have a good knowledge of the area (the territory in which their communities live, do activities, and socialise). Because of this knowledge, they can easily locate good sources through prospecting and testing, or most commonly, hearsay (Gosselain, 2008, p.70).

When a good source is found, the clay can be extracted in four different ways. It can firstly be extracted just below the surface by clearing the organic and mineral layer, and then extracting the clay (surface collection). This can be done on the ground, but also on a hill or slope. Secondly, it can be extracted by digging a hole in the ground until the most suitable layer is reached (pit extraction). The pits usually have a depth between one and two meters, with a diameter between two and three meters. However, they can be as big as quarries. The pits can be used multiple times, but are often abandoned after the potting season, when the layer of clay is entirely exhausted or because of the rising water. Thirdly, the raw material can be extracted from galleries. They start by making a vertical shaft, and when the intended clay bed is reached, a horizontal shaft is added. Most galleries are abandoned after the potting season, but can be used for several years. Lastly, the raw materials can be extracted from the bottom of the river (underwater extraction). This method is quite uncommon and is mostly used during the dry season, when the water recedes (Gosselain & Livingstone Smith, 2005, pp.35-36).

Most of the time, the raw materials are collected from a source that is located within ten kilometres of the potter's workplace (Kramer, 1985, p.80). In a field study in Niger, where 206 clay sources were accurately located, one-third of the sources were within 1 km, two-thirds within 3km, and three-quarters within 5 km walking distance from the potter’s workplace (Gosselain, 2008, p.70). Sometimes the raw materials can also be purchased from middlemen. There hasn’t been a lot of research on the location and characteristics of potters' workshops, but it is indicated that most of the potters work where they live (Kramer, 1985, p.80).

2.3.2 Preparing the raw materials

The processing of the clay can be divided into four categories: pre-treatments, removal and addition of non-plastics, and homogenisation. During the pre-treatments, the raw material is dried, soaked, or soured for one or more days (Gosselain & Livingstone Smith, 2005, pp. 37-39). Most of the time, after the extraction of the clay, it is first stored in the open air for a minimum of a year. By airing the clay, the organic impurities decay, which makes the clay more suitable for processing. Clay is naturally too plastic, which makes it hard to shape (Mittendorff & Berends, 2018, p.5). After the pre-treatments, a few methods can be used to remove unwanted non-plastics, like hand sorting or crushing, pounding, grinding, sieving, shaking, or winnowing the raw materials. Sometimes, potters mix a part of the raw materials with water to make a thick solution, which they then put into the pottery paste. The addition of non-plastics to the clay paste is also called tempering. Temper can be added in order for the clay to hold its shape and to prevent the clay from breaking in the oven. Not all potters add tempering to the clay. A lot of materials can be added as temper: dust, mud, soil, clay (same or other), rocks, sand, iron stone, crushed potsherds, straw, dung, bark, ash, grass, shells, or stems (Gosselain & Livingstone Smith, 2005, pp. 37-39; Mittendorff & Berends, 2018, p.5). Lastly, the clay paste is homogenised through kneading, trampling, or pounding (Gosselain & Livingstone Smith, 2005, pp. 37-39).

Each of these steps in making the pottery is influenced by a lot of factors including: the potter’s environment (natural and cultural), the properties and qualities of the raw material, traditions, the changes made to the raw material, the available raw material, political or economic changes, religion, ethnicity, ideology, the local geology, patterns of settlement and land tenure, the intended vessel's function, individual perceptions of raw materials, and the techniques employed in other stages of the manufacturing process (Roux, 2017, p.103; Beltrame et al., 2020, p.130; Gosselain & Livingstone Smith, 2005, p.34).

Most potters follow tradition; they use the same techniques, recipes, and tools as their teachers. They insist on using a specific clay recipe, but use the same preparation technique for vessels with a different function (Gosselain & Livingstone Smith, 2005, p. 41). It has been indicated that most of the potters know of different clay processing recipes and seem to link them to specific social identities. Most of the time, the potters will then only use the recipes of the community/ social identity that they identify with. So, for example, in southwest Niger, specific recipes for processing clay appear to be widely understood and used as technical expressions of social and communal identity within the communities (Berg, 2008, p.72). In eastern Niger, there is also evidence that shows that recipes tend to become standardised within kinship networks that span large areas. These areas represent a collection of tradition and experience shaped by family ties and bound through marriages and movements (Gosselain, 2008, p.72).

2.3.3 Shaping of the vessel

Multiple techniques can be used to shape the vessels. The forming techniques can be divided into techniques that use rotating kinetic energy (wheel-made) and those that don't use rotating kinetic energy (handmade). Wheel-based forming techniques involve the use of rotational motion and include methods such as wheel-throwing, a common roughing out and preforming technique. Three other preforming techniques that use rotating kinetic energy are wheel moulding, wheel coiling, and turning (Roux, 2017, p.104). Vessels made using these techniques mostly have a regular shape, a uniform surface, and a clean and smooth fracture. The sherds can be easily recognised by horizontal rings (Mittendorff & Berends, 2018, pp.5-6).

Eight forming techniques do not use rotating kinetic energy (handmade). These can be divided into two groups: those that work with assembled elements (the slab technique and the coiling technique by crushing, drawing, and pinching) and those that shape a solid clay mass (modelling by drawing and pinching, moulding, and hammering). Seven preforming techniques also do not use rotating kinetic energy. These can be further divided based on the state of the clay: techniques applied to wet clay and those applied to leather-hard clay (Roux, 2017, p.104). Handmade vessels usually have an irregular shape and surface, and an erratic fracture. Most of the handmade pots are made within the household and are for personal use. Wheel-thrown ceramics are generally produced on a large scale in production centres. In the early Middle Ages, most of the wheel-thrown vessels were imported, and the handmade vessels were made locally (Mittendorff & Berends, 2018, pp.5-6).

Most techniques rely on a specific clay recipe for the right application. You cannot throw a vessel, for example, if the clay isn't in a specific hydric state. A lot of the techniques give different results when they are applied to different materials. The vessel can be formed from one piece of clay or segments. The shape and size identify a segment, for example, a coil, ring, band, or slab. The easiest way to join segments is by connecting their edge surfaces at right angles, forming the shortest joints that run perpendicular to the vessel. Larger contact areas between the segments enhance the mechanical strength of the vessel. For this reason, many forming traditions use inclined surfaces, overlapping joints, or irregular joint shapes when joining segments. Wheel-throwing, drawing, moulding, and pinching are all techniques that use one piece of clay for the modelling of the vessel. The basic form of the vessel is then made from one piece of clay, which is incorporated into the vessel (Thér, 2020, pp. 4-5).

Just like the preparation of the raw materials, shaping techniques likely hold high social significance. Most potters have a technique that is passively known and highly favoured. This technique is almost always associated with specific groups, passed down through generations, and used to express a particular social identity. Most potters are aware of other shaping techniques and may incorporate elements of these into their practices. If the identities connected to these other or new techniques conflict with the identity the potter was born into or personally claims, the adoption of such technologies might be significantly hindered, even when their technical advances are evident (Gosselain, 2008, pp. 74-75).

2.3.4 Surface treatment

After the vessel is shaped, its surface is treated, and the finishing touches are added. The finishing techniques can be used on wet clay (smoothing) or on leather-hard clay (brushing and smoothing). Surface treatments alter the vessel's surface and involve either rubbing the surface or applying coatings. There are three decorative techniques divided by their dimensionality.

- One-dimensional or low-relief decorating, such as painting.
- Negative relief or recessed decorations, which include impressed (simple, rolled, pivoting), paddled, incised (simple, pivoting, scratching, carving), and excised (excised, pierced) techniques.
- Two-dimensional or high-relief decoration, involving applied elements or moulded forms (Roux, 2017, p.104).

Usually, the decorations are applied to the vessels before firing (Kramer, p.82). Most of the early medieval ceramics aren't decorated, especially the handmade vessels. The following decorations occur mostly on Merovingian wheel-thrown vessels: simple thumb and finger stamps, engobe (Mittendorff & Berends, 2018, p.7), impressions of roller stamps, straight or wavy incised lines (De Bruin et al., 2021, p.163), grooves, horizontal ridges, chevrons, regular impressions, bumps, round or oval impressions, and rosettes (Nieuwhof, 2013, pp.60-61). In the early Middle Ages, glaze was applied in patches scattered on the outside of the pot for decoration. In the late Middle Ages, glaze was also applied to the inside of pots to make them less porous (Mittendorff & Berends, 2018, p.7).

2.3.5 Firing

The final and very crucial step is firing, which gives the vessels their final properties. These properties are not only influenced by the clay's characteristics, but also by the firing temperature, heating rate, duration of exposure, and firing atmosphere (Roux, 2017, pp. 104-105). The firing of the ceramics could be done in two different ways. The first one was to fire the ceramics in a pit (field kiln). This was the easiest way to fire pots, and was mainly applied for household production. This firing technique could only be applied to smaller quantities. This technique involved digging a pit in which a fire was built. After that, the ceramics were placed inside the pit, and the pit could be closed. A disadvantage of this technique was that the temperature of the fire couldn’t be controlled very well. Because of this, there was a risk that the pots would be baked too soft if the temperature was too low, or that the pots would break if the temperature was too high. The level of oxygen is also difficult to control inside the pit, which is why the ceramics can have colour patches (Mittendorff & Berends, 2018, p.6). The field kilns were often located at some distance from the potter’s workshop to avoid competitors from looking, exposure to damage, or all the smoke. A small number of potters do not fire their own ceramics. The field kilns could be fuelled with a lot of different materials, for example, animal dung, wood, coal, and plants (Kramer, 1985, p.81).

Another way to fire the ceramics was by using a closed kiln, lying or standing. This technique was seen as more advanced and could be used to fire large quantities of ceramics (Mittendorff & Berends, 2018, p.6). The size of the kiln's firing chamber can indicate how many vessels were fired at the same time (Kramer, 1985, p.81). The building and firing of the oven was very time-intensive and could take several days. The advantage of this technique was that the temperature could be controlled very precisely, making the chance of a mistake far less. Also, the amount of oxygen could be controlled inside the oven, which helps determine the colour of the ceramics (Mittendorff & Berends, 2018, p.6).

When there is a lot of oxygen, you talk about an oxidising firing process. During an oxidising firing process, iron-rich clay turns brown, orange, or red, and calcareous clay white or pink. When there is no to little oxygen, you talk about a reducing firing process. During a reducing firing process, iron-rich clay turns black to grey, while calcareous clay turns yellow. Sometimes we can speak of a combined firing process, with both firing processes. This occurs when, at the end of the firing process, oxygen is added to the oven, which causes the outside to turn red and the inside to stay dark. This is often visible on the fracture of the shard (Mittendorff & Berends, 2018, p.6).

3. The settlement of Oegstgeest

The site of the settlement of Oegstgeest was found in 1990. Surveys and trial trenches defined the limits, indicating the presence of well-preserved remains that promised to reveal an almost complete settlement. In the following years, ARCHOL B.V., ADC archeoprojecten, and the faculty of Archaeology of Leiden University excavated the site (De Bruin et al. 2021, p.7). This chapter introduces the landscape, settlement, and pottery found at the site.

3.1 The landscape

3.1.1 Formations and deposits

The landscape of the early medieval settlement of Oegstgeest consists of Holocene river deposits that fall under the formation of Echteld, previously known as the Betuwe formation. The Holocene river deposits were deposited by the river Rhine (Hemminga & Hamburg, 2006, p.11). The Rhine originates in Switzerland, flows through Germany and part of France, and empties into the North Sea in the Netherlands. During the Early Middle Ages, the main channel of the Rhine was located in the northern part of the delta, with its mouth near Katwijk. Oegstgeest is located 4 km from Katwijk, which indicates that the early medieval settlement was located in a deltaic environment close to the sea (De Bruin et al., 2021, p.8). The Rhine is a meandering river, meaning that the river has one, more or less strong meandering riverbed (Hemminga et al.,2006, p.11). Along the coast, the landscape featured a series of former beach barriers and low dunes, alternating with lower-lying areas. The river cut through these barriers, and ebb and flood tides accessed the hinterland via a narrow, funnel-shaped mouth. As a result, the inland areas were influenced by the tides, making the land near the river brackish. The brackishness decreased towards the east and is believed to have extended up to 15 km upstream (De Bruin et al., 2021, p.8).

During periods of high tide, the river regularly overflows its banks and causes floods. When the floodplain (the lower-lying area behind the levees) floods, coarse sediment is transported and remains in the riverbed, while the finer sediment is carried to the flooded area. In the floodplain, the flow velocity of the water then decreases, leading to the deposition of coarse sediment (such as sulphur and light clay). The coarse sediment is collected next to the riverbank where a levee forms. The finer sediments (medium-heavy clay) are transported further into the lower-lying area behind the levees. When the water level in the river drops, the water in this plain is cut off from the river by drying embankments. In this stagnant water, the fine sediment gradually settles. The lowest parts of the basin are very wet, even when there are no floods. In these areas, peat may begin to form. The layers of peat gathered here are classified under the Nieuwkoop formation, previously known as the Broek formation (Hemminga & Hamburg, 2006, p.11). During peak discharges, mainly in winter and spring, the lower sections of the levees and the floodplain may flood. If a levee breaches, a crevasse might form. When water breaks through a levee via a gully, it deposits new sediment, creating a crevasse. During high tides, other crevasses can form when the river's flow is obstructed (De Bruin et al., 2021, p.8).

3.1.2 At the site

At the site of the settlement of Oegstgeest, the levee was intersected by crevasse gullies and small streams. In the western part of the Rhine, water flowed through two channels that divided and merged regularly. This, combined with drainage from crevasses and watercourses, created a patchy environment with islands. The area featured alternating dry areas and wetlands, where the higher and drier parts of the levees were inhabited (De Bruin et al., 2021, p.8).

The Merovingian settlement of Oegstgeest was situated on the northern bank of the Rhine, one of the most important rivers in North-West Europe, near the North Sea. The settlement was built on the higher and drier parts of the landscape. These areas were not always dry, as they were dissected by gullies and small streams (De Bruin et al., 2021, p.11). The landscape immediately surrounding the settlement of Oegstgeest was an estuarine, brackish floodplain with no trees. Even in more distant areas, trees were absent due to the formation of peat. However, alder carr could have grown at the inland edges, where fresh water was available. The presence of trees might also be expected on the higher parts of the landscape, such as levees and former beach barriers. At the time of the Merovingian settlement, the climate was relatively cold, a period known as the Dark Ages Cold Period. This era spanned from 250 to 700 AD, with a wet period from 1 to 500 AD and a drier period from 500 to 800 AD. In conclusion, the inhabitants of the Merovingian settlement experienced a relatively dry but cold climate (De Bruin et al., 2021, pp.10-11).

3.2 The settlement

The settlement was divided into four clusters by gullies and creeks, with the layout structured around low-lying areas and depressions. The largest depression was present in the southeast and may have had a special significance due to the exceptional finds that were collected there. At the settlement of Oegstgeest, a lot of different structures were excavated. In describing the structures, the settlement is divided into four clusters (see Figure 3.1) (De Bruin et al. 2021, p.24).

3.2.1 House sites and houses

In clusters A and B, house sites were observed. It is possible that house sites were also present in other clusters, but they were not observed. House sites are areas where the presence of a house is assumed. Sometimes, there is enough evidence to suggest the presence of a house, and sometimes, it remains only hypothetical. In cluster A, two possible house sites were found. Only some fragmentary ditches that might have surrounded the house were found in the first house site. However, the presence of wells and outhouses suggests the presence of at least one house. At the second possible house site, only a row of postholes that formed the northeastern short end of the house was found. Two wells can be connected to the house, and the absence of any other features in the zone indicates the presence of a house. In cluster B, almost no features from houses were found, but other elements were found that point to the presence of houses. Three oval ditches, a well, and a fence were discovered. The reason why not many features from the houses themselves were found can be explained by the presence of a concentration of sods that was found in the cluster. It is suggested that the houses were built on raised platforms or that the houses themselves were made out of sods (De Bruin et al., 2021, pp. 26-27).

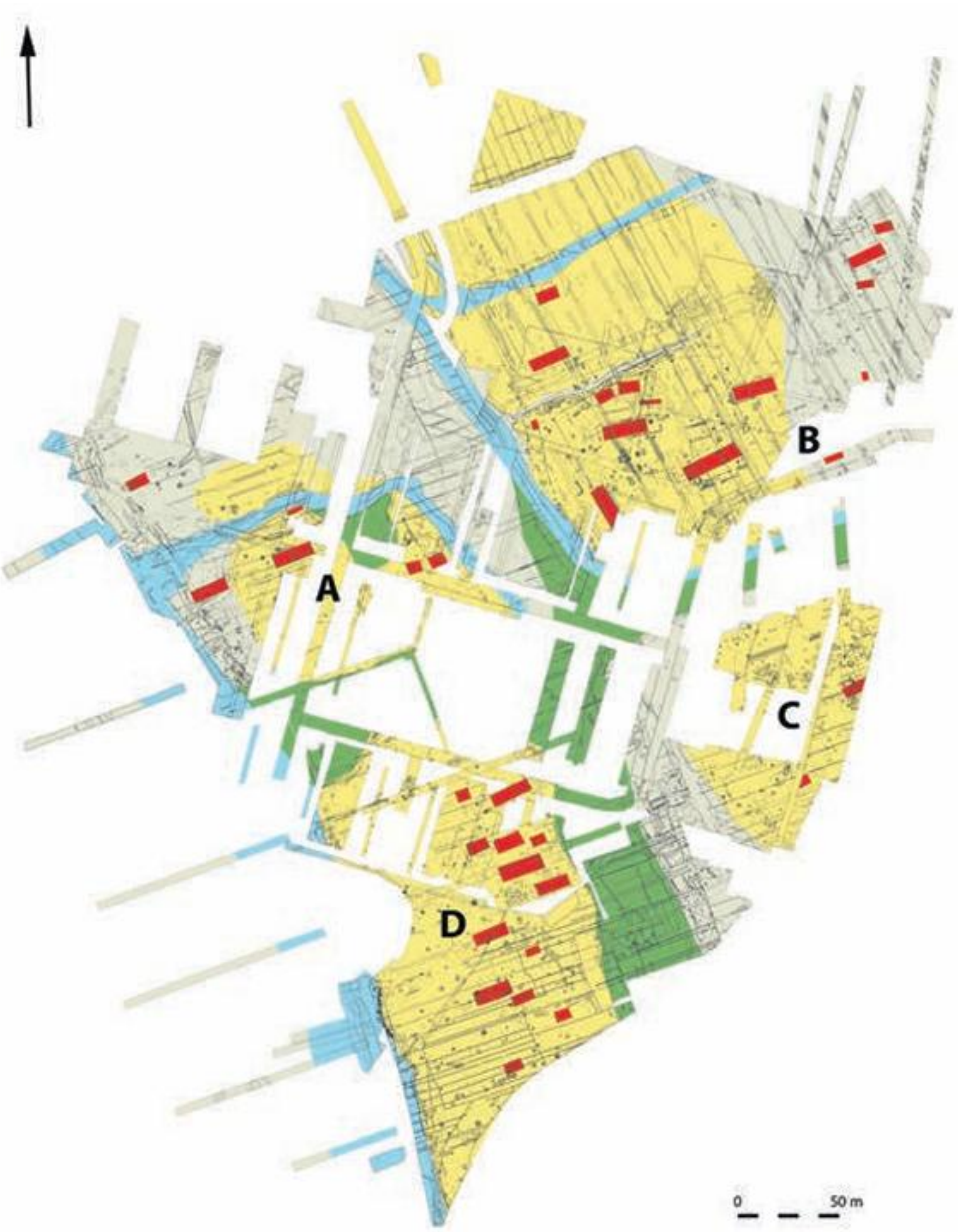


Figure 3.1: Overview of the settlement of Oegstgeest with the four clusters A-D (De Bruin, 2013, p.311)

Overall, twenty-six early medieval houses were discovered at the settlement of Oegstgeest. Most of these houses had a west-southwest/east-northeast orientation, while a few had a north-northwest/south-southeast orientation. The partial preservation of the houses might have resulted from clay extraction and levelling activities in the area. However, it is also possible that the houses were built on raised platforms, as previously proposed. The wood from most houses was likely removed and reused after they fell out of use. Most house plans belong to the Katwijk type (by Menno Dijkstra), although the houses do vary from each other. The placement of entrances and the practical three-way division characterise the Katwijk type. Entrances are located on the front side, with two opposite entrances in the middle part and one on the long side (see figure 3.2). This house type is a byre-house, usually rectangular, with one to four aisles. A row of posts supports the roof along and outside the walls. All houses in the settlement are Katwijk Type B, and can be divided into three subtypes. The first includes the largest house plans; the second consists of three house plans primarily built using bedding trenches; and the third features a single house plan with unusual construction (De Bruin et al., 2021, p. 28). Additionally, three small houses were excavated within the settlement. There were probably more, but they were not preserved well enough to be identified (De Bruin et al., 2021, p. 37).

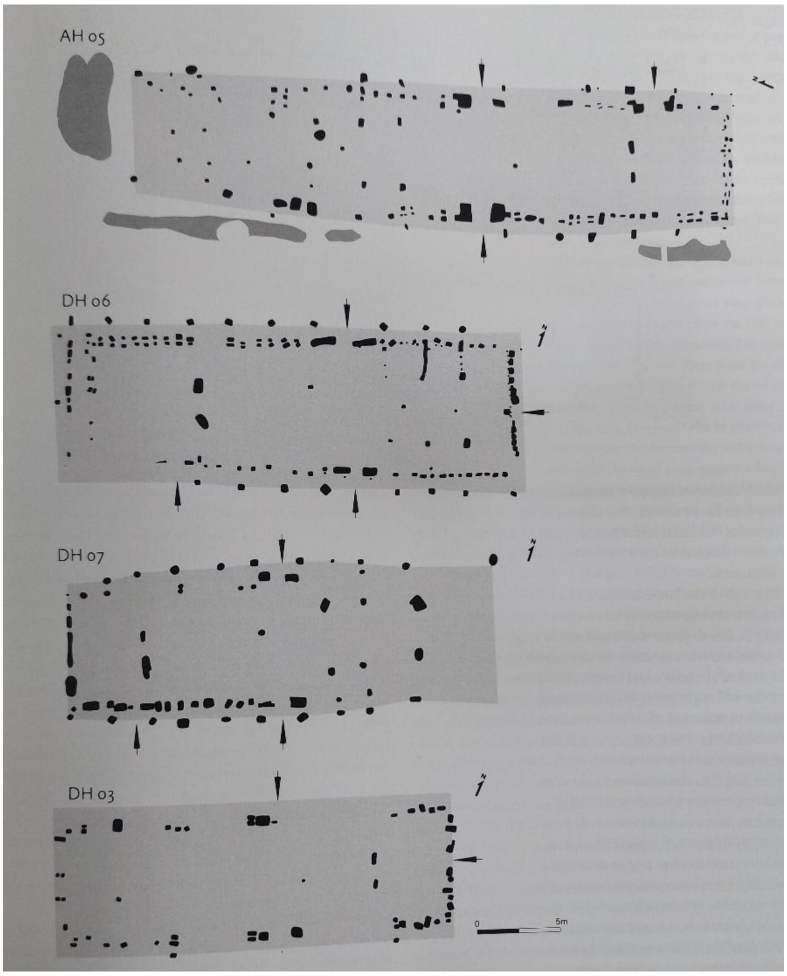


Figure 3.2: Houses Katwijk subtype 1 found at the settlement of Oegstgeest (De Bruin et al., 2021, p. 37)

3.2.2 Other structures

Besides the houses, additional structures were excavated at the site, such as outhouses, pits, and yards. A total of seventy-three outhouses were excavated, evenly distributed across the site. Each house probably had several outhouses, and the orientation of outhouses and houses seems to match. Most outhouses were built on posts driven deep into the subsoil, but constructions varied. Some posts weren't driven as deeply, possibly indicating they served as small sheds. The floors of the outhouses were likely raised for better storage. In most cases, the poles were removed and probably reused after the outhouses fell out of use, but some posts were found in situ and preserved. Indicators of iconic early medieval sunken huts were not found at the settlement (De Bruin et al., 2021, pp.38-39).

A total of 104 early medieval wells were discovered at the site. This large number indicates that multiple wells were in use simultaneously in each yard. Alternatively, the wells might have been only suitable for short-term use due to the salinisation of groundwater. Most of the wells still had wooden linings and could be categorised into three types: wells with a square structure, wells with a round structure, or wells with no obvious construction method. Reused planks from ships and imported barrels were used for the linings. Inside some wells, archaeobotanical remains and organic artefacts were found (p.49). The site also contained 940 pits spread across clusters and outside the settlement. Nine distinct types were identified, though there is some overlap between them. Some pits reflect specific processes and artisanal activities carried out at the site (De Bruin et al., 2021, p.57).

