LIVING WITH FLINT

Lithic biographies and daily life in the Rhine-Meuse Delta during the Vlaardingen Culture period (3400–2500 BCE)

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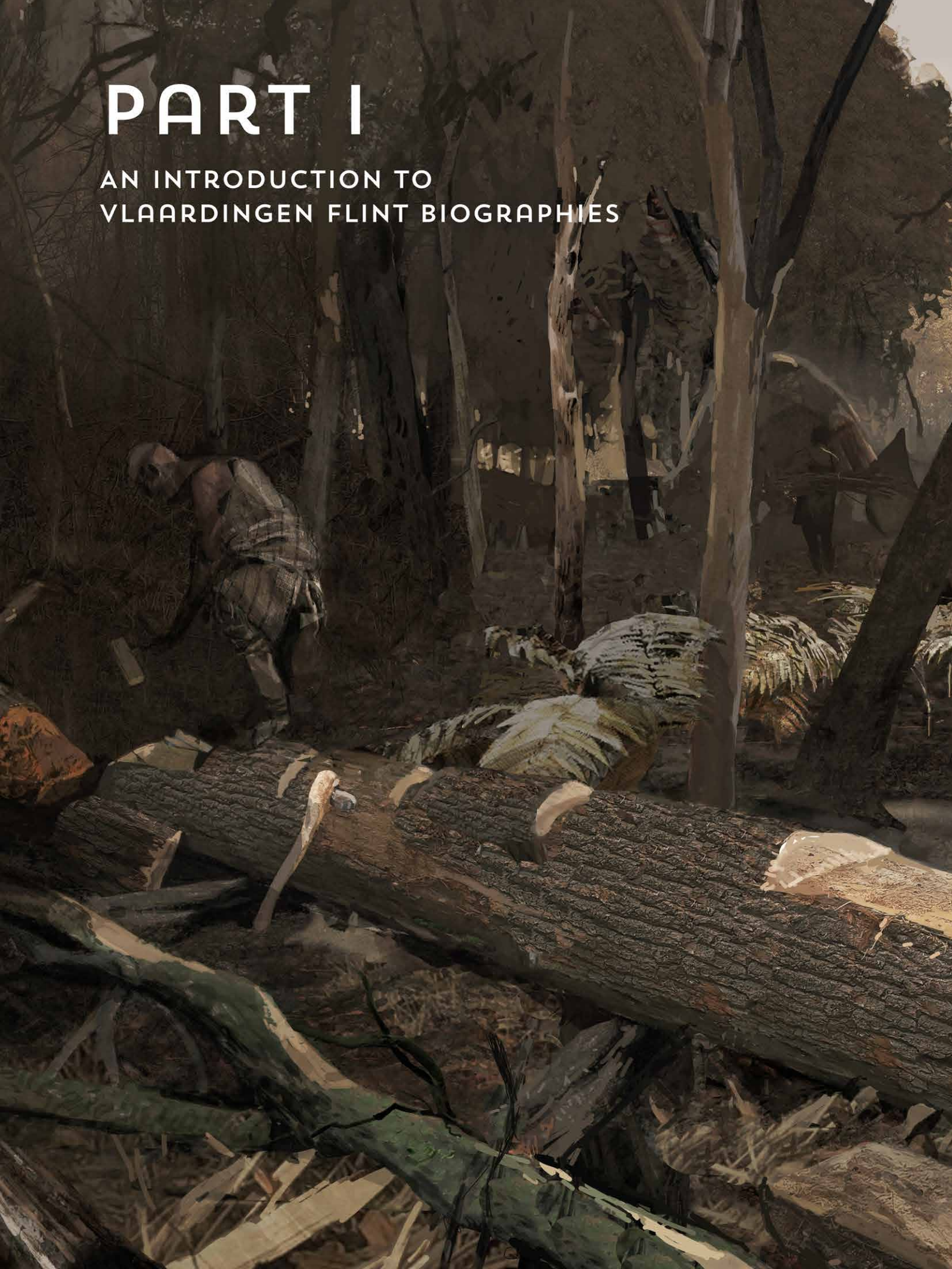


PART I

AN INTRODUCTION TO VLAARDINGEN FLINT BIOGRAPHIES

1

Living with flint in the Neolithic wetlands

Life in the Dutch lowlands has always been shaped by the dynamic relationship between people and water. The major rivers function as highways facilitating contact, but also as borders separating north and south. The dynamic coastal area provides a wealth of opportunities: providing fishing grounds and access to potential overseas contacts, but also challenges caused by regular flooding and the rapidly changing environment. The Vlaardingen Culture (VLC) can rightfully be considered to be the epitome of adaptability to this dynamic environment. Archaeologists often assume that prehistoric people tended to seek out stable high and dry places for habitation. But if we look at the distribution map of VLC sites in the Netherlands we see they are systematically located in close proximity to water (Fig. 1.1). The dry sandy soils of Brabant, which during the later parts of prehistory became a prime focal point for habitation, are still largely uninhabited (Jansen, 2021, p. 52; Schinkel, 2005; Van den Dikkenberg & Brandsen, 2025). People therefore did not live in these dynamic wetland landscapes because population pressure forced them off the high and dry grounds. People favoured a life in the ever-changing wetlands, because the opportunities outweighed the risks.

Compared to other Neolithic cultural groups such as the Funnel Beaker Culture (FBC), the Corded Ware Culture (CWC), or the Bell Beaker Culture (BB) the VLC presents us with a wealth of settlement data. The 158[1] known VLC settlement sites constitute a unique dataset to study Neolithic daily life in the wetlands (Van den Dikkenberg & Brandsen, 2025). This includes a number of well-excavated sites with house plans and occasionally well-preserved organic remains (Glasbergen et al., 1961; Louwe Kooijmans, 1987; Stokkel, 2017b; Van Beek, 1990; Van Iterson Scholten, 1977; Van Zoolingen, 2021b; Verhart, 1992). Despite this rich dataset we still know very little about daily life in the VLC. It is clear that a great deal of variation exists among these sites, often depending on their location in the landscape (Amkreutz, 2013b; Raemaekers, 2003; Van Gijn, 1990a). VLC sites are found in different environmental settings: 1) on the coastal dune area; 2) the levees; 3) the riverdunes in the delta; 4) the levees and riverdunes in the eastern Netherlands; 5) and recently in the cover-sand area of Noord-Brabant (Raemaekers, 2003; Van Gijn & Bakker, 2005; Van Kampen, 2013). This study will focus primarily on the coastal dune and levee sites. We see that at levee sites extensive evidence for fishing and hunting is present, while sites in the coastal dune area mainly present evidence for cattle herding (Brinkkemper et al., 2011; Clason, 1967; Groenman-van Waateringe et al., 1968; Kooistra et al., 2024; Prummel, 1987; Raemaekers, 2003; Van Dijk, 2021; Van Dijk et al., 2017). A challenge when interpreting this variation is the difference in preservation between these zones (Dusseldorp & Amkreutz, 2020). The levee sites of Hekelingen III and Vlaardingen Arij Koplaan are some

1 In our overview we listed 158 VLC sites, since then two new sites have been excavated in 2025 which have not yet been published, one in Lisse and one in Voorschoten. Because these have not yet been published they are not included in the present overview.

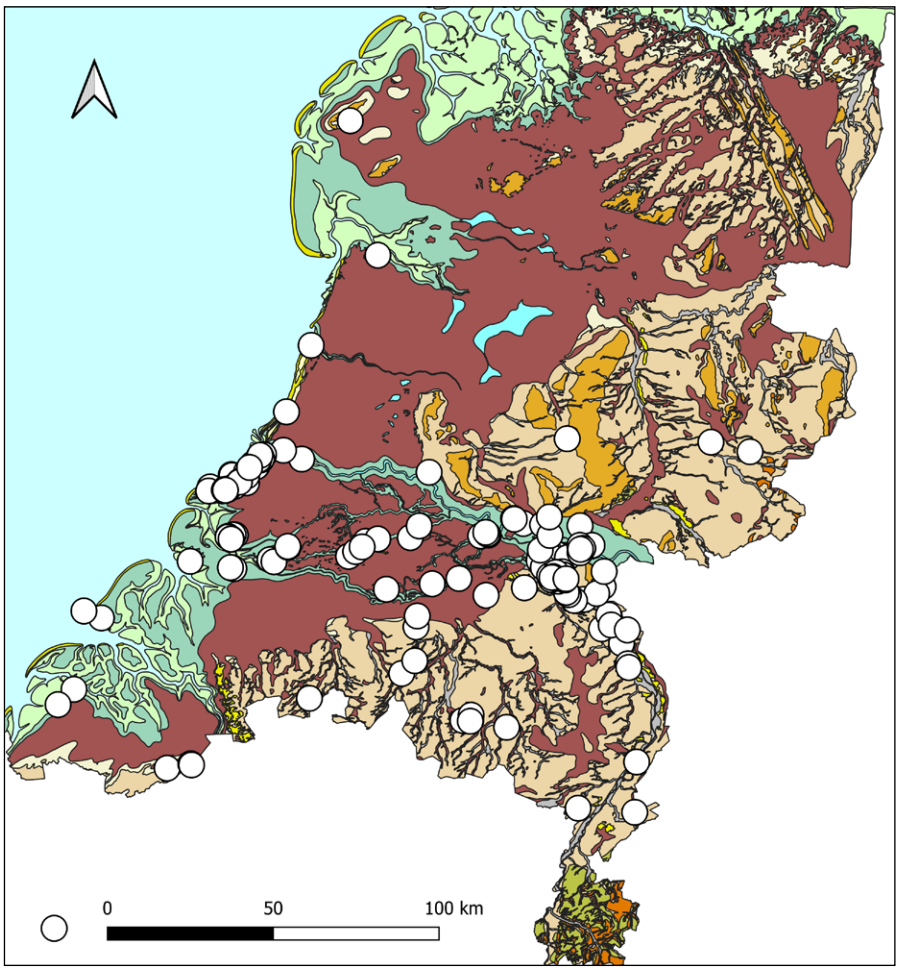


Figure 1.1 VLC sites plotted on the palaeogeographic map of the Netherlands ca. 2750 BCE (after Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020).

of the best preserved Neolithic sites in the Netherlands. Here a large assemblage of animal bones and even well-preserved plant fibres and wooden objects were discovered (Clason, 1967; Glasbergen et al., 1961; Louwe Kooijmans, 1987; Maarleveld, 1985; Out & Dörfler, 2017; Prummel, 1987; Van Iterson Scholten, 1977). The coastal dune sites by contrast have poorly-preserved animal remains, and virtually no objects of organic materials (Glasbergen et al., 1967a; Groenman-van Waateringe et al., 1968; Kooistra et al., 2024; Van Baardewijk & Vermeeren, 2017; Van Dijk, 2021; Van Dijk et al., 2017; Vorst & Vermeeren, 2021). If we want to grasp the reason for this variation we need to rely on methodologies which can overcome this preservation bias. A detailed study of flint artefacts provides a unique opportunity to get to the core of this problem. Substantial assemblages of well-preserved flint artefacts are ubiquitous at VLC sites in these diverse landscape zones (Van Gijn, 2010b). Use-wear analysis provides a unique opportunity to obtain information on the 'missing majority' of organic perishable materials which must have structured and facilitated life in the wetlands (Hurcombe, 2008). While wood, plant fibres, bone, and antler may be unequally preserved at VLC sites, depending on their location in the landscape, the traces from processing these materials can be encountered on flint artefacts both in wet and dry places (Van Gijn, 1990b). This provides a meaningful proxy

through which we can grasp the dynamic daily lives of VLC people in the Rhine-Meuse delta.

On a wider European scale it is worth noting that the VLC period is chronologically situated at the transition between the Middle and Late Neolithic. This period is characterised by major changes, partially brought about by human migrations (Allentoft et al., 2015; Haak et al., 2015). During this period the CWC was introduced across Europe. In the western Netherlands however, the VLC persisted. Recent studies on CWC groups in the Netherlands highlight the continuity between the CWC and VLC periods, demonstrating that CWC communities extensively borrowed and learned from preceding VLC communities (Beckerman, 2015; García-Díaz, 2017; Kroon, 2024; Kroon et al., 2019). Thus, despite being geographically confined to the wetland areas of the Netherlands, the VLC had a profound impact on the Late Neolithic Beaker Cultures. It is worth noting that these interactions have so far predominantly been described from the perspective of these recipient CWC communities, who clearly borrowed from the pre-existing local VLC communities. This has been especially demonstrated by Kroon who worked on CWC and VLC ceramics (Kroon, 2016, 2024; Kroon et al., 2019). The reverse side of these interactions has however been largely neglected. How did VLC communities react to this new group? To answer this, it is necessary to look at how the VLC communities responded to those changes by examining which CWC traits they incorporated.

A further topic of debate is the position of the VLC in the Neolithisation process. The VLC is sometimes cited as the consolidation phase, following the model of Zvelebil and Rowley-Conwy, for the Dutch Neolithic (Louwe Kooijmans, 1993, p. 103; Raemaekers, 2003, p. 745; Zvelebil & Rowley-Conwy, 1984). During this phase people begin to rely predominantly on agriculture for food production (Zvelebil & Rowley-Conwy, 1984, p. 106). Therefore, the period often features prominently in debates surrounding the Neolithisation process in the western Netherlands (Amkreutz, 2010; 2013b; Dusseldorp & Amkreutz, 2020; Raemaekers, 2003). Despite being recognised as crucial for our understanding of the changes taking place during the Late Neolithic, the VLC itself has received little attention in the past fifteen years. The last major overview studies on the VLC were presented as a *Westerheem* Special Issue in 2010 and as a public outreach book, written by Verhart (De Ridder et al., 2010; Verhart, 2010a). A proper systematic study of VLC lithics has so far been lacking. As Amkreutz noted in relation to these sites: *"there is a distinct need for new research in determining the origin of the lithic material"* (Amkreutz, 2013b, p. 343). Use-wear studies feature prominently in the site distribution model proposed by Raemaekers (2003). Yet, Raemaekers' study is based exclusively on Van Gijn's pioneering 1990 analyses of the Hekelingen III and Leidschendam Prinsenhof material (Raemaekers, 2003; Van Gijn, 1990b). Since 2003, many (n=32) new VLC sites have been discovered, and these often defy notions about VLC settlement systems (Van den Dikkenberg & Brandsen, 2025). At Den Haag Wateringse Binnentuinen and Den Haag Noordweg 76 for example the first temporary camps were discovered in the coastal dune area, while it was previously assumed that temporary habitation was restricted to the levees (Bulten & Stokkel, 2017; Raemaekers, 2003; Van Zoolingen & Rieffe, 2023). Clearly, a systematic study of VLC flint incorporating recent insights provided by development-led archaeology, new methodologies as well as revisiting some of the key VLC sites is due. The *Putting Life into Late Neolithic Houses* project was therefore initiated in 2021 in order to gain new insights into daily life in VLC settlements (Van Gijn, 2021b). This book is the result of a PhD trajectory as part of this project, which is further introduced in the next section. In this study detailed lithic analyses is used to shed light on the domestic life in the VLC period.

1.1 The project: Putting Life into Late Neolithic houses

This study forms an integral part of the NWO-funded project *Putting Life into Late Neolithic Houses, investigating domestic craft and subsistence activities through experiments and material analysis* (Project code: AIB.19.020). In 2016 an experimental reconstruction of a Late Neolithic VLC house was built in the archaeological open-air educational centre Masamuda (Vlaardingen Broekpolder). Although various material aspects of the VLC had been studied, the question remained how life was structured inside and outside of these houses (Van Gijn, 2021b; Van Gijn et al., 2025). What activities did people carry out in and around these houses? How did they move around the landscape and what kind of relationships did they have with people living further inland? The project aims to address these questions through experimental archaeology and detailed material analyses. The experiments conducted in this project were mostly done in Masamuda, in collaboration with local volunteers (Petrogiannaki & Van Gijn, 2024; Van den Dikkenberg et al., 2024b; Van Gijn, 2021b). In these experiments, D. Pomstra and L. Wolterbeek were involved in making the necessary replicas, and in providing expertise before and during the experiments (Van den Dikkenberg et al., 2024a, 2024b). The project consists of a team of specialists who focus on the analysis of different materials, through a variety of scientific analyses including use-wear, archaeobotany, SEM, ED-XRF, petrography, and residue analysis. In addition to archaeological specialists, diverse perspectives are brought in by the craft specialists (D. Pomstra and L. Wolterbeek) and the artist (K. Wilson), who are instrumental in broadening our scope. This multimaterial and multidisciplinary perspective is only

addressed occasionally in this book. The main reason is that these other analyses are a) conducted by project members other than the author; b) will be published in the synthesis volume which brings together a joint publication by all project members (Van Gijn et al., in prep.). The present book will therefore focus on the perspective that is brought by the detailed analysis of flint artefacts.