The only ditches that were found in the settlement were the ditches that surrounded house AH 06 and the house sites in cluster B. A lot of remains of fences were found, which were used to mark borders. The fences were constructed using oblong, triangular, and rectangular posts set close together, with wickerwork above ground. Sometimes the posts had been removed after the fences fell out of use. In other instances, the wood wasn't preserved, or only the top of the posts was preserved. The fences weren't only used to indicate house yards, but also to keep animals in or outside the settlement. This has been supported by the fact that some fences were built next to gullies, which could have only been intended to prevent the animals from entering the water. Multiple structures were also built in and along the gullies. Most of these structures have been well-preserved due to the high groundwater levels. Structures such as dikes were built to manage water and mitigate flood risks, while bridges and small dams were constructed to connect separate pieces of land. Also, structures like possible fish traps, quay works, and landing areas that were dug out were found. The landing areas that were situated along the riverbank were probably made for interaction with ships. The fact that some of the wells were lined with wood from ships indicates that shipping took place at the settlement (De Bruin et al., 2021, p.63).

Lastly, a total of eleven human burials and ten animal burials were discovered, along with depositions of human bones. The human burials date to the Merovingian settlement period, except for one Iron Age grave. Five of the human burials were found together at the edges of the four clusters, with three dogs and three horses found near these burials. Two of the female human burials contained multiple clothing accessories, such as brooches, belts, and a necklace. Human bones were also deliberately deposited in gullies and low-lying areas. Additionally, objects like pottery and animal bones were deposited in ditches, gullies, pits, and wells. One notable deposition is the silver and gold 'Oegstgeest Bowl,' found in a shallow creek.

Since the creek was so shallow that the object could have been recovered if lost, it is likely a deliberate deposition, which aligns well with other depositions in and around the settlement (De Bruin et al., 2021, pp.81-84).

3.3 The pottery

From all the excavations, a total of 18.421 ceramic fragments were excavated. The majority of the pottery, 85%, is from the Merovingian Period (450-750 A.D.). The rest of the pottery dates from the Iron Age, ca. 800 B.C- 50 B.C., to the New period, 1500-present (De Bruin et al., 2021, p.159). Because the thesis is focused on the Merovingian ceramics, the ceramics from the other periods won't be further discussed here.

3.3.1 Merovingian ceramics and function

The Merovingian ceramics can be divided into two groups: handmade ceramics and wheel-thrown ceramics. Around 84.9% of the Merovingian ceramics that were found are wheel-thrown, and around 15.1% are handmade. The wheel-thrown and handmade ceramics can be further divided. The wheel-thrown ceramics can be divided into fine wares, coarse wares, and redwares. The fine and coarse wares can also be further divided into oxidised and reduced fired ceramics. See also chapter 2.1.1. The handmade ceramics can be divided into the (late) Anglo-Saxon wares and Hessen-Schortens wares. See also chapter 2.1.2. The Merovingian pottery per fabric type found at the settlement is shown in Table 3.1. (De Bruin et al., 2021, pp.159-161).

Pottery fabric	Total fragments	Percentage
Wheel-thrown coarse ware, oxidised	9302	59,4%
Wheel-thrown coarse ware, reduced	3146	20.1%
Wheel-thrown fine ware, oxidised	225	1.4%
Wheel-thrown fine ware, reduced	508	3.2%
Late Merovingian Badorftype pottery	22	>1%
Late Merovingian pottery	3	>1%
Handmade pottery	2351	15,1%
Loom weight	92	>1%
Dice	1	>1%
Total	15650	100%

Table 3.1: Total of Merovingian pottery per fabric type (De Bruin et al., 2021, p. 161)

The wheel-thrown pottery has mostly been used for cooking. Over 29% of the oxidised fired shards of the wheel-thrown pottery, for which soot marks were documented, show evidence of external contact with fire. Oxidised coarse ware was primarily used for cooking, while oxidised fine ware and finely tempered hard coarse ware were used for cooking to a lesser extent or not at all. Ethnographic research has proposed that the colour of the pottery in the Middle Ages was associated with use and cleanliness. After 700, the colours red and black aren't used as much as they used to. When looking at the colour, orange/red pots seem to have had more contact with fire than pots of other colours (De Bruin et al., 2021, p.163).

3.3.2 Pottery types

Multiple types of wheel-thrown and handmade pottery were found at the settlement. the different types will be discussed here shortly.

Wheel-thrown

A total of 279 biconical (KWT) pots were found at the settlement. The biconical pots are wheel-thrown and mostly made of fine ware. They can also occur in (fine) coarse ware. The biconical pots date from approximately 485 to 710, and as the name indicates, the vessels have a biconical shape. Biconical pots in both fine ware and coarse ware types have been excavated at the site (De Bruin et al., 2021, pp.163-164). In total, 1642 rims of ovoid pots (WWT)/ wolbwandtöpfe were found at the settlement. The ovoid pots are wheel-thrown and classified as coarse ware. Nearly 73% of the ovoid pots were oxidised fired, and 27% were reduced fired. Most of the shards were medium-hard or hard-fired, and the ovoid pots date from around 530 to 725 (De Bruin et al., 2021, pp. 168-169). The ovoid pots serve various functions; they are most commonly used for cooking, storing food, and heating food. The size of the pots can suggest their function. However, because the size cannot be determined from fragments alone, the rim diameter is often used. Results from Oegstgeest indicate that smaller pots were primarily used for consuming food or drinks, while larger pots likely served functions such as storage. There appears to be no correlation between the colour, rim size, and usage of the ovoid pots (De Bruin et al., 2021, pp.182-183).

Ten sherds of bottles were found at the site, along with eight wall fragments and two rims. Four sherds are reduced fired, with one also being fine-smoked. The remaining six sherds are oxidised fired. All the reduced fired bottles, except for the smoked one, are hard-fired. The bottles are elongated, designed to hold liquids, and feature an outwardly curved rim, a short or long neck, and a cylindrical or spherical body. A total of twenty-six sherds from pitchers and amphorae were discovered at the settlement. A pitcher is used to store liquids but does not have a spout; if the vessel has a spout, it is called a jug. Pitchers have one to three ribbon-shaped handles, and if they have multiple handles, they can also be classified as amphorae. Not all sherds may have been identified as pitchers due to the breakable nature of the pottery. About 84% of all pitchers were oxidised fired, with nearly all being orange. On the outside, two pitchers show traces of soot (De Bruin et al., 2021, pp.188-190).

Vessels used to pour liquids and equipped with a spout are defined as jugs. Thirty-four jugs have been discovered; however, from a few shards, it is unclear whether they are jugs or pitchers. There are two types of jugs. The first features a trefoiled-shaped spout opposite the handle, which occupies about one-third of the rim and has a large neck. The second has a small spout created by a slight outward bend of the rim opposite the handle. It is not always possible to determine the type of jug because of an incomplete profile or rim. Many of the jugs are made of hard-fired oxidising pottery, primarily produced in the Eifel Region (De Bruin et al., 2021, pp. 191-192). Ninety rim sherds of bowls were found. The majority of the bowls were oxidised fired. Two types of bowls can be distinguished based on wall design. Slightly convex and unarticulated walls are classified as Sha type one, while articulated walls with a clear shoulder are Sha type two (De Bruin et al., 2021, p.194). Lastly, four blue-grey sherds with a white-grey core were found. These sherds belonged to medium-sized, flat-based pots that date from the late Merovingian period to the early Carolingian period. These sherds may indicate that, after 675, the site remained inhabited if the interpretation of the sherds is correct (De Bruin et al., 2021, p.196).

Handmade

Anglo-Saxon wares (AS) were found at the settlement. Characteristics of this ware are the decorations on the body of the pot. They are rounded biconic pots with vertical ridges and/or stamps, indentations, and geometrical grooves. Anglo-Saxon ware is a distinctive style of pottery that originated in Jutland and Schleswig-Holstein. In the fourth and fifth centuries, the Anglo-Saxon wares spread to Lower Saxony. Two types of handmade biconical vessels were identified from the settlement. The first is softly fired black smoked pottery with no recognisable temper. The second is stone-gritted (De Bruin et al., 2021, p.197).

A tricky group of ceramics from the Middle Ages that was found at the settlement is Hessens-Schortens (HS), also called Eitöpfe. The pottery is, in general, soft fired, black/dark grey in the middle, and thick-walled (>6 mm). The outside of the pot is rough, but can be polished or made smooth. The colour on the outside of the pot can vary, but the Hessens-Schortens ceramics found at the settlement are mostly yellow-orange (39.6%), followed by grey to black (35.8%) and brown/beige (23.5%). The temper can be made out of stone-grit, chaff temper, quartz, grog temper, shell temper, or fine sand, but a combination is also possible. Hessens-Schortens pottery with chaff temper is known as Trisum ware. Trisum ware is soft fired, thick-walled, plant-tempered, and has, most of the time, no decoration. From the settlement, most of the handmade pottery (36%) has primarily a quartz temper, followed by stone-grit (19%), chaff temper (17%), and sand temper (16%). The least amount of pottery was tempered with grog (9%) and shell (2%). Small pieces of mica were observed in sherds with all types of temper. It is noticeable that grey/black coloured pots are mostly tempered with grog or stone grit, and that yellow and orange-red pots are mostly tempered with chaff, but also shell, sand, and quartz. In total, 403 rim fragments of Hessens-Schortens were found at the settlement. The Hessens-Schortens wares can have different shapes. Globular pots are most frequent (94%), followed by neckless bowls (3%). Not so common are the bottles (2%), mini pots (0.7%), and beakers (0.2%). There is currently no general typology for handmade pottery, due to the absence of closed cemetery contexts and a shortage of stratigraphically collected material. The dating of the pottery is from around 450 to 845, when the *Kugeltopf* replaces the Hessens-Schortens. However, there doesn't seem to be a lot of change in the shape of the vessels over time (De Bruin et al., 2021, pp. 198-200).

4. Methodology

The goal of this research is to get new insights into the production and provenance of Merovingian handmade and wheel-thrown ceramics. During this research, a literature study, macroscopic analysis, and chemical analysis were conducted. The research has been carried out based on one main question and five sub-questions. The main question will be answered based on all three research methods. In this chapter, the research and its sub-questions will be presented, along with the sampling strategy and research methods.

In the original plan, a petrographic analysis of the ceramics from Oegstgeest was also included in the methodology. Unfortunately, this had to be taken out due to an unforeseen unavailability of the ceramics. Due to this change, the research question and the sub-questions have been slightly altered. The goal of the research remained the same; however, more focus has been laid on what is already known about the Merovingian handmade and wheel-thrown ceramics. This change has been discussed and approved by the supervisor.

4.1 Research questions

Main question

What new insights on the production and provenance of Merovingian handmade and wheel-thrown ceramics can be gained based on a macroscopic and chemical analysis of the ceramics from the Merovingian settlement of Oegstgeest?

Sub-questions

1. What did the Merovingian settlement found at the site of Oegstgeest look like?
2. What is currently known about the production and provenance of early medieval handmade and wheel-thrown ceramics in Europe?
3. What is the description and interpretation of the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest?
4. What is the chemical composition of the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest? And what information can be derived from it?
5. What is the difference between the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest based on the macroscopical and chemical analysis? And what information can be derived from it?

4.2 Samples

Only a part of the shards found at the settlement of Oegstgeest were analysed during this research, due to the large quantity of shards. Forty-one of the handmade and forty-three of the wheel-thrown ceramics were analysed with a macroscopic analysis and a chemical analysis with the use of a handheld XRF. In Table 4.1, an overview is given of all the shards that were macroscopically and chemically analysed, with the find number and project. When selecting the shards, care was taken to ensure that there were roughly equal numbers of handmade and wheel-thrown ceramics. Care was also taken to ensure that shards from each project were examined and that all the pottery types were represented. As far as possible, handmade and wheel-thrown shards from the same find number were selected to examine different types of shards from the same context.

Project	Find number	Type	Amount of sherds
OBSP11	V619KER	Handmade	6
OBSP12	V2022KER	Handmade	2
OBSP12	V2150KER	Handmade	1
OBSP12	V2336KER	Handmade	1
OBSP12	V2382KER	Handmade	3
OBSP12	V2586KER	Handmade	3
OBSP12	V2618KER	Handmade	2
OBSP12	V2621KER	Handmade	2
OBSP12	V2647KER	Handmade	2
OBSP12	V2652KER	Handmade	5
OBSP12	V2683KER	Handmade	1
OBSP14	V5252KER	Handmade	1
ONRZ09-10	V483KER	Handmade	1
ONRZ09-10	V975KER	Handmade	1
OSLP10	V740AME	Handmade	4
OSLP10	V804KER	Handmade	6
OBSP11	V193KER	Wheel-thrown	3
OBPS11	V368KER	Wheel-thrown	5
OBSP12	V2076KER	Wheel-thrown	3
OBSP12	V2081KER	Wheel-thrown	2
OBSP12	V2484KER	Wheel-thrown	5
OBSP12	V2586KER	Wheel-thrown	7
OBSP12	V2627KER	Wheel-thrown	6
OBSP12	V2652KER	Wheel-thrown	7
OBSP12	V2653KER	Wheel-thrown	1
ONRZ09-10	V483KER	Wheel-thrown	4

Table 4.1: List of samples for the macroscopic and chemical analysis (created by M.L. Smedema)

4.3 Literature study

During the literature study, sources have been sought that provide information about the settlement of Oegstgeest, the pottery assemblage of Oegstgeest, the production of handmade and wheel-thrown Merovingian ceramics, and the provenance of handmade and wheel-thrown Merovingian ceramics. Based on the literature study, the sub-questions one, two, and three will be answered. The most relevant sources that have been used during the literature study are as follows:

- Boon, H. (2011). Hessens-Schortens. *Een typologische studie naar vroegmiddeleeuws, handgevormd aardewerk in Noord-Nederland* [Unpublished thesis}. Rijksuniversiteit Groningen.
- De Bruin, J. (2013). De Merovingische nederzetting in Oegstgeest. *Westerheem*, *62(6)*. 309-315.
- De Bruin, J., Bakels, C. & Theuws, F. (2021). *Oegstgeest, a riverine settlement in the early medieval world system*. SPA Uitgevers.
- de koning, J. (2023). Middeleeuws aardewerk voor circa 1000 AD. In H. Stoepker (Ed.), *Sporen van Susteren: Archeologische vondsten uit een Karolingische abdij en een adellijk vrouwenstift* (pp.641-727). Limburgs Museum. https://doi.org/10.17026/dans-xsf-nypw
- de Koning, J., Gerrets, D., & Nieuwhof, A. (2020A). Wheel-thrown pottery of the Merovingian and Carolingian periods at Wijnaldum. In A. Nieuwhof (Ed.), *The Excavations at Wijnaldum : Volume 2: Handmade and Wheel-thrown Pottery of the first Millennium AD* (pp.99-146). University of Groningen/Groningen Institute of Archaeology and Barkhuis Publishing.
- Dijkstra, M. F. P. (2011). *Rondom de mondingen van Rijn & Maas : landschap en bewoning tussen de 3e en 9e eeuw in Zuid-Holland, in het bijzonder de Oude Rijnstreek*. Sidestone Press.
- Gosselain, O.P & Livingstone Smith, A. (2005). The Source. Clay Selection and Processing Practices in Sub-Saharan Africa. In A. Livingstone Smith, D. Bosquet and R. Martineau (Eds.), *Pottery Manufacturing Processes: Reconstruction and Interpretation. BAR International Series 1349* (pp. 33-48). Archaeopress.
- Hemminga, M. & Hamburg, T. (2006). *Een Merovingische nederzetting op de oever van de oude Rijn*. Archol rapport 69. Archol.
- Knol, E. (1993): *De Noordnederlandse kustlanden in de Vroege Middeleeuwen* [Doctoral dissertation, Vrije Universiteit Amsterdam]. Vrije Universiteit Amsterdam.
- Kramer, C. (1985). Ceramic ethnoarchaeology. *Annual Review of Anthropology, 14,* pp. 77-102
- Krol, T. N. (2006). *Angelsaksisch aardewerk in Noord-Nederland*. Nieuwe perspectieven op het Noordnederlandse kustgebied na het bewoningshiaat in de vierde eeuw. De Vrije Fries, 86.

- Van Spelde, F. (2012). *Merovingische tonpotten in West-Nederland. Een vroegmiddeleeuws gebruiksvoorwerp in context* [Unpublished thesis]. Leiden University.
- Verhoeven, A. A. A. (2016). Aardewerk. In M. F. P. Dijkstra, A. A. A. Verhoeven, & K. C. J. van Straten (Eds.), *Nieuw licht op Leithon: Archeologisch onderzoek naar de vroegmiddeleeuwse bewoning in plangebied Leiderdorp-Plantage* (pp. 153-210). Universiteit van Amsterdam.

The other sources used for the literature study are noted in the references. During the literature study, only peer-reviewed and reliable sources have been used. The sources have been checked for reliability and usability. In this regard, among other things, there has been looked at the author(s), date of publication, and publisher. The sources have been referenced according to the rules of APA 7th edition.

4.4 Macroscopic analysis

A macroscopic analysis involves examining ceramics with the naked eye and a binocular magnifying glass. This is a common approach in the study of archaeological ceramics. The macroscopic analysis in this thesis is primarily focused on the identification, description, and interpretation of the fabric groups of the handmade and wheel-thrown ceramics from Oegstgeest. Based on the macroscopic analysis, sub-questions 4 and 5 will be answered.

Because the excavations were carried out by multiple parties throughout the years, the ceramics were analysed by multiple people over the years. M.E.P. Dijkstra, E.J. Bult, and students within the framework of the Medieval pottery lab under the supervision of E.J. Bult determined and analysed the ceramics. The determination method used by Dijkstra can be found in the chapter ''Aardewerk'' in the excavation report from Archol (Dijkstra, 2006, pp.51-72). The determination and macroscopic analysis conducted by Bult and the students followed the fabric classification system used by Dijkstra (Dijkstra, 2006; Dijkstra, 2007; Dijkstra,2009; Van Grinsven & Dijkstra, 2007, pp. 85-98). The determinations made by Bult and the students were put into an Access database and were analysed with Dijkstra's determinations using Excel. An integrated database was made by Bult containing all of the ceramics from the campaigns. This database has been used during this thesis for the macroscopic analysis. In the database, the fabric groups, colour, quantity, matrix, type, and subtype were described (De Bruin et al. 2021, pp.158-159). The frequency, size, shape and sorting of the visible inclusions were determined based on the following charts.

Inclusion size	
Fine	0.02- 0.1mm
Medium	0.1-0.5mm
Coarse	0.5- 2.0mm
Very coarse	2.0- 10mm

Table 4.2: inclusion size clusters (Revello Lami, 2023, p.214)

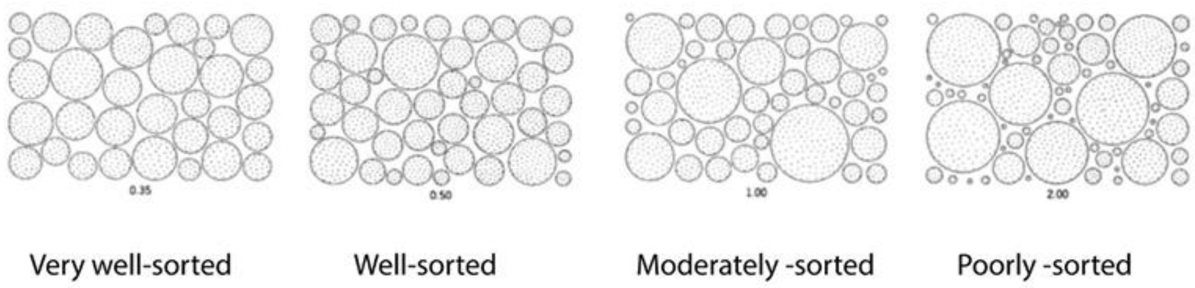


Figure 4.1: Types of sorting for inclusions (Revello Lami, 2023, p.214)

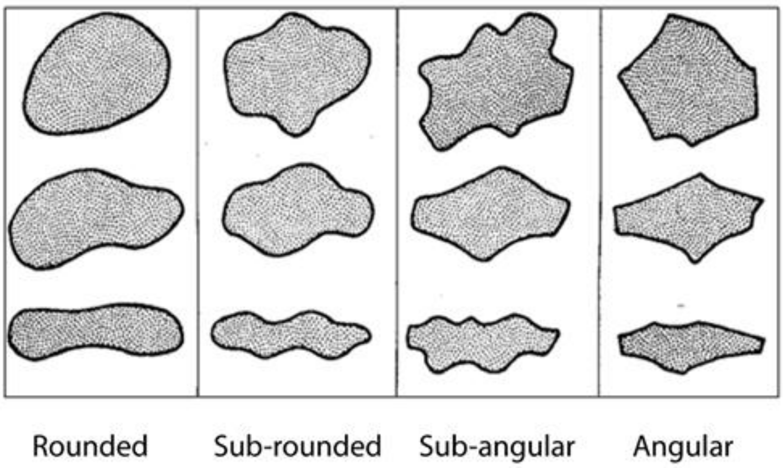


Figure 4.2: Shape and rounding of grains (Revello Lami, 2023, p.215)

4.5 Chemical analysis

A chemical analysis has been carried out on the handmade and wheel-thrown ceramics from Oegstgeest. The chemical analysis has been conducted to assess the chemical composition of the ceramics. The chemical analysis was conducted using X-ray Fluorescence. Based on the chemical analysis, sub-question five will be answered.

X-ray fluorescence, or XRF spectroscopy, can be used to identify the elements present in a lot of different inorganic materials, like ceramics. It provides information about the chemical composition of the clay. This enables the identification of different types of clay and provides more information about their sources. This technique is qualitative, non-destructive, and requires no or only minimal sample preparation. This makes the technique excellent for the study of art and archaeological artefacts (Bezur et al., 2020, p.17). What makes the use of an XRF appealing is that it is cost-effective, fast, and easy to use. One of the downsides is that not all elements, for example, rare earth elements or elements with very low concentrations, can be detected (Shackley, 2010, pp.9-10). For XRF spectroscopy, the absorption that occurs when an X-ray hits a material is the most important. When the entire energy of an X-ray is transferred to an inner-shell electron, it is absorbed by the atom. If the X-ray has high energy and the X-ray photon collides with an inner-shell electron, the electron can be ejected. This excites the atom and, to restore stability, an electron will drop from a higher shell into the lower shell, where a vacancy is created. During this transition, the electron loses energy in the form of emitted X-rays. Each element has a unique electron structure, so these X-rays are characteristic of the type of electron transmission and the element present. XRF spectroscopy detects and analyses these X-rays to identify the elemental composition of materials (Bezur et al., 2020, p.17).

For this thesis, the chemical analysis has been carried out with a handheld XRF (HH-XRF). The HH-XRF is portable, quick, has a beam diameter of approximately 8 mm, and is very effective at detecting the elements present. However, quantification is difficult, and it is only a surface technique. The XRF analysis was conducted at the Material Culture Laboratory of Leiden University, and the ceramics required no sample preparation. A Brucker Tracer 5 XRF was used with the setting Mudrock Air for a duration of 90 seconds per measurement.

A total of 84 sherds, including both handmade and wheel-thrown ceramics, were chemically analysed. Due to the small size of most of the sherds, around 2 to 3 measurements were taken for each vessel from the inside, outside, and core. However, in some cases, it was only possible to take 1 measurement. Some of the ceramics were small and had a large curve, which made it impossible to take multiple reliable measurements of the in and outside. The results were compared with the chemical data of local and general Holocene deposits, local tertiary deposits, and sediments spread through the Netherlands from twenty-four locations from DINOloket (Ondergrondgegevens | DINOloket, n.d.). Based on whether the ceramics from Oegstgeest chemically matched the Dutch and local sediments, the provenance of the handmade and wheel-thrown ceramics was determined.

5. Results

5.1 Introduction

In this chapter, the results of the macroscopic and chemical analysis are presented. At first, the fabric groups that have been identified by the macroscopic analysis are discussed. Secondly, the results from the chemical analysis are discussed. Lastly, the results from the two analyses will be combined and summarised.

5.2 Macroscopic analysis

Here, the results from the macroscopic analysis will be presented. A part of the macroscopic analysis was carried out by M.E.P. Dijkstra, E.J. Bult, and students within the framework of the Medieval pottery lab under the supervision of E.J. Bult over the years for the publication of the book Oegstgeest: A riverine settlement in the early medieval world system (2021). The integrated database with the determinations of the ceramics from Oegstgeest made by Bult has been used during the macroscopic analysis. In the integrated database, the fabric groups, colour, quantity, matrix, type, and subtype were described for most of the ceramics. Within the macroscopic analysis, the frequency, size, shape and sorting of the visible inclusions were also determined.