1.2 Research questions and case studies

This study aimed to investigate the flint from VLC settlements from a biographical perspective. Central to this study is the question: *How does variability in lithic biographies inform us about life in the Rhine-Meuse–Scheldt delta during the Vlaardingen Culture period?* The question can be broken down further into sub-questions:

1. *How and where did people obtain flint during this period?*
2. *How did people incorporate exotic imported flint in the local technological system?*
3. *How can we characterise the lithic technological system of the VLC?*
4. *What kind of technological choices were made by VLC people, and how can we explain them?*
5. *How do the above aspects vary across different environmental zones, and how should we account for this variation?*
6. *How do these lithic studies contribute to our understanding of what constitutes the VLC as an archaeological culture, and to our understanding of how the VLC relates to other contemporary groups?*

Four key sites were selected for analysis in this project. These sites were not only selected for the lithic analyses, but also for the other analyses done as part of the project (e.g. the residue analysis of pottery, and the use-wear analysis of non-flint stone tools as well as bone and antler tools). The sites were selected from different environmental settings, notably the coastal dune area (Den Haag Steynhof), the levees (Hekelingen III and Vlaardingen Arij Koplaan), and the salt marshes in West Frisia (Zandwerven). The latter was selected because it is located in close proximity to the West Frisian cluster of CWC sites which were analysed as part of the NWO project "*Unlocking Noord-Holland's Late Neolithic Treasure Chest*" (Beckerman, 2015; García-Díaz, 2017; Kleijne et al., 2016). Zandwerven is the only site in the region classified as a VLC site which raises the question of how this site is related to this cluster of CWC settlements. These sites were partly analysed using similar methodologies, in some cases to address comparable questions, in order to investigate daily life during the Late Neolithic in the region (García-Díaz, 2017; Oudemans & Kubiak-Martens, 2012; Oudemans & Kubiak-Martens, 2013, 2014). This provided a good opportunity to study the site in a wider context. In addition to the main case studies several other coastal dune sites (Den Haag Gavi Kavel, Den Haag Wateringse Binnentuinen, and Den Haag Noordweg 76) were also subjected to analysis to answer specific questions. They also provided additional data relevant to the central question of this thesis.

Experimental archaeology was an essential aspect of the present study. Although the extensive experimental reference collection of the Leiden Laboratory for Material Culture Studies was indispensable, new research questions and the finding of traces without an experimental match made it necessary to conduct new experiments to interpret previously unclassified traces.

1.3 Roadmap through the book

This study can be divided into three sections: an introduction presenting the methodology, theory and background for the study, a section presenting the experimental and archaeological results, and finally a presentation of the discussion and conclusions of the study. This structure is elaborated below:

Part I: An introduction to Vlaardingen flint biographies

- Chapter 1 provides an introduction and context of the project.
- Chapter 2 will provide a background to the VLC, starting with the research history and the chronological position of the VLC. This will be followed by a section on other relevant Neolithic groups. This will finally arrive at the core of the matter: the current state of research on VLC flint.
- Chapter 3 presents the theoretical background to this study, introducing concepts such as communities of practice and object biographies.
- Chapter 4 introduces the methods employed in this study to reconstruct these object biographies, including the methodology for the sourcing study, technological analysis and use-wear analysis.

Part II: Biographies of Vlaardingen Culture flint

Part II can be seen as the 'results' section of the study, presenting both the experimental (chapter 5) and archaeological results (chapters 6–10).

- Chapter 5 presents the results of the additional experiments conducted, focusing on use-wear experiments. It also includes technological experiments and an experiment regarding the recycling of flint axes.
- Chapter 6 will present the first archaeological case study. This will deal with the site of Den Haag Steynhof, a recent large-scale excavation of a VLC settlement in the coastal dune area.
- Chapter 7 will present several minor case studies on other sites in the area of The Hague: Den Haag Wateringse Binnentuinen, Den Haag Noordweg 76, and Den Haag Gavi Kavel.

- Chapters 8 and 9 present the object biographies of flint from the two main levee sites of Hekelingen III (chapter 8) and Vlaardingen Arij Koplaan (chapter 9).
- Chapter 10 deals with the West Frisian site of Zandwerven, located in the salt marshes, which was the first VLC excavation.

Part III: Living with flint in the Rhine-Meuse delta
This section will present a discussion on the role of flint in VLC societies. The discussions are primarily based on the case studies presented in part II, but they also borrow extensively from data found in the (grey) literature. This section will also include the final conclusions of the study.

- Chapter 11 focuses on the raw material acquisition, how and where people obtained flint. It will also address the question of how 'exotic' flint was appropriated and used by Vlaardingen communities.
- Chapter 12 will focus on the technological system of the VLC. This will first be addressed through a study of lithic technology. Next, the use-wear analysis will provide a proxy for technologies involving other (often perishable) materials. This chapter also addresses questions regarding craft specialisation and subsistence activities.
- Chapter 13 tackles the question as to how we should define the VLC from a lithics perspective. What is unique for the Vlaardingen Culture? And how should we account for the observed variation among VLC sites? This chapter also includes a discussion on the relations between the VLC and contemporary groups.
- Chapter 14 will synthesise the conclusions for this study.

1.4 Data availability

In line with the prerequisites of NWO, the data published here is made publicly available. Several parts of the dataset were previously made available in published studies. The dataset of known VLC sites in the Netherlands was gathered in collaboration with the EXALT (Excavating Archaeological Literature – Enabling scientific discovery by applying multilingual text mining to archaeological documents) project (grant number: AIB.19.011). The full dataset with data on all 158 sites was published open access (Van den Dikkenberg & Brandsen, 2025), and can be accessed in Zenodo: https://zenodo.org/records/14842975. The ED-XRF data for Den Haag Steynhof, Den Haag Wateringse Binnentuinen, Hekelingen III, and Vlaardingen Arij Koplaan was published as an appendix accompanying the publication in *X-Ray Spectrometry* (Van den Dikkenberg & Braekmans, 2025). Other datasets are included as appendices in the DANS Data Station Archaeology and can be accessed via: DOI:10.17026/AR/BHJW9I. These include the Microsoft Access databases for the case studies, an appendix containing microscopically identified finishing traces on flint axes for all sites, and a list of blade types, which are not included in the regular use-wear databases. The ED-XRF data for the axe from Den Haag Gavi Kavel were not previously published; they are now made available as an appendix in DANS Data Station Archaeology. All experiments conducted as part of this study are made available as part of the reference collection of the Laboratory for Material Culture Studies in Leiden. Here, all experimental forms and use-wear forms are stored both physically and as online PDF files; these can be accessed upon request. Furthermore, all figures (with the exception of the artworks by Kelvin Wilson) accompanying this book are uploaded in the DANS Data Station Archaeology dataset as high-resolution images. Finally, the use-wear photographs taken as part of this study are made available through DANS Data Station Archaeology: DOI:10.17026/AR/BHJW9I.

2

The Vlaardingen Culture

Part of this study involved a literature review to contextualise the results of the case studies presented in this book. In collaboration with the EXALT project an overview was compiled of 158[2] known Vlaardingen Culture (VLC) sites. These are mostly found along the coast and the rivers of the Rhine-Meuse-Scheldt delta (Van den Dikkenberg & Brandsen, 2025). The VLC is largely restricted to the wetlands of the western Netherlands. Only one Belgian site, Oudenaarde-De Donk, has typical VLC material, notably, S-shaped pots with perforations under the rim (Parent et al., 1986/1987, pp. 32–34). Typologically, the VLC does not have any diagnostic flint artefacts which were exclusively used by VLC communities. Early publications mention flint oval axes and chisels as typical artefact types (Van Regteren Altena et al., 1962b). It is interesting to note that these artefact types were not produced by VLC communities, but that they were imported in a ready-made state (Bakker, 2006; Van den Dikkenberg, 2024b). Technologically, there also seems to be little that sets the VLC flint apart from that of other contemporary groups such as the FBC, Stein group, or the CWC. They all share a similar simple ad hoc flaking technology (Amkreutz et al., 2016; García-Díaz, 2017; Peeters, 2016). Therefore, the main focus of the present study is on the most promising aspects of VLC lithics, notably their origin and use, rather than on typology (Amkreutz, 2013b; Van Gijn, 2010b).

This chapter starts with an overview of the research history of the VLC, from the earliest finds at the start of the 20th century to the present day. This is followed by a discussion on the chronology, emergence, and disappearance of the VLC phenomenon. I discuss the position of the VLC in the cultural and physical landscape of the Dutch Neolithic delta. Finally, the current state of lithic research on VLC sites is addressed.

2.1 Research history

2.1.1 Before the Vlaardingen Culture (1910–1958)

While CWC and FBC sites in the Netherlands have been excavated since the dawn of Dutch archaeology in the 18th and 19th centuries, the VLC has only been 'discovered' fairly recently (Fokkens, 2005a; Janssen, 1852, p. 7; Van Regteren Altena et al., 1962a, p. 4). The first archaeological find that could probably be attributed to the VLC is a tanged arrowhead, discovered in 1910 at Hulst Nieuw Namen Zandgroeve Kauterberg (ARCHIS2 waarnemingsnummer: 21157). These arrowheads are typical for the Late Neolithic A (2900–2500 BCE) and they are a regular occurrence at VLC sites in the region (although they are also known from CWC sites). Subsequent discoveries also consisted of single finds, notably two oval flint axes found in Voorburg Park Vronensteyn and Den Haag Centraal/Lange Poten (Bulten, 2010, p. 93; De Wit, 1960; Dorenbos & Koot, 2010, p. 106).

The first excavation of a VLC site was conducted by Van Giffen in 1929 at Zandwerven (Van Giffen, 1930). The finds were at the time unparalleled, although Van Giffen noted that he had seen similar pots with perforated rims in Brittany (Van Giffen, 1930, p.

2 In addition to these 158 known VLC sites two recently discovered sites can be noted, one in Lisse and one in Voorschoten.

161). He recognised that the remains consisted both of CWC remains as well as, stratigraphically older, unknown Neolithic remains. The single find of a nearly complete VLC pot at Neede (Gelderland) in 1934 was only later attributed to the VLC (Louwe Kooijmans, 2010, pp. 201–202; Lüüdik-Kaelas, 1955, p. 73; Van Regteren Altena, 1958, p. 157; Van Regteren Altena et al., 1962b, p. 99). The second excavation of, what would later be called the Vlaardingen Culture, was conducted at Hekelingen in 1950, led by Modderman. Modderman drew parallels between the archaeological remains discovered at Zandwerven and those found at Hekelingen. This led him to conclude that they likely belonged to an independent, hitherto unknown, archaeological culture (Modderman, 1953). At this time the Neolithic settlements at Toterfout Halve Mijl and Haamstede Brabers were also discovered (Glasbergen, 1954; Verhart, 1992). In 1959 De Laet coined the term *Kustneolithicum* (Coastal Neolithic), for the first time providing a name for the complexes found at Hekelingen, Haamstede Brabers and Zandwerven (De Laet & Glasbergen, 1959, p. 83).[3] The discovery of a flint axe at Vlaardingen in 1958, initially ascribed to the Etrebølle Culture by Verhagen, led to the subsequent excavations at Vlaardingen Arij Koplaan (Verhagen 1958). As we will see in the following section these excavations in turn led to the seminal publication by Van Regteren Altena *et al.* in which they first coined the term 'Vlaardingen Culture' to describe this newly discovered Neolithic complex (Glasbergen et al., 1961; Van Regteren Altena et al., 1962b, p. 99; Verhagen, 1958).

2.1.2 Defining the Vlaardingen Culture (1959–1964)

The aforementioned discovery of a flint axe led to a series of five excavation campaigns at Vlaardingen Arij Koplaan (Glasbergen et al., 1961; Van Beek, 1990, p. 26; Van Regteren Altena et al., 1962a). Unique about the site is the excellent organic preservation. The site has well-preserved cord fragments, wooden poles, cereal grains, and a lot of bone and antler material, including the largest assemblage of bone and antler tools ever found on a VLC site (Clason, 1967; Glasbergen et al., 1961; Maarleveld, 1985; Van Beek, 1990; Van den Dikkenberg & Van Gijn, 2024; Van Iterson Scholten, 1977; Van Regteren Altena et al., 1962a). The site also has several house plans, with occasionally well-preserved stumps of wooden poles (Glasbergen et al., 1961). For the first time (cremated) human remains were also discovered at a VLC site (Van Regteren Altena et al., 1962a, p. 31). The abundant material finds led the excavators to assign the remains to a new archaeological culture, the 'Vlaardingen Culture' (Van Regteren Altena et al., 1962a). The threefold publication by Van Regteren Altena et al. aimed to a) define the VLC, b) provide an overview of known VLC sites, c) to describe the cultural affiliations of the VLC (Van Regteren Altena et al., 1962a; 1962b; 1962c). They defined the VLC mostly based of specific types of, predominantly quartz-tempered, pottery. Notably flat based ceramics with everted rims, occasionally with perforations below the rim. Ceramics occasionally have knobs, but otherwise they tend to be undecorated. Exceptions are decorated ceramic discs and collared flasks (Van Regteren Altena et al., 1962b, p. 101). Lithics were typically of a southern origin, characteristic types were flint oval axes and chisels, transverse arrowheads, leaf-shaped arrowheads, and simple scrapers and borers (Van Regteren Altena et al., 1962b, p. 101). Houses tend to be small and rectangular in nature with a central row of posts. In terms of subsistence strategies it was noted that VLC people heavily relied on hunting and fishing in addition to stock breeding and cereal cultivation (Van Regteren Altena et al., 1962b, p. 101). It was noted early on that the VLC sites were located in diverse landscape zones including the levees, coastal dunes, and further inland along rivers and streams (Van Regteren Altena et al., 1962b, pp. 101–103). Chronologically, it was established that the VLC was contemporary both with the FBC and CWC (Van Regteren Altena et al., 1962b, p. 103). The cultural historical definition of what the VLC entailed provided a solid basis for subsequent research. Critically, it allowed archaeologists to assign newly discovered sites to the VLC complex.

2.1.3 Further research and pioneering studies (1964–2003)

New excavations at Voorschoten Boschgeest and Leidschendam Prinsenhof in the 1960s led to new insights into the VLC. The excavations at Voorschoten Boschgeest provided a first opportunity to establish a chronological framework for the VLC, based on ceramic typologies. The chronological changes consisted of a change from quartz to grog tempered ceramics, and the disappearance of knobs and perforations under the rims of pots (Glasbergen et al., 1967a; 1967b). In 1976 Louwe Kooijmans further refined this chronology by differentiating four VLC phases, 1a, 1b, 2a, and 2b (Louwe Kooijmans, 1976, pp. 283–289). The earliest of these phases was mostly known from the recent excavations at the Hazendonk (Louwe Kooijmans, 1976, p. 280).

3 Modderman is often erroneously credited with inventing this term; however, it does not feature in his seminal 1953 publication (Amkreutz, 2010; Van Gijn, 1990b, 97; Van Gijn and Bakker, 2005; Modderman, 1953). In a 1992 letter to Bakker, Modderman did note that he would have preferred the term *Hekelingen-cultuur* (Hekelingen Culture), since the Hekelingen site was excavated prior to Vlaardingen. Nevertheless, because the term 'Vlaardingen Culture' had already been coined before Modderman could publish his views on the 'Hekelingen Culture', the former term prevailed (Verhart, 2010a, 82).

The 1970s and 1980s saw a boom in VLC discoveries in the eastern Netherlands near Nijmegen. The discoveries mostly consisted of rescue excavations and surveys conducted by local AWN[4] archaeology volunteers (De Groot, 1982; 1992; Janssen, 1978; Tuijn, 1989). Spectacular new excavations at Hekelingen III in 1980, close to the initial excavations by Modderman, shed new light on the occupation at VLC settlements (Louwe Kooijmans, 1987). Remarkable about the site is that, instead of the rectangular house plans known from other excavations, it has round clusters of postholes, which appear to represent small round huts. The clusters were found along a levee, in many ways mirroring the excavations at Vlaardingen. The discovery is significant because it led to a discussion about the occupation duration at these sites. The strong emphasis on wild resources, along with small round huts, seemed to resemble a temporary settlement, rather than a permanently inhabited site (Louwe Kooijmans, 1986; Louwe Kooijmans, 1987; Louwe Kooijmans & Van de Velde, 1980; Prummel, 1987; Van Gijn, 1990b; Verhart, 1983).