Twelve different fabric groups were identified for the wheel-thrown ceramics, and eleven different fabric groups were identified for the handmade ceramics. Above the description of the fabric, the projects and find numbers are described. Due to the large amount of wheel-thrown and handmade shards, only the macroscopic analysis of the shards that were selected for the chemical analysis is described here. For the entire macroscopical analysis of the sherds, refer to the integrated database made by E.J. Bult (De Bruin et al. 2021, pp.158-159).

5.2.1 Wheel-thrown ceramics

Fabric W1

- OBSP12: V2652KER-7, V2076KER-3

This fabric has been fired in a reducing firing process and is soft. The colour of the inner and outer surface is dark grey, and the core is light grey. The surface on the outer and inner walls is slightly coarse with visible, rounded quartz. The matrix is fine and hackly, with almost no voids. The inclusions in the fabric are common and consist of medium (0.1-0.5mm), moderately-sorted, rounded quartz (white).

Fabric W2

- OBSP12: V2586KER-5, V2081KER-2, V2484KER-5, V2627KER-6
- OBSP11: V368KER-5

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is brownish grey to dark grey, and the core is light grey. The surface on the outer and inner walls is coarse with visible, rounded quartz. The matrix is fine to fine and hard, slightly hackly, and has almost no voids. The inclusions in the fabric are frequent and consist of mica and medium (0.1-0.5mm), well-sorted, rounded quartz (white).

Fabric W3

- OBSP12: V2586KER-6, V2586KER-7, V2484KER-3
- OBSP11: V368KER-3, V193KER-1
- ONRZ09-10: V483KER-1, V483KER-2

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is light grey to dark grey or a more brownish grey. The core is light grey. The surface on the outer and inner walls is slightly coarse with visible, sub-rounded quartz. The matrix is hard, slightly hackly, and has a small number of voids. The inclusions in the fabric are common to many and consist of fine to medium (<0.5mm), moderately-sorted, sub-rounded quartz (white-pink).

Fabric W4

- OBSP12: V2627KER-5

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is dark grey (almost black), with a brownish dark grey core. The surface on the outer and inner walls is coarse and has a stone grit (granite). The matrix is hard, hackly, and has frequently small voids. The inclusions in the fabric are frequent and consist of mica and very coarse (2.0-10mm), poorly sorted, sub-angular stone fragments (white to brown).

Fabric W5

- OBSP12: V2586KER-1, V2586KER-2, V2586KER-3, V2652KER-1, V2652KER-2, V2652KER-6, V2653KER, V2627KER-1, V2627KER-2, V2076KER-1, V2484KER-1, V2081KER-1
- OBSP11: V193KER-2, V193KER-3, V368KER-2
- ONRZ09: V483KER-3, V483KER-4

This fabric has been fired in an oxidising and reducing firing process. The colour of the inner and outer surface is yellow/orange grey, with an orange to grey core. The surface on the outer and inner walls is slightly coarse and has visible, rounded quartz. The matrix is hard, slightly hackly, and has several small voids. The inclusions in the fabric are few and consist of fine (0.02-0.1mm), very well-sorted, rounded quartz with mica.

Fabric W6

- OBSP12: V2484KER-2, V2484KER-4

This fabric has been fired in an oxidising and reducing firing process and is soft. The colour of the inner and outer surface is greyish orange, and the core is grey. The surface on the outer and inner walls is slightly coarse and has visible round quartz. The matrix is fine, hackly, and has some voids. The inclusions in the fabric are few and consist of medium (0.1- 0.5mm), moderately-sorted, sub-rounded quartz.

Fabric W7

- OBSP12: V2652KER-3, V2627KER-3

This fabric has been fired in an oxidising firing process and is soft. The colour of the inner and outer surface is greyish orange, and the core is orange. The surface on the outer and inner walls is slightly coarse and has visible round quartz. The matrix is fine, slightly hackly, and has several voids. The inclusions in the fabric are few and consist of medium (0.1- 0.5mm), moderately-sorted, sub-rounded quartz (white), and sometimes mica.

Fabric W8

- OBSP12: V2586KER-4, V2652KER-4

This fabric has been fired in an oxidising firing process. The colour of the inner and outer surface is white to brownish orange, and the core is light orange. The surface on the outer and inner walls is slightly coarse and has visible, rounded quartz. The matrix is fine, smooth, and has a few visible voids. The inclusions in the fabric are common and consist of very coarse (2.0-10 mm), moderately-sorted, sub-rounded quartz.

Fabric W9

- OBSP12: V2076KER-2

This fabric has been fired in an oxidising firing process and is soft. The colour of the inner and outer surface is greyish red, and the core is red. The surface on the outer and inner walls is slightly coarse and has visible round quartz. The matrix is fine, hackly, and has several voids. The inclusions in the fabric are frequent and consist of coarse (0.5- 2mm), well-sorted, rounded quartz and very coarse (2.0- 10mm) red-orange iron nodules.

Fabric W10

- OBSP11: V368KER-1

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface alternates between light and dark grey, and the core is light grey. The surface of the outer and inner walls is smooth. The matrix is fine, smooth, and has hardly any voids. The fabric has a very fine sand temper (0.02- 0.1mm).

Fabric W11

- OBSP12: V2652KER-5

This fabric has been fired in an oxidising firing process and is soft. The colour of the inner and outer surface is light orange, and the core is also light orange. The surface on the outer and inner walls is slightly coarse and has visible quartz. The matrix is fine, hackly, and has several voids. The inclusions in the fabric are few and consist of coarse (0.5- 2mm), poorly-sorted, angular quartz (white).

Fabric W12

- OBSP12: V2627KER-4
- OBSP11: V368KER-4

This fabric has been fired in an oxidising firing process. The colour of the inner and outer surface is brownish-yellow, and the core is yellow. The surface on the outer and inner walls is slightly coarse and has visible round quartz. The matrix is fine to hard, hackly, and has several voids. The inclusions in the fabric are few and consist of fine (0.02- 0.1mm), well-sorted, rounded quartz (white).

5.2.2 Handmade ceramics

Fabric H1

- OBSP12: V2150KER, V2382KER-1, V2382KER-3, V2621KER-2, V2652KER-5
- ONRZ09-10: V483KER-1
- OBSP14: V5252KER

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is grey, and the core is dark grey. The surface on the outer and inner walls is slightly coarse. The matrix is slightly hackly. The fabric has a very fine sand (0.02- 0.1mm) and organic (plant) temper.

Fabric H2

- OBSP12: V2022KER-1

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is light grey, and the core is dark grey. The surface of the outer and inner walls is smooth. The matrix is smooth. The fabric has a very fine sand (0.02- 0.1mm) and organic (plant) temper.

Fabric H3

- OBSP12: V2022KER-2
- OSPL10: V804KER-2, V804KER-4

This fabric has been fired in a reducing firing process. The colour of the inner surface is dark grey, the outer surface is a light brownish grey, and the core is grey to a light brownish grey. The surface of the outer and inner walls is slightly coarse. The matrix is slightly hackly. The fabric has a very fine sand (0.02- 0.1mm) and organic (plant) temper.

Fabric H4

- OBSP12: V2586KER-1

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is grey, and the core is light grey. The surface of the outer and inner walls is slightly coarse. The matrix is slightly hackly. The fabric has a very fine sand (0.02- 0.1mm) and organic (plant) temper.

Fabric H5

- OSLP10: V740AME-1, V740AME-2, V740AME-3, V740AME-4

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is light to dark grey, and the core is dark grey. The surface of the outer and inner walls is coarse. The matrix is hackly. The fabric has a very fine sand (0.02- 0.1mm) and organic (plant) temper with very fine (0.02- 0.1mm), well-sorted, rounded quartz (white).

Fabric H6

- OBSP12: V2382KER-2, V2618KER-1, V2618KER-2
- OBSP11: V619KER-1, V619KER-4, V619KER-6
- ONRZ09-10: V975KER

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is dark to light grey, and the core is light grey. The surface of the outer and inner walls is coarse. The matrix is hackly. The inclusions in the fabric are common and consist of medium to coarse (0.1- 2.0mm), moderately-sorted, angular quartz (white) and very coarse (2.0-10mm), poorly sorted, sub-angular stone fragments (white to brown).

Fabric H7

- OBSP12: V2336KER, V2586KER-2, V2586KER-3, V2621KER-1, V2647KER-1, V2647KER-2, V2652KER-4, V2652KER-6 V2683KER,
- OSPL10: V804KER-1, V804KER-3, V804KER-5, V804KER-6

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface alternates between dark and light grey, and the core is dark grey. the surface on the outer and inner walls is coarse. The matrix is hackly. The inclusions in the fabric are few and consist of fine to medium (<0.5mm), poorly-sorted, sub-rounded quartz.

Fabric H8

- OBSP11: V619KER-2, V619KER-3

This fabric has been fired in a reducing firing process. The colour of the inner and outer surface is brownish-grey to dark grey, and the core is dark grey. The surface on the outer and inner walls is coarse, and the matrix is slightly hackly. The inclusions in the fabric are frequent and consist of mica and coarse (0.5-2.0mm), poorly sorted, sub-rounded stone fragments (white to brown).

Fabric H9

- OBSP11: V619KER-5

This fabric has been fired in a reducing and oxidising firing process. The colour of the inner and outer surface is greyish brown, and the core is grey. The surface on the outer and inner walls is coarse. The matrix is slightly hackly. The inclusions in the fabric are frequent and consist of mica and fine (0.1- 0.5mm), well-sorted, rounded stone fragments (white to brown).

Fabric H10

- OBSP12: V2652KER-3

This fabric has been fired in a reducing and oxidising firing process. The colour of the inner and outer surface is orangish grey, and the core is light orange. The surface on the outer and inner walls is slightly coarse. The matrix is slightly hackly. The fabric has a very fine sand (0.02-0.1mm) and organic (plant) temper.

Fabric H11

- OBSP12: V2652KER-1, V2652KER-2

This fabric has been fired in an oxidising firing process. The colour of the inner and outer surface is light orange, as well as the core. The surface on the outer and inner walls is slightly coarse. The matrix is slightly hackly. The fabric has a very fine sand (0.02- 0.1mm) temper.

5.3 Chemical analysis

Here, the results from the chemical analysis will be presented. The results are presented in four scatterplots, each showing a relevant pair of elements plotted against one another. The complete XRF data from all the samples can be found in Appendix 1. In the scatterplots, the XRF data from the wheel-thrown and handmade ceramics from Oegstgeest are presented together with the chemical data of local and general Holocene deposits, local tertiary deposits, and general sediments spread through the Netherlands (background data), from twenty-four locations from DINOloket (Ondergrondgegevens | DINOloket, n.d.). The twenty-four locations are shown in Figure 5.1. The local deposits are highlighted in green.

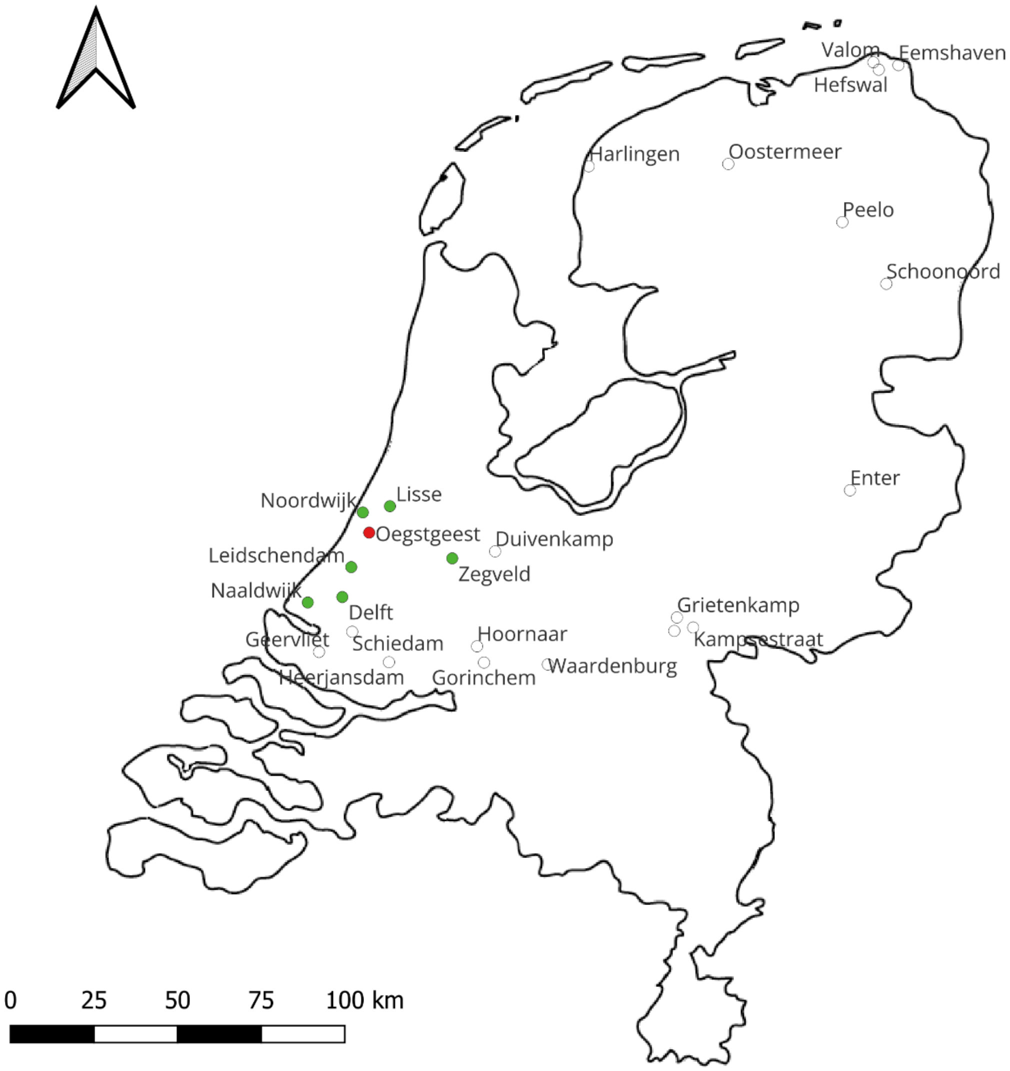


Figure 5.1: Map with locations of deposits (created by M.L. Smedema after data by Ondergrondgegevens | DINOloket, n.d.)

Ratio TiO_2: Fe_2O_3

Figure 5.2 illustrates the titanium oxide– iron oxide ratio. Within the scatterplot, seven clusters were identified.

Cluster 1: The first cluster consists of one coarse wheel-thrown vessel (V2076KER-3) with a very high level of TiO_2 and a low level of Fe_2O_3. The high level of TiO_2 far exceeds the levels present in the Dutch sediments, as shown in grey and green. This means that the vessel is made with a type of clay that doesn't occur within the Netherlands and has a foreign provenance.

Cluster 2: The second cluster that can be identified consists of eight measurements from six coarse wheel-thrown vessels (V483KER-4, V2081KER-1, V2627KER-6, V2652KER-3, V2627KER-4, V2652KER-6) and one measurement from one coarse handmade vessel (V2647KER-1). The vessels have a relatively high level of TiO_2 and a low level of Fe_2O_3. The one handmade vessel has the highest level of TiO_2 out of the cluster. The high levels of TiO_2 exceed the levels present in the Dutch sediments. This indicates that the vessels have a foreign provenance.

Cluster 3: The third cluster consists of one coarse wheel-thrown vessel (V2081KER-2) with a slightly lower amount of TiO_2 than the second cluster and a low level of Fe_2O_3. The levels of TiO_2 and Fe_2O_3 correspond with the levels of the Dutch sediments from DINOloket, indicating that the vessel was most likely made from non-local Dutch clay and has a Dutch provenance.

Cluster 4: The fourth cluster consists of ten measurements from seven coarse wheel-thrown vessels (V2652KER-2, V2484KER-1, V2652KER-1, V483KER-2, V2652KER-4, V2076KER-1, V193KER-2) with a slightly lower amount of TiO_2 than the third cluster and a low level of Fe_2O_3. The levels of TiO_2 and Fe_2O_3 correspond with the levels from local and general Dutch background sediments and local Dutch Holocene sediments, indicating that the vessels most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 5: The fifth cluster consists of one coarse handmade vessel (V2647KER-1) with the same level of TiO_2 as the fourth cluster, but with a lower level of Fe_2O_3. The levels do not correspond with the levels present in the Dutch sediments. This indicates that the vessel has most likely a foreign provenance.

Cluster 6: The sixth cluster is the largest and consists of coarse wheel-thrown and handmade vessels and one fine wheel-thrown vessel with low levels of TiO_2 and Fe_2O_3. There seems to be an even amount of wheel-thrown and handmade vessels within the cluster, but the handmade vessels seem to contain a lesser amount of TiO_2. The levels of TiO_2 and Fe_2O_3 correspond with the levels from local and general Dutch background sediments and local and general Dutch Holocene sediments, indicating that the vessels most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 7: The seventh cluster that has been identified consists of ten coarse handmade vessels (V483KER-1, V619KER-5, V2618KER-1, V619KER-4, V2382KER-2, V804KER-1, V2382KER-1, V2150KER, V2382KER-3, V804KER-2) with a low level of TiO2 and a higher level of Fe2O3. The levels of TiO2 and Fe2O3 correspond with those from local and general Dutch background sediments and local and general Dutch Holocene sediments, indicating that the vessels were made with clay from within the Netherlands and were produced with local clay or Dutch clay with a similar composition to the local clay. The handmade vessel with the highest amount of Fe2O3 (V804KER-1) only corresponds with the levels of local Tertiary sediments, indicating that the vessel was most likely made with local Tertiary clay.

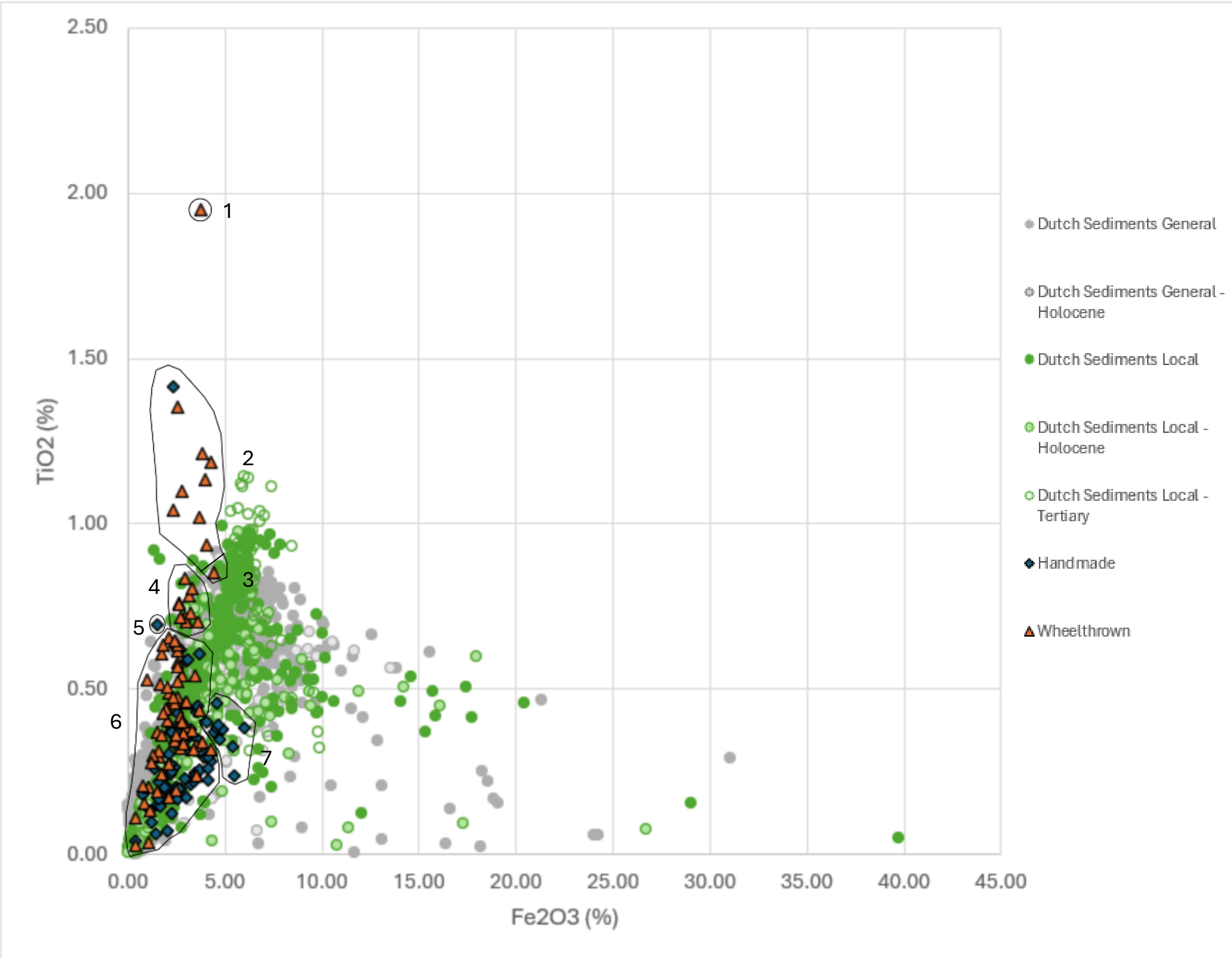


Figure 5.2: Scatterplot of the TiO2: Fe2O3 values for the analysed handmade and wheel-thrown vessels and general and local Dutch sediments (results as wt%) (created by M.L. Smedema)

Ratio Sr: Cao

Figure 5.3 illustrates the strontium– calcium oxide ratio. Within the scatterplot, eight clusters were identified.

Cluster 1: The first cluster that can be identified consists of one coarse handmade vessel (V2652KER-3) with a very high level of Sr and a low level of CaO. The high level of Sr exceeds the levels present in the Dutch sediments. This means that the vessel most likely has a foreign provenance.

Cluster 2: The second cluster consists of three measurements from two coarse wheel-thrown vessels (V483KER-1, V483KER-3) with both a very high level of Sr and CaO. The high levels exceed the levels presented in the Dutch sediments. This means that the vessels most likely have a foreign provenance.

Cluster 3: The third cluster consists of two coarse handmade vessels (V2382KER-3, V2586KER-1) with a low level of CaO and a high level of Sr, which is slightly lower than cluster 1. The high levels of Sr exceed the levels present in the Dutch sediments. This means that the vessels are most likely of foreign provenance.

Cluster 4: The fourth cluster consists of one coarse wheel-thrown vessel (V483Ker-1) with a lower level of Sr and a slightly higher level of CaO compared to cluster three. The high level of Sr exceeds the levels presented in the Dutch sediments. This means that the vessel most likely has a foreign provenance.

Cluster 5: The fifth cluster that can be identified consists of seven measurements from five coarse handmade vessels (V2586KER-2, V2586KER-1, V2382KER-2, V2382KER-1, V483KER-1) and one measurement from a coarse wheel-thrown vessel (V2484KER-2). The vessels have a lower level of Sr and a lower level of CaO compared to cluster four. The wheel-thrown vessel falls in the middle of the cluster. The high levels of Sr exceed the levels present in the Dutch sediments. This means that the vessels have most likely a foreign provenance.

Cluster 6: The sixth cluster consists of two coarse wheel-thrown vessels (V2484KER-2, V2484KER-4) with a lower level of Sr and CaO than cluster 5. The high levels of Sr exceed the levels present in the Dutch sediments. This means that the vessels have most likely a foreign provenance.

Cluster 7: Cluster seven is the largest and consists of coarse handmade and wheel-thrown vessels and one fine wheel-thrown vessel with low levels of Sr and CaO. The vessels within the cluster with a higher level of Sr don't seem to correspond to the levels of the Dutch sediments, meaning that they most likely have a foreign provenance. The vessels with a lower level of Sr seem to correspond with the levels of the local tertiary sediments, and the vessels with the lowest level of Sr seem to correspond with the levels of local and general Holocene and background sediments. This indicates that the vessels with the lower levels of Sr most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 8: The last cluster consists of four measurements from two coarse handmade vessels (V2336KER, V2586KER-3) with a low level of Sr and a slightly higher level of CaO. The levels don't directly correspond with the levels of the Dutch sediments, but they seem close to the local sediments. This indicates that the vessels are most likely foreign, but could be made from clay similar to the local sediments.

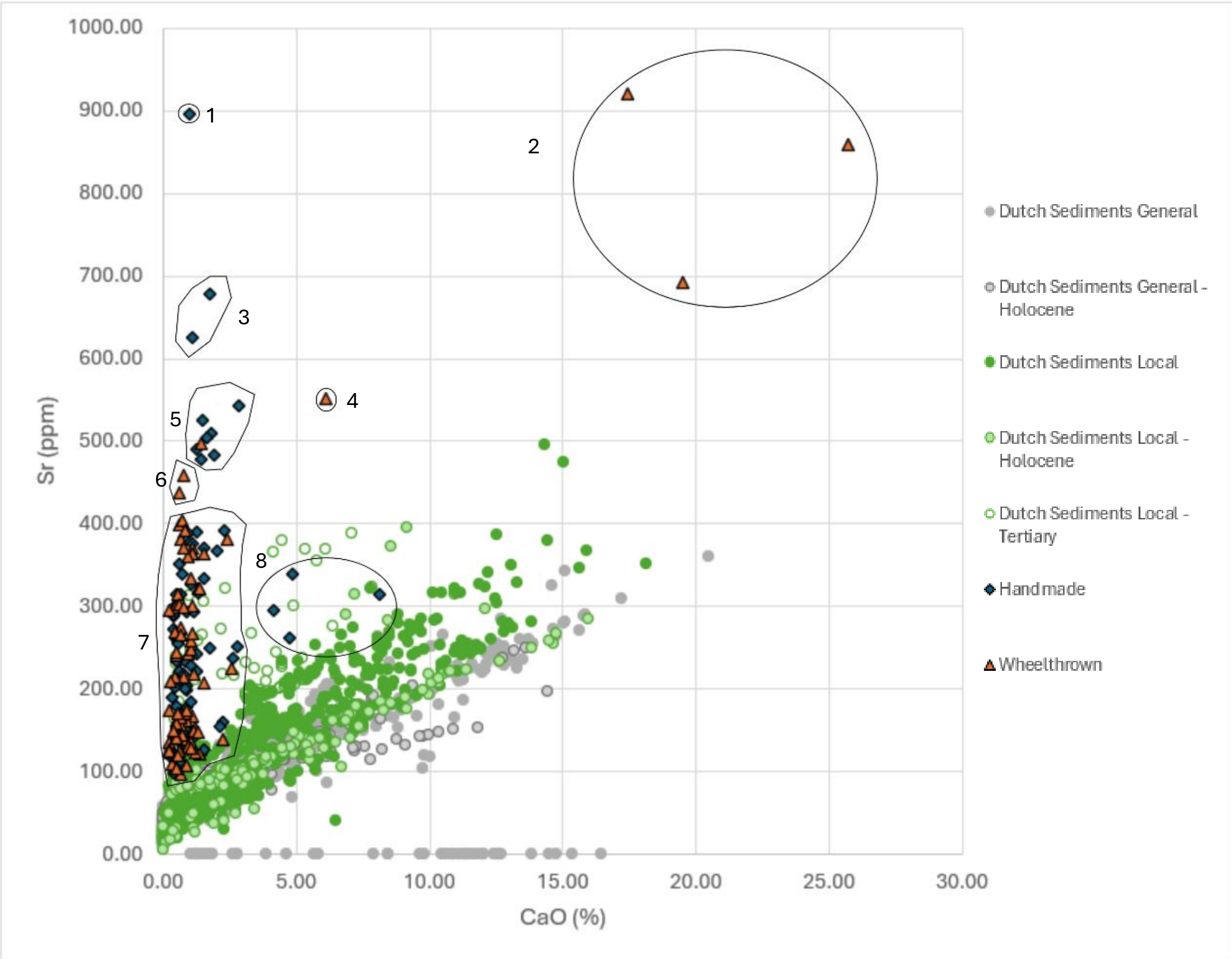


Figure 5.3: Scatterplot of the Sr: CaO values for the analysed handmade and wheel-thrown vessels and general and local Dutch sediments (results as wt%) (created by M.L. Smedema)

Ratio K2O: Al2O3

Figure 5.4 illustrates the potassium oxide– aluminium oxide ratio. Within the scatterplot, eight clusters were identified.

Cluster 1: Cluster one consists of three coarse wheel-thrown vessels (V2586KER-4, V2652KER-2, V368KER-3) with a high level of K2O and a medium level of Al2O3. The high levels of K2O exceed the levels present in the Dutch sediments. This means that the vessels are most likely of foreign provenance. The levels don't directly correspond with the levels of the Dutch sediments, but they seem close to the local sediments. Indicating that the vessels are most likely foreign, but could be made from clay similar to the local sediments.

Cluster 2: The second cluster that can be identified consists of two coarse handmade vessels (V619KER-5, V619KER-3) with a lower level of K2O and Al2O3 compared to cluster one. The high levels of K2O exceed the levels present in the Dutch sediments, which indicates that the vessels have a foreign provenance.

Cluster 3: The third cluster consists of one fine and three coarse wheel-thrown vessels (V2652KER-7, V368KER-1, V2586KER-5, V2627KER-5) and five coarse handmade vessels (V2382KER-2, V2618KER-2, V2647KER-2, V2586KER-3, V619KER-6). The vessels have a lower amount of K2O and Al2O3 than cluster two. The high levels of K2O exceed the levels present in the Dutch sediments. This indicates that the vessels have most likely a foreign provenance.

Cluster 4: The fourth cluster consists of five coarse wheel-thrown vessels (V193KER-2, V193KER-3, V2652KER-5, V2586KER-7, V2627KER-2) and one coarse handmade vessel (V2683KER-1). The vessels have a higher amount of Al2O3 than cluster three. The high levels of K2O exceed the levels present in the Dutch sediments. This indicates that the vessels are most likely of foreign provenance.

Cluster 5: The fifth cluster is the largest and consists of both coarse and fine wheel-thrown and handmade vessels with low levels of K2O and Al2O3. The levels of most of the vessels correspond with the levels from local and non-local Dutch background sediments and local and non-local Holocene sediments, indicating that the vessels most likely have a Dutch provenance and that some were locally produced. Only a few vessels within the cluster fall outside the group and don't correspond, making them most likely of foreign provenance.

Cluster 6: The sixth cluster consists of eleven coarse wheel-thrown vessels (V2653KER, V2081KER-1, V2586KER-2, V2652KER-4, V2652KER-1, V2076KER-1, V483KER-4, V2627KER-4, V2627KER-6, V2652KER-3, V2652KER-6) with a low level of K2O and a higher level of Al2O3. The levels of the vessels correspond with the levels from local and general Dutch background sediments and local and general Dutch Holocene sediments, indicating that the vessels most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 7: The seventh cluster consists of one coarse wheel-thrown vessel (V2076KER-1) with a higher level of Al2O3 compared to cluster six. The levels don't match the levels present in the Dutch sediments. This indicates that the vessel has most likely a foreign provenance.

Cluster 8: The eighth cluster consists of one coarse handmade vessel (V2647KER-1) with a lower level of K2O compared to cluster six. The levels don't match the levels present in the Dutch sediments. This indicates that the vessel has most likely a foreign provenance.

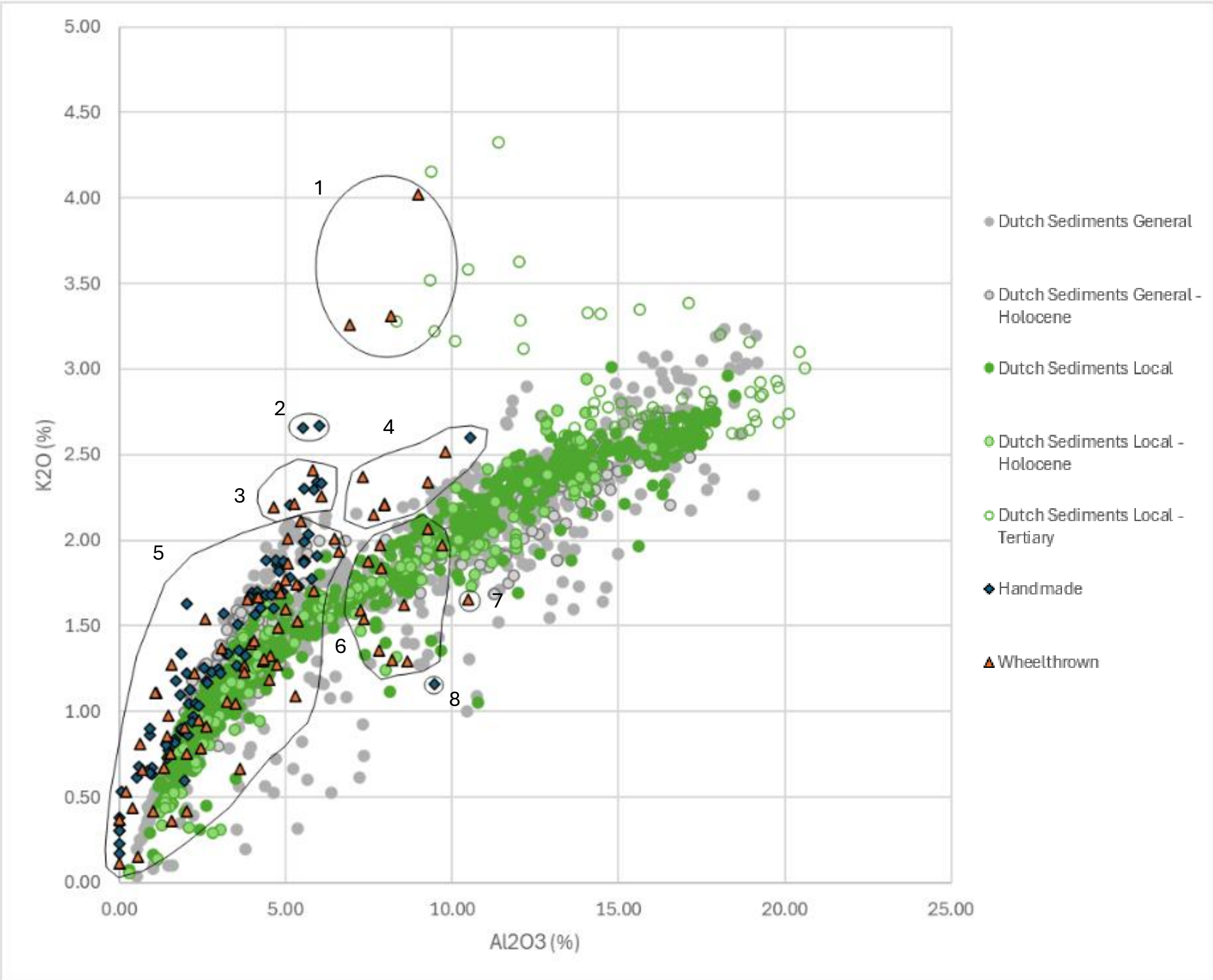


Figure 5.4: Scatterplot of the K2O: Al2O3 values for the analysed handmade and wheel-thrown vessels and general and local Dutch sediments (results as wt%) (created by M.L. Smedema)

Ratio Cr: TiO2

Figure 5.5 illustrates the chromium- titanium oxide ratio. Within the scatterplot, five clusters were identified.

Cluster 1: The first cluster consists of one coarse handmade vessel (V2647KER-1) and twelve measurements of eight coarse wheel-thrown vessels (V2627KER-6, V483KER-4, V2627KER-4, V2076KER-1, V2484KER-1, V2652KER-6, V2081KER-1, V2652KER-2) with high levels of Cr and TiO_2. The high levels of Cr and TiO_2 exceed the levels present in the Dutch sediments. This means that the vessels have most likely a foreign provenance.

Cluster 2: The second cluster consists of nine coarse wheel-thrown vessels (V2586KER-4, V2653KER, V2586KER-2, V483KER-2, V2652KER-1, V2076KER-1, V193KER-3, V2652KER-4, V193KER-2) with lower levels of Cr and TiO_2 compared to cluster one. The levels of the vessels correspond with the levels from local and general Dutch background sediments and general Dutch Holocene sediments, indicating that the vessels most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 3: The third cluster is the largest and consists of both coarse and fine wheel-thrown and handmade vessels with low levels of Cr and TiO_2. The levels of the vessels correspond with the levels from local and general Dutch background sediments and local and general Holocene sediments, indicating that the vessels most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Cluster 4: The fourth cluster consists of one coarse wheel-thrown vessel (V2076KER-3) with a lower level of Cr compared to cluster two and the highest level of TiO_2. The levels don’t match the levels present in the Dutch sediments. This means that the vessel most likely has a foreign provenance.

Cluster 5: The fifth cluster consists of one coarse wheel-thrown vessel (V2081KER-2) with a lower level of Cr and TiO_2 compared to cluster four. The levels don’t match the levels present in the Dutch sediments. This means that the vessel most likely has a foreign provenance.

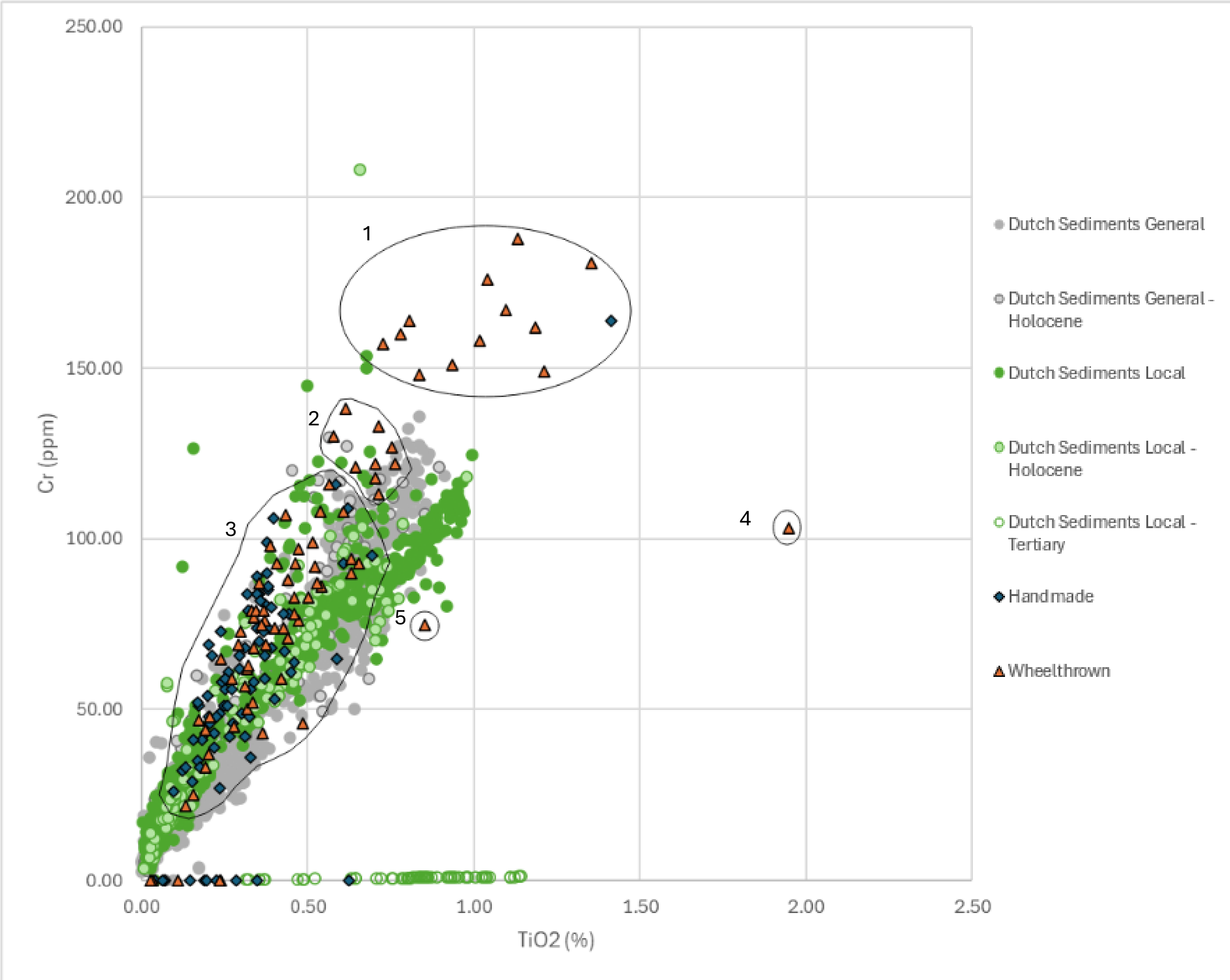


Figure 5.5: Scatterplot of the Cr: Tio2 values for the analysed handmade and wheel-thrown vessels and general and local Dutch sediments (results as wt%) (created by M.L. Smedema)

5.4 Summary

In this chapter, the results from the macroscopic and chemical analyses will be combined and summarised. The vessels with a foreign provenance consist of twelve coarse wheel-thrown vessels, one fine wheel-thrown vessel, and nine coarse handmade vessels. The foreign wheel-thrown vessels fall under different fabrics, including W1, W2, W3, W4, W5, W6, W8, W10, and W11. The foreign handmade vessels also fall under different fabrics, including H4, H6, H7, and H8. Most of the foreign handmade vessels fall under fabric H7, which is a dark/light grey reduced fired fabric with a hackly matrix and fine to medium poorly-sorted, sub-rounded quartz.

Some of the vessels have a Dutch and foreign provenance based on the different ratios of different elements. It is, of course, not possible for the vessels to have a Dutch as well as a foreign provenance at the same time. Further research, such as a petrographic analysis and the comparison of the vessels to ceramics from foreign production centres, can better determine whether the vessels are indeed of foreign provenance. Based on this research, it is most likely that the shards have a foreign provenance, but are made with clays that have a similar chemical composition to the Dutch/local reference sediments.

The vessels with a likely foreign (Dutch and foreign) provenance consist of thirteen coarse wheel-thrown vessels and six coarse handmade vessels. The foreign wheel-thrown vessels fall under different fabrics, including W2, W3, W5, W7, and W12. Most of the foreign wheel-thrown vessels fall under fabric W5, which is a yellow/orange grey oxidised and reduced fired fabric with a hard, slightly hackly matrix with several small voids. The inclusions in the fabric are few and consist of fine, very well-sorted, rounded quartz with mica. The foreign handmade vessels also fall under different fabrics, including H1, H6, H7, and H9. Most of the foreign handmade vessels fall under fabric H1, which is a (dark) grey reduced fired fabric with a slightly hackly matrix and a very fine sand and organic (plant) temper.

The vessels with a likely local/Dutch provenance, which were produced with local clay or Dutch clay with a similar composition to the local clay, consist of five coarse wheel-thrown vessels and four coarse handmade vessels. The wheel-thrown vessels fall under the fabrics W5 and W8. Most of them fall under fabric W5, which is a yellow/orange grey oxidised and reduced fired fabric with a hard, slightly hackly matrix with several small voids and fine, very well-sorted, rounded quartz and mica. The handmade vessels also fall under different fabrics, including H1, H3, and H6. Two of them fall under H6, which is a dark to light grey reduced fired fabric with a hackly matrix and medium to coarse, moderately-sorted, angular quartz and very coarse, poorly sorted, sub-angular stone fragments. Only one coarse handmade vessel has a local Tertiary provenance, which falls under fabric H7. An overview of the provenance and fabric of the vessels mentioned above can be found in Table 5.1.

The rest of the vessels that aren’t mentioned above fall within the larger clusters in the scatterplots. The majority of the vessels within these larger clusters correspond with the general and local Dutch sediments, indicating that the vessels most likely have a Dutch provenance and that some were produced with local clay or Dutch clay with a similar composition to the local clay. The vessels within the larger clusters that correspond with the general and/or local Dutch sediments fall under the following fabrics: H1, H2, H3, H5, H6, H7, H8, H10, H11, W2, W3, W5, W9 and W12. This means that all of the vessels that fall under the fabrics H2, H5, H10, H11, and W9 most likely have a Dutch provenance and were produced with local clay or Dutch clay with a similar composition to the local clay.

Only the vessels within the largest cluster (7) in Figure 5.3, which shows the ratio Sr: CaO, indicate that a large percentage of the coarse and fine handmade and wheel-thrown vessels have a most likely foreign provenance. This is due to the consistently low levels of CaO in the measurements from the vessels from Oegstgeest. This result seems rather odd because the rest of the plots indicate that these vessels from Oegstgeest are likely made from Dutch or local clays. More research is needed to explain why the levels of CaO are so low within the measurements. Since the measurements are consistent, a possible explanation could be that it is due to a measurement error.

Find number	Wheel-thrown/handmade	Coarse/ Fine	Provenance	High amount of...	Low amount of....	Fabric
V2076KER-3	Wheel-thrown	Coarse	Foreign	TiO_2	Fe_2O_3, Cr	W1
V2652KER-7	Wheel-thrown	Coarse	Foreign	K_2O	Al_2O_3	W1
V2586KER-5	Wheel-thrown	Coarse	Foreign	K_2O	Al_2O_3	W2
V2586KER-7	Wheel-thrown	Coarse	Foreign	Al_2O_3	K_2O	W3
V483KER-1	Wheel-thrown	Coarse	Foreign	Sr, CaO		W3
V2627KER-5	Wheel-thrown	Coarse	Foreign	K_2O	Al_2O_3	W4
V2627KER-2	Wheel-thrown	Coarse	Foreign	Al_2O_3, Cr	K_2O	W5
V483KER-3	Wheel-thrown	Coarse	Foreign	Sr, CaO		W5
V2484KER-2	Wheel-thrown	Coarse	Foreign	Sr	CaO	W6
V2484KER-4	Wheel-thrown	Coarse	Foreign	Sr	CaO	W6
V2586KER-4	Wheel-thrown	Coarse	Foreign	K_2O, Al_2O_3, Cr	TiO_2	W8
V368KER-1	Wheel-thrown	Fine	Foreign	K_2O	Al_2O_3	W10
V2652KER-5	Wheel-thrown	Coarse	Foreign	Al_2O_3	K_2O	W11
V2627KER-6	Wheel-thrown	Coarse	Likely foreign	TiO_2, Al_2O_3, Cr	Fe_2O_3, K_2O	W2
V2081KER-2	Wheel-thrown	Coarse	Likely foreign	TiO_2,	Fe_2O_3, Cr	W2
V368KER-3	Wheel-thrown	Coarse	Likely foreign	K_2O	Al_2O_3	W3
V2081KER-1	Wheel-thrown	Coarse	Likely foreign	TiO_2, Al_2O_3, Cr	Fe_2O_3, K_2O	W5
V193KER-2	Wheel-thrown	Coarse	Likely foreign	TiO_2, AL_2O_3, Cr	Fe_2O_3	W5
V2652KER-2	Wheel-thrown	Coarse	Likely foreign	K_2O, Al_2O_3, Cr, TiO_2	Fe_2O_3	W5
V2484KER-1	Wheel-thrown	Coarse	Likely foreign	Al_2O_3, Cr, TiO_2	Fe_2O_3	W5
V2076KER-1	Wheel-thrown	Coarse	Likely foreign	TiO_2, Al_2O_3, Cr	Fe_2O_3, K_2O	W5

V483KER-4	Wheel-thrown	Coarse	Likely foreign	TiO2, Al2O3, Cr	Fe2O3, K20	W5
V193KER-3	Wheel-thrown	Coarse	Likely foreign	Al2O3, Cr	K2O, TiO2	W5
V2652KER-6	Wheel-thrown	Coarse	Likely foreign	TiO2, Al2O3, Cr	Fe2O3, K2O	W7
V2652KER-3	Wheel-thrown	Coarse	Likely foreign	TiO2, Sr, Al2O3, Cr	Fe2O3, CaO, K2O	W7
V2627KER-4	Wheel-thrown	Coarse	Likely foreign	TiO2, Al2O3, Cr	Fe2O3, K2O	W12
V483KER-2	Wheel-thrown	Coarse	Dutch (local)	TiO2, Cr	Fe2O3,	W3
V2586KER-2	Wheel-thrown	Coarse	Dutch (local)	Al2O3, Cr	K2O, TiO2	W5
V2653KER	Wheel-thrown	Coarse	Dutch (local)	Al2O3, Cr	K2O, TiO2	W5
V2652KER-1	Wheel-thrown	Coarse	Dutch (local)	TiO2, Al2O3, Cr	Fe2O3, K2O	W5
V2652KER-4	Wheel-thrown	Coarse	Dutch (local)	TiO2, Al2O3, Cr	Fe2O3, K2O	W8
V2586KER-1	Handmade	Coarse	Foreign	Sr	CaO	H4
V619KER-6	Handmade	Coarse	Foreign	K2O	Al2O3	H6
V2618KER-2	Handmade	Coarse	Foreign	K2O	Al2O3	H6
V2586KER-2	Handmade	Coarse	Foreign	Sr	CaO	H7
V2647KER-1	Handmade	Coarse	Foreign	TiO2, Al2O3, Cr	Fe2O3, K2O	H7
V2647KER-2	Handmade	Coarse	Foreign	K2O	Al2O3	H7
V2586KER-3	Handmade	Coarse	Foreign	Sr, K2O	CaO, Al2O3	H7
V2683KER-1	Handmade	Coarse	Foreign	Al2O3, Cr	K2O	H7
V619KER-3	Handmade	Coarse	Foreign	K2O	Al2O3	H8
V2382KER-1	Handmade	Coarse	Likely foreign	Fe2O3, Sr	TiO2, CaO	H1
V2382KER-3	Handmade	Coarse	Likely foreign	Fe2O3, Sr	TiO2, CaO	H1
V483KER-1	Handmade	Coarse	Likely foreign	Fe2O3,	TiO2, Sr, CaO	H1
V2382KER-2	Handmade	Coarse	Likely foreign	Fe2O3, Sr, K2O	TiO2, CaO, Al2O3	H6
V2336KER	Handmade	Coarse	Likely foreign	Sr	CaO	H7
V619KER-5	Handmade	Coarse	Likely foreign	Fe2O3	TiO2, K2O, Al2O3	H9
V2150KER	Handmade	Coarse	Dutch (local)	Fe2O3	TiO2	H1
V804KER-2	Handmade	Coarse	Dutch (local)	Fe2O3	TiO2	H3
V619KER-4	Handmade	Coarse	Dutch (local)	Fe2O3	TiO2	H6
V2618KER-1	Handmade	Coarse	Dutch (local)	Fe2O3	TiO2	H6
V804KER-1	Handmade	Coarse	Dutch (Local, tertiary)	Fe2O3	TiO2	H7

Table 5.1: Summary of the provenance, elements, and fabric from the wheel-thrown and handmade vessels (created by M.L. Smedema)

6. Analysis

In this chapter, the results presented in the previous chapter will be analysed and interpreted. First, the provenance of the clay and ceramics will be discussed. Then the production of the ceramics will be discussed. Both the chemical and macroscopic analyses can provide information about the provenance and production of the ceramics found at the settlement of Oegstgeest. Especially, the chemical analysis can provide information about the provenance of the ceramics. Because only a portion of the entire pottery assemblage has been analysed during this research, it is essential to keep in mind that the results presented here may not provide an accurate representation of the entire assemblage.