During the 1980s the first use-wear analyses were conducted on VLC lithics, notably from the Hazendonk, Hekelingen III, Leidschendam Prinsenhof, Vlaardingen Arij Koplaan and Voorschoten Boschgeest (Bienenfeld, 1986; Van Gijn, 1984; 1990b). The analyses, especially those of Hekelingen III and Leidschendam Prinsenhof, further contributed to the debate surrounding the occupation duration at these different VLC sites (Van Gijn, 1990a; 1990b). An important publication by Louwe Kooijmans was the first to raise the discussion about the relationship between the VLC, Stein group, and Wartberg group. He proposed that potentially the VLC should be seen as part of a larger cultural complex, spanning from the western Netherlands to central Germany (Louwe Kooijmans, 1983; also see section 2.3.1).

In 2003 Raemaekers proposed a model synthesising the observed differences among these VLC sites, based on published archaeological, archaeozoological, archaeobotanical, and use-wear studies (Raemaekers, 2003). Importantly, Raemaekers linked the different settlement types in a coherent system of interdependent settlement clusters. He identified three clusters of sites: 1) permanent settlements in the coastal dune area, with an emphasis on cereal cultivation and animal husbandry; 2) seasonal camps on the levee sites (Vlaardingen Arij Koplaan and Hekelingen III), with an emphasis on the exploitation of wild resources, notably hunting and fishing; 3) river dune sites, which were poorly defined, but which appeared to be visited on a temporary basis for specific activities such as hunting and fishing (Raemaekers, 2003, pp. 744–745). The second, and likely the third group, functioned as satellite settlements for the permanent settlements which were located in the coastal dune area, and possibly also on the cover-sand area of Noord-Brabant (Raemaekers, 2003, pp. 744–745). The model, although criticised as well (Amkreutz, 2013b), was highly influential as it provided a framework to assign subsequent discoveries of VLC sites to these groups, based on their archaeological assemblages and spatial setting (Petrogiannaki & Van Gijn, 2024; Van Dijk et al., 2017, p. 217).

2.1.4 Vlaardingen and Malta archaeology (2003–2017)

Excavations undertaken in the Malta era[5] produced a wealth of new information. A significant find is provided by the discovery of ard marks at Hellevoetsluis Ossenhoek (Van Hoof, 2009b). For the ard marks previously uncovered during the excavations at Zandwerven it is uncertain whether they truly belong to the VLC phase or rather to the subsequent CWC layers. The ard marks at Hellevoetsluis are thus the first that could be unequivocally attributed to the VLC (Van Hoof, 2009b). The excavations at Veldhoven Habraken and Oerle Zuid revealed the first VLC house plans in Brabant. These houses are remarkable because they are much larger than the house plans known from Haamstede Brabers and Vlaardingen Arij Koplaan (Glasbergen et al., 1961; Hissel, 2012; Van Beek, 1990; Van Kampen, 2013; Van Regteren Altena et al., 1962a; Verhart, 1992). The excavators suggested that these larger houses might have functioned as byre-houses in which livestock was kept (Van Kampen, 2013). Around this time the first VLC house plan in the Nijmegen area was also discovered in Wijchen Oostflank (Van Kampen, 2017, pp. 340–342). In 2009 Beckerman and Raemaekers provided a new typology for VLC ceramics based on metric analyses, aimed to better understand the chronological developments in the VLC period (Beckerman & Raemaekers, 2009). In 2010 the AWN dedicated a special issue to the fifty-year anniversary of the discovery of the VLC (De Ridder et al., 2010). The special issue contained contributions from all major VLC experts, discussing topics such as the subsistence strategies in the VLC period, the use of flint, pot depositions, (micro) regional overviews, and the relationships with the Stein group, as well as contributions on newly discovered sites (Amkreutz, 2010; Arts, 2010; Beerenhout, 2010; Bloo & Ploegaert, 2010; Brinkkemper et al., 2011; Bulten, 2010; Diependaele & Drenth, 2010; Dorenbos & Koot, 2010; Goossens, 2010; Houkes, 2010; Louwe Kooijmans, 2010; Ten Anscher & Bosman, 2010; Teubner & Tuijn, 2010; Valk & Hirschel, 2010; Van Gijn, 2010b; Verhart, 2010b; Verhart

4 The AWN is the Association for Archaeology Volunteers in the Netherlands (*Vereniging van vrijwilligers in de archeologie*).

5 Referring to the introduction of contract archaeology, following the Valetta convention in 1992, at the turn of the century.

& de Ridder, 2010). The volume provided a substantive overview of the status quo on VLC research at the time. The VLC featured prominently in the 2013 study by Amkreutz on the Neolithisation process of the Rhine-Meuse delta (Amkreutz, 2013b).

In 2012 and 2016 two VLC houses were reconstructed, both based on the same house plan from Haamstede Brabers (Pomstra & Van Gijn, 2013; Van Gijn, 2021b; Van Gijn & Pomstra, 2016). The building projects provided some of the most extensively documented experimental housebuilding projects in the world. All activities were conducted with Stone Age technologies and replicated tools. All tool use was documented, and the tools subsequently became part of the reference collection for use-wear analysis at the Laboratory for Material Culture Studies in Leiden (Van Gijn, 2021b; Van Gijn & Pomstra, 2016).

2.1.5 New discoveries and renewed interest (2017–2025)

Although the VLC continued to be part of the wider Neolithisation debate, it received little scholarly attention as a standalone topic in the past decade (Dusseldorp & Amkreutz, 2020). In recent work by Kroon the VLC mostly featured as a local backdrop against which the introduction of the CWC could be studied (Kroon, 2016, 2024; Kroon et al., 2019). On the other hand, in a recent Ancient DNA study the individuals from CWC sites in Noord-Holland were dubbed 'Vlaardingen-CWC' individuals (Olalde et al., 2025). In terms of new discoveries the most significant publications came from the area of The Hague. The sites Den Haag Wateringse Binnentuinen and Den Haag Steynhof provided the best documented coastal dune sites so far (Stokkel & Bulten, 2017; Van Zoolingen & Bulten, 2021a). Furthermore, the discoveries of small temporary structures in Den Haag Wateringse Binnentuinen and Den Haag Noordweg 76 demonstrated that temporary settlements also occurred in the coastal dune area (Stokkel, 2017b; Van Zoolingen & Rieffe, 2023). Two new research projects on the VLC were initiated during this period. The first project, initiated by the municipality of The Hague (Den Haag) deals with Neolithic foodways of sites within the borders of the municipality (Kooistra et al., 2024). The second being the *Putting Life into Late Neolithic Houses* project, of which this study is an outcome (Van Gijn, 2021b).

2.2 Chronology of the Vlaardingen Culture

Chronologically the VLC (3400–2500 BCE) is uniquely situated at the transition between the Middle (4200–2900 BCE) and Late Neolithic (2900–2000 BCE) periods, within the Dutch chronology (Van den Broeke et al., 2005). The group is thus contemporary both with the Funnel Beaker Culture (3400–2500 BCE) and Corded Ware Culture (2900–2500 BCE) in the eastern Netherlands. The VLC period is traditionally divided in two main subphases which roughly correspond to an earlier, Middle Neolithic, phase (VL1) and a Late Neolithic phase (VL2). These phases are further subdivided into four phases in total: 1a, 1b, 2a, and 2b. The phases are defined based on ceramic typologies. Phase 1a (ca. 3400–3200 BCE) is the earliest phase which is only known from the Hazendonk excavations, and possibly from those at Den Haag Gavi Kavel (Bulten, 2010; Lammertsma & Grabowski, 2025; Louwe Kooijmans, 2005; Van Gijn & Bakker, 2005). It is debated whether a distinction between phase 1a and 1b is possible, because the characteristics mentioned for phase 1a are also present in ceramics from phase 1b (Raemaekers, 2005). The division between phase 2a and 2b is only based on whether CWC pottery is present in the assemblages (Van Gijn & Bakker, 2005). To overcome these problems with the chronological phases, Beckerman and Raemaekers developed a new chronology for the VLC (Beckerman & Raemaekers, 2009). They defined three phases based on five typological groups, termed group A–E (for a description of these types see: Beckerman & Raemaekers, 2009):

- *The early phase,* with only pot type A, coincides with the phase 1a;
- *The middle phase,* with pot types A,B,C,D, coincides with phase 1b;
- *The late phase,* with pot types D and E, coincides with phase 2a and 2b (Beckerman & Raemaekers, 2009).

It was assumed that the type of temper could be used to identify early and late VLC ceramics. Quartz temper was thought to relate to the earlier phases, while grog was deemed to be characteristic of the later VLC phases (Van Gijn & Bakker, 2005). The extensive studies of the material from Den Haag Wateringse Binnentuinen and Den Haag Steynhof by Bloo however cast doubt on this notion. Bloo was furthermore critical about the use of the ceramic groups by Beckerman and Raemaekers for chronological purposes (Bloo, 2017, p. 136; 2021).

Besides the use of ceramics it should be noted that occasionally flint and stone tools can further elucidate the chronology at VLC sites. Lousberg flint is occasionally present at VLC sites, but the mines at Lousberg were exhausted by 3000 BCE (Hirschel, 2009; Schyle, 2006; Verhart, 1983). Lousberg flint can thus be related specifically to the earlier phases of the VLC (3400–3000 BCE). The introduction of tanged arrowheads in the VLC coincides with the introduction of the CWC (Houkes et al., 2017, p. 182). They can therefore be related to the later phases of the VLC (2900–2500 BCE). Similarly, the scarce presence of battle axes at VLC sites can also be related to the introduction of the CWC (Glasbergen et al., 1961, pp. 50–51; Van Regteren Altena et al., 1962a, p. 13).

2.2.1 The roots of the Vlaardingen Culture

It is generally accepted that the VLC is strongly rooted in earlier Hazendonk-3 group[6] and Swifterbant Culture traditions (Amkreutz et al., 2016). These groups display many similarities in terms of subsistence strategies, lithic technologies and typologies, and ceramic technologies (Amkreutz et al., 2016; Raemaekers, 1999, pp. 159–160, 182). It is, however, striking that in the overview of VLC sites, which was compiled for the present study in collaboration with the EXALT project, only one out of the 158 identified VLC sites was clearly occupied both during the late Hazendonk-3 phase and the early VLC phase (Louwe Kooijmans, 1974; Van den Dikkenberg & Brandsen, 2025).

It is remarkable that at the site of the Hazendonk no gradual transition can be observed. Decorated Hazendonk-3 pottery does not occur in the early VLC 1a layer (Louwe Kooijmans, 1974). It is possible that some of the palimpsest sites in the eastern Netherlands were continuously occupied between the Michelsberg/Hazendonk-3 phases and the VLC phase, but clear evidence for this is conspicuously absent (for example at Cuijk-De Nielt: Chtcheglov et al., 2017). It is noteworthy that the emergence of the VLC, Stein group, and FBC all happen more or less simultaneously around 3400 BCE and that they coincide with the disappearance of the Hazendonk-3 group, Michelsberg and Swifterbant Cultures. Recent DNA analyses revealed genetic continuity between Swifterbant/Hazendonk-3 communities and later Vlaardingen-CWC communities (Olalde et al., 2025), but this does not necessarily negate the strong evidence for discontinuity in settlement use and material culture in the Rhine-Meuse delta around 3400 BCE. The DNA analysis focuses on coarse-grained pan-European populations (notably three main genetic groups, indigenous hunter-gatherers, early farmers, and populations with 'steppe ancestry'). Due to the lack of early VLC skeletal finds ancient DNA analyses provide an insufficient tool for understanding the population dynamics in the Rhine-Meuse delta around 3400 BCE.

It is interesting that there is continuity in the exploitation of flint mines in Limburg between the Michelsberg and Stein phases (Felder et al., 1998; Schyle, 2006). The observed continuity in lithic technologies between the Hazendonk-3 and VLC phases is rather superficial. The use of simple ad hoc flaking technologies are shared over a wider region, also encompassing for example the FBC (Amkreutz et al., 2016; Houkes, 2016; Peeters, 2016). The exploitation of flint mines is however complex, it requires detailed knowledge of local underground (and thus invisible prior to digging) geology. In this sense I would argue that there is more evidence for continuity between the Michelsberg and Stein phases than there is for continuity between the Hazendonk-3 and VLC phases. While it remains speculative, I would argue that around 3400 BCE the Rhine-Meuse delta was potentially briefly depopulated, and that this period should be seen as a general period of crisis and change in the wider region. This is a notion also previously proposed for the micro-region of The Hague (Kooistra et al., 2024). The resurgence, associated with the emergence of the VLC, can possibly be related to an influx of people from the Stein area. This might explain the significant similarities between these groups (Louwe Kooijmans, 1983; Van den Dikkenberg, 2024b; Verhart, 2010b). It should be noted that the above remains hypothetical. It is also possible that these similarities result from social interaction between wetland and upland communities, a theme I will return to in chapter 11. In the absence of DNA and isotopic analysis, actual population movements and dynamics cannot be adequately reconstructed. Nevertheless, it is important to factor in the discontinuity in settlement use between these phases in future interpretations of the transition between the Hazendonk-3 phase and the VLC period.

2.2.2 Disappearance of the Vlaardingen Culture

The end-date for the VLC phase is traditionally set at 2500 BCE (Amkreutz et al., 2016, p. 271). After 2500 BCE the VLC was replaced by the Bell Beaker Culture (2500–2000 BCE). It is interesting to note that many VLC (n=30) sites provide evidence for later BB occupation phases (Tab. 2.1). This is often evidenced by the presence of BB ceramics (n=27) and ^{14}C dates which fall in the BB period (n=8). This means that 19% of the total number of known VLC sites (n=158) have evidence for later BB occupation phases (based on the overview by Van den Dikkenberg & Brandsen, 2025).

This continuity in site use during the VLC sharply contrasts with the earlier discontinuity observed at the end of the Hazendonk-3 period and the start of the VLC. Ancient DNA analyses, however, indicate little continuity between VLC populations and later BB populations (Olalde et al., 2025). It should be stressed that these analyses were not conducted on actual VLC populations (as suitable skeletal material is lacking). Therefore, this population turnover appears to be based primarily on a comparison of VLC-CWC skeletons and Hazendonk-3 group skeletons. Nevertheless, the introduction of new people during the BB phase corresponds to similar trends observed for example in Britain (Olalde et al., 2018). In this sense it seems plausible that the population turnover during the

6 The terms 'Hazendonk group' and 'Hazendonk-3 group' have both been used to designate this assemblage. I will not go into detail regarding the terminological debate. Following the recommendations of Raemaekers, I will use the term 'Hazendonk-3 group', as it is more specific and explicitly excludes the other Hazendonk layers from the Hazendonk excavations (Raemaekers, 2005, 269–271).

Toponym	BB ceramics	^{14}C dates in BB phase
Almkerk Waardhuizense Weg	Yes	No
Arnhem Schuytgraaf De Laar 16 en 98–1	Yes	No
Barendrecht Zuidpolder (20–58)	Yes	Yes
Beuningen Hogewaldstraat 3	No	Yes
Boxmeer Sterckwijck	Yes	No
Cuijk de Nielt	Yes	No
Den Haag Rhyenhof	Yes	No
Den Haag Wateringse Binnentuinen	No	Yes
Goudriaan Donk Van Koorevaar	Yes	No
Groesbeek Hüsenhoff	Yes	No
Groesbeek Klein America	Yes	No
The Hazendonk	Yes	No
Hekelingen III	Yes	Yes
Hoog Blokland Site 1 and 2	Yes	No
Meshallen en Kraanvogel Wijchen	Yes	No
Ottoland Oosteind	Yes	No
Overasselt Kraaijenberg	Yes	No
Rijswijk Huys ter Nieuburchlaan	No	Yes
Siebengewald	Yes	No
Tilburg Schaapsven B en Fietspad	Yes	No
Veldhoven Habraken	Yes	Yes
Vlaardingen Arij Koplaan	Yes	Yes
Voorburg Park Arentsburgh Effathaterein	Yes	No
Voorschoten Boschgeest	Yes	No
Wijchen Huurlingsedam vindplaats 3	Yes	No
Wijchen Homberg	Yes	No
Wijchen Hoogbroek	Yes	No
Wijchen Oosterweg	Yes	Yes
Wijchen Randweg Oost	Yes	No
Wylermeer	Yes	No

Table 2.1 VLC sites with evidence for BB occupation either through the presence of BB ceramics or based on ^{14}C dates falling within the BB range (2500–2000 BCE) (Bloo, 2014, p. 83; Chtcheglov et al., 2017, p. 180; De Groot, 1978, pp. 8–10; De Groot, 2013, p. 86; De Jong, 1988, p. 12; De Koning et al., 2010, pp. 114, 161; Den Hartog, 1986; Dorenbos et al., 2011, p. 47; Drenth, 2015, p. 91; 2012, p. 61; Glasbergen et al., 1967a, p. 21; Haarhuis, 1996, p. 22; Heirbaut et al., 2010, p. 114; Hiddink, 2000, p. 11; Houkes & Verhoef, 2014; Janssen, 1976; Janssen & Tuijn, 1978, pp. 241–243; Kok, 1965, p. 122; Lanting & Van der Plicht, 1999/2000, pp. 69–82; Louwe Kooijmans, 1974, pp. 146–368; 1985, p. 100; Moree et al., 2011, pp. 47–48; Stokkel, 2017a, p. 278; Van Beek, 1990; Van den Brink & Van Kampen, 2013; Van Kampen et al., 2013, pp. 92–93; Verscharen, 1987, p. 15; Winter, 2015, p. 26; Zuidhoff et al., 2015, p. 100).