6.1 Provenance

As seen in the previous chapter, the ceramics can be divided into those having a (likely) foreign provenance, a (likely) Dutch provenance, or a likely local provenance. A total of forty-one handmade and forty-three wheel-thrown ceramics were analysed. Out of the forty-three wheel-thrown ceramics, seventeen chemically matched with the local clay deposits from within the Netherlands. Out of the forty-one handmade ceramics, twenty-six chemically matched with the local clay deposits from within the Netherlands. The ceramics matched both the local and general Dutch clay deposits. This indicates that the vessels were most likely made with local clay. Based on this research, it is not possible to exactly determine the provenance of the clay or where the ceramics were produced. It is also not possible to say if the ceramics were all made in the same production centre. Only five early medieval pottery production sites are known within the Netherlands: Ubbergen, Maastricht-Wijck, Maastricht Lanakerveld, Cuijk, and Kessel. However, none of the wheel-thrown ceramics found at Oegstgeest seem to have come from these production centres. One of the stamps found on the wheel-thrown ceramics corresponds to a stamp found on pots in Maastricht, Obbicht, Stein, and Rhenen. This suggests that some of the wheel-thrown pots from Oegstgeest were likely produced in the west or centre of the Netherlands (De Bruin et al., 2021, p.210). This suggestion is supported by and explains the fact that some of the wheel-thrown ceramics from Oegstgeest match the local and Dutch clays.

It has been assumed that the handmade ceramics were locally produced for the household. The handmade pottery is presumably produced in local field kilns. However, no archaeological traces of these field kilns have been found (De Bruin et al., 2021, p.210). The fact that most of the handmade ceramics seem to have a local provenance seems to support the assumption that they were produced in a local field kiln with local clay.

Twenty-six of the wheel-thrown vessels and fifteen of the handmade ceramics did not chemically match the Dutch clay deposits, which indicates that they are of foreign provenance. The exact origin is unclear, but a small percentage of all wheel-thrown ceramics was probably imported from the Eifel region and produced at the Mayen production centre. 7.5% of all the wheel-thrown ceramics were tempered with Volcanic augite, which indicates that they were imported from the Eifel region. None of the wheel-thrown ceramics that were analysed during this research seemed to have these inclusions. The rest of the ceramics with a foreign provenance, especially the wheel-thrown ceramics, were probably imported from the German Vorbringe. This has been assumed by the fact that a large part of the ovoid pots have a WWT-E rim type (De Bruin et al., 2021, p.210). The fact that most of the wheel-thrown ceramics seem to have a foreign origin is not very surprising, since it has been assumed that, in the early Middle Ages, most of the wheel-thrown vessels were imported (Mittendorff & Berends, 2018, pp.5-6). These results only support this assumption.

Some of the handmade ceramics did not chemically match the Dutch clay deposits, indicating that they have a foreign provenance. Although they do not comprise the majority of the analysed handmade ceramics, it is noticeable that they do not match the Dutch clay deposits. This result was unexpected and may provide new and important insights. As stated earlier, in the early Middle Ages, most of the handmade ceramics were produced locally and were not imported (Mittendorff & Berends, 2018, pp.5-6). It is unknown where the handmade ceramics were exactly produced or why they seem to be imported. More research and a comparison to pottery from production centres outside the Netherlands are needed to establish the provenance of the ceramics further. It is also quite possible that the ceramics are made from a type of clay within the Netherlands that was not included in the DINOloket database. Or that they seem to have a foreign provenance due to a measurement error, since only a few of the measurements seem to point to a foreign provenance.

Only one of the wheel-thrown vessels and one of the handmade vessels are made out of fine ware. All the others are made out of coarse ware. The fine wheel-thrown vessel has a foreign provenance, and the fine handmade vessel has a likely Dutch provenance. So, there doesn't seem to be a difference between the provenance of the fine and coarse wares.

The ceramics with a local Dutch provenance, both handmade and wheel-thrown, seem to fall under different fabrics (W2, W3, W5, W8, W9, W12, H1, H2, H3, H5, H6, H7, H8, H10, H11). Both the handmade and wheel-thrown fabrics are reduced fired, oxidised fired, or reduced and oxidised fired combined. The clay matrix from the wheel-thrown fabrics with a local Dutch provenance varies a lot. They, however, have all quartz inclusions, and some of the fabrics also have pieces of mica. The handmade fabrics have quite a similar matrix, but the tempers are a bit more diverse. The fabrics have either a sand and organic (plant) temper (with sometimes quartz), a quartz temper, a quartz temper with stone grit, or a sand temper. What is noticeable is that the fabrics with a stone grit with mica seem absent from the group of ceramics with a local or Dutch provenance, both handmade and wheel-thrown.

The ceramics with a foreign provenance also seem to fall under different fabrics (W1, W2, W3, W4, W5, W6, W7, W8, W10, W11, W12, H1, H4, H6, H7, H8, H9). The wheel-thrown fabrics are also reduced fired, oxidised fired, or reduced and oxidised fired combined. The handmade ceramics are only reduced fired or reduced and oxidised fired. Both the clay matrix and the tempers differ for the wheel-thrown fabrics. The fabrics are tempered with quartz, quartz and mica, stone grit and mica, or sand. The handmade fabrics have a quite similar matrix with different tempers. The fabrics have either a sand and organic (plant) temper (with sometimes quartz), a quartz temper, a quartz temper with stone grit, a stone grit temper with mica, or a sand temper.

6.2 Production

In this part of the chapter, the production of the ceramics from Oegstgeest will be discussed based on the macroscopical and chemical analysis. This will be done following the different steps in the chaîne opératoire. The chemical analysis can provide information about the collection of the raw materials, while the macroscopical analysis can provide information about the rest of the steps in the chaîne opératoire.

6.2.1 Collection of raw materials

The first step in the chaîne opératoire is the collection of raw materials. The handmade ceramics that have been studied have a similar clay matrix; however, they seem to have different tempers. Most of the handmade ceramics were probably made with a similar type of clay, likely local clay; however, it is unclear whether the same clay source was used for the production of the pottery. Even though the clay matrix is similar, different types of temper have been used. This suggests that the potters used the same clay source(s) but may have employed different recipes when preparing the clay. This fits well with the assumption that the handmade ceramics were produced on a household scale and that each household produced its own pottery. This way, the same clay source is used, and the clays look very similar, but the clay recipes all have small variations due to household preferences. A couple of the ceramics were likely made with clay from outside the Netherlands. The fact that a couple of the handmade ceramics seem to have been made from clay outside of the Netherlands is quite odd, since it is believed that most of the handmade ceramics were made with local clay. Based on this research, it cannot be established where the clay from outside the Netherlands was collected. Therefore, more research is needed. There is also a possibility that the ceramics were made from Dutch clay, but that this type of clay was not included in the DINOloket database. Or that there has been a measurement error.

The wheel-thrown ceramics that have been studied have a different clay matrix and different tempers. Most of the wheel-thrown vessels were made with foreign clay, which perfectly fits the assumption that, in the early Middle Ages, most of the wheel-thrown vessels were produced on a large scale in different production centres outside the Netherlands. Some of the wheel-thrown ceramics were made with local clay, which can be explained by the fact that a couple of known and unknown early medieval pottery production centres were located in the Netherlands (also in the vicinity of Oegstgeest). The fact that the clay matrix and the tempers differ indicates that the ceramics were likely made from different clay sources and in different production centres with different clay recipes.

6.2.2 Preparing raw materials

As said previously, most of the handmade ceramics were likely made with clay from the same clay source. However, they seem to have different tempers and different fabrics were identified. This indicates that different clay recipes have been used for the making of the handmade ceramics. An explanation for why the handmade ceramics were made with different clay recipes might be that vessels with different functions required specific clay recipes. This, however, doesn't seem to be the case for the handmade ceramics from Oegstgeest. While not all of the exact functions of the ceramics are known, a large number of the handmade ceramics were used for cooking/ heating (De Bruin et al., 2021, p.208). Another explanation can be that the potters used different clay recipes due to tradition, religion, ethnicity, or technological restraints. These factors can influence how the potters prepare their clay. It is common for potters to follow tradition, use a specific clay recipe, and use the same preparation technique for vessels with a different function (Gosselain & Livingstone Smith, 2005, p. 41). This can explain why the handmade ceramics were made using a similar clay source, but by using different clay recipes.

The wheel-thrown ceramics were likely made with clay from different clay sources. They also have different tempers and different fabrics were identified. It can be assumed that the wheel-thrown ceramics were made with different clay recipes in different production centres in and outside the Netherlands. It is possible that the different production centres might have used clay sources only in the vicinity of the production centre. Although the tempers differ, a lot of the tempers include quartz. An explanation for the similar use of temper might be that similar clay recipes were used for ceramics with the same function. This may well apply to this pottery assemblage, since most of the wheel-thrown ceramics were used for cooking (De Bruin et al., 2021, p.208).

6.2.3 Shaping of the vessel

Within this research, it was not possible to determine how exactly the handmade and wheel-thrown ceramics were formed. More research is needed in order to understand which techniques were used for the shaping of the ceramics. At first, there doesn't seem to be a lot of difference in the techniques that were used to shape the handmade ceramics and wheel-thrown ceramics. However, there is some variability in the shapes of the ceramics. The difference in shape is likely based on the different functions of the ceramics. For example, the egg-shaped handmade pots of type Dorestad H3 and the handmade neckless bowls of type Dorestad H4 were used for cooking or water heating. There also seems to be a link between the diameter of the wheel-thrown pots and the function of the pots. Pots with a diameter smaller than 17.5 cm or larger than 23 cm were significantly more used for cooking, while pots between 17.5 and 23.5 cm were used less for cooking. (De Bruin et al., 2021, pp.208-210). Not all of the ceramics could be tied to a specific function, which is why further research is needed to establish the correlation between shape and function.

6.2.4 Surface treatment

For the handmade and wheel-thrown ceramics that have been analysed during this study, almost no surface treatment has been applied. The only surface treatment that has been identified on some of the sherds is the smoothing of the outside surface of the vessel. This fits well with the assumption that most of the early medieval ceramics aren’t decorated (Mittendorff & Berends, 2018, p.7). When examining the entire pottery assemblage, some handmade and wheel-thrown ceramics have been decorated with stamps, grooves, and/or rouletting. This includes some of the biconical vessels (KWT), bottles, pitchers, bowls, and Anglo-Saxon vessels (De Bruin et al., 2021, pp. 166, 188, 189, 197). Unfortunately, these vessels have not been analysed during this study. Further research about the handmade and wheel-thrown vessels with decorations can indicate if there is a correlation between the decorations and fabric.

6.2.5 Firing

The handmade and wheel-thrown ceramics were both fired under oxidising and reducing conditions. Between the reducing and oxidising fired ceramics, there doesn’t seem to be a clear division. What is noticeable about the analysed handmade ceramics is that only two have been fired under oxidising firing conditions. However, this is only for the researched ceramics and might not represent the entire pottery assemblage from the settlement of Oegstgeest. The wheel-thrown sherds within this research seem to be around equally oxidised and reduced fired. However, within the entire pottery assemblage, only 1/3 of the wheel-thrown ceramics have been reduced fired. A few of the handmade and wheel-thrown ceramics have been fired with both firing processes. During this research, it was not possible to establish which ceramics were fired inside a pit furnace or kiln. More research is needed to determine this, in particular, a petrographic analysis. A link between oxidising or reducing fired pots and function could not be found. There was, however, a link between the colour of the pots and function. The orange coloured pots seem to have had more contact with fire than pots of other colours. An explanation for this link can be that the colour of the pottery in the Middle Ages was associated with use and cleanliness (De Bruin et al., 2021, p.163, 208).

7. Conclusion

In the conclusion, the sub-questions and main question will be answered based on the literature research and the macroscopic and chemical analysis. At first, the sub-questions will be addressed, and then the main question will be answered based on the answers to the sub-questions.

7.1 Sub-questions

1. **What did the Merovingian settlement found at the site of Oegstgeest look like?**

The early medieval settlement of Oegstgeest was located on the northern bank of the Rhine in a deltaic environment close to the sea. The landscape consisted of alternating dry areas and wetlands. The settlement was built on the drier and higher parts of the landscape. The surrounding area was a brackish estuarine floodplain without trees. The climate at the time of the settlement was relatively dry but cold.

Gullies and creeks divided the settlement into four clusters, with the layout structured around low-lying areas and depressions. In clusters A and B, possible house sites were found. The lack of house features that were found can be explained by the suggestion that the houses were built on raised platforms or that the houses themselves were built out of sods. In total, twenty-six early medieval houses were discovered. Most of the houses were only partially preserved, probably due to clay extraction and levelling activities. Even though the house plans varied quite a bit, most of them belong to the Katwijk type. Additional structures that were excavated at the site consist of outhouses, wells, pits, ditches, fences, dikes, bridges, dams, fish traps, quay works, and landing areas. Eleven human burials and ten animal burials were also found at the site. Except for one Iron Age grave, the burials date to the Merovingian settlement. Depositions were found in gullies, low-lying areas, ditches, pitts and wells.

2. **What is currently known about the production and provenance of early medieval handmade and wheel-thrown ceramics in Europe?**

Raw materials are commonly extracted from a clay source in the vicinity of the potter's workplace. After the collection, the raw materials are prepared. The processing of the clay can be split into: pre-treatments, removal and addition of non-plastics, and homogenisation. Each step in the processing of the clay is influenced by factors, like tradition. After the processing of the clay, the vessel is shaped. The techniques that are used to shape the vessel can be divided into techniques that use rotating kinetic energy and those that don't use rotating kinetic energy. Usually, the handmade pots were made locally on a household scale, and the wheel-made pots were made in large-scale production centres and were imported. Decorations are usually applied to the vessels before firing, but most of the early medieval ceramics don't have decorations. Lastly, the ceramics are fired. This can be done in a field kiln or a closed kiln through an oxidising or reducing firing process. Sometimes we can speak of a combined firing process.

Red ware is produced in Mayen and Trier. The Merovingian fine wares are often produced locally, in the German Eifel region, or small production centres alongside the Meuse and Rhine. Merovingian coarse ware is often produced in the German Eifel region, especially around the city of Mayen. Coarse ware was also produced in smaller production centres alongside the Meuse and Rhine. Anglo-Saxon wares are found in Flemish and Dutch coastal areas, the Dutch inlands, and Anglo-Saxon England. Hessens-Schortens is produced on a household scale and was made locally. Late Anglo-Saxon ware is found in southern Germany, England and the Netherlands.

3. **What is the description and interpretation of the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest?**

Around 15.657 Merovingian handmade and wheel-thrown ceramics were found at the settlement of Oegstgeest. Around 84.9% of the Merovingian ceramics are wheel-thrown, and around 15.1% are handmade. The wheel-thrown ceramics that were found consist of: 279 biconical pots, 1642 ovoid pots/ Wolbwandtöpfe, thirty-four jugs, ten bottles, twenty-six shards from pitchers and amphorae, ninety bowls, and four blue-grey shards with a white-grey core. The biconical pots were made in both fine and coarse ware, and the ovoid pots were made in only coarse ware. The wheel-thrown pottery was mostly used for cooking. The handmade ceramics that were found consist of Anglo-Saxon wares, Hessens-Schortens wares/ Eitöpfe, and Trisum wares. Two types of handmade Anglo-Saxon biconical vessels were identified. A total of 403 rim fragments of Hessens-Schortens were found at the settlement. The Hessens-Schortens pottery can have different shapes, but globular pots were found most frequently.

During the macroscopical analysis, twelve different fabric groups were identified for the wheel-thrown ceramics, and eleven different fabric groups were identified for the handmade ceramics. Most of the wheel-thrown and handmade vessels were made out of coarse ware; only one of each was made out of fine ware. The clay matrix and tempers differ for the wheel-thrown ceramics. The handmade ceramics have a more uniform clay matrix with different tempers.

4. **What is the chemical composition of the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest? And what information can be derived from it?**

During the chemical analysis, the ratios of titanium oxide– iron oxide (TiO_2- Fe_2O_3), strontium– calcium oxide(Sr- CaO), potassium oxide– aluminium oxide (K_2O-Al_2O_3), and chromium-titanium oxide (Cr- TiO_2) were presented in four scatterplots. In the scatterplots, the XRF data from the wheel-thrown and handmade ceramics from Oegstgeest were presented together with the chemical data of local and general Holocene deposits, local tertiary deposits, and sediments from twenty-four locations within the Netherlands from DINOloket. Within the scatterplots, clusters with ceramics from Oegstgeest were identified. These clusters with ceramics were compared with the chemical composition of the Dutch sediments in order to determine the provenance. The vessels with a foreign provenance consist of twelve coarse wheel-thrown vessels, one fine wheel-thrown vessel, and nine coarse handmade vessels. The vessels with a likely foreign provenance consist of thirteen coarse wheel-thrown vessels and six coarse handmade vessels. The vessels with a likely Dutch provenance consist of five coarse wheel-thrown and four coarse handmade vessels. Only one coarse handmade vessel has a local Tertiary provenance. The largest group of handmade and wheel-thrown vessels fall within the larger clusters in the scatterplots.

5. **What is the difference between the Merovingian handmade and wheel-thrown ceramics found at the settlement of Oegstgeest based on the macroscopical and chemical analysis? And what information can be derived from it?**

Of the forty-three wheel-thrown ceramics, seventeen have a likely local provenance. Of the forty-one handmade ceramics, twenty-six have a likely local provenance. It is not possible to exactly determine where the ceramics were produced, but it is suggested that a small percentage of the wheel-thrown pots were likely made in the west or centre of the Netherlands. Because most of the handmade ceramics seem to have a local provenance, they were likely produced in a local field kiln with local clay. The rest of the handmade and wheel-thrown ceramics likely have a foreign provenance. Most of the wheel-thrown ceramics were probably imported from the German Vorbringe. A small number of handmade ceramics seem to have a foreign provenance. This is noticeable, but more research about these sherds and their provenance is needed.

Most of the handmade ceramics were made from similar clay sources but with different recipes, suggesting small-scale, household-level production influenced by factors like tradition or ethnicity. The wheel-thrown ceramics were likely made in different large-scale production centres with different clay recipes, mainly outside the Netherlands. The use of a similar temper for the wheel-thrown ceramics might be due to a similar function. Most of the wheel-thrown ceramics were used for cooking. It is not known how exactly the ceramics from Oegstgeest were formed. There is some variability in the shapes of the ceramics, probably due to the different functions. There seems to be a link between the diameter of the wheel-thrown pots and their use for cooking. The only surface treatment that has been identified during this study is the smoothing of the outside surface of the vessel. When we look at the entire pottery assemblage, some of the handmade and wheel-thrown ceramics have been decorated. Further research is needed to establish if there is a correlation between the decorations and the fabric. Both handmade and wheel-thrown ceramics were fired under oxidising and reducing conditions. There doesn’t seem to be a link between the firing of the pots and their function. However, orange coloured pots appear to have been mostly in contact with fire.

7.2 Main question

What new insights on the production and provenance of Merovingian handmade and wheel-thrown ceramics can be gained based on a macroscopic and chemical analysis of the ceramics from the Merovingian settlement of Oegstgeest?

At the site of the Merovingian settlement of Oegstgeest, 15.657 Merovingian handmade and wheel-thrown ceramics were found. 84.9% of the ceramics are wheel-thrown, and 15.2% are handmade. The ceramics consist of wheel-thrown biconical pots, ovoid pots, jugs, bottles, pitchers and handmade Anglo-Saxon wares, Hessens-Schrotens wares, and trisum wares. During this research, forty-one handmade and forty-three wheel-thrown ceramics were macroscopically and chemically analysed. During the macroscopical analysis, eleven different fabric groups were identified for the handmade ceramics, and twelve different fabric groups were identified for the wheel-thrown ceramics.

Most of the handmade ceramics seem to have a local provenance and were likely made in a local field kiln with local clay. The clay matrix of the handmade ceramics was quite uniform; however, different tempers were added. This can indicate that most of the handmade ceramics used a similar clay source; however, different recipes were used for preparing the clay. This indication corresponds to the idea that the handmade ceramics were produced locally on a household scale. Each household probably used the same local clay for the handmade ceramics, but might have used a different clay recipe due to factors like tradition. Some of the handmade ceramics seem to have a foreign provenance. This is a noticeable and unexpected result, since it is assumed that most of the handmade ceramics were produced locally and were not imported. It is unclear where these ceramics were produced, and why they don't chemically match the Dutch sediments. A comparison to pottery from production centres outside the Netherlands and more research is needed to define the provenance of these handmade ceramics. But if they are indeed made out of clay from outside the Netherlands, this might change the way we look at Merovingian handmade ceramics.

Most of the wheel-thrown ceramics seem to have a foreign provenance. The exact origin isn't clear, but they were probably imported from the German Vorbringe. Seventeen of the forty-three wheel-thrown ceramics have a likely local provenance. They were likely made in unknown production centres in the west or centre of the Netherlands. For the wheel-thrown ceramics, both the clay matrix and tempers differ. This indicates that the wheel-thrown ceramics were made with clay from different clay sources and with different clay recipes. Most of the wheel-thrown ceramics seem to be made in large-scale production centres outside the Netherlands and were imported. What is noticeable is that a small percentage seems to be made in large-scale production centres located within the Netherlands. The wheel-thrown ceramics were likely made from clay sources in the vicinity of the production centres. The use of a similar temper for the wheel-thrown ceramics might point to the use of a similar clay recipe for vessels with a similar function. Namely, most of the wheel-thrown ceramics were used for cooking.

There also seems to be a link between the diameter of the wheel-thrown pots and their use for cooking.

The handmade and wheel-thrown ceramics were both fired under oxidising and reducing conditions. There doesn’t seem to be a clear division, and no link between the firing of the pots and their function was found. There was, however, a link between the orange coloured pots and their contact with fire.

8. Discussion and looking forward

Within this thesis, the early medieval ceramics from the settlement at Oegstgeest were researched. A chemical and macroscopic analysis was conducted in order to get more information and a better understanding of Merovingian handmade ceramics. This research followed the research of Sophie Vullings (2023) about the production, perception, and value of early medieval handmade ceramics in Northern Gaul. The goal of this research was to get a better understanding of the Merovingian handmade ceramics, which are often overlooked and misunderstood. The ceramics were analysed with a different approach to provide more and/or new information about the production and provenance of these ceramics.

The original plan was to conduct a chemical, macroscopical and petrographic analysis. Unfortunately, the petrographic analysis has not taken place due to the unforeseen unavailability of the materials. However, at this moment, the ceramics that have been analysed during this study have been sampled and prepped for a petrographic analysis. I therefore recommend that a petrographic analysis will still be carried out in the future to provide more insight into the Merovingian ceramics from Oegstgeest. By conducting a petrographic analysis on the ceramics, more information about the collecting and preparing of the raw materials and firing of the ceramics can be gathered. During this research, it was not possible to exactly determine which clay sources had been used, where the ceramics were produced, and in what type of kiln the ceramics were fired. By carrying out a petrographic analysis, the composition and making of the ceramics can be further determined, and these questions can be answered.