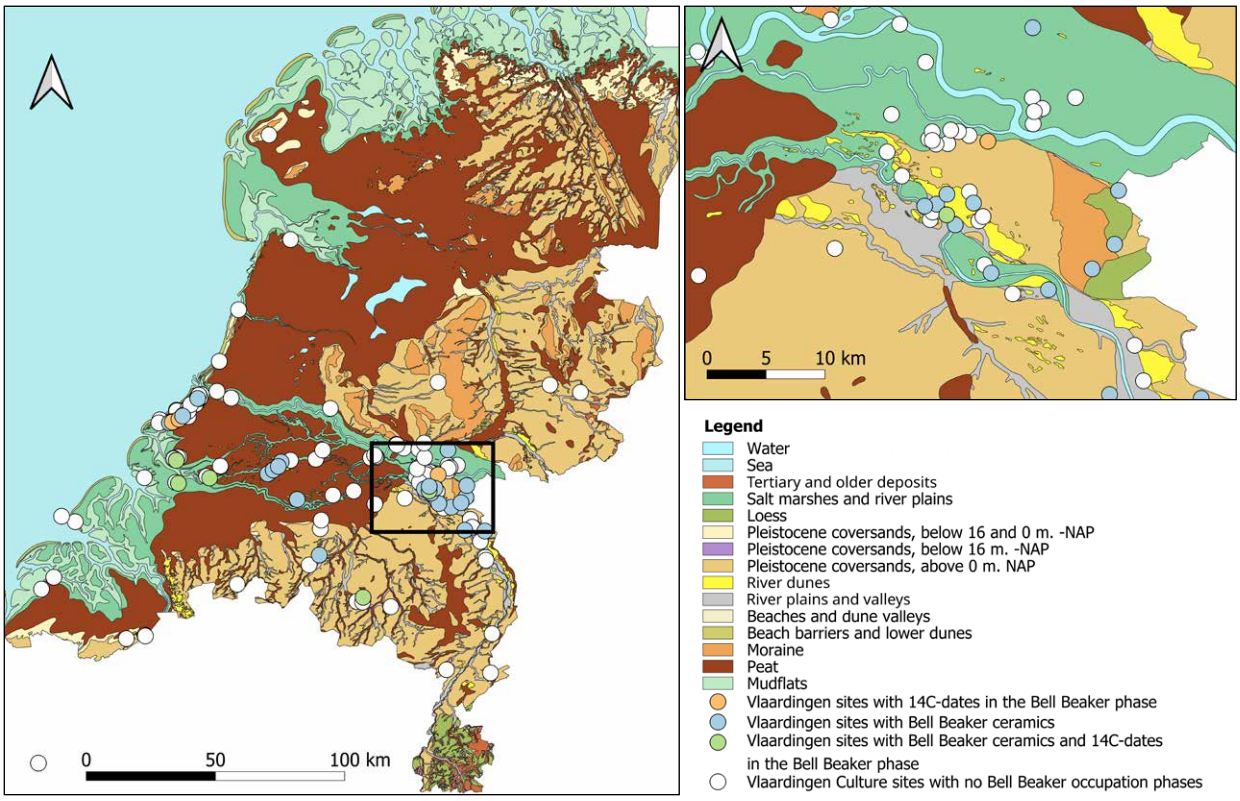


Figure 2.1 BB occupation at VLC sites (after Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020; based on Table 2.1).

BB phase indeed represents a real phenomenon. While seemingly abrupt, the settlement evidence suggests that there may have been a degree of overlap and coexistence. The situation mirrors that of the introduction of the CWC in the eastern Netherlands. It has recently been suggested that there was a period of about 175 years in which the FBC and CWC coexisted, prior to the disappearance of the former (Bourgeois et al., 2025b). Whether the continuity in settlement locations should be seen as an indication of a gradual transition is uncertain. A study of VLC and BB ceramics from Vlaardingen Arij Koplaan suggested there was technological continuity in terms of ceramic technology between the VLC and BB phases (Stet, 2021, p. 83). Kleijne furthermore observed continuity "*between Late Neolithic Vlaardingen vessels, Corded Ware beaker pot vessels and Bell Beaker common ware*", which further supports the notion of overlap between the VLC and BB periods (Kleijne, 2019, p. 184). Interestingly, one of the water pits at Den Haag Wateringse Binnentuinen was dug during the VLC occupation and continued to be used and altered during the BB phase (Stokkel, 2017a, p. 278). It is noteworthy that the continuity in occupation is not a localised phenomenon. BB ceramics are found on a wide variety of VLC sites both on the levees, coastal dune area, and further inland (Fig. 2.1). The largest concentration of BB material at VLC sites is formed by the many palimpsest sites in the Nijmegen area, which further hampers a proper understanding of this phenomenon.

Regardless of the above sketched evidence for continuity, some time during the Late Neolithic B (2500–2000 BCE), the VLC disappeared. A more in-depth study of the potential overlap between these groups falls outside of the scope of the present study, but would be worthwhile, considering the frequent presence of BB material on VLC sites.

2.3 The Neighbours

The VLC bordered on five contemporary archaeological cultures, with whom, to varying degrees, VLC people maintained contact: the Stein group, the Deûle-Escaut group, the Seine-Oise-Marne Culture, the FBC, and the CWC (Fig. 2.2). The here employed term 'archaeological culture' carries a lot of, mainly negative, connotations. The problems mostly stem from the equation of archaeological cultures with ethnic or linguistic groups (Lang, 2001). While these critiques are in many ways valid it should be recognized that the setup of this study, the choice to focus on the VLC, was predetermined by the setup of the *Putting Life into Late Neolithic houses project*. The aim of this project was to study the material remains from the Vlaardingen Culture. It should also be noted that in the context of Dutch archaeology these archaeological cultures are used predominantly used to designate chronological

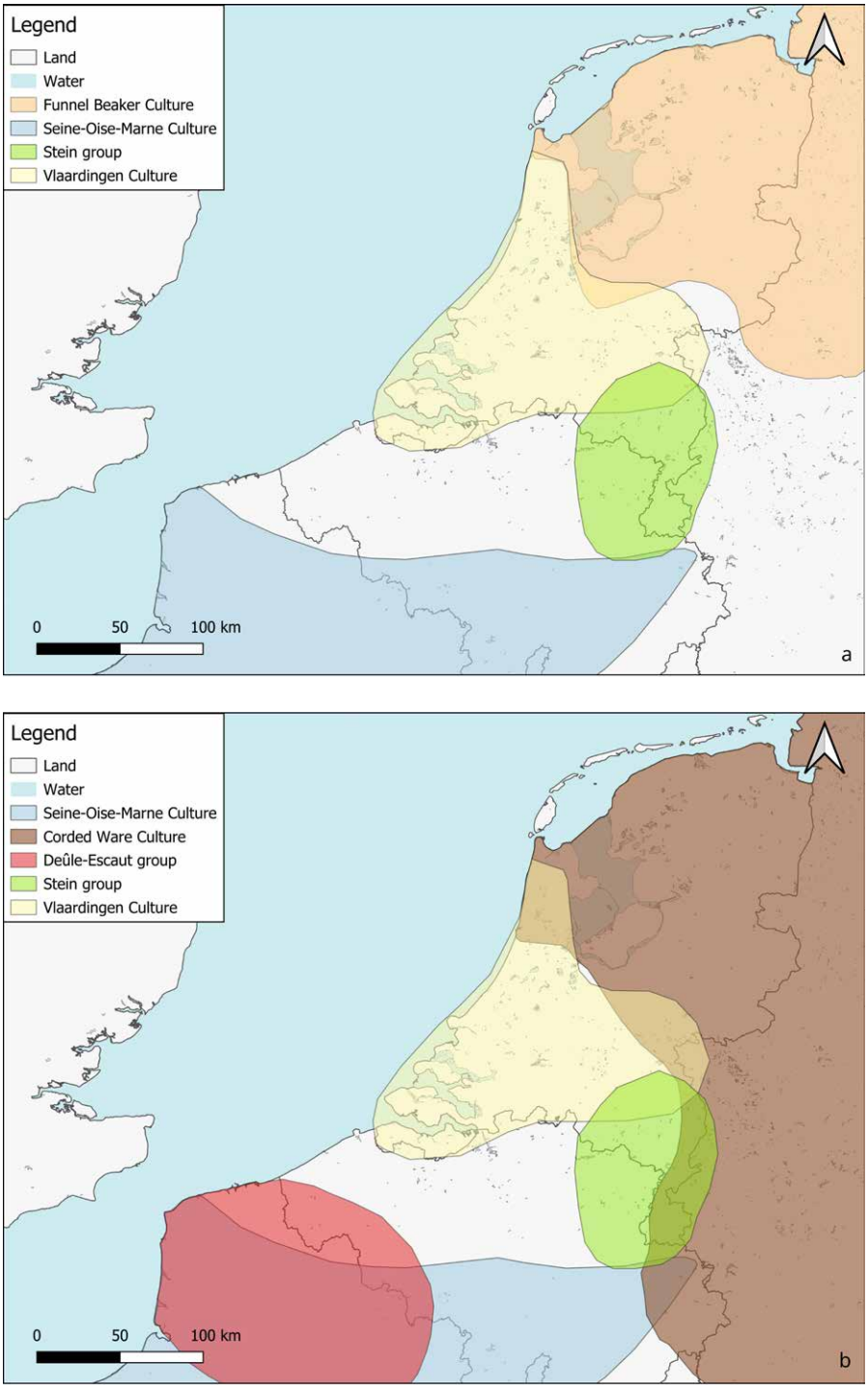


Figure 2.2 Archaeological cultures in the area bordering on the VLC, a) ca. 3000 BCE; b) ca. 2750 BCE (Hazen & Drenth, 2018; Kroon, 2024; Louwe Kooijmans, 1983; Verhart, 2010b; basemap: © EuroGeographics 2024).

periods and regions of study (more often than periods such as 'Late Neolithic'). While these cultures will not be taken at face value they were used because they were important in shaping the setup of this study.

In its most basic form archaeological cultures can be defined as "*an artificial term created by the archaeologists merely for the organisation of archaeological material, and it means the spatial and temporal coexistence of certain types of artefacts and/or antiquities*" (Lang, 2001, p. 51). I agree that archaeological cultures cannot be equated with ethnic groups or biological populations (Furholt, 2020). However, the fact that traits in material culture are shared over wider areas is significant. The reproduction of material culture requires knowledge sharing (Wenger, 1999). It should also be acknowledged that communities are shaped by their day-to-day practices (Knappett, 2011). This sharing of material

practices through participation allows for the identification with others (Wenger, 2010). This has been convincingly argued for Beaker Cultures by Wentink (Wentink, 2020). While a more in-depth discussion on this topic falls outside of the scope of the present study, it is important to conclude the following. Archaeological cultures share material culture, which in turn is a reflection of shared practices and actions. Identities are multi-scaled, but it is undeniable that identities are partly shaped by the reproduction of material culture. At some level archaeological cultures therefore do likely reflect group/community identities. While these should not be equated with ethnic groups, and while it should not be denied that we are looking at one of the many scales, or social worlds (Furholt, 2020) at which identities are formed. Therefore, they do provide acceptable entities for analysing contacts between groups. Although these neighbouring groups are not the primary focus of this study, a brief overview of their material culture and connections to the VLC provides necessary context for understanding the VLC. It should be noted that these groups here are not taken at face value. But by comparing the material remains from these regions we might gain insight into knowledge sharing across different regions.

2.3.1 Stein group (3400–2500 BCE)

The main Neolithic group with which the VLC is associated is the Stein group. The discovery of the burial vault in Stein by Modderman in 1963, and subsequent discoveries of contemporary settlement traces in the Limburg area, led Louwe Kooijmans to define the Stein group as a new entity, one which was closely related to the VLC (Louwe Kooijmans, 1983; Modderman, 1964). The VLC and Stein group are virtually indistinguishable based on material culture, which has led some authors to use overarching terms such as 'Vlaardingen-Stein Complex' to describe sites without assigning them to one culture or the other (Louwe Kooijmans, 1983; Van den Dikkenberg, 2024b; Van den Dikkenberg & Brandsen, 2025; Verhart, 2010b). The Stein group is located in the south-eastern part of the Netherlands, and in neighbouring regions in Flanders. Similarities between the groups are so overwhelming that, rather than describing the Stein group, it seems more fruitful to briefly address the scarce differences between the groups. The main difference is the supposed absence or scarcity of Limburg flint types, such as Lousberg, Valkenburg, and Rijckholt flint, at VLC settlements (Louwe Kooijmans, 1983; Verhart, 2010b). These flint types are ubiquitous on Stein sites and their absence at VLC sites is deemed to indicate that these groups were part of different social networks (Verhart, 2010b). Another difference seems to be the absence of axe and blade production at VLC sites, while these technologies are present in the Stein group (Van den Dikkenberg, 2024b). In terms of ceramics the groups seem to be virtually indistinguishable, only the absence of ceramic discs in the Stein group, as opposed to their (occasional) presence at VLC sites, is cited as a defining characteristic of the Stein group (Verhart, 2010b).

Because of the similarities between the VLC and Stein group it is difficult to assess the nature of contacts between the two. For the FBC ceramic imports and imitations can be recognised based on typological analyses. In order to discuss these themes for VLC and Stein ceramics detailed petrographic and perhaps geochemical analysis would be necessary, and these are presently lacking. Research on the Stein group is further hampered by the fact that most sites consist of artefact clusters, often consisting of palimpsests with earlier and later material (Verhart, 2010b). Use-wear studies on Stein settlements are largely lacking. The lithics from the burial chamber in Stein were however analysed by Van Gijn. She demonstrated that both the flint axe and transverse arrowheads found in the megalithic monument were used prior to their deposition (Van Gijn, 2010a, pp. 137–138). Because use-wear studies on Stein settlement material are lacking, direct comparison of VLC and Stein lithics is currently impossible. Nonetheless, the absence of typical Limburg flints at VLC sites may indicate differences in social networks (Louwe Kooijmans, 1983; Verhart, 2010b), as Verhart and Louwe Kooijmans argued, noting that typical flints from Limburg (and thus the territory of the Stein group) are absent at VLC sites (Louwe Kooijmans, 1983; Verhart, 2010b). This is a theme which is discussed in later chapters.

2.3.2 Seine-Oise-Marne culture (3500-2700 BCE)

The Seine-Oise-Marne culture (SOM) is a Middle to Late Neolithic culture, largely contemporary with the VLC (Manning et al., 2014). The flint mines of Spiennes were at the time exploited by people of the SOM (Verheyleweghen, 1966). The presence of Spiennes flint at VLC sites such as Hekelingen III indicates contacts between VLC and SOM communities, though it remains unclear whether shared elements in material culture (e.g., collared flasks, transverse arrowheads) are due to direct contact or wider regional trends shared also with the FBC and Stein group (Louwe Kooijmans, 1983; Verhart, 1983; 2010b). Transverse arrowheads are in fact known from an incredibly wide geographic area, spanning from western Europe as far as the Indus Valley (Gadekar, 2025, see Fig. 2.12). Furthermore, it has been pointed out that the Stein group also appears to share many similarities with the SOM culture (Amkreutz, 2025).