Within this research, it was not possible to determine the exact provenance for all of the analysed ceramics. The ceramics were only chemically compared to Dutch sediments, but not to sediments from outside the Netherlands. A couple of the ceramics, mostly wheel-thrown, did not match the Dutch sediments and seemed to have a foreign provenance. To determine the exact provenance of these ceramics, a comparison to ceramics from production centres and sediments from outside the Netherlands is needed. It is particularly interesting to compare the handmade ceramics that seem to have a foreign provenance. Instead of the wheel-thrown ceramics, for which large-scale production centres outside the Netherlands are known, the handmade ceramics were believed to have been made locally on a household scale. By comparing these handmade ceramics, their provenance might be discovered, and it might be confirmed that they were produced outside the Netherlands. If they are indeed made (out of clay from) outside the Netherlands, this might change the way we look at Merovingian handmade ceramics and their production. It is also possible that the ceramics were made from a type of clay within the Netherlands that was not included in the DINOloket database. Or that they seem to have a foreign provenance due to a measurement error.

During the research, only 84 out of the 15.657 Merovingian ceramics found at the settlement of Oegstgeest were analysed. In order to get a better insight into the production and provenance of the handmade and wheel-thrown ceramics found at the site, more of the ceramics could be analysed in the future. The ceramics that have been analysed during this study consisted only of

2 fine ware ceramics, and almost none of the ceramics were decorated. It would therefore be especially interesting to analyse more of the fine ware ceramics and ceramics with (unique) decorations. By analysing the ceramics with decorations, it might be established if there is a connection between decorations and fabric or decorations and function.

One thing that was very noticeable during the chemical analysis was that a large part of the ceramics from Oegstgeest showed consistently low levels of CaO. Because of these low levels, a part of these ceramics seemed to be of foreign provenance. This, however, doesn't seem to correspond with the rest of the results from the chemical analysis. More research is needed to explain why the levels of CaO are so low within the measurements, and what explanation can be given for it. The low levels of CaO can give new insight into the production and provenance of the handmade and wheel-thrown ceramics; however, since the measurements are consistent, a possible explanation could be that it is due to a measurement error.

In the end, this thesis has provided more information and a better understanding of the Merovingian handmade and wheel-thrown ceramics from the early medieval settlement of Oegstgeest. Through a chemical and macroscopical analysis of the ceramics, more and new information was gathered about the production and provenance of these ceramics. This thesis proves that there is more information to be discovered about the Merovingian handmade ceramics. Together with the research of Sophie Vullings (2023), this thesis is a step forward in a better understanding of the Merovingian handmade ceramics, which are often overlooked and misunderstood. However, more work is still needed. Hopefully, the research on Merovingian handmade ceramics will be continued, and more Merovingian handmade ceramics from different sites will be further analysed. This research is already a start in the right direction, because the Merovingian handmade ceramics are more than meets the eye.

Abstract

The Merovingian handmade ceramics are often ill-researched and overlooked. It has been believed that the handmade ceramics were poorly produced by unskilled potters. However, they are more than meets the eye. Within this research, the provenance and production of the handmade and wheel-thrown ceramics from the settlement of Oegstgeest have been researched. The ceramics have been analysed with a chemical and macroscopic analysis to gather more and new information, and to put the handmade ceramics in a different and more positive light. Also, a literature study was carried out about the Merovingian pottery and the settlement of Oegstgeest. For the chemical and macroscopical analysis, only a selection of 84 handmade and wheel-thrown ceramics was analysed due to the large quantity of shards. Within the research, the following research question was answered:

What new insights on the production and provenance of Merovingian handmade and wheel-thrown ceramics can be gained based on a macroscopic and chemical analysis of the ceramics from the Merovingian settlement of Oegstgeest?

The Merovingian settlement of Oegstgeest was located on the northern bank of the Rhine and was built on the drier and higher parts of the landscape. Within the settlement, multiple house sites and houses were found, and it was suggested that the houses were built on raised platforms or that the houses themselves were built out of sods. Additional structures like outhouses, wells, ditches, dikes, dams, and quay works were also found at the site. Human burials, animal burials and multiple depositions were also found at the site. A total of 15.657 Merovingian handmade and wheel-thrown ceramics were found at the settlement of Oegstgeest. The wheel-thrown ceramics that were found consist of biconical pots, ovoid pots, jugs, bottles, pitchers, amphorae, and bowls. The handmade ceramics that were found consist of Anglo-Saxon wares, Hessens-Schortens wares/ Eitöpfe, and Trisum wares. During the macroscopical analysis, twelve different fabric groups were identified for the wheel-thrown ceramics, and eleven for the handmade ceramics. Almost all of the wheel-thrown and handmade ceramics were made out of coarse ware. The clay matrix and tempers differ for the wheel-thrown ceramics. The handmade ceramics have a more uniform clay matrix with different tempers.

During the chemical analysis, the XRF data from the ceramics from Oegstgeest were presented in scatterplots together with the chemical data of Dutch sediments. The ceramics from Oegstgeest were compared with the chemical composition of the Dutch sediments in order to determine the provenance. Twenty-six wheel-thrown vessels and fifteen handmade vessels have a (likely) foreign provenance. Five wheel-thrown and four handmade vessels have a likely Dutch provenance, and the rest of the ceramics have a Dutch or local provenance. The exact place of production is unknown, but some of the wheel-thrown pots were likely made in the west or centre of the Netherlands, and most were probably imported from the German Vorbringe. Most of the handmade ceramics were likely produced in a local field kiln with local clay on a household level. The different clay recipes were likely influenced by different factors.

The wheel-thrown ceramics were likely made in different large-scale production centres with different clay recipes. The use of a similar temper for the wheel-thrown ceramics might be due to a similar function (cooking). There is some variability in the shapes of the ceramics, probably due to the different functions. There doesn't seem to be a link between the firing of the pots and their function, but orange coloured pots appear to have been in contact with fire the most.

Samenvatting

Het Merovingische handgemaakte aardewerk is vaak niet goed onderzocht en wordt vaak over het hoofd gezien. Het wordt meestal geloofd dat het aardewerk slecht gemaakt is door ongeschoolde potters. Maar ze zijn meer dan je op het eerste gezicht zou denken. Binnen dit onderzoek zijn de herkomst en productie van de handgemaakte en gedraaide scherven uit de nederzetting van Oegstgeest onderzocht. Het keramiek is door een chemische en macroscopische analyse geanalyseerd om meer en nieuwe informatie te verzamelen. En om de handgemaakte scherven in een ander en een positiever licht te zetten. Er is ook een literatuurstudie uitgevoerd naar het Merovingische aardewerk en de nederzetting van Oegstgeest. Door de grote hoeveelheid scherven is er alleen een selectie van 84 handgemaakte en gedraaide scherven onderzocht. Binnen het onderzoek is de volgende hoofdvraag beantwoord:

Welke nieuwe inzichten over de productie en herkomst van het Merovingische handgemaakte en gedraaide keramiek kunnen gewonnen worden op basis van een macroscopische en een chemische analyse van de scherven uit de Merovingische nederzetting van Oegstgeest?

De Merovingische nederzetting van Oegstgeest lag aan de noordelijke oever van de Rijn en was gebouwd op de drogere en hoger gelegen delen in het landschap. Binnen de nederzetting werden meerdere huisplattegronden gevonden en er werd gesuggereerd dat de huizen op verhoogde platforms waren gebouwd of dat de huizen zelf uit graszoden waren opgetrokken. Daarnaast werden op de locatie ook andere structuren gevonden, zoals bijgebouwen, putten, sloten, dijken, dammen en kadewerken. Op de site werden ook menselijke begravingen, dierlijke begravingen en meerdere deposities gevonden. In de nederzetting van Oegstgeest werden ongeveer 15.657 Merovingische handgemaakte en gedraaide scherven gevonden. Het gedraaide keramiek dat werd gevonden, bestaan uit biconische potten, eivormige potten, kruiken, flessen, kannen, amforen en kommen. Het handgemaakte keramiek dat werd gevonden bestaat uit Angelsaksisch aardewerk, Hessens-Schortens aardewerk/Eitöpfe en Trisum aardewerk. Tijdens de macroscopische analyse werden twaalf verschillende baksels geïdentificeerd voor het gedraaide keramiek en elf voor het handgemaakte keramiek. Bijna al het gedraaide en handgemaakte keramiek was gemaakt van grof aardewerk. De kleimatrix en magering verschillen voor het gedraaide keramiek. Het handgemaakte keramiek heeft een meer uniforme kleimatrix met verschillende mageringen.

Tijdens de chemische analyse werden de XRF-gegevens van het keramiek uit Oegstgeest samen met de chemische gegevens van Nederlandse sedimenten in spreidingsdiagrammen weergegeven. Het keramiek uit Oegstgeest werd vergeleken met de chemische samenstelling van de Nederlandse sedimenten om de herkomst te bepalen. Zesentwintig gedraaide scherven en vijftien handgemaakte hebben een (waarschijnlijk) buitenlandse herkomst. Vijf gedraaide en vier handgemaakte scherven hebben waarschijnlijk een Nederlandse herkomst, en de rest van het keramiek heeft een Nederlandse of lokale herkomst. De exacte plaats van productie is onbekend, maar sommige van de gedraaide potten zijn waarschijnlijk gemaakt in het westen of

midden van Nederland, en de meeste zijn waarschijnlijk geïmporteerd uit het Duitse Vorbringe. Het merendeel van de handgemaakte keramiek is waarschijnlijk op huishoudelijk niveau geproduceerd in een lokale veldoven met lokale klei. De verschillende kleirecepten zijn waarschijnlijk beïnvloed door verschillende factoren. De gedraaide potten zijn waarschijnlijk gemaakt in verschillende grootschalige productiecentra met verschillende kleirecepten. Het gebruik van een vergelijkbare magering voor de gedraaide potten kan te wijten zijn aan de gelijke functie (koken). Er is enige variatie in de vormen van het keramiek, waarschijnlijk als gevolg van de verschillende functies. Er lijkt geen verband te bestaan tussen de baktemperatuur van de potten en hun functie, maar oranje potten lijken het meest in contact te zijn geweest met vuur.

References

Beltrame, M., Sitzia, F., Liberato, M., Santos, H., Barata, F. T., Columbu, S., & Mirão, J. (2020). Comparative pottery technology between the Middle Ages and Modern times (Santarém, Portugal). *Archaeological and Anthropological Sciences*, *12(7): 130.* https://doi.org/10.1007/s12520-020-01053-x

Bezur, A., Lee, L., Loubser, M., & Trentelman, K. (2020). *Handheld XRF in Cultural Heritage: A practical workbook for conservators*. J. Paul Getty Trust and Yale University.

Boon, H. (2011). Hessens-Schortens. *Een typologische studie naar vroegmiddeleeuws, handgevormd aardewerk in Noord-Nederland* [Unpublished thesis}. Rijksuniversiteit Groningen.

De Bruin, J. (2013). De Merovingische nederzetting in Oegstgeest. *Westerheem*, *62(6)*. 309-315.

De Bruin, J., Bakels, C. & Theuws, F. (2021). *Oegstgeest, a riverine settlement in the early medieval world system*. SPA Uitgevers.

de koning, J. (2023). Middeleeuws aardewerk voor circa 1000 AD. In H. Stoepker (Ed.), *Sporen van Susteren: Archeologische vondsten uit een Karolingische abdij en een adellijk vrouwenstift* (pp.641-727). Limburgs Museum. https://doi.org/10.17026/dans-xsf-nypw

de Koning, J., Gerrets, D., & Nieuwhof, A. (2020A). Wheel-thrown pottery of the Merovingian and Carolingian periods at Wijnaldum. In A. Nieuwhof (Ed.), *The Excavations at Wijnaldum: Volume 2: Handmade and Wheel-thrown Pottery of the first Millennium AD* (pp.99-146). University of Groningen/Groningen Institute of Archaeology and Barkhuis Publishing.

de Koning, J., Nieuwhof, A., & Gerrets, D. (2020B). Handmade pottery of the Merovingian and Carolingian periods at Wijnaldum. In A. Nieuwhof (Ed.), *The Excavations at Wijnaldum: Volume 2: Handmade and Wheel-thrown Pottery of the first Millennium AD* (pp.159-191). University of Groningen/Groningen Institute of Archaeology and Barkhuis Publishing.

Dijkstra, M.F.P. (2006). Aardewerk. In M. Hemminga & T. Hamburg (Eds.), *Een Merovingische nederzetting op de oever van de oude Rijn*. (pp. 51-72). Archol.

Dijkstra, M. F. P. (2011). *Rondom de mondingen van Rijn & Maas : landschap en bewoning tussen de 3e en 9e eeuw in Zuid-Holland, in het bijzonder de Oude Rijnstreek*. Sidestone Press.

Gosselain, O.P. (2008). Thoughts and adjustments in the potter's backyard. In I. Berg (Ed.), *Breaking the Mould: Challenging the Past through Pottery. Bar international Series 1861* (pp. 67-80). Archaeopress.

Gosselain, O.P. & Livingstone Smith, A. (2005). The Source. Clay Selection and Processing Practices in Sub-Saharan Africa. In A. Livingstone Smith, D. Bosquet and R. Martineau (Eds.), *Pottery Manufacturing Processes: Reconstruction and Interpretation. BAR International Series 1349* (pp. 33-48). Archaeopress.

Hemminga, M. & Hamburg, T. (2006). *Een Merovingische nederzetting op de oever van de oude Rijn*. Archol rapport 69. Archol.

Knol, E. (1993): *De Noordnederlandse kustlanden in de Vroege Middeleeuwen* [Doctoral dissertation, Vrije Universiteit Amsterdam]. Vrije Universiteit Amsterdam.

Kramer, C. (1985). Ceramic ethnoarchaeology. *Annual Review of Anthropology, 14,* pp. 77-102

Krol, T. N. (2006). *Angelsaksisch aardewerk in Noord-Nederland*. Nieuwe perspectieven op het Noordnederlandse kustgebied na het bewoningshiaat in de vierde eeuw. De Vrije Fries, 86.

Krol, T. N., Dee, M., & Nieuwhof, A. (2020). The Chronology of Anglo-Saxon Style Pottery in Radiocarbon Dates: Improving the Typo-chronology. *Oxford Journal of Archaeology*, *39*(4), 410-441.

Kroon, E.J., Huisman, D.J., Bourgeois, Q.P.J., Braekmans, D.J.G. & Fokkens, H (2019). The introduction of Corded Ware Culture at a local level: An exploratory study of cultural change during the Late Neolithic of the Dutch West Coast through ceramic technology. *Journal of Archaeological Science Reports, 26*. doi:10.1016/j.jasrep.2019.101873

Lanting, J. N. & Van der Plicht, J. (2010). De 14C-chronologie van de Nederlandse Pre- en Protohistorie VI: Romeinse tijd en Merovingische periode, deel A: historische bronnen en chronologische thema's. *Palaeohistoria*, 51/52, 27-168.

Marie. (2022). Traditional Pottery Wheel History - Pottery Crafters. *Pottery Crafters*. https://potterycrafters.com/traditional-pottery-wheel-history

Mittendorff, A. & Berends, A.S. (2018). *Syllabus 1, Keramiek uit de vroege en volle middeleeuwen (ca. 450-1250)*. Hogeschool Saxion.

Nieuwhof, A. (2008). Het handgemaakte aardewerk, ijzertijd tot vroege middeleeuwen. In J.A.W. Nicolay (Ed.), *Opgravingen bij Midlaren. 5000 jaar wonen tussen Hondsrug en Hunzedal. Deel 1*. Barkhuis & University of Groningen Library.

Nieuwhof, A. (2013). Anglo-Saxon immigration or continuity?: Ezinge and the coastal area of the northern Netherlands in the Migration Period. *Journal of Archaeology in the Low Countries*, 5(1), 53–83.

Ondergrondgegevens | DINOloket. (n.d.). https://www.dinoloket.nl/ondergrondgegevens

Revello Lami, M. (2023). *Chapter 6 Macroscopic Fabric Analysis*.

Roux, V. (2017). Ceramic Manufacture. The chaîne opératoire Approach. In A. Hunt (Ed.), *The Oxford Handbook of archaeological ceramic analysis* (pp. 101-113). Oxford University Press.

Sam. (2024). *Exploring GB*. Exploring GB. https://www.exploringgb.co.uk/blog/anglo-saxon-oven-discovered-in-northumberland

Shackley, M. S. (2010). An introduction to X-ray fluorescence (XRF) analysis in archaeology. In *X-ray fluorescence spectrometry (XRF) in geoarchaeology* (pp. 7-44). Springer.

Soulat, J., Bocquet-Liénard, A., Savary, X. & Hicker, V. (2012). Hand-made pottery along the Channel coast and parallels with the Scheldt valley. In R. Annaert, K. De Groote, Y. Hollevoet & F. Theuws (Eds.), *The very beginning of Europe? : cultural and social dimensions of Early Medieval migration and colonisation (5th-8th century) : archaeology in contemporary Europe : conference Brussels - May 17-19, 2011*. Flanders Heritage Agency.

Taayke, E. (2020). Handmade pottery of the Migration period and the Merovingian period. In A. Nieuwhof (Ed.), *The Excavations at Wijnaldum: Volume 2: Handmade and Wheel-thrown Pottery of the first Millennium AD* (pp.69-98). Barkhuis Publishing.

Thér, R. (2020). Ceramic technology. How to reconstruct and describe pottery-forming practices. *Archaeological and Anthropological Sciences*, *12*(8), 172. https://doi.org/10.1007/s12520-020-01131-0

Van Grinsven, P.F.A. & Dijkstra M.F.P. (2007). *De vroeg middeleeuwse nederzettting te Koudekerk aan den Rijn. Een bijna vergeten opgraving in de Lagewaardse polder*. AWN.

Van Spelde, F. (2012). *Merovingische tonpotten in West-Nederland. Een vroegmiddeleeuws gebruiksvoorwerp in context* [Unpublished thesis]. Leiden University.

Verhoeven, A. A. A. (2016). Aardewerk. In M. F. P. Dijkstra, A. A. A. Verhoeven, & K. C. J. van Straten (Eds.), *Nieuw licht op Leithon: Archeologisch onderzoek naar de vroegmiddeleeuwse bewoning in plangebied Leiderdorp-Plantage* (pp. 153-210). Universiteit van Amsterdam.

Vullings, S. (2023). *Muddy Marvels: An exploratory study into the production, perception & value of early medieval handmade ceramics in Northern Gaul*. Leiden University, Faculty of Archaeology.

Appendix 1

XRF data

Sample	Na2O (wt%)	MgO (wt%)	Al2O3 (wt%)	SiO2 (wt%)	P2O5 (wt%)	K2O (wt%)	TiO2 (wt%)	CaO (wt%)	MnO (wt%)	Fe2O3 (wt%	S (ppm)	Cl (ppm)	V (ppm)	Cr (ppm)	Cr (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Ga (ppm)	As (ppm)	Se (ppm)	Rb (ppm)	Sr (ppm)	Sr (ppm)	Y (ppm)	Zr (ppm)	Nb (ppm)	Mo (ppm)	Ba (ppm)	Pb (ppm)	Th (ppm)	U (ppm)
V2150Ker	0.00	0.76	2.14	12.61	0.40	1.13	0.21	1.26	0.08	3.24	0.12	0.00	0.0085	0.0066	66	0	0.0024	0.004	0.024	0.0016	0.0053	0	0.0108	0.039	390	0.0035	0.0164	0.0013	0	0.0296	0.0027	0	0
V2150Ker	0.00	0.93	4.41	20.62	1.21	1.88	0.33	2.29	0.11	5.41	0.30	0.00	0.0158	0.0056	56	0.0011	0.0029	0.0022	0.0211	0.0018	0.0058	0	0.0116	0.0391	391	0.0039	0.0172	0.0012	0	0.0414	0.0035	0	0
V2336Ker	0.00	1.23	2.04	12.96	5.77	1.63	0.24	8.10	0.07	2.16	0.36	0.57	0.0075	0.0058	58	0.0006	0.0015	0.001	0.0189	0.0014	0.0026	0	0.0124	0.0315	315	0.0037	0.0259	0.0014	0	0.0356	0.0026	0	0
V2336Ker	1.26	0.66	0.00	1.91	1.80	0.30	0.07	4.86	0.29	2.04	0.10	0.00	0.0053	0	0	0	0.0018	0.0091	0.0232	0.0006	0.0032	0	0.0096	0.0339	339	0.0026	0.0207	0.0016	0.0013	0.0199	0	0	0
V2382Ker-1	0.00	0.97	4.84	23.95	0.48	1.84	0.35	1.23	0.17	4.70	0.07	0.00	0.0131	0.0074	74	0.001	0.0021	0.0032	0.0226	0.0015	0.0059	0	0.0141	0.0491	491	0.0039	0.0207	0.0013	0	0.0347	0.0055	0	0
V2382Ker-1	0.89	0.73	2.99	15.52	0.19	1.25	0.26	0.86	0.07	2.42	0.07	0.00	0.0107	0.0042	42	0	0.0019	0.0053	0.0145	0.0014	0.0027	0	0.0131	0.0198	198	0.003	0.0202	0.001	0	0.0214	0.004	0	0
V2382Ker-2	0.00	0.74	5.97	23.75	0.88	2.34	0.37	1.78	0.26	4.40	0.06	0.00	0.0127	0.0081	81	0.0011	0.0026	0.0023	0.0253	0.0019	0.0053	0	0.0157	0.051	510	0.0043	0.0174	0.0016	0	0.0482	0.0049	0.0027	0
V2382Ker-2	1.04	0.75	3.57	16.05	0.80	1.51	0.28	1.62	0.15	4.31	0.03	0.00	0.0136	0	0	0	0.0026	0.0037	0.0237	0.0017	0.0043	0	0.0142	0.0504	504	0.004	0.0187	0.0012	0	0.0477	0.0038	0.0015	0
V2382Ker-3	0.00	0.69	2.80	17.02	1.24	1.23	0.24	1.75	0.16	5.51	0.06	0.00	0.0125	0.0073	73	0	0.0015	0.0023	0.0263	0.0013	0.0081	0	0.0129	0.0678	678	0.0036	0.0214	0.001	0	0.0425	0.0052	0	0
V2382Ker-3	1.33	0.56	0.60	6.33	0.08	0.68	0.23	0.60	0.09	1.81	0.05	0.00	0.0021	0.0027	27	0	0.0019	0.0035	0.0207	0.0017	0.0023	0	0.0143	0.0233	233	0.0034	0.0203	0.0012	0	0.021	0.0039	0	0
V2586Ker-1	0.00	0.86	3.99	20.28	0.25	1.69	0.31	1.49	0.11	3.71	0.07	0.00	0.0098	0.0068	68	0.0005	0.0031	0.0084	0.0304	0.0019	0.0046	0	0.0144	0.0526	526	0.0044	0.0193	0.0014	0	0.0483	0.0048	0	0
V2586Ker-1	0.00	0.90	4.10	18.06	0.23	1.56	0.29	1.11	0.11	3.90	0.05	0.00	0.0131	0.0062	62	0	0.0027	0.0051	0.0319	0.0019	0.006	0	0.0152	0.0625	625	0.0042	0.0168	0.0016	0	0.0516	0.0044	0	0
V2586Ker-2	1.18	0.88	3.94	22.59	0.71	1.67	0.31	2.82	0.25	3.72	0.09	0.00	0.0109	0.0042	42	0.001	0.0022	0.0088	0.0505	0.0014	0.0026	0	0.012	0.0543	543	0.0034	0.0135	0.0011	0	0.0353	0.0027	0	0
V2586Ker-2	0.00	0.83	3.05	18.39	0.34	1.22	0.25	1.94	0.15	3.49	0.06	0.00	0.011	0.0051	51	0	0.0015	0.0084	0.0351	0.0011	0.0037	0	0.0107	0.0484	484	0.0029	0.0159	0.001	0	0.029	0.0027	0	0
V2586Ker-3	1.10	0.90	5.56	16.74	4.33	2.30	0.58	4.74	0.04	2.97	0.48	0.37	0.0152	0.0116	116	0.0009	0.0025	0.0023	0.0205	0.0031	0.0028	0	0.0163	0.0261	261	0.0042	0.0188	0.0022	0	0.0365	0.0051	0.0018	0
V2586Ker-3	1.73	0.60	0.09	3.55	0.77	0.53	0.59	4.14	0.06	3.09	0.14	0.00	0	0.0065	65	0	0.0037	0.0085	0.0221	0.0019	0.0032	0	0.0113	0.0296	296	0.0039	0.0163	0.0017	0	0.0291	0.0027	0	0
V2618Ker-1	0.00	0.80	5.70	24.60	0.49	2.04	0.38	1.30	0.07	4.59	0.05	0.00	0.0141	0.0074	74	0.0012	0.0031	0.0056	0.0172	0.0018	0.0036	0	0.0134	0.0317	317	0.0042	0.0219	0.0014	0	0.0521	0.0043	0.0017	0
V2618Ker-1	1.36	0.64	0.98	8.95	0.12	0.67	0.19	0.48	0.02	1.77	0.04	0.00	0.0107	0	0	0	0.0025	0.0053	0.0134	0.0011	0.003	0	0.0096	0.0234	234	0.0025	0.0155	0.0012	0	0.0185	0.0038	0.0017	0
V2618Ker-2	0.00	0.74	6.07	22.73	0.64	2.34	0.43	1.28	0.05	3.51	0.07	0.00	0.0147	0.0067	67	0.0006	0.0033	0.0038	0.0153	0.0023	0.003	0	0.0161	0.0243	243	0.0048	0.0223	0.002	0	0.0337	0.0031	0.0016	0
V2618Ker-2	0.86	0.63	2.57	13.12	0.45	1.26	0.30	0.90	0.02	2.13	0.05	0.00	0.0079	0.0049	49	0	0.0028	0.0046	0.012	0.0019	0.0023	0	0.0162	0.0203	203	0.0046	0.0209	0.0013	0	0.0316	0.0041	0	0
V2621Ker-1	1.39	0.61	1.71	12.73	0.09	1.18	0.61	0.81	0.03	3.65	0.06	0.00	0.0039	0.0093	93	0	0.003	0.0114	0.0102	0.0013	0.0038	0	0.0138	0.0233	233	0.0037	0.0281	0.0016	0	0.0383	0.0052	0	0
V2621Ker-1	1.12	0.71	1.67	12.10	0.21	0.83	0.19	0.61	0.14	2.45	0.03	0.00	0.0111	0.0043	43	0	0.0024	0.0075	0.0112	0.0011	0.0049	0	0.0131	0.0221	221	0.004	0.0272	0.0013	0	0.0232	0.0034	0	0
V2647Ker-1	0.00	0.38	9.46	23.04	0.22	1.16	1.41	0.89	0.02	2.30	0.14	0.00	0.0124	0.0164	164	0.0005	0.0035	0.0025	0.0082	0.0031	0.0009	0	0.0128	0.0293	293	0.0038	0.0301	0.0047	0	0.0396	0.0034	0	0
V2647Ker-1	1.13	0.68	0.00	1.76	0.60	0.23	0.18	2.77	0.01	0.75	0.43	0.00	0.0045	0.0041	41	0	0.0047	0.0244	0.0203	0.0019	0.0016	0	0.0099	0.0252	252	0.0037	0.0268	0.0044	0	0.015	0	0	0
V2647Ker-2	0.00	0.78	5.87	22.98	0.42	2.29	0.38	1.26	0.04	2.61	0.13	0.00	0.0119	0.009	90	0.0006	0.0035	0.0019	0.0232	0.0023	0.0024	0	0.0142	0.0221	221	0.0043	0.024	0.0017	0	0.0407	0.004	0.0015	0
V2647Ker-2	1.11	0.70	0.00	2.32	0.67	0.38	0.10	2.25	0.02	1.20	0.28	0.00	0.0049	0.0026	26	0	0.0044	0.0189	0.0176	0.0013	0.0029	0	0.0131	0.016	160	0.0037	0.019	0.0015	0	0.0103	0	0	0
V2652Ker-1	0.00	0.68	3.81	19.53	0.16	1.32	0.29	0.93	0.07	4.09	0.22	0.00	0.011	0.0066	66	0.0005	0.002	0.0041	0.0258	0.0019	0.0032	0	0.0163	0.0389	389	0.0039	0.0219	0.0015	0	0.0326	0.0061	0.0016	0
V2652Ker-1	1.54	0.55	0.94	8.31	0.08	0.86	0.25	0.52	0.03	2.27	0.06	0.00	0.0069	0.0056	56	0	0.0015	0.0027	0.0272	0.0019	0.0029	0	0.0178	0.0205	205	0.0039	0.0222	0.0017	0	0.0219	0.005	0	0
V2652Ker-3	0.00	0.60	4.75	24.53	0.24	1.86	0.37	0.79	0.03	2.46	0.04	0.00	0.0117	0.0059	59	0.0005	0.0017	0.0022	0.0176	0.0021	0.0023	0	0.0121	0.0383	383	0.0032	0.0252	0.0014	0	0.0383	0.0054	0	0
V2652Ker-3	1.17	0.61	1.86	12.59	0.31	1.10	0.24	1.01	0.10	3.48	0.08	0.00	0.0096	0.0049	49	0	0.0009	0.0075	0.0322	0.0017	0.007	0	0.0103	0.0896	896	0.0031	0.0215	0.0014	0	0.0328	0.0026	0	0
V2652Ker-4	0.00	0.65	5.56	24.88	0.38	1.99	0.44	1.53	0.25	3.52	0.38	0.00	0.0079	0.0078	78	0.0012	0.003	0.0022	0.0261	0.0018	0.0032	0	0.0153	0.0334	334	0.0041	0.0212	0.0015	0	0.0376	0.0037	0.0014	0
V2652Ker-4	1.32	0.61	3.14	16.34	0.51	1.57	0.45	1.55	0.28	3.57	0.08	0.00	0.006	0.0061	61	0	0.0036	0.008	0.0345	0.0017	0.0035	0	0.0139	0.037	370	0.0035	0.0189	0.0013	0.0007	0.0473	0.0049	0.0016	0
V2683Ker-1	0.00	1.11	10.57	21.82	0.11	2.60	0.62	0.90	0.02	2.74	0.14	0.00	0.0225	0.0109	109	0.0008	0.0042	0.0037	0.0145	0.0041	0.003	0	0.0209	0.0141	141	0.0053	0.0185	0.0023	0	0.0283	0.0044	0.0016	0
V2683Ker-1	1.09	0.66	2.07	6.06	0.10	0.86	0.26	0.65	0.00	1.38	0.15	0.00	0.0087	0.0061	61	0	0.0032	0.0091	0.0166	0.0036	0.0025	0	0.0208	0.0136	136	0.0049	0.0164	0.0024	0	0.0142	0.0049	0	0
V483Ker-1	0.00	1.05	5.56	21.09	0.69	1.88	0.46	2.02	0.08	4.55	0.08	0.00	0.0146	0.0064	64	0.0006	0.0022	0.005	0.0267	0.0025	0.0022	0	0.016	0.0368	368	0.004	0.0182	0.0022	0	0.0512	0.0036	0	0
V483Ker-1	0.00	0.87	4.42	18.02	0.36	1.68	0.34	1.41	0.02	2.74	0.05	0.00	0.0131	0.0058	58	0	0.0016	0.0044	0.0198	0.0021	0.0017	0	0.0165	0.0478	478	0.0037	0.0165	0.0017	0	0.0484	0.0025	0	0
V5252Ker-1	1.56	0.66	1.44	9.55	0.04	0.73	0.17	0.47	0.04	2.56	0.04	0.00	0.0059	0.0035	35	0	0.0014	0.0038	0.0222	0.0014	0.0049	0	0.0122	0.026	260	0.0036	0.0204	0.0012	0	0.0262	0.0034	0	0
V5252Ker-1	1.72	0.69	0.00	2.50	0.03	0.34	0.63	0.40	0.15	2.47	0.04	0.00	0	0	0	0	0.0012	0.0025	0.0211	0.0011	0.0048	0	0.0113	0.0273	273	0.0031	0.0193	0.0012	0	0.0248	0	0	0
V5252Ker-1	1.13	0.76	2.25	13.15	0.16	0.97	0.22	0.68	0.09	3.34	0.04	0.00	0.0116	0.0043	43	0	0.0019	0.0035	0.024	0.0014	0.0071	0	0.014	0.0267	267	0.004	0.0221	0.0012	0	0.0293	0.0073	0	0
V2647Ker-1E	0.96	0.60	1.98	7.94	0.55	0.60	0.69	1.74	0.01	1.54	0.24	0.00	0.0054	0.0095	95	0	0.0041	0.0095	0.0153	0.0029	0.0014	0	0.0118	0.025	250	0.0037	0.0299	0.0045	0	0.0337	0.0031	0	0
V5252Ker-1E	0.78	0.69	1.50	9.98	0.12	0.77	0.17	0.58	0.08	3.00	0.03	0.00	0.009	0.0051	51	0	0.0015	0.0036	0.0216	0.001	0.0068	0	0.0126	0.0258	258	0.0035	0.0208	0.001	0	0.0287	0.0052	0	0
V5252Ker-1E	1.23	0.69	1.87	11.34	0.07	0.89	0.20	0.55	0.11	2.71	0.04	0.00	0.0109	0	0	0	0.0011	0.0032	0.0246	0.0012	0.004	0	0.0126	0.0258	258	0.0033	0.0218	0.001	0	0.0289	0.0048	0	0
V619Ker-1	0.82	0.92	5.60	25.02	0.08	1.87	0.40	0.90	0.03	2.77	0.06	0.00	0.0109	0.0106	106	0.0006	0.0039	0.0057	0.0226	0.0021	0.0019	0	0.0172	0.0177	177	0.0034	0.0237	0.0015	0	0.039	0.004	0.0013	0
V619Ker-1	1.68	0.59	1.87	12.01	0.06	1.34	0.35	0.76	0.02	2.89	0.08	0.00	0.0091	0.0084	84	0	0.0032	0.0066	0.024	0.0016	0.0026	0	0.0118	0.0165	165	0.0027	0.0195	0.0013	0	0.0484	0.0033	0	0
V619Ker-2	0.00	0.92	5.80	24.78	0.06	1.78	0.39	0.88	0.01	2.10	0.06	0.00	0.0095	0.0068	68	0.0004	0.0035	0.005	0.0209	0.0019	0.002	0	0.0166	0.0155	155	0.0035	0.0246	0.0018	0	0.0339	0.0034	0.0016	0
V619Ker-2	0.92	0.86	3.53	16.45	0.05	1.27	0.37	0.82	0.02	2.15	0.04	0.00	0.0098	0.0073	73	0	0.0037	0.0082	0.025	0.0016	0.0024	0	0.0145	0.02	200	0.0038	0.0226	0.0018	0	0.0309	0.0046	0.0015	0
V619Ker-3	0.00	1.08	6.01	22.11	0.08	2.67	0.38	1.04	0.02	3.23	0.08	0.00	0.014	0.0085	85	0.0008	0.0023	0.0059	0.019	0.0021	0.0032	0	0.0166	0.0184	184	0.0028	0.0158	0.001	0	0.0339	0.005	0.0015	0.0013
V619Ker-3	1.40	0.68	0.55	5.22	0.09	0.62	0.12	0.47	0.03	2.28	0.03	0.00	0.006	0.0032	32	0	0.0016	0.0044	0.0155	0.0019	0.0047	0	0.0142	0.0179	179	0.0023	0.0129	0.001	0	0.0136	0.0043	0	0
V619Ker-4	0.00	0.93	4.64	19.21	0.19	1.60	0.38	1.15	0.08	4.87	0.06	0.00	0.0116	0.0099	99	0.0004	0.005	0.0081	0.0362	0.0022	0.0073	0	0.0181	0.0294	294	0.0044	0.0191	0.0019	0	0.0405	0.0053	0.0024	0
V619Ker-4	0.91	0.69	1.67	9.56	0.04	0.82	0.20	0.53	0.04	2.51	0.04	0.00	0.007	0.0048	48	0	0.0034	0.0091	0.0286	0.0022	0.0051	0	0.013	0.0255	255	0.0038	0.0162	0.0016	0	0.0296	0.0037	0	0

V619Ker-5	0.00	0.95	5.51	20.16	0.10	2.65	0.40	1.07	0.03	4.07	0.06	0.00	0.0136	0.0053	53	0.0005	0.002	0.0051	0.0202	0.0024	0.0042	0	0.0201	0.0228	228	0.0034	0.0164	0.0016	0	0.026	0.0038	0	0
V619Ker-5	1.06	0.67	0.93	6.50	0.02	0.90	0.16	0.44	0.01	1.74	0.06	0.00	0.0041	0.0041	41	0	0.0012	0.0049	0.0105	0.0014	0.0037	0	0.0184	0.0202	202	0.0033	0.0155	0.0017	0	0.0142	0.0045	0	0
V619Ker-6	0.00	0.93	5.12	22.04	1.01	2.21	0.43	2.15	0.02	2.54	0.28	0.00	0.0128	0.0078	78	0.0005	0.0028	0.0085	0.0124	0.0019	0.0029	0	0.0108	0.0155	155	0.0029	0.0175	0.0011	0	0.0367	0.0038	0.0011	0
V619Ker-6	1.25	0.64	0.00	1.29	0.05	0.17	0.04	0.26	0.00	0.38	0.04	0.00	0	0	0	0	0.0018	0.0188	0.0095	0	0.0028	0	0.0086	0.0118	118	0.0029	0.0158	0	0.0022	0.0094	0	0	0
V740Ker-1	0.00	0.84	2.11	14.69	0.49	1.04	0.23	1.01	0.15	4.09	0.03	0.00	0.0141	0.0048	48	0	0.0022	0.0043	0.0181	0.0011	0.0099	0	0.0103	0.0327	327	0.0039	0.0294	0.001	0	0.0243	0.0046	0	0
V740Ker-1	1.17	0.69	1.00	8.58	0.03	0.63	0.15	0.31	0.01	1.49	0.03	0.00	0.0062	0.0029	29	0	0.0016	0.0093	0.0161	0.0017	0.0066	0	0.0107	0.019	190	0.0039	0.03	0.0011	0	0.0107	0.0048	0	0
V740Ker-2	1.22	0.81	2.62	16.37	0.14	1.18	0.25	0.61	0.06	3.64	0.03	0.00	0.0123	0.0059	59	0	0.0016	0.0069	0.0162	0.001	0.011	0	0.0103	0.0351	351	0.0035	0.0332	0.001	0	0.0252	0.0047	0	0
V740Ker-2	1.09	0.81	2.66	16.20	0.22	1.17	0.26	0.74	0.07	4.16	0.03	0.00	0.0098	0.0051	51	0	0.0018	0.0064	0.0158	0.0011	0.0101	0	0.0108	0.0339	339	0.0037	0.0301	0.001	0	0.0253	0.0055	0	0
V740Ker-3	1.02	0.76	1.89	12.71	0.29	0.90	0.20	0.75	0.04	2.64	0.03	0.00	0.0082	0.0054	54	0	0.0021	0.0021	0.0129	0.0011	0.0052	0	0.0116	0.0218	218	0.0035	0.0331	0.0011	0	0.0188	0.0036	0	0
V740Ker-3	1.07	0.69	0.88	8.12	0.04	0.65	0.15	0.37	0.13	1.63	0.03	0.00	0.0064	0	0	0	0.0054	0.0092	0.0204	0.001	0.0063	0	0.0115	0.0289	289	0.0033	0.029	0.001	0	0.0165	0.0052	0	0
V740Ker-4	0.00	1.10	4.71	24.69	0.20	1.88	0.37	0.92	0.01	2.27	0.06	0.00	0.0107	0.0066	66	0.0004	0.0026	0.0047	0.0194	0.0014	0.0021	0	0.0137	0.0163	163	0.004	0.0348	0.0015	0	0.0221	0.0035	0	0.0014
V740Ker-4	1.03	0.84	2.31	14.59	0.24	1.05	0.23	0.63	0.06	2.94	0.03	0.00	0.0121	0	0	0	0.0019	0.0061	0.015	0.0013	0.0077	0	0.0104	0.0315	315	0.003	0.0289	0.0011	0	0.0228	0.0035	0	0
V2652Ker-6	1.05	0.65	3.22	13.59	0.06	1.34	0.27	0.51	0.01	2.15	0.09	0.00	0.0078	0.0046	46	0	0.0026	0.0047	0.0221	0.0022	0.0023	0	0.0156	0.0314	314	0.0037	0.0257	0.0016	0	0.0296	0.0048	0.0018	0
V2652Ker-6	0.76	0.62	3.28	13.69	0.06	1.33	0.27	0.51	0.01	2.15	0.09	0.00	0.0089	0.0056	56	0	0.0029	0.0048	0.0217	0.0017	0.002	0	0.016	0.0303	303	0.0034	0.0252	0.0018	0	0.0292	0.0054	0.0025	0
V2652Ker-6	0.00	0.57	4.81	20.41	0.22	1.82	0.35	1.09	0.07	2.52	0.05	0.00	0.0098	0	0	0.0002	0.0027	0.0054	0.0256	0.002	0.0028	0	0.0154	0.0376	376	0.0038	0.0245	0.0018	0	0.0366	0.0042	0.0013	0
V804Ker-1	0.00	1.09	5.96	26.24	0.13	1.91	0.38	0.89	0.14	6.00	0.04	0.00	0.0132	0.0086	86	0.002	0.0033	0.0016	0.0105	0.0018	0.0102	0	0.0146	0.0144	144	0.0046	0.0283	0.0018	0	0.0334	0.0083	0.0014	0
V804Ker-2	0.98	1.11	5.39	23.43	0.07	1.73	0.39	0.79	0.02	4.62	0.03	0.00	0.0137	0.008	80	0.0007	0.0028	0.0013	0.0094	0.002	0.0027	0	0.0145	0.0141	141	0.0037	0.026	0.0016	0	0.0268	0.0026	0.0013	0
V804Ker-2	0.88	0.81	3.61	16.88	0.08	1.36	0.32	0.73	0.21	3.03	0.06	0.00	0.0106	0.0084	84	0	0.0032	0.0103	0.0092	0.0017	0.0049	0	0.0142	0.0144	144	0.0038	0.0242	0.0016	0	0.0203	0.0032	0	0
V804Ker-3	0.00	0.93	4.92	23.36	0.08	1.70	0.35	1.07	0.04	3.04	0.04	0.00	0.0089	0.007	70	0.0005	0.0031	0.0029	0.0103	0.0018	0.0029	0	0.0153	0.014	140	0.0039	0.0279	0.0017	0	0.0298	0.0046	0	0
V804Ker-3	1.13	0.74	1.41	10.04	0.02	0.81	0.18	1.42	0.01	1.63	0.04	0.00	0.0079	0.0033	33	0	0.002	0.0056	0.011	0.0016	0.0023	0	0.0134	0.0121	121	0.0036	0.0257	0.0013	0	0.0182	0.0039	0	0
V804Ker-4	1.00	0.91	4.96	24.36	0.09	1.88	0.35	0.69	0.03	3.04	0.04	0.00	0.0086	0.0084	84	0.0006	0.0021	0.0035	0.0083	0.0016	0.0029	0	0.0109	0.0134	134	0.0039	0.0335	0.0015	0	0.032	0.0067	0.0017	0
V804Ker-4	0.84	0.80	2.39	13.86	0.08	1.03	0.22	0.61	0.01	1.59	0.03	0.00	0.0088	0.0039	39	0	0.0024	0.0046	0.0087	0.0011	0.0019	0	0.0111	0.0113	113	0.0031	0.0308	0.0015	0	0.0234	0.0035	0	0
V804Ker-5	0.00	0.95	4.17	19.98	0.09	1.70	0.32	0.94	0.06	2.78	0.04	0.00	0.0107	0.0079	79	0.0002	0.0035	0.0106	0.0121	0.0018	0.0048	0	0.0144	0.0127	127	0.004	0.0253	0.0012	0	0.0306	0.0072	0.0014	0
V804Ker-5	0.89	0.76	1.41	10.06	0.03	0.81	0.17	1.55	0.01	1.59	0.04	0.00	0.0029	0.0052	52	0	0.0027	0.0048	0.0097	0.0015	0.0014	0	0.0147	0.0127	127	0.0034	0.0295	0.0012	0	0.0154	0.0028	0	0
V804Ker-6	0.00	0.97	5.12	20.68	0.08	1.78	0.35	0.87	0.05	3.57	0.05	0.00	0.0109	0.0089	89	0.0004	0.0026	0.0067	0.0088	0.0019	0.0059	0	0.014	0.0149	149	0.0041	0.0191	0.0015	0	0.0272	0.0041	0.0015	0
V804Ker-6	1.24	0.69	0.00	3.04	0.01	0.31	0.06	0.26	0.07	1.43	0.02	0.00	0.0025	0	0	0	0.0016	0.0108	0.0114	0.0018	0.0076	0	0.0121	0.0124	124	0.0041	0.0191	0.0011	0	0.0079	0.0049	0	0
V975Ker-1	0.00	0.70	2.03	17.02	0.44	1.22	0.20	2.63	0.02	2.00	0.16	0.00	0.0066	0.0069	69	0	0.0024	0.0154	0.0246	0.0015	0.0027	0	0.0138	0.0238	238	0.004	0.0207	0.0012	0	0.039	0.0037	0	0
V975Ker-1	1.26	0.67	0.92	6.81	0.02	0.64	0.13	0.40	0.00	1.10	0.03	0.00	0.0048	0.0033	33	0	0.0028	0.0115	0.0397	0.0018	0.0029	0	0.0165	0.029	290	0.0041	0.0162	0.0017	0	0.018	0.0046	0	0
V2022Ker-1	0.95	0.75	2.19	11.92	0.05	0.94	0.20	0.40	0.01	1.85	0.03	0.00	0.0078	0.0046	46	0	0.0027	0.0026	0.0106	0.0012	0.002	0	0.014	0.0099	99	0.0035	0.0239	0.0011	0	0.0204	0.0025	0	0
V2022Ker-1	0.00	0.95	5.58	25.09	0.11	1.87	0.36	0.83	0.02	3.09	0.06	0.00	0.0121	0.0082	82	0.0009	0.0038	0.004	0.0138	0.0017	0.0028	0	0.0162	0.0133	133	0.0041	0.026	0.0012	0	0.0267	0.0043	0.0014	0
V2022Ker-2	0.00	0.89	4.25	22.85	0.10	1.60	0.32	0.80	0.02	2.59	0.05	0.00	0.0104	0.0048	48	0.0005	0.003	0.0049	0.0207	0.0015	0.0074	0	0.0139	0.0151	151	0.0041	0.0272	0.0014	0	0.0262	0.0045	0.0013	0.0016
V2022Ker-2	1.19	0.92	4.59	25.18	0.10	1.68	0.33	0.63	0.14	2.80	0.04	0.00	0.0113	0.0036	36	0.0007	0.0036	0.0012	0.0181	0.0016	0.0033	0	0.0138	0.0113	113	0.0035	0.0281	0.0014	0	0.0275	0.0056	0.0012	0
V2586Ker-1	0.00	0.70	4.76	14.70	0.12	1.27	0.47	0.50	0.01	2.55	0.15	0.00	0.0157	0.0076	76	0	0.0025	0.0049	0.0122	0.0031	0.002	0	0.0179	0.0147	147	0.0042	0.0212	0.0023	0	0.0204	0.0027	0.0014	0
V2586Ker-1	0.68	0.67	4.54	14.07	0.20	1.32	0.46	0.48	0.01	2.43	0.09	0.00	0.0129	0.0083	83	0	0.0031	0.006	0.0134	0.0026	0.0021	0	0.0188	0.0161	161	0.0042	0.0225	0.0024	0	0.0195	0.0045	0	0
V2586Ker-2	0.00	0.85	7.86	18.87	0.18	1.97	0.58	1.06	0.01	2.58	0.05	0.00	0.0161	0.013	130	0.0003	0.0025	0.0036	0.0105	0.0035	0.0022	0	0.0173	0.0135	135	0.0037	0.0163	0.0022	0.0007	0.031	0.0038	0.0014	0
V2586Ker-2	0.92	0.62	2.61	9.92	0.06	0.91	0.29	0.70	0.01	1.60	0.06	0.00	0.0068	0.0069	69	0	0.003	0.0084	0.0108	0.0037	0.0026	0	0.0194	0.0141	141	0.004	0.0188	0.0021	0	0.014	0.0049	0	0
V2586Ker-2	1.19	0.68	1.55	5.52	0.04	0.75	0.31	0.30	0.00	1.56	0.05	0.00	0.0103	0.0057	57	0	0.0021	0.0066	0.0086	0.0031	0.0031	0	0.0175	0.0123	123	0.0038	0.017	0.0022	0	0.017	0.0032	0	0
V2586Ker-3	2.03	0.54	1.12	6.59	0.10	1.11	0.33	1.09	0.03	3.51	0.26	0.00	0.0128	0.0079	79	0	0.0027	0.0047	0.0152	0.002	0.0032	0	0.0143	0.0167	167	0.0038	0.022	0.0019	0	0.0435	0.0034	0.0014	0
V2586Ker-4	0.00	1.02	8.99	22.13	0.22	4.02	0.61	0.79	0.01	2.58	0.09	0.00	0.0206	0.0138	138	0.0009	0.0029	0.0032	0.0126	0.0038	0.0032	0	0.0187	0.0139	139	0.0041	0.0177	0.002	0.0007	0.0276	0.0042	0	0
V2586Ker-4	1.44	0.68	0.22	2.36	0.01	0.53	0.20	0.20	0.00	1.04	0.04	0.00	0.0047	0.0037	37	0	0.0023	0.0064	0.0119	0.0034	0.0038	0	0.0192	0.0136	136	0.0043	0.0177	0.002	0	0.0071	0.0062	0	0
V2586Ker-5	0.00	0.93	5.28	19.58	0.55	2.21	0.35	1.37	0.03	2.37	0.08	0.00	0.0148	0.0087	87	0.0003	0.0028	0.0037	0.0345	0.0023	0.0012	0	0.0164	0.0122	122	0.0042	0.0224	0.0017	0	0.0344	0.0029	0.0016	0.0017
V2586Ker-5	1.12	0.84	1.47	8.71	0.10	0.98	0.19	0.68	0.02	1.51	0.05	0.00	0.0075	0.0044	44	0	0.0031	0.005	0.0543	0.0019	0.0011	0	0.0164	0.0097	97	0.0044	0.0221	0.0016	0	0.0203	0	0	0
V2586Ker-6	0.98	0.61	3.24	14.52	0.27	1.06	0.44	1.52	0.04	2.00	0.05	0.00	0.0099	0.0071	71	0	0.0023	0.0073	0.0256	0.0026	0.0026	0	0.0116	0.0363	363	0.0032	0.013	0.0016	0	0.0237	0.0029	0	0
V2586Ker-6	1.07	0.70	0.40	5.02	0.07	0.43	0.15	0.65	0.01	0.84	0.04	0.00	0.0051	0.0025	25	0	0.0018	0.0076	0.0234	0.0017	0.003	0	0.0109	0.0381	381	0.0024	0.0128	0.0015	0	0.0152	0	0	0
V2586Ker-7	0.00	0.82	7.99	23.15	0.31	2.21	0.41	1.51	0.05	2.00	0.09	0.00	0.0154	0.0093	93	0.0005	0.003	0.0039	0.01	0.003	0.0023	0	0.0106	0.0207	207	0.0027	0.013	0.0011	0	0.039	0.0041	0.0013	0
V2586Ker-7	0.88	0.71	4.53	14.15	0.06	1.19	0.30	0.70	0.03	1.29	0.06	0.00	0.0135	0.0073	73	0	0.0033	0.0047	0.0116	0.0026	0.0016	0	0.0101	0.0144	144	0.0028	0.0136	0.0011	0	0.0286	0.005	0	0
V2652Ker-1	0.88	0.77	7.87	16.67	0.07	1.84	0.76	0.54	0.02	2.63	0.10	0.00	0.0156	0.0122	122	0	0.0019	0.0024	0.0162	0.0034	0.0025	0	0.0166	0.0164	164	0.0037	0.021	0.0027	0	0.0267	0.0047	0.0016	0
V2652Ker-1	1.00	0.63	1.02	4.13	0.03	0.42	0.21	0.23	0.00	0.77	0.06	0.00	0.0027	0.0048	48	0	0.0016	0.0054	0.0107	0.0025	0.0023	0	0.0143	0.0127	127	0.0032	0.0186	0.0024	0	0.0066	0.0039	0	0