2.3.3 Deûle-Escaut group (2900–2200 BCE)

A Late Neolithic group not previously discussed[7] in relation to the VLC is the Deûle-Escaut group. Recently, several sites attributed to this group have been discovered in western

7 Although the group was briefly mentioned by Verhart (2010).

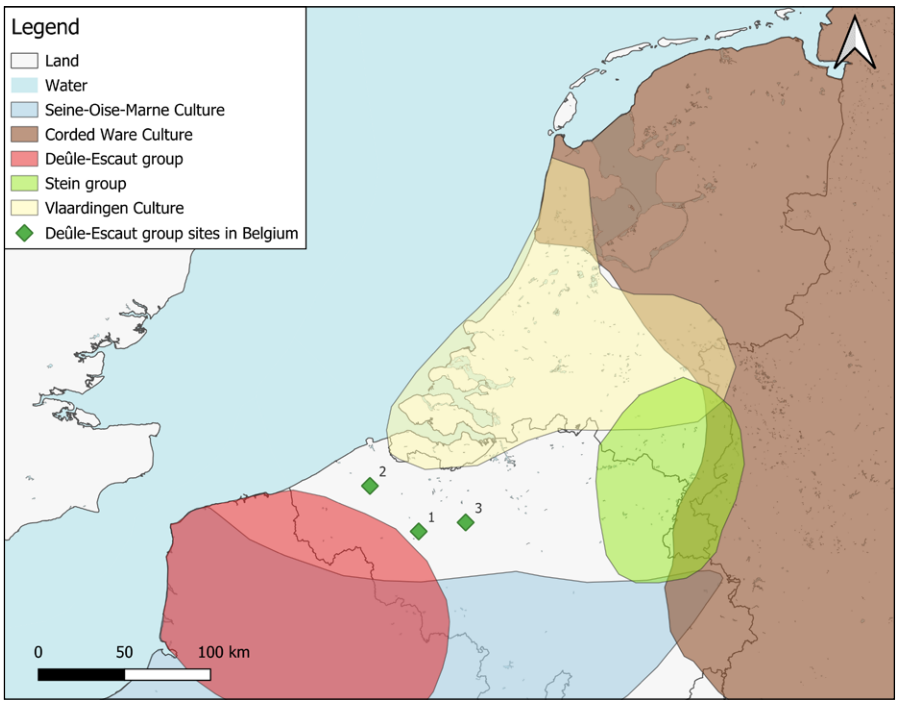


Figure 2.3 Map with Deûle-Escaut group sites in Belgium: 1) Aalst-Siesegemkouter; 2) Oudenaarde, Heurnestraat; 3) Waardamme Vijvers (Beugnier & Crombé, 2007; Hazen & Drenth, 2018; Louwe Kooijmans, 1983; Van Gijn & Bakker, 2005; Verbrugge et al., 2018; basemap: © EuroGeographics 2024).

Flanders (Beugnier & Crombé, 2007; Demeyere et al., 2004; Hazen & Drenth, 2018; Sergant et al., 2009; Verbrugge et al., 2018). The group is interesting because Cap Blanc Nez flint, known from many VLC sites, originates from the area inhabited by the Deûle-Escaut group (Houkes, 2021b; Houkes et al., 2017; Verhart, 1983). The distribution of the Deûle-Escaut group, as visualised in the Figure 2.3, suggests that the group is located more to the south. But many of the recent discoveries come from an area north of the traditionally assumed geographical area of the Deûle-Escaut group (Fig. 2.3). This suggests that the group might well extend all the way to the border of the VLC area. These Belgian sites have not previously been discussed in relation to the VLC. They are briefly introduced here to highlight features distinguishing the Deûle-Escaut group from neighbouring VLC sites.

In terms of house plans the Deûle-Escaut group is characterised by a different type of houses than the VLC. Houses at Oudenaarde are rectangular with wall ditches for posts, unlike VLC houses at Haamstede Brabers, which lack ditches, or Veldhoven-type houses, which are oval with a central post row (Hazen et al., 2018; Van Kampen, 2013; Verhart, 1992). Like the VLC assemblages the lithic assemblages of the Deûle-Escaut group are dominated by a flake technology (Drenth, 2018, p. 79; Parent et al., 1987; Sergant, 2010). Microdenticulates are considered a typical feature of lithic assemblages of the group (Beugnier & Crombé, 2007).

At Oudenaarde-De Donk, typical VLC material was found, suggesting that north-western Flanders functioned as an interaction zone between VLC and Deûle-Escaut communities (Parent et al., 1986/1987, p. 37). A detailed study of these interactions would be valuable but falls outside the scope of this study.

2.3.4 Funnel Beaker Culture (3400–2900/2750 BCE)

Regarding the FBC, it can be noted that connections seem to be scarce. The ceramic repertoire displays some shared types, such as the use of collared flasks and ceramic discs. Regarding the former, it can be noted that these occur regularly across a wide geographical area, spanning from the SOM to the FBC (Amkreutz, 2025; Van Regteren Altena et al., 1962c). Their presence can therefore not uncritically be equated with FBC influences. More convincing arguments for connections between these groups are provided by the occasional presence of typical FBC ceramics at VLC sites. For example, several decorated FBC sherds were found at Hellevoetsluis Ossenhoek and Den Haag Steynhof (Bloo, 2021; Van Hoof, 2009a). According to the recent study of Kroon the *chaînes opératoires* of FBC ceramics and those of the VLC become more similar over time. This is indicative of learning: it seems that FBC and VLC potters learned from each other (Kroon, 2024, p. 210). It is fascinating that these intensive interactions, evident from a ceramics perspective, are not mirrored in lithic studies. Typical rectangular FBC flint axes are completely absent at VLC sites. The rather complex technology required to produce such axes was not shared with VLC communities.

2.3.5 Corded Ware Culture (2900–2500 BCE)

Around 2900 BCE the FBC disappears from the eastern Netherlands to be replaced by the CWC (Fokkens, 2005b; Van Gijn & Bakker, 2005). DNA analysis initially suggested that this change was brought about by migrations from the east, through which steppe ancestry was introduced throughout Europe (Haak et al., 2015). A recent paper has called into question the chronological co-occurrence of the introduction of the CWC phenomenon with steppe ancestry. It now appears that steppe ancestry and CWC burial traditions were not introduced simultaneously (Bourgeois et al., 2025a). Regardless of debates surrounding the genetic signature of the CWC, from a material culture perspective it seems that interactions between CWC and VLC communities were more intensive than those with earlier FBC communities. CWC ceramics are frequently found at VLC sites (Bloo, 2017; Glasbergen et al., 1967a; Ufkes, 2020; Van Regteren Altena et al., 1962c). Occasionally, typical CWC battle axes are found at VLC settlements (Van Regteren Altena et al., 1962c). Typical CWC tanged arrowheads, absent from earlier VLC sites, were presumably introduced under the influence of the CWC (Drenth, 2016; Houkes, 2014; Houkes et al., 2017; Verhart, 1983). This introduction of tanged arrowheads during the later VLC phases is well documented by Verhart at Hekelingen III (Verhart, 1983, p. 26). An interesting enigma is provided by the cluster of CWC sites in West Frisia. The sites are traditionally assigned to the CWC, but detailed analyses of the ceramics and lithics on these sites revealed a high degree of similarity between VLC lithics and ceramics and those from these CWC sites (Beckerman, 2015; García-Díaz, 2017; Kroon et al., 2019). In a recent paper authors referred to this cluster as 'Vlaardingen-CWC' sites (Olalde et al., 2025). The authors demonstrated that individuals from this cluster had a major genetic local ancestry component. In addition, a minor genetic component consisted of 'steppe ancestry' (Olalde et al., 2025). Interestingly, the results of genetic and material culture studies at these sites align closely. A coherent picture emerges in which local (VLC) traditions persist while new people introduce new CWC elements.

2.4 Landscape and subsistence

Early on, it was recognised that VLC sites are highly varied in terms of subsistence strategies, flint procurement strategies, and settlement types (Raemaekers, 2003; Van Gijn, 1990a; 1990b; 2010b; Van Gijn & Bakker, 2005). Van Gijn's use-wear study of the Hekelingen III assemblage favoured an interpretation of the site as a temporarily occupied settlement, a view that has since been widely accepted (Louwe Kooijmans, 1993, p. 94; Raemaekers, 2003, p. 744; Van Gijn, 1990a; 1990b). In his seminal publication Raemaekers linked the occupation duration of VLC sites to their location in the landscape (Raemaekers, 2003). According to him VLC sites in the coastal dune area consisted of permanently inhabited sites, while those on the levees were interpreted as temporarily occupied sites. The former were clearly focused on the exploitation of domesticated animals and plants, while the latter focused on the exploitation of wild resources. These temporary settlements were inhabited by task forces coming either from the permanently inhabited sites in the coastal dune area, or from those on the cover-sand area of Noord-Brabant (Raemaekers, 2003, pp. 744–745). In the model, levee sites were presented as subordinate settlements exploited either by inhabitants of the coastal dune area or by those from the cover-sand area in Noord-Brabant. I, however, agree with Amkreutz that a subordinate position of these sites should not automatically be assumed (Amkreutz, 2013b, pp. 337–338). Debates about the duration of occupation at VLC sites largely centred on non-lithic arguments. Hence, the present study cannot independently resolve such issues. Nevertheless, in two of the criteria proposed by Amkreutz, for defining the occupation duration on Mesolithic and Neolithic sites, lithics provided an important contribution. Clear evidence for crop cultivation was regarded as an indicator mainly related to permanent occupation. Such evidence can include ard marks, cereal pollen, land clearings, and lastly flint sickles with wear traces related to cereal harvesting (Amkreutz, 2013b, pp. 371–375). The latter could potentially be found in this study, and will therefore provide an additional argument in these debates. Another argument proposed by Amkreutz was the range of lithic artefact types encountered on these sites. In permanently inhabited and seasonally occupied sites we expect the complete range of tool types to be present. In short-term camps we expect a limited range of tools, while in extractive camps we expect a specific toolkit to be present, related to the extractive activity taking place (Amkreutz, 2013b, p. 375). Amkreutz focused on tool types, but for VLC sites this perspective seems less fruitful considering toolkits often consist of ad hoc tools (Amkreutz, 2013b, p. 375; Van Gijn, 2010b). Therefore, it seems more fruitful to approach these aspects from a use-wear perspective, focusing on activities conducted with lithics rather than on artefact types. In line with the work by Van Gijn, I therefore focus on the use of lithics on different sites (Van Gijn, 1990a; 1990b; 2010b). As noted above, subsistence strategies form a key aspect in these debates. Although zooarchaeology and archaeobotany are not part of the present study they do provide important perspectives which need to be taken into account. A main overview on VLC subsistence strategies was published by Brinkkemper et al. (Brinkkemper et al., 2011). This overview forms the basis for the sections below, which mostly focus on new insights based on publications from the past fifteen years.

2.4.1 Domesticates during the VLC period

Subsistence strategies of the VLC entailed both animal husbandry and crop cultivation (Brinkkemper et al., 2011; Dusseldorp & Amkreutz, 2020; Louwe Kooijmans, 1987;

		Zandwerven	Voorburg Arentsburg	Vlaardingen Arij Koplaan	Veldhoven Habraken	Rijswijk Schaapsweg	Leidschendam Berberis	The Hazendonk (Vlaardingen 1b)	Hellevoetsluis Ossenhoek	Hekelingen III	Den Haag Wateringse Binnentuinen	Den Haag Steynhof	Barendrecht-Zuidpolder
Hordeum vulgare var. nudum	Naked barley	X	X	X	X	-	X	X	X	X	X	X	X
Triticum dicoccon	Emmer wheat	X	X	X	X	X	X	X	X	X	X	X	-
Triticum monococcum	Einkorn wheat	-	-	-	-	X	-	-	-	-	-	-	-
Triticum aestivum	Bread wheat	-	-	X	-	-	-	-	-	-	-	-	-
Triticum spec.	Wheat	-	-	X	-	-	-	X	-	-	-	-	-
Avena spec.	Oats*	-	-	X	-	-	-	-	-	-	-	-	-
Cerealia indet.	Cereals indet.	-	-	X	-	-	-	-	-	-	-	-	-
Linum usitatissimum	Linseed	-	X	-	X	-	X	-	-	X	-	-	-
Papaver somniferum ssp. setigerum	Opium poppy	-	-	X	-	-	-	-	-	-	-	-	-

Table 2.2 Domesticated plants on Vlaardingen sites, based on the overview study of Brinkkemper et al. X = present, - = absent (after Brinkkemper et al., 2011, p. 211; Fischer, 2020; Fischer & Kooistra, 2014; Kooistra, 2017; Kooistra et al., 2021; Kubiak-Martens & Oudemans, 2021; Kubiak-Martens et al., 2013).
*It is unclear whether these concern wild or cultivated oats, Brinkkemper et al. favour the interpretation that these likely concern wild oats, considering there is no evidence for the cultivation of oats before the Iron Age (2011, 211).

Raemaekers, 2003). Crop cultivation was geared towards the cultivation of emmer wheat (*Triticum dicoccon*) and naked barley (*Hordeum vulgare*). Other cereal species, like einkorn (*Triticum monococcum*) and bread wheat (*Triticum aestivum*), are scarce (Tab. 2.2). Crop cultivation in the Swifterbant period was similarly focused on the cultivation of emmer wheat and naked barley (Peeters et al., 2021, pp. 83–85). Linseed (*Linum usitatissimum*) was originally considered to be of scant importance, having only been found in Hekelingen III (Brinkkemper et al., 2011). However, recently linseed was found at Leidschendam Berberis, Voorburg Artensburg, and Veldhoven Habraken (Fischer, 2020; Fischer & Kooistra, 2014; Kubiak-Martens et al., 2013). This indicates that linseed might have been more common in the VLC period than was hitherto assumed. Linseed is well known from Early Neolithic LBK and Middle Neolithic Michelsberg culture sites in Limburg, but it is absent in Swifterbant and Hazendonk-3 sites in the Rhine-Meuse delta (Bakels & Zeiler, 2005). It thus seems that linseed was introduced in the delta during the VLC period.

During the VLC period the ard was introduced to the Rhine-Meuse delta. The oldest ard marks in the Netherlands came from FBC sites in the northern Netherlands (Bakels & Zeiler, 2005). Swifterbant period agricultural practices were characterised by hoe agriculture (Peeters et al., 2021). The use of the ard thus signified the introduction of a new kind of agriculture, potentially the introduction was related to contacts with FBC communities. Ard marks are known from Hellevoetsluis Ossenhoek, Leidschendam Berberis, Den Haag Rhyenhof, and Den Haag Wateringse Binnentuinen which indicates that cultivation took place locally at these sites (Lanzing & Siemons, 2014; Stokkel, 2017b; Van den Blink, 2020; Van Hoof, 2009b). The VLC and CWC settlements at Zandwerven and Velsen Hoogbroek also contain ard marks. It is however unclear whether these are related to the VLC or subsequent CWC habitation phases (Ten Anscher & Bosman, 2010; Van Iterson Scholten, 1988).

Domestic animals mostly consisted of cattle (*Bos taurus*) and pigs (*Sus scrofa*), with some sheep (*Ovis aries*) and goats (*Capra hircus*). But these latter two were not well adapted to the wetland environment, where they are more susceptible to diseases, which might explain the overall focus on cattle herding. Dogs (*Canis familiaris*) were also found frequently (Brinkkemper et al., 2011). To what extent animals were kept for secondary products is not well known. Some of the cows at VLC sites in the area of The Hague were slaughtered at a more advanced age, possibly signifying that they were used first for milk production or traction (Kooistra et al., 2024). The recent study, conducted as part of the *Putting Life into Late Neolithic houses* project, by O. Craig and his team in York indicated that milk was also consumed, especially at Den Haag Steynhof (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31). The aforementioned ard marks also suggest that animals were likely also kept for traction.

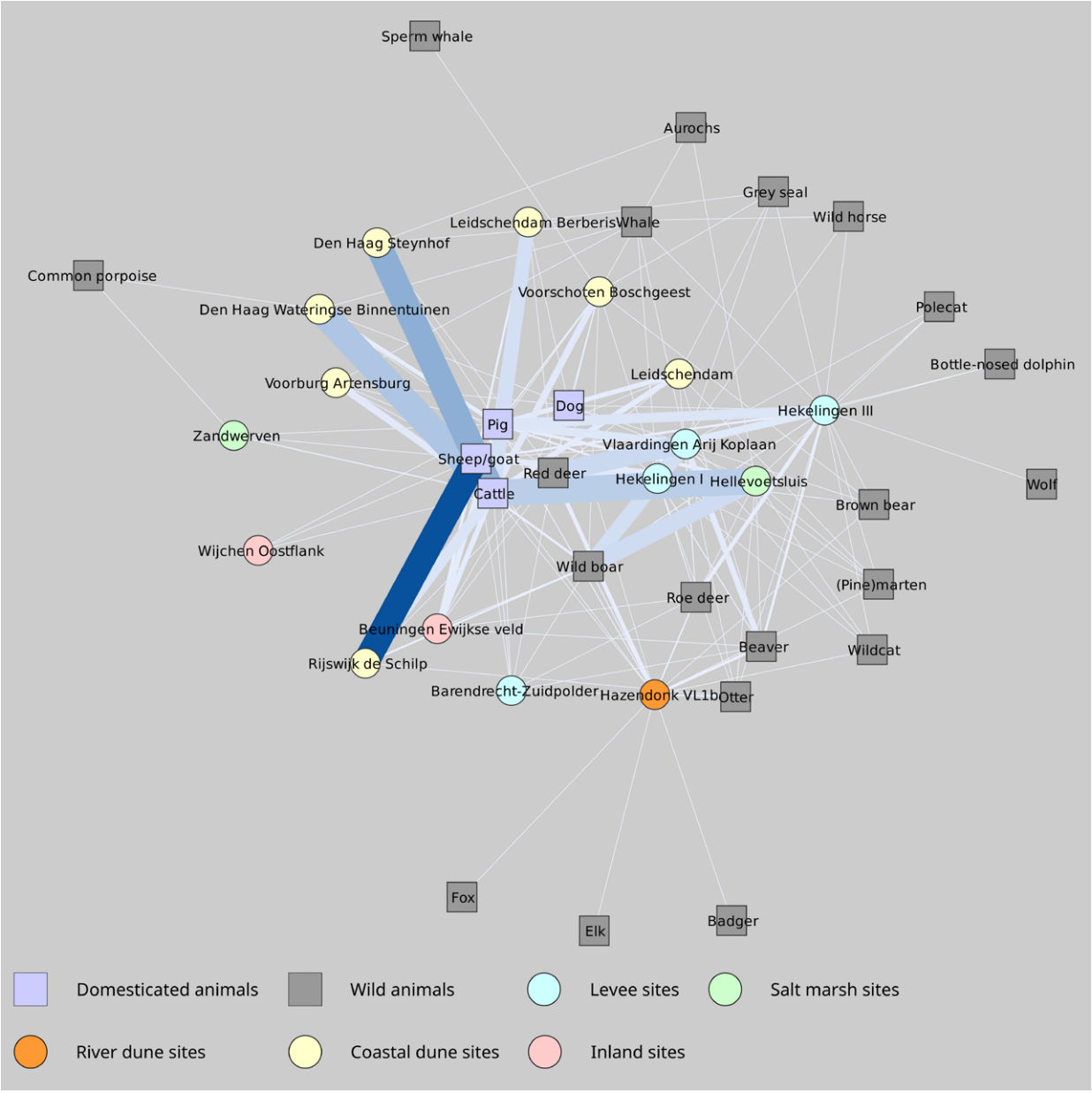


Figure 2.4 Network representation of animal species (squares), for VLC sites (circles), links are ranked by weight, visualised in stress minimisation layout (after Brinkkemper et al., 2011; Buitenhuis & Veldhuis, 2020; Van Dijk, 2021; Van Dijk et al., 2017; Van Haasteren, 2017; Zeiler, 2014).

2.4.2 Wild animals and plants

Hunting, fishing, fowling and wild plant gathering all played an important role in the subsistence strategies of the VLC. Yet, the nature and intensity of these strategies varied greatly across different landscape zones. On the levee sites and the river dune site of the Hazendonk bones from wild animals outnumber those from domesticated animals (Brinkkemper et al., 2011; Clason, 1967; Louwe Kooijmans, 1987; Prummel, 1987). There is a strong discrepancy in terms of animal species found in different environmental zones. In their 2011 study Brinkkemper et al. presented an overview of zooarchaeological data for VLC sites, in Figure 2.4 this overview is supplemented with recent studies and visualised in a network graph. It is clear that domesticated mammals occur both in the coastal dune area and on the levee sites, but they are far more abundant in the coastal dune area. Of the wild mammals red deer (*Cervus elaphus*) is the only species consistently present both in the coastal dune area as well as on the levee sites, although it is far more abundant on the latter. Red deer

was clearly important because it also supplied secondary products notably antler and metapodia (Maarleveld, 1985). Hunting of fur bearing animals is strongly associated with levee and river dune sites. These furs were clearly also important products gathered at these sites (Louwe Kooijmans, 1987; Prummel, 1987; Van Gijn, 1990b). The salt marsh site of Hellevoetsluis seems to plot with the levee sites, rather than the coastal dune sites in terms of animal species. This is surprising, because in the publication the site is grouped with the coastal dune sites (Van Dijk, 2009). Likewise evidence for fowling and fishing mostly comes from the levee sites and Hellevoetsluis Ossenhoek (Brinkkemper et al., 2011). It should however be noted that the relatively poor organic preservation on coastal dune sites play a part in this. When animal bones are heavily degraded a bias is formed towards the preservation of bones from larger animals, while fish and bird bones tend to be underrepresented.

Fishing practices were geared towards freshwater species. Occasionally, people fished in the estuaries and water surrounding the tidal flats. Fishing took place, according to Beerenhout, using spears, fish traps, dugouts and nets (2010). At Vlaardingen Arij Koplaan and Hekelingen III remains of fishing weirs were found in the riverbank (Beerenhout, 2010, p. 57; Brinkhuizen, 1983; Louwe Kooijmans, 1987, p. 248; Van Iterson Scholten, 1977, p. 140). Sturgeon was presumably caught during the mating season when the fish migrate in large numbers. Sturgeon was only available on a seasonal basis while most other fish could be caught year-round (Beerenhout, 2010, pp. 62–64).

Shellfish tends to be overlooked in discussions on VLC subsistence strategies. Yet, the site of Zandwerven can be considered to be a shell midden, especially mussels were abundantly present (Van Regteren Altena & Bakker, 1961). At VLC sites in the south shellfish is scarce (Kooistra et al., 2024; Van Dijk, 2021; Van Dijk et al., 2017). They contrast sharply with Zandwerven and contemporary CWC sites in West Frisia (Kooistra et al., 2024; Van Regteren Altena & Bakker, 1961; Zeiler & Brinkhuizen, 2013; Zeiler & Brinkhuizen, 2014). Shellfish consumption thus seems to be a micro-regional phenomenon, largely restricted to West Frisia.

Discussions on wild plants in the VLC are generally biased towards collected seeds and nuts (Brinkkemper et al., 2011). These tend to preserve better in the archaeological record than leaves, bulbs, and tubers (Van Amerongen, 2016, p. 219). Collected plants include nuts like hazelnut (*Corylus avellana*), hawthorn (*Crataegus monogyna*), wild apple (*Malus sylvestris*), and blackthorn (*Prunus spinosa*) (Brinkkemper et al., 2011; Kooistra, 2017; Kooistra et al., 2021). In addition to fruits and nuts plants with edible green parts are also frequently found at VLC sites. This concerns for example plants such as wild celery (*Apium graveolens*) and stinging nettle (*Urtica dioica*). Whether these were collected for consumption, or whether they occurred naturally, is generally unclear (Kooistra, 2009). The organic residue analysis by L. Kubiak-Martens as part of the *Putting Life into Late Neolithic houses* project furthermore demonstrated the importance of wild green plants on levee sites of the VLC. At Vlaardingen Arij Koplaan and Hekelingen III wild green plants, notably *Allium* plants were ubiquitous (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31). This study highlights that gathering was especially important on the levees, and that they were of lesser importance for the subsistence strategies employed on the coastal dune sites.

2.5 Flint in the Vlaardingen Culture

VLC flint is characterised by a degree of uniformity in terms of typological and technological aspects (Amkreutz, 2010). However, this superficial uniformity is negated by a diversity observed in the provenance and use of flint (Amkreutz, 2010; 2013b; Van Gijn, 1990b, 2010b). Therefore, to fully grasp the pluriformity of VLC flint a biographical approach is necessary. Below, the status quo of VLC flint research is summarised.

2.5.1 The origin of flint

It has long been recognised that different types of flint occurred on different VLC sites (Fig. 2.5). The flint of Zandwerven was for example, shown to be of a northern origin, while the flint from Hekelingen I mostly consisted of flint of a southern origin (Modderman, 1953; Van Regteren Altena et al., 1962b). The lithic assemblages from the coastal dune sites of Haamstede Brabers, Voorschoten de Donk and Leidschendam Prinsenhof mostly consisted of small rolled nodules (Van Gijn, 1990b, p. 134; Van Veen, 1989; Verhart, 1992). The notion that coastal dune sites are, as a group, characterised by a uniform use of low-quality flints has recently been nuanced. Research by Houkes on VLC sites in the region of The Hague demonstrated that high-quality Hesbaye flint formed a major component in these assemblages (Houkes, 2021b, 2024; Houkes et al., 2017). His analyses of axe fragments at these sites led to the hypothesis that access to high-quality flint on the coastal dunes was not equally distributed. Communities on the southern part of the coastal dune area, close to the river Meuse, were well connected, while those further north along the dunes generally relied on low-quality flints such as Meuse-eggs (Houkes, 2024).

For some flint types it is difficult to exactly assess their origin. For Cap Blanc Nez flint it is unclear whether it is derived directly from the cliffs of Cap Blanc Nez, or whether this type of flint was transported north by the sea, and was subsequently collected in Zeelandic Flanders. For flint types like Meuse-eggs it is also unclear how far westward these have been transported by the rivers. For the source

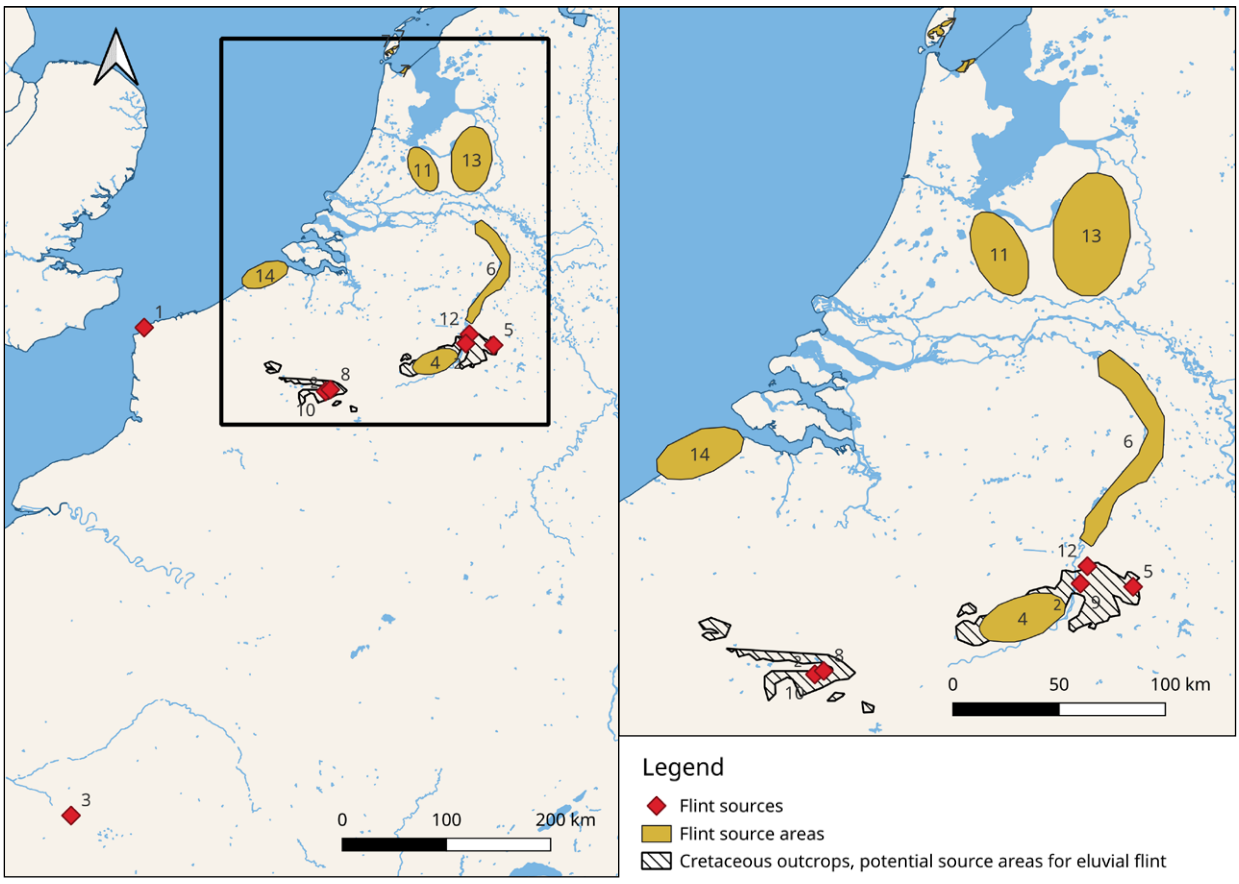


Figure 2.5 Flint sources and source areas mentioned in the book: 1) Cap Blanc Nez; 2) eluvial flint, potential outcrops; 3) Grand-Pressigny; 4) Hesbaye; 5) Lousberg; 6) Meuse terraces; 7) moraines; 8) Obourg; 9) Rijckholt; 10) Spiennes; 11) Utrechtse Heuvelrug; 12) Valkenburg; 13) Veluwe; 14) Zeelandic Flanders (after Di Modica & Pirson, 2016; Lahaye et al., 2022; Van Gijn et al., 2006; Vos et al., 2020; basemap: © EuroGeographics 2024).

locations for Meuse-eggs, terrace flint, Cap Blanc Nez flint, and Hesbaye flint the maps in this book will be based on those originally provided in the Schipluiden publication (Van Gijn et al., 2006, p. 132). For the flint mines the source areas are easier to pinpoint to specific geographic locations.

Although the pluriform use of sources at VLC sites has been fairly well documented in previous studies, several questions regarding these sourcing studies remain (Amkreutz, 2010; 2013b; Van Gijn, 2010b; Verhart, 1983). It was recognised that flint was imported from far away, also from flint mining areas in Belgium and Limburg (Amkreutz, 2013b; Van Gijn, 2010b). But what exactly did people import? Did people mostly import ready-made flint axes and chisels? Or did they also import flint nodules? And how does this differ from source to source? It is also unclear whether these imports signify direct exchange, or whether we should envision them as being imported through a system of down-the-line exchange. It also remains unclear to what extent the procurement of flint is embedded in taskscapes involving other activities. A recent analysis of flint from West Frisian CWC settlements suggests that flint procurement was embedded in other subsistence activities (García-Díaz, 2017, p. 272). The detailed study of raw materials from VLC sites in this book aims to shed light on these questions.

2.5.2 Lithic technology and skill

Despite the spatial/temporal discontinuity between the Hazendonk-3 group mentioned in section 2.2.1, there is a high degree of continuity in terms of lithic technology and typology there between the Hazendonk-3 group and VLC. The Hazendonk-3 flint technology is generally characterised by a simple ad hoc flaking technology (Raemaekers, 2005; Van Gijn et al., 2006). Macrolithic blades are present, but these invariably consist of ready-made imports from flint mining areas in Limburg and Belgium (Raemaekers, 2005). The predominant use of hard hammer percussion and the use of bipolar percussion to split small pebbles are characteristic both for the Hazendonk-3 and VLC phases (Raemaekers, 2005; Van Gijn, 2010b; Van Gijn et al., 2006).

Nr.	Site	Number of artefacts studied	Literature
1	Barendrecht Zuidpolder	4	Moree et al., 2011
2	Cuijk de Nielt	11	Verbaas, 2017
3	Den Haag Steynhof	66	Carter, 2021; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024; Van Gijn, 2021
4	Den Haag Wateringse Binnentuinen	103	Houkes et al., 2017; Mullaart, 2016
5	The Hazendonk VL 1a & 1b	54	Bienenfeld, 1986
6	Hazerswoude-Rijndijk	15	Verbaas, 2010
7	Hekelingen III	337	Van Gijn, 1990
8	Hellevoetsluis Ossenhoek	81	Metaxas, 2009; Metaxas, 2010
9	Leidschendam Prinsenhof	73	Van Gijn, 1984; 1990; Vernon, 2018
10	Rijswijk Schaapsweg	8	Van Gijn & Nieuwenhuis, 2002
11	Veldhoven Habraken	55	Van Gijn & Siebelink, 2013
12	Vlaardingen Arij Koplaan	68	Van Gijn, 1984; Vernon, 2018
13	Voorburg Artensburg	32	Houkes & Verbaas, 2014
14	Voorschoten Boschgeest	36	Van Gijn, 1984; Vernon, 2018
15	Voorschoten De Donk	11	Van Veen, 1989
16	Wijchen Oostflank	24	Houkes & Drenth, 2017

Table 2.3 Use-wear analysis conducted at VLC sites prior to the present study.

Although the reuse and recycling of flint axes is well known from Hazendonk-3 sites, this practice became much more prominent during the VLC period (Raemaekers, 2005; Van Gijn, 2010a).

Although general observations have been made about the technological system, aspects such as the use of different percussion types, flake terminations, or the importance of recycled flint axes have not been systematically analysed. These aspects are important because they inform us about technological traditions, and communities of practice (see chapter 3). For this reason, these aspects are analysed in the present study. In addition to the sites examined, data from previous studies is systematically gathered to provide additional context. Lastly, production/finishing traces have never been systematically analysed for VLC sites. For the sites under study these are analysed to provide additional insights into the production sequence for flint axes (Van den Dikkenberg, 2024a). This informs us about shared technological practices, not only on VLC sites but also of communities near the flint mines in the southern Netherlands and Belgium.