V2652Ker-2	0.00	0.70	8.17	21.43	0.23	3.31	0.84	1.22	0.02	2.93	0.56	0.00	0.0158	0.0148	148	0.0007	0.003	0.0029	0.0164	0.0029	0.0023	0	0.0173	0.0153	153	0.004	0.023	0.0025	0	0.0268	0.0033	0.0012	0
V2652Ker-2	1.30	0.61	3.50	11.20	0.07	1.04	0.49	0.50	0.19	2.12	0.19	0.00	0.0087	0.0046	46	0	0.0026	0.0036	0.0151	0.0028	0.0025	0	0.0155	0.0143	143	0.0041	0.0213	0.0022	0	0.0896	0.0032	0.0013	0
V2652Ker-3	0.00	0.50	8.19	24.54	0.15	1.30	1.10	0.93	0.02	2.78	0.26	0.00	0.0066	0.0167	167	0.0007	0.0025	0.0019	0.0101	0.0024	0.0011	0	0.0089	0.0243	243	0.0034	0.0345	0.0039	0	0.03	0.0027	0	0
V2652Ker-3	0.99	0.52	3.62	12.67	0.08	0.67	0.65	0.55	0.01	2.13	0.06	0.00	0.0075	0.0093	93	0	0.0024	0.0027	0.0108	0.0026	0.0011	0	0.0092	0.0315	315	0.0031	0.0311	0.0038	0	0.0305	0	0	0
V2652Ker-4	0.00	0.71	7.48	26.23	0.19	1.88	0.70	1.10	0.03	3.58	0.11	0.00	0.0144	0.0118	118	0.0012	0.0026	0.0026	0.0301	0.0028	0.0027	0	0.0167	0.03	300	0.0039	0.0183	0.002	0	0.0228	0.0036	0.002	0
V2652Ker-4	0.87	0.61	3.75	16.61	0.34	1.27	0.54	1.12	0.02	2.79	0.13	0.00	0.0137	0.0086	86	0	0.0027	0.0016	0.0228	0.0028	0.0021	0	0.0174	0.0218	218	0.0043	0.0188	0.0021	0	0.0231	0.0043	0.0014	0.0015
V2652Ker-5	0.00	0.76	7.31	26.02	0.09	2.37	0.46	0.78	0.01	2.92	0.06	0.00	0.0094	0.0078	78	0.001	0.0029	0.0025	0.0181	0.002	0.0023	0	0.0184	0.0214	214	0.0041	0.0258	0.0018	0	0.0378	0.0039	0.0012	0
V2652Ker-5	1.24	0.67	0.71	5.72	0.01	0.66	0.13	0.23	0.03	1.13	0.07	0.00	0.0051	0.0022	22	0	0.0031	0.0053	0.0173	0.0025	0.0027	0	0.0173	0.0125	125	0.0041	0.0248	0.0022	0	0.0106	0.0037	0	0
V2652Ker-6	0.00	0.58	8.65	21.94	0.23	1.29	1.19	0.65	0.17	4.25	0.07	0.00	0.01	0.0162	162	0.0009	0.0028	0.003	0.0248	0.0031	0.0019	0	0.0116	0.0275	275	0.004	0.031	0.0066	0	0.0367	0.0025	0.0017	0
V2652Ker-6	0.00	0.47	5.29	16.41	0.15	1.09	1.02	0.48	0.04	3.67	0.08	0.00	0.0078	0.0158	158	0	0.0029	0.0046	0.0129	0.0034	0.0016	0	0.0142	0.024	240	0.0037	0.0286	0.0044	0	0.0362	0	0	0
V2652Ker-7	0.00	0.93	5.81	26.00	0.37	2.41	0.46	1.32	0.07	2.99	0.10	0.00	0.0102	0.0093	93	0.001	0.0032	0.0032	0.0248	0.0019	0.0029	0	0.0153	0.0321	321	0.0043	0.0198	0.0017	0	0.0403	0.0043	0	0
V2652Ker-7	1.01	0.65	1.44	9.84	0.43	0.86	0.19	1.10	0.09	2.46	0.28	0.00	0.0077	0.0033	33	0	0.0026	0.0054	0.0261	0.0018	0.0034	0	0.0139	0.0371	371	0.0042	0.0177	0.0014	0	0.0343	0.0033	0	0
V2653Ker-	0.00	0.63	9.28	20.49	0.30	2.07	0.71	0.87	0.01	2.93	0.11	0.00	0.0159	0.0133	133	0.0005	0.0021	0.0031	0.0125	0.0033	0.0023	0	0.0144	0.0161	161	0.0035	0.0202	0.0021	0	0.0263	0.0046	0.0014	0.0014
V2076Ker-1	0.00	0.86	10.50	21.29	0.17	1.65	0.78	0.67	0.03	3.15	0.07	0.00	0.0147	0.016	160	0.0005	0.0023	0.0034	0.0104	0.0034	0.0023	0	0.0151	0.0168	168	0.0035	0.0185	0.0022	0	0.0285	0.0041	0.0014	0
V2076Ker-1	0.00	0.65	7.82	16.77	0.21	1.36	0.70	0.83	0.03	2.97	0.44	0.00	0.0128	0.0122	122	0	0.002	0.0032	0.0103	0.0032	0.0022	0	0.0147	0.0171	171	0.0037	0.0189	0.0023	0	0.032	0.0044	0.0013	0
V2076Ker-1	0.00	0.77	4.11	24.18	0.29	1.67	0.34	1.08	0.22	3.80	0.38	0.00	0.0094	0.0068	68	0.0007	0.0016	0.0017	0.0217	0.0015	0.0033	0	0.0113	0.0364	364	0.0037	0.026	0.0014	0	0.04	0.0044	0	0
V2076Ker-2	0.00	0.76	4.18	24.31	0.29	1.67	0.34	1.08	0.23	3.81	0.38	0.00	0.0089	0.0077	77	0.0007	0.0022	0.0019	0.0219	0.0013	0.003	0	0.0112	0.0364	364	0.0039	0.0261	0.0013	0	0.0432	0.0042	0	0
V2076Ker-2	1.92	0.63	0.63	8.68	0.25	0.81	0.24	0.93	0.35	3.53	0.05	0.00	0.0056	0	0	0	0.0015	0.0019	0.0234	0.0012	0.0042	0	0.0099	0.036	360	0.0036	0.0257	0.0011	0	0.0378	0.0045	0	0
V2076Ker-3	0.00	0.78	4.77	15.58	0.07	1.49	0.39	0.92	0.03	2.99	0.62	0.00	0.0137	0.0098	98	0	0.0036	0.0035	0.0206	0.0023	0.0022	0	0.0153	0.013	130	0.0047	0.0237	0.0014	0	0.0346	0.0035	0.0016	0
V2076Ker-3	1.49	0.53	1.59	8.43	0.03	1.28	1.95	0.35	0.02	3.72	0.07	0.00	0	0.0103	103	0	0.0044	0.0027	0.0204	0.0026	0.0025	0	0.0163	0.0109	109	0.0046	0.0247	0.0021	0	0.0414	0.0047	0.0012	0
V2081Ker-1	0.00	0.64	9.71	23.28	0.10	1.97	0.94	0.46	0.03	4.08	0.04	0.00	0.0139	0.0151	151	0.0014	0.0048	0.0031	0.0173	0.0032	0.0028	0	0.0149	0.0268	268	0.0038	0.0285	0.004	0	0.033	0.0039	0.0016	0
V2081Ker-1	1.33	0.52	2.38	9.28	0.09	0.95	1.21	0.44	0.02	3.86	0.09	0.00	0.0036	0.0149	149	0	0.0052	0.0045	0.0122	0.0033	0.0025	0	0.0147	0.0215	215	0.0041	0.0287	0.0037	0	0.0354	0.0032	0	0
V2081Ker-2	1.83	0.49	1.10	7.68	0.39	1.11	0.85	1.35	0.16	4.45	0.12	0.00	0	0.0075	75	0	0.0022	0.0028	0.0197	0.0019	0.0049	0	0.0123	0.0322	322	0.0044	0.0209	0.0014	0	0.0608	0.0031	0	0
V2081Ker-2	0.90	0.72	5.01	17.88	0.07	1.60	0.34	0.64	0.07	2.43	0.04	0.00	0.0125	0.0079	79	0	0.0029	0.0031	0.0189	0.0022	0.0026	0	0.0133	0.0266	266	0.0043	0.0218	0.0013	0	0.0387	0.0035	0	0
V2484Ker-1	0.80	0.67	7.97	17.87	0.09	2.21	0.81	0.62	0.02	3.31	0.07	0.00	0.0151	0.0164	164	0.0006	0.0042	0.0032	0.0284	0.0037	0.0017	0	0.0145	0.0399	399	0.0043	0.0258	0.0041	0.0007	0.0694	0.0041	0.0013	0
V2484Ker-1	0.98	0.60	6.49	14.85	0.35	2.01	0.73	1.06	0.02	3.24	0.17	0.00	0.0137	0.0157	157	0.0003	0.004	0.0059	0.0353	0.0036	0.0026	0	0.0156	0.0247	247	0.0041	0.0277	0.0041	0	0.0564	0.0039	0.0014	0
V2484Ker-2	0.00	0.68	6.60	24.22	0.15	1.93	0.43	0.75	0.07	3.69	0.06	0.00	0.0127	0.0107	107	0.0013	0.0029	0.0069	0.0363	0.0021	0.0042	0	0.0203	0.0459	459	0.0054	0.0309	0.0016	0	0.0508	0.0058	0	0
V2484Ker-2	0.97	0.63	3.77	16.30	0.85	1.23	0.32	1.42	0.29	4.31	0.05	0.00	0.0132	0.0062	62	0	0.0029	0.0046	0.0444	0.0017	0.0049	0	0.0168	0.0497	497	0.005	0.0309	0.0011	0	0.0371	0.0035	0	0
V2484Ker-3	0.97	0.55	2.28	11.95	0.03	1.22	0.24	0.45	0.02	1.77	0.15	0.00	0.0081	0.0065	65	0	0.0036	0.0054	0.0208	0.002	0.0036	0	0.0163	0.0299	299	0.0042	0.0232	0.0021	0	0.0305	0.0066	0	0
V2484Ker-4	0.00	0.59	3.98	17.45	0.09	1.39	0.32	0.60	0.04	3.38	0.04	0.00	0.0114	0.005	50	0	0.0029	0.0039	0.0296	0.0022	0.004	0	0.0172	0.0438	438	0.0045	0.0198	0.0011	0	0.0378	0.004	0	0
V2484Ker-4	0.00	0.79	4.84	20.81	0.11	1.69	0.37	0.69	0.05	3.31	0.05	0.00	0.013	0.0069	69	0.0006	0.0037	0.0049	0.0323	0.0021	0.0037	0	0.0196	0.0405	405	0.0044	0.0208	0.0018	0	0.0416	0.0061	0	0
V2484Ker-5	0.00	0.82	4.79	19.07	0.14	1.73	0.32	0.60	0.02	2.70	0.05	0.00	0.0116	0.0063	63	0.0002	0.0033	0.008	0.0268	0.0019	0.0035	0	0.0136	0.0302	302	0.0046	0.0206	0.0017	0	0.0394	0.005	0.0012	0
V2484Ker-5	0.00	0.75	3.86	17.40	0.12	1.65	0.42	0.79	0.04	2.73	0.08	0.00	0.0094	0.0059	59	0	0.0035	0.0083	0.0338	0.0017	0.0044	0	0.0141	0.037	370	0.0041	0.0202	0.0013	0	0.0351	0.0047	0	0
V2627Ker-1	0.00	0.80	5.08	20.76	0.37	1.87	0.37	0.89	0.02	2.85	0.09	0.00	0.0132	0.0079	79	0.0004	0.0022	0.0028	0.0205	0.0021	0.0022	0	0.0138	0.0107	107	0.0038	0.0189	0.0014	0	0.0346	0.0046	0	0
V2627Ker-2	0.00	0.88	7.65	21.46	0.13	2.15	0.57	0.88	0.02	2.53	0.36	0.00	0.0144	0.0116	116	0.0005	0.0032	0.0044	0.0164	0.0033	0.0014	0	0.0185	0.0174	174	0.0051	0.0285	0.0021	0	0.0388	0.0052	0.0014	0.0015
V2627Ker-2	1.56	0.51	2.61	10.31	0.14	1.54	0.52	1.14	0.02	2.57	0.53	0.00	0.0129	0.0092	92	0	0.0035	0.0042	0.0162	0.0026	0.0016	0	0.0173	0.015	150	0.0049	0.0279	0.0023	0	0.047	0.0038	0.0016	0
V2627Ker-3	0.00	0.62	5.37	22.10	1.73	1.53	0.40	2.58	0.11	2.80	0.13	0.00	0.0114	0.0074	74	0.0009	0.0023	0.003	0.0261	0.0019	0.0033	0	0.013	0.0225	225	0.0047	0.0326	0.0015	0	0.038	0.0042	0	0
V2627Ker-3	0.00	0.63	4.33	16.32	0.08	1.29	0.36	0.49	0.03	2.45	0.12	0.00	0.0108	0.0043	43	0	0.0022	0.0029	0.0222	0.0018	0.0018	0	0.0137	0.0103	103	0.0043	0.0329	0.0016	0	0.0274	0.0029	0	0
V2627Ker-4	0.00	0.53	7.26	24.21	0.19	1.59	1.04	1.05	0.03	2.31	0.18	0.00	0.012	0.0176	176	0.0006	0.0027	0.0015	0.011	0.002	0.0015	0	0.0107	0.0333	333	0.0033	0.0333	0.0044	0	0.0476	0.0029	0	0
V2627Ker-5	0.00	0.96	4.65	22.36	1.19	2.19	0.33	2.39	0.19	2.85	0.21	0.05	0.0113	0.0052	52	0.0008	0.0032	0.0026	0.035	0.0018	0.0051	0	0.0125	0.0381	381	0.0042	0.0179	0.0012	0	0.0405	0.0026	0	0
V2627Ker-5	1.01	0.66	1.98	10.43	0.20	0.90	0.17	0.67	0.04	2.13	0.38	0.00	0.0073	0.0047	47	0	0.0023	0.0015	0.0122	0.0017	0.0019	0	0.0117	0.0157	157	0.0036	0.0167	0.0014	0	0.0387	0.0021	0	0
V2627Ker-6	0.00	0.56	7.35	22.75	0.16	1.54	1.13	1.05	0.03	3.96	0.43	0.00	0.0096	0.0188	188	0.001	0.0034	0.0078	0.0172	0.0026	0.0014	0	0.0111	0.0259	259	0.0035	0.0327	0.0043	0	0.0388	0.0029	0	0
V2627Ker-6	1.15	0.58	2.45	12.25	0.11	0.79	0.44	0.49	0.01	1.97	0.07	0.00	0.0099	0.0088	88	0	0.0023	0.0042	0.0124	0.0023	0.0014	0	0.0107	0.0244	244	0.0034	0.0299	0.0037	0	0.024	0	0	0
V2627Ker-6	1.18	0.62	1.60	6.87	0.04	0.36	0.37	0.22	0.00	1.52	0.10	0.00	0.0045	0.0076	76	0	0.0024	0.0076	0.0121	0.0023	0.0014	0	0.0112	0.0174	174	0.0035	0.0304	0.0041	0	0.0137	0	0	0
V368Ker-1	0.00	0.66	6.08	20.34	0.12	2.26	0.61	1.09	0.02	1.73	0.89	0.00	0.0133	0.0108	108	0.0003	0.0024	0.0035	0.0152	0.0031	0.005	0	0.0199	0.0267	267	0.0047	0.0242	0.0024	0	0.0288	0.0043	0.0019	0
V368Ker-1	1.10	0.62	0.00	2.04	0.01	0.37	0.11	0.28	0.00	0.41	0.51	0.00	0.0023	0	0	0	0.0018	0.0096	0.0192	0.0026	0.005	0	0.0173	0.0209	209	0.0044	0.0234	0.0026	0	0.0063	0.0055	0	0
V368Ker-2	0.74	0.81	3.10	13.65	0.31	1.37	0.27	2.26	0.04	2.10	0.99	0.00	0.013	0.0059	59	0	0.0026	0.0039	0.019	0.0019	0.0013	0	0.0151	0.0138	138	0.0048	0.0222	0.0016	0	0.0313	0.0032	0.0015	0
V368Ker-3	0.00	0.67	6.92	22.36	0.58	3.26	0.63	1.34	0.01	1.82	1.18	0.00	0.0141	0.0094	94	0.0005	0.0029	0.0043	0.0146	0.0025	0.0022	0	0.0195	0.0148	148	0.0054	0.0269	0.0025	0	0.0282	0.0036	0.0012	0.0019
V368Ker-3	0.00	0.68	5.07	16.86	0.07	2.01	0.52	0.60	0.01	1.65	0.85	0.00	0.0132	0.0099	99	0	0.0028	0.0018	0.0128	0.0024	0.0018	0	0.0189	0.0125	125	0.0049	0.0266	0.0023	0	0.017	0.0052	0.0019	0
V368Ker-4	0.00	0.45	5.34	21.08	0.06	1.75	0.63	1.20	0.02	2.58	1.40	0.00	0.0101	0.009	90	0.0007	0.0029	0.0015	0.0075	0.0022	0.0052	0	0.0123	0.0123	123	0.0033	0.0191	0.0018	0	0.0289	0.0039	0.0012	0
V368Ker-4	0.69	0.56	1.35	8.13	0.02	0.67	0.28	0.53	0.01	1.20	0.62	0.00	0.0053	0.0045	45	0	0.0014	0.0043	0.0066	0.0019	0.0035	0	0.0121	0.0119	119	0.003	0.0189	0.0018	0	0.0178	0.0049	0	0
V368Ker-5	0.00	0.67	5.02	16.05	0.10	1.77	0.47	1.01	0.02	2.34	1.08	0.00	0.0142	0.0097	97	0	0.0023	0.0028	0.0122	0.0023	0.003	0	0.0156	0.0128	128	0.0034	0.0191	0.0017	0	0.0344	0.0039	0	0
V193Ker-1	0.77	0.70	4.36	11.08	0.14	1.31	0.36	0.48	0.01	1.71	0.06	0.00	0.0117	0.0075	75	0	0.0021	0.0039	0.0101	0.003	0.0022	0	0.02	0.014	140	0.0037	0.0149	0.0024	0	0.0223	0.0038	0	0
V193Ker-2	0.00	0.99	9.81	22.15	0.24	2.51	0.71	0.67	0.01	2.72	0.05	0.00	0.0168	0.0113	113	0.0006	0.0024	0.0027	0.0101	0.0041	0.0023	0	0.0217	0.0165	165	0.004	0.0166	0.0021	0	0.026	0.0025	0.0012	0
V193Ker-2	0.79	0.74	4.06	11.80	0.16	1.41	0.43	0.52	0.00	1.81	0.04	0.00	0.0122	0.0074	74	0	0.0023	0.0035	0.0099	0.0032	0.0024	0	0.0213	0.0158	158	0.004	0.0157	0.0018	0	0.0176	0.0036	0.0016	0
V193Ker-3	0.00	1.13	9.28	20.16	0.15	2.34	0.64	0.56	0.01	2.43	0.04	0.00	0.0177	0.0121	121	0.0005	0.002	0.0026	0.0099	0.004	0.0023	0	0.0216	0.017	170	0.0039	0.0175	0.0021	0	0.0252	0.0055	0.0012	0
V193Ker-3	0.75	0.70	5.86	14.20	0.09	1.71	0.50	0.40	0.01	2.00	0.04	0.00	0.015	0.0083	83	0	0.002	0.0023	0.0102	0.0037	0.0027	0	0.0204	0.015	150	0.0038	0.0161	0.0022	0	0.0241	0.0036	0.0013	0
V483Ker-1	0.00	1.15	4.85	17.87	2.42	1.69	0.54	6.13	0.10	3.47	0.18	0.04	0.0121	0.0108	108	0.001	0.0026	0.0085	0.0404	0.0025	0.002	0	0.0124	0.0551	551	0.0041	0.0282	0.0053	0	0.0688	0.0031	0	0
V483Ker-1	0.00	1.33	2.02	8.82	3.37	0.76	0.24	19.52	0.37	3.53	0.22	0.00	0.006	0	0	0.001	0.0015	0.009	0.0708	0.0013	0.0038	0	0.0091	0.0692	692	0.0044	0.0249	0.0033	0	0.0605	0.0037	0	0
V483Ker-2	1.08	0.58	5.47	18.81	0.26	2.11	0.75	0.81	0.01	2.65	0.09	0.00	0.0116	0.0127	127	0.0002	0.0025	0.0027	0.0133	0.0029	0.0012	0	0.0117	0.0391	391	0.0035	0.0272	0.0047	0	0.0639	0	0	0
V483Ker-3	1.58	0.57	0.58	1.88	11.71	0.15	0.03	25.72	0.16	1.05	0.22	0.00	0.0071	0	0	0.0004	0.0015	0.0126	0.0864	0	0.0034	0	0.0006	0.0859	859	0.0021	0.0015	0	0	0	0.0045	0	0
V483Ker-3	1.50	0.51	0.00	0.94	7.48	0.11	0.03	17.44	0.02	0.40	0.17	0.00	0.0042	0	0	0	0	0.0159	0.0956	0	0.0049	0	0	0.0921	921	0.0046	0.0031	0	0	0	0.0087	0	0
V483Ker-4	0.00	0.50	8.55	21.23	0.12	1.62	1.35	0.79	0.02	2.59	0.11	0.00	0.0039	0.0181	181	0.0007	0.0031	0.0048	0.0207	0.0029	0.0019	0	0.0119	0.0298	298	0.0032	0.0303	0.0049	0	0.0349	0.0027	0	0
V483Ker-4	1.15	0.54	2.04	7.62	0.03	0.42	0.53	0.23	0.00	0.98	0.06	0.00	0.0038	0.0087	87	0	0.0033	0.0062	0.0224	0.0031	0.0017	0	0.0127	0.0295	295	0.0036	0.0308	0.0046	0	0.0164	0.0038	0	0