2.5.3 Using flint during the Vlaardingen Culture period

On sixteen VLC sites use-wear analyses have been conducted (Tab. 2.3). In fact, some of the earliest use-wear studies in the Netherlands were done on VLC assemblages (Bienenfeld, 1986; Van Gijn, 1984). The most significant study was conducted by Van Gijn on the assemblages of Hekelingen III and Leidschendam Prinsenhof (Van Gijn, 1990b). The study was important because it made a key contribution to the debates about the occupation duration at VLC sites, notably at Hekelingen III (Raemaekers, 2003; Van Gijn, 1990a; 1990b). For two VLC sites the use-wear analyses were unsuccessful because the artefacts were too heavily affected by post-depositional traces (Houkes & Drenth, 2017; Van Veen, 1989, p. 36). A number of studies were conducted by archaeology students at Leiden University as part of their thesis projects (Carter, 2021; Metaxas, 2010; Mullaart, 2016; Petrogiannaki, 2022; Vernon, 2018). Occasionally, students carried out these studies in collaboration with commercial projects (Houkes et al., 2017; Metaxas, 2009, 2010; Mullaart, 2016). Most of the analyses were conducted as part of commercial excavations (Houkes & Drenth, 2017; Houkes & Verbaas, 2014; Houkes et al., 2017; Metaxas, 2009; Moree et al., 2011; Van Gijn, 2021a; Van Gijn & Nieuwenhuis, 2002; Van Gijn & Siebelink, 2013; Verbaas, 2010, 2017). Some of these studies were merely pilot studies, exploring the potential of the assemblages for further analysis (Van Gijn & Nieuwenhuis, 2002; Van Veen, 1989). Other studies were directed at specific research questions, focusing on for example the repair of pots, hide working in the VLC, hafting of scrapers, or the harvesting of cereals at VLC sites (Carter, 2021; Houkes & Verbaas, 2014; Houkes et al., 2017; Mullaart, 2016; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024; Van Gijn, 2021a; Vernon, 2018). Because in these cases artefacts are selected based on specific criteria, the assemblages are not intercomparable. For example, in the studies focusing on hide working only

scrapers were selected (Mullaart, 2016; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024). Similarly, for the studies on pottery repairs only borers were selected (Carter, 2021; Van Gijn, 2021a).

In order to apply use-wear analysis for broader interpretations on site function, broad selections, including both formal and informal tool types, are required (Van Gijn, 1990b). In addition to the seminal study by Van Gijn on Hekelingen III and Leidschendam Prinsenhof we can point to the studies of the materials from the Hazendonk, Hellevoetsluis Ossenhoek, and Veldhoven Habraken (Bienenfeld, 1986; Metaxas, 2009, 2010; Van Gijn & Siebelink, 2013). In the present study a similar broad selection is made to understand the variation at VLC sites. Lastly, as is discussed more extensively in chapter 3 and chapter 11, use-wear analysis can also be combined with provenance studies. This can provide insights into how imported flints were incorporated into the local technological system. This is a theme previously explored by Van Gijn for the Late Mesolithic, Swifterbant, and Hazendonk-3 group, but which has so far not been investigated for the VLC (Van Gijn, 2009b, 2015).

3

Object biographies and communities

This study employs several theoretical concepts which guide the interpretations of the data in the discussions presented in chapters 11–13. The main concept which forms a red thread running through the study is that of object biographies which is discussed in the following section.

3.1 A biographical approach

The study of object biographies and the study of *chaîne opératoires* are in many ways similar. Hence this section briefly discusses both approaches, notably to highlight the differences, and to argue why in this thesis the term object biography is favoured over the use of the *chaîne opératoire* approach.

3.1.1 *Chaîne opératoire*

A *chaîne opératoire* approach focuses on operational sequences. A *chaîne opératoire* consists of three elements; the objects involved, the steps or sequences of gestures, and lastly the specific knowledge and practical skills (Hodder, 2012, p. 53; Pélegrin et al., 1988, pp. 57–58). In essence a *chaîne opératoire* is a succession of choices and decisions that leads to a sequence of production stages and corresponding techniques and products. Through the reconstruction of *chaîne opératoires* scholars seek to reconstruct the organisation of a technological system (Sellet, 1993, p. 106). It involves a search for standardised products and the repeated sequences which led to the production of these products (Pélegrin, 1990, p. 117). This repetition of behaviour can be used to define communities of practice, who reproduce technologies as part of a social system (Roux, 2016).

3.1.2 Object biographies

The notion of object biographies was first introduced in 1929 by Sergei Tret'iakov (Fontijn, 2013; Tret'iakov, 2006). He developed the concept as a literary method for narrative construction, intended as a means to combat idealism in novels (2006). Tret'iakov describes the compositional structure of this "*biography of the object*" as "*a conveyor belt along which a unit of raw material is moved and transformed into a useful product through human effort*" (Tret'iakov, 2006, p. 61). While his approach was strictly focused on literature, it relied on the same metaphor that draws a parallel between the birth and transformation of people and of objects. Despite this early use of the term by Tret'iakov, the concept was not adopted in archaeological and anthropological theory until the seminal 1986 publication by Kopytoff (Fontijn, 2013; Kopytoff, 1986).

Kopytoff applies the concept of object biographies to envision the life histories of objects in the same way as we construct human biographies (Kopytoff, 1986). An object is born (created), it lives (its use-life), it is cared for (curation and repair) and eventually it dies (the object is discarded or destroyed) (Van Gijn, 2010a). Investigating these steps is not unique to a biographical approach. Questions relating to the origin or the production of objects

have always been part of archaeological practices. What is unique about a biographical approach is however that it allows us to tie these different approaches into a holistic framework. A biographer does not merely provide lists of places where people were born. A biographer studies relationships between dispersed events in a lifecycle. It is well known that events in someone's youth can have profound effects later in life. Even the place where someone is born has far-reaching consequences. Similarly, an object biographer seeks to study the relationships between the results of provenance studies, technological studies, and use-wear studies. This allows us to ask questions such as; were objects made of exotic raw materials treated differently from objects made of locally sourced materials (Van Gijn, 2008, 2015)?

3.1.3 Object biographies or itineraries

The notion of object biographies has also been criticised. Hahn and Weiss note that it is often difficult to pinpoint specific steps such as the 'birth' or 'death' of an object (Hahn & Weiss, 2013). Does an object die when it is discarded? This is problematic, as biographical approaches can also address the life of objects after excavation, once they enter museum collections (Norton, 2016). To overcome such perceived issues, Hahn and Weiss introduce the notion of *itineraries*. According to them, the concept highlights the non-linear character of object mobility. An itinerary does not only incorporate movement through time and space; it also foregrounds moments of inertia (Hahn & Weiss, 2013). The notion of a biography is thus replaced with that of a journey. The object, in this metaphor, is referred to as the *itinerant*. These itinerants move, often not by choice, through an itinerary (Hahn & Weiss, 2013). While the term addresses some of the shortcomings of a biographical approach, it still fails to encompass the complexity of the material record. Unlike itinerants or humans, objects can split and merge infinitely. Flint objects, for example, begin their itinerary or biography as nodules. Once knapped, a single object (the nodule) becomes dozens of objects. Later, these pieces can be merged again, as when multiple flint inserts are set into a composite tool. In such cases the flint also merges with other materials, which themselves have itineraries or biographies before becoming part of a new object. This complexity is amplified with materials such as glass or metal, which can be melted down. This complex nature of the material record is perhaps best captured by the notion of *entanglements* (Hodder, 2012). If we are to find a suitable metaphor, it would likely be an ecosystem: one that continuously changes form while moving across time and space. Realistically, objects have neither a definitive birth nor death, as they constantly transform.

Nevertheless, while it is important to acknowledge this complexity, I argue that a biographical approach is suitable for the questions I address here. Although flint ultimately derives from organic matter formed in the Cretaceous period, my interest lies in the part of its itinerary in which it was handled during the Neolithic. A biographical approach is therefore well suited. The 'birth' of flint objects occurs when the material is sourced (picked up, mined, or otherwise acquired). While the objects continue to exist beyond that point, they 'die' when they are abandoned. Of course, they are effectively reborn when excavated, and the present study also forms part of their biography. For the purposes of this study, however, my focus lies on the trajectory between sourcing and abandonment.

3.1.4 Specific and generalised biographies

Gosden and Marshall make a distinction between 'specific' and 'generalised' biographies (Gosden & Marshall, 1999, pp. 171–172). An example of a generalised biography is that guitars are built, played, their strings occasionally replaced, and eventually they die, because they become too damaged for repair. This biography holds true for most guitars, and it is therefore a generalised biography for guitars. A specific biography for a guitar might be that the guitar is being bought and played by a famous musician. When the musician dies the guitar might end up at an auction where it will be sold for a large sum of money to a private collector. There it will be a cherished display object for many years. Eventually, the collector might then donate the guitar to a museum where it ends up in a collection, perhaps even being restored and put on public display (Fontijn, 2002, p. 26). This biography is specific for the individual guitar, and it cannot be used to generally describe what happens to guitars.

3.1.5 *Chaîne opératoires* or biographies

A *chaîne opératoire* approach by definition entails a quest in search of generalised biographies. In a *chaîne opératoire* waste is seen as a byproduct of a production process (Soressi & Geneste, 2011, p. 337). In a biographical approach waste fragments have their own individual biographies. The technological system of the VLC is characterised by ad hoc technologies. Simple unmodified flakes and waste fragments, which are often seen as a byproduct of a *chaîne opératoire,* are used for a wide variety of tasks (Van Gijn, 2010a, p. 90; 2010b, p. 85). A biographical perspective would consider these as objects in their own right, rather than as byproducts. A *chaîne opératoire* emerges as a cognitive project which is eventually concretised into a series of actions (Tafelmaier et al., 2022, p. 28). A biography is not merely shaped as a cognitive project. Human life, and by extension the material record we leave behind, is littered with mistakes, errors, and failure. Humans deal with these errors, they repair, recycle, and discard objects. A large portion of the flint at VLC settlements consists of recycled flint axe fragments (Van den Dikkenberg et al., 2024a). These are all part of axes which were initially shaped into

a ground and polished axe, intended to be used. Yet, at some point in their biography these axes broke. If a *chaîne opératoire* is seen as a series of choices which led to actions, the breakage of these axes cannot reasonably be seen as part of a *chaîne opératoire* (Pélegrin, 1990). Nevertheless, this breakage is something that happened frequently, and which in turn provided new opportunities, as the broken axes could be recycled and turned into different kinds of objects. Accidents and mistakes are thus essential aspects which shaped the material record we study. Therefore, although a *chaîne opératoire* has its merits, the present study focuses on a biographical approach as it accounts for a wider range of human-object interactions, and because it places mistakes and errors on equal footing with intentional choices.

3.1.6 From artefact biographies to populations

In the present study the aim is to reconstruct individual biographies, to investigate differences and similarities in craft and subsistence strategies on different sites. Following Hägerstrand, we can envision artefact assemblages as populations (Hägerstrand 1974b, 272–5 in: Carlstein, 1982, p. 8). Individual objects have biographies which mirror human biographies (Kopytoff, 1986). Artefact assemblages similarly display dynamics observed in human populations. Artefact assemblages also have a plurality of backgrounds and origins. It is difficult to link individual artefact biographies to individual human biographies. Even when objects are buried with a deceased person, we should be cautious about linking them directly to the identity of the deceased, as burials are constructed by the living community and often express communal ideals (Fowler, 2013). It is more fruitful to link human populations to artefact populations. Settlements are inhabited by a specific human population, the artefacts produced and used by these people are concentrated in and around these settlement zones.

Conceiving artefact assemblages as populations bridges the gap between 'individual' and 'generalised' (Gosden & Marshall, 1999, pp. 171–172). In a generalised biography the specifics of individual biographies are neglected in favour of a generalised, perhaps idealised, biography. Within the notion of artefact populations there is room for diversity and deviating individual trajectories. Furthermore, many of the questions we ask for human or animal populations can also be asked for artefact populations. Conceptualising assemblages as populations provides us with meaningful proxies to make inferences about the human populations who produced and used these objects. Collectively, as a population, these artefacts inform us about specific human populations. For the four case studies in this thesis a broad and representative assemblage of artefacts is selected. Use-wear analysis on these artefact populations thus provides us with information about craft activities and subsistence strategies employed by different groups/populations.

Humans and objects are indivisible, they can only be at one place at a time (Hägerstrand, 1970, p. 21). Human time can be envisioned as a finite resource which is allocated. If people spend time on hunting and fishing, they will have less time for farming, and vice versa. Use-wear analysis may provide a proxy for time allocation, indicated by the degree of wear of tools used for different activities. Unfortunately, there are severe constraints to such an approach. First, it is impossible to match degrees of wear to allocated time. Secondly, many past activities do not require the use of formal tools. The house construction project in Masamuda can serve as an example (personal communication A.L. van Gijn and D. Pomstra, 2023). In the construction of the house, it was noted that a lot of the time devoted to house construction did not involve any tools. Furthermore, many of the tools which were used were wooden tools which are generally not preserved in the archaeological record (Van Gijn & Pomstra, 2016). It is thus useless to attempt to comprehensively reconstruct past time allocations based on flint tools, or even based on all preserved tools on a site.

Despite this, understanding tool use as time allocation is interesting if we envision artefact assemblages as populations. We can employ use-wear analysis to understand the relative time allocation within an artefact population, and by extension a human population. We can observe whether groups spend relatively more time on hide working or on bone working. We can study whether people spend time maintaining long-distance exchange networks, or whether they perhaps gathered resources locally. Such observations in turn relate to the discussion of communities of practice, a concept that is introduced in section 3.5.

3.2 Direct procurement or down-the-line exchange

People can go to sources directly to procure raw materials, or they can acquire materials and objects through exchange. Regarding the latter, different modes of exchange have been defined, most importantly for this study direct exchange and down-the-line exchange. In the latter model the exchange of a commodity takes place between neighbouring villages or communities. Villages close to a source import large quantities of a specific commodity. Of this they only consume a part and they pass on a given portion to their neighbours, who then repeat this pattern. In the down-the-line exchange model a commodity is found abundantly near the source where there is direct contact between the producers of the commodity and those who import it. Beyond this the quantity of a commodity rapidly and exponentially decreases because the amount of commodities which can be passed on decreases every

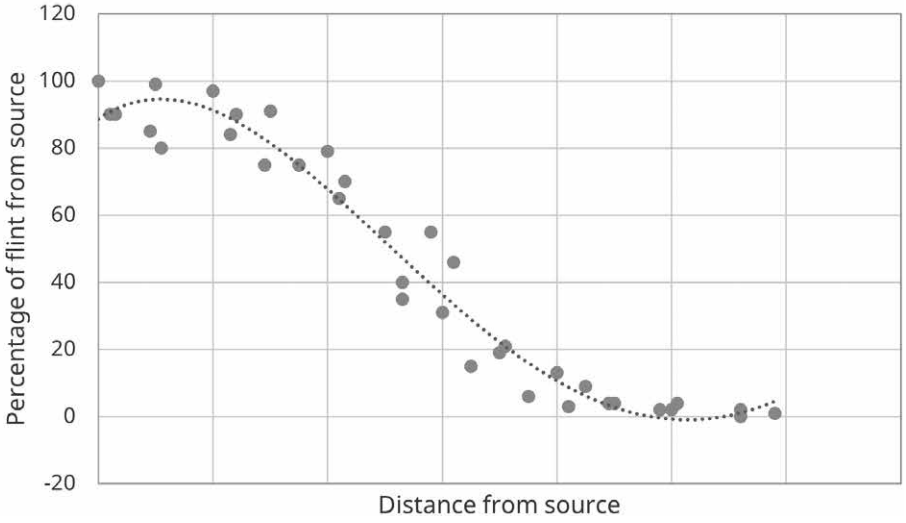


Figure 3.1 Hypothetical scatter-plot with trendline for the distribution of flint from a particular source for a down-the-line exchange model.

step of the way (Renfrew, 2011, pp. 465–466). The down-the-line exchange model has been applied to explain the exchange of Rijckholt flint during the early Neolithic (De Grooth, 2015, p. 35). This system has also been proposed for the procurement of Spiennes, Rijckholt and Hesbaye flint in the VLC (Amkreutz, 2013b, p. 343).

When direct exchange takes place people import directly from the source. Therefore the distance to the source does not necessarily impact the availability of a commodity. If a community directly imported commodities from the source the commodity can be very abundant even if the site is located far from the source (Renfrew, 2011, p. 470). If the abundance of a certain commodity is plotted against the distance we could observe the presence of a down-the-line exchange system because the abundance rapidly decreases with distance from a source (Fig. 3.1).

An alternative explanation could be that mobility of groups dispersed flint. For Hekelingen III and Vlaardingen it had been suggested that these groups came from the sandy uplands in Brabant (Van Gijn, 2010a, p. 57). A last explanation could be that flint was directly procured from these sources, either through exchange or because people went there to obtain flint by themselves. Down-the-line exchange and direct procurement do not necessarily need to be mutually exclusive. For the LBK period in the Danube area it has been suggested that a mix of both modes existed. In addition to indirect procurement it was also observed that certain 'settlements of users' themselves served as redistribution centres for the distribution of mined flint (Lech, 1997, p. 628). Similarly Ibáñez et al. observed that obsidian exchange in the Near East did not directly fit with a simple down-the-line exchange model. They suggested that the distribution of obsidian was likely the result of a complex exchange network which involved both interconnected local clusters as well as localities which are connected to more distant groups (Ibáñez et al., 2016b).

3.3 Cultural appropriation of material culture

As noted above, objects can be imported from other regions. What is significant about the adaptation of these objects is not the fact that they are adopted, but the way in which they are redefined and put to use (Kopytoff, 1986, p. 67). Studies on sourcing are therefore inherently entangled with studies of use and the recontextualisation of objects, which highlights the necessity of the biographical approach adopted in this thesis (Van Gijn, 2008, 2015). This redefining of objects in new (from the perspective of the object) cultural contexts can be referred to as appropriation (Hahn, 2004). Cultural appropriation as a theoretical concept is often applied to (post)colonial contexts. It involves both the appropriation of objects as well as the appropriation of ideas (Cuthbert, 1998). Simply put the concept can be defined as "*the taking of cultural products, ideas or inventions from others and calling them one's own*" (Ra'ad, 2010, p. 124).

A problem with the above mentioned political, post-colonial, definition is that it essentially involves notions about intellectual ownership claims, which cannot be reconstructed for prehistoric societies. An interesting case in this respect involves the Grand-Pressigny flint daggers which were imported to CWC areas in the Netherlands during the Late Neolithic. These daggers were produced in France and they were transported to the Netherlands where they were redefined and incorporated in the local cosmological system. In France and Switzerland these daggers were used as harvesting tools, as revealed by use-wear analysis (Beugnier & Plisson, 2004). In the Netherlands these daggers bear traces resulting from movement of the objects in sheaths made from plant material. Rather than being functional harvesting tools, these objects were thus redefined, being used for display instead (Van Gijn, 2010a, pp. 145–148). We thus observe a redefining of meaning and value, but that does not necessarily reflect claims of intellectual ownership. Rather it seems to be the case that

these objects were recognised as 'foreign' non-local objects, rather than as daily-life tools. In the case of these daggers, but also in the case of the incorporation of non-local flint in VLC settlements, we are less concerned with the potential political background involving intellectual ownership claims. It is more interesting to consider whether these objects are redefined and put to use in a new context (Kopytoff, 1986, p. 67). Therefore, in this thesis cultural appropriation is not approached from the perspective of (intellectual) ownership claims. Rather, the perspective proposed by Hahn is applied, who uses the concept of appropriation as a tool "*to explain the local roles of global goods*" (Hahn, 2004, p. 219).

The broader definition of cultural appropriation as provided by Hahn is more suitable for archaeological contexts, as it emphasises objects and their roles instead of their political context (Hahn, 2004). His approach is centred on capitalist economies and personal ownership. Rather than problematising this capitalist focus on personal ownership it suffices to state that I will view the notion of 'personal possessions' as one of the possibilities. Through appropriation objects indeed can become personal possessions, but they can equally become communal possessions. Either way I assume that the same dynamics take place in the appropriation of these objects. Similarly, the capitalist perspective in which according to Hahn "*the commodity has a certain price*" can be substituted with a notion that "*commodities have a certain value*", rather than a 'price' (Hahn, 2004, p. 220).

Hahn distinguishes four phases in the appropriation of objects: 1) material appropriation, 2) objectification, 3) incorporation, and lastly 4) transformation. The first step refers to how objects become 'personal' possessions, or in our case personal or communal possessions (Hahn, 2004, p. 220). In the second step the objects are classified as belonging to one of the categories of known objects in a household. This step of classification also entails the naming of objects. The incorporation step involves the ability to use things 'correctly' (Hahn, 2004, p. 220). It is thus in this step that a 'use-value', in the Marxist sense, is attributed to these objects (Marx, 1999). The final step, transformation, results from the former. Now objects are transformed into autonomous goods, which are integrated into the local context, into a part of the individual or collective possessions. The object is now only to a limited extent still seen as something foreign from the local perspective (Hahn, 2004, p. 222). It is noteworthy that this step seems to be an automatic consequence of the previous step. If objects are thus 'correctly' used they are to a lesser extent regarded as foreign objects. It is interesting that Hahn sees these steps as phases through which all objects pass upon entering a new cultural context (Hahn, 2004, p. 220). This is debatable, as objects can also be stuck indefinitely in one of these steps. For example people can also come into contact with objects which cannot be classified as belonging to one of the known categories of objects in a household. Or objects may never be incorporated. This is for example often seen with souvenirs taken during travels. Objects like oil lamps for example frequently enter western households as souvenirs. The objects go through the phase of material appropriation because they now become individual possessions. They are also classified in the sense that they are recognised as being lamps, and as such they are named 'oil lamp'. Yet, they do not progress to the phase of objectification as they are not being put to use. They are never truly regarded as lamps, despite their naming and functional recognition. Hereby they maintain a special status as 'pieces of places', as artefacts also carry associations with the places from which they originate (Bradley, 2000, pp. 81–86). It should be noted that for prehistoric, illiterate, societies we cannot truly identify the second step involving classification independently from the third step of objectification. Unless people correctly use objects in a new context we cannot know whether they were classified correctly. For consistency I use the four phases defined by Hahn, but it is worth noting that the second step is thus only assumed to have taken place if the third step can be demonstrated.

3.4 Taskscapes

To contextualise the networks in which lithics circulate I apply the concept of 'taskscapes'. While it was initially envisioned that the raw material study could be an independent topic, it was gradually understood that raw material procurement strategies were intertwined with other activities. This pertains notably to the procurement of other types of stone. It was also realised that the specific Vlaardingen Culture procurement strategies had a strong social dimension (see section 11.5.2). While concepts such as 'embedded procurement' might account for the procurement of other resources, the social dimension behind these activities is not considered in such a framework (Binford, 1979, p. 259). In order to account for this social dimension, I incorporated the concept of taskscapes.

Ingold defines a taskscape as a 'pattern of dwelling activities' (1993, p. 153). Taskscapes do not only encompass housebound activities, they also include journeys and social activities (Ingold, 1993, pp. 159–167). The study of lithic raw materials allows us to reconstruct journeys travelled by objects. Objects move from places of origin to destinations. With the exception of pigeon post and unmanned drones they are generally accompanied by human carriers along their routes. In the case of a down-the-line exchange system these journeys can involve multiple human carriers. In direct procurement strategies they generally involve single humans or human groups. Using the concept of taskscapes we can envision these journeys not as singular activities, being limited to the transport of raw materials. Taskscapes are inherently social in nature, they thus also involve

Figure 3.2 Components of a social theory of learning, the archaeological record is added to demonstrate how the study of material culture can inform us about past learning and how this can serve as a proxy for studying other aspects of past life such as community and identity (after Wenger, 1999, p. 5).

human interactions (Ingold, 1993, p. 159). The visiting of flint sources in order to acquire raw materials likewise has a social dimension (Edmonds, 1997). On their journeys people meet other people. For Neolithic flint axes we see that people import those axes as finished products (Bakker, 2006). The transport of axes, as reconstructed through raw material studies, thus inherently entails a social dimension, as well as the exchange of objects (Bradley & Edmonds, 1993). As Binford observed in Nunamiut societies, raw material procurement can also be embedded in subsistence tasks (Binford, 1979, p. 259). In the case of VLC raw material procurement strategies this seems rather unlikely as the ranges from which raw materials were procured far exceeded the expected ranges in which subsistence activities took place. Nevertheless, this is not to say that raw material procurement cannot be embedded in other kinds of activities. For CWC settlements in Noord-Holland it was observed that non-flint stone and flint raw materials were derived from the same Pleistocene deposits in Wieringen and Texel (García-Díaz, 2017, p. 209). Clearly, the procurement of flint and non-flint stone was embedded in the same taskscape. Taskscapes are inherently tied to affordances (Gibson, 1977). In the above example flint and non-flint stone procurement is embedded in a single taskscape because the deposits of Wieringen and Texel accommodate both activities. Taskscapes are thus shaped by human social interactions, human-object interactions, and lastly by the affordances of the landscape. Applying this concept thus allows us to connect journeys, tasks, and landscapes in a holistic framework.

3.5 Communities of practice

Material culture provides insights into the communities that produced, and used, objects. The acquisition of raw materials, the production of artefacts and the proper use of tools require specific kinds of knowledge. Through learning this knowledge is shared within communities of practice (Wenger, 1999, pp. 6–7). Material culture can be studied as a proxy for reconstructing communities of practice. This can in turn inform us about important aspects of past life such as community and identity (Fig. 3.2).

Communities of practice are shaped and defined by their day-to-day actions. These actions are related to artefact production and use. As argued by Knappett, material culture should not be seen as a mere by-product. Material culture plays an active role in shaping these communities of practice (Knappett, 2011). They are defined by a 'regime of competence', a set of shared criteria and expectations by which membership is recognised. Members should be able, and are allowed, to engage productively with other members of the community. It entails an understanding of what matters to the community and a shared perspective on the world. Lastly, it requires appropriately using the repertoire of resources that the community has accumulated through its history of learning (Wenger, 2010). The creation and use of material culture is thus defined by this regime of competence. Therefore, technological and use-wear analyses provide us with insights into past communities of practice.

The concept of communities of practice is often applied at a local scale, within a settlement, for example, in order to identify shared learning practices. It should be noted that similarities in craft production often extend well beyond a local scale, beyond the level of a single settlement (Heitz, 2023, p. 69). Communities of practice can thus extend beyond residence groups (Heitz, 2023, p. 93). The sharing of knowledge about craft production can also extend beyond stylistic or typological borders as was recently demonstrated by Kroon (2024). This implies that communities of practice can also be recognised at a macro scale. Knowledge can be shared across communities over vast distances. However, in addition to the presence of an 'ingroup' the concept also implies an 'outgroup', people who are not part of these communities of practice, and with whom certain knowledge about crafts is not shared. This is, for example, the case with knowledge of axe production. This knowledge is shared

amongst communities near the flint mines in Belgium and Dutch Limburg, but it is not shared with VLC communities, even though these communities regularly exchanged goods (Van den Dikkenberg, 2024b).

3.6 Craft specialisation

A surprising result of the use-wear analysis in this thesis concerns extensive evidence for hide working at Den Haag Steynhof (see chapter 6 and 12). These results warrant a brief introduction to the concept and meaning of craft specialisation. The notion of craft specialisation as a topic for archaeological studies was first discussed by Childe (1925). The emergence of craft specialisation in Eurasia is intrinsically linked to the Neolithic (Baysal, 2013; De Grooth, 1991; Lemorini et al., 2020; Perlès, 1992; Sliva & Keeley, 1994). The earliest evidence comes from Early Neolithic sites in Greece and West Asia (Lemorini et al., 2020; Perlès, 1992; Thuesen et al., 2023). In Belgium and the southern Netherlands the earliest evidence for craft specialisation comes from Early Neolithic Bandkeramik sites (Sliva & Keeley, 1994; Van Gijn & Mazzucco, 2013). The emergence of flint mines during the Middle Neolithic in Belgium and Limburg furthermore led to the emergence of part-time specialists who produced flint axes (De Grooth, 1991, p. 177). Evidence for craft specialisation in the Rhine-Meuse delta, however, largely eludes us. It has however been suggested for the assemblage of Den Haag Wateringse Binnentuinen that the large amount of scrapers, which through use-wear analysis could be linked to hide-processing, might be indicative of craft specialisation (Houkes et al., 2017).

Craft specialisation has been defined in a plurality of ways ranging from very broad definitions which include all production in which goods are transferred from producers to non-dependent actors, to more narrow definitions such as the definition provided by Costin (Clark & Parry, 1990; Costin, 1991; Flad & Hruby, 2008). Costin defines craft specialisation as a "*differentiated, regularized, permanent, and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least in part for their livelihood, and consumers depend on them for acquisition of goods they do not produce themselves*" (Costin, 1991). I would argue that the latter part of this definition is not relevant to the present study. It does not matter whether consumers do, or do not, produce these goods themselves. If we go to a restaurant we can order food which on a daily basis we would cook ourselves. This does not imply that the chefs who spend their lives working, cooking these meals, are not full-time specialists. Notwithstanding the major impact craft specialisation can have on consumers, I believe that definitions should primarily focus on the producers in these systems. I will therefore adhere to the broader definition provided by Perlès who defines craft specialisation as "*production that is conceived and carried out in response to needs above and beyond those of the production group itself (whether it is home- or village-based) and therefore designed to be exchanged at least in part for other products*" (Perlès, 1992, p. 134).

If the production of hides at Den Haag Wateringse Binnentuinen exceeded the local needs this would indeed indicate craft specialisation at the site. But when is this local need exceeded? To understand specialisation the supposed specialised activity needs to be understood in relation to the other activities at the site. It was suggested that hide working was a primary activity at Wateringse Binnentuinen, but if other tool categories are not analysed this remains an assumption (Houkes et al., 2017). It has been demonstrated extensively that at VLC sites unmodified flint is often employed for a wide variety of tasks (Van Gijn, 1990b). The use-wear analysis at Wateringse Binnentuinen, which focused on retouched tools (scrapers), does not provide information about the breadth of activities taking place here (Houkes et al., 2017; Mullaart, 2016). The lithic assemblage of Den Haag Steynhof is remarkably similar to that of Den Haag Wateringse Binnentuinen (Houkes, 2021b; Houkes et al., 2017). Here scrapers also clearly dominate, and use-wear analysis has established that these, like those from Wateringse Binnentuinen, were predominantly used for hide-processing (Houkes, 2021b; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024). In the present study a broad selection of tools, not only focusing on scrapers, are analysed. In chapter 12 these results are contextualised by comparing the results of Den Haag Steynhof with those at other VLC, Swifterbant, Hazendonk-3 group, and CWC sites. If the importance of hide working at Den Haag Steynhof exceeds the production for local consumption we could consider this to be evidence for craft specialisation (Perlès, 1992).

4

Sources, techniques and use-wear analysis

Several methodologies are used in this research. These are all focused on a better understanding of the object biographies. To study the first stage of these biographies, the sourcing of raw materials, visual inspections and ED-XRF analyses are used. Regarding the second stage, the production of artefacts, a number of variables is recorded, as introduced in section 4.2. Use-wear analyses are employed to understand the use-life of artefacts. In order to classify unknown traces from production and use a series of experiments is conducted as well. Finally, a number of computer programs are employed to record and visualise the data.

4.1 Sourcing flint and ED-XRF analysis

The sourcing of flint artefacts usually takes place based on visual inspections. However, as Spiennes and Rijckholt/Lanaye flints are notoriously difficult to distinguish, ED-XRF is employed in an attempt to distinguish these sources based on elemental variations (De Grooth, 2011, p. 125; Van den Dikkenberg & Braekmans, 2025).

4.1.1 Lithotheque and visual inspection

Regarding the flint sources, several variables are included in the database. These include the cortex type and cortex extent, the grain size of the flint, and the raw material type. The latter corresponds to the origin of the flint. The identification of raw materials is based on visually observed characteristics of the flint such as the translucency, colour, inclusion types and frequencies, and the previously mentioned cortex types and grain sizes. The work is based on direct comparisons with reference material from the lithotheque in the Laboratory for Material Culture Studies in Leiden, as well as on information derived from the literature, mostly based on the work by De Grooth (2011). The lithotheque was originally compiled by L. Verhart and has proven indispensable for the analysis. Although most material could be identified through visual comparison with the lithotheque, occasional field trips were undertaken to further expand the collection. This included a trip to Latinne (Belgium) to collect Hesbaye flint (Fig. 4.1a), a trip to Eys (Dutch Limburg) to collect Simpelveld flint, and a trip to the Grebbeberg in Rhenen (Utrecht) to collect terrace flint. Many of the encountered flint sources consist of cretaceous flints which are extensively described by De Grooth (2011). This concerns, for example, Hesbaye and Rijckholt flint (Fig. 4.1a and b). It also included typical flints of a secondary origin (Fig. 4.1c and d). Terrace flint can for example be recognised by its smooth weathered surface (Van Gijn, 2010a, p. 18). Meuse-eggs are egg-shaped nodules with a matt, hard outer surface consisting of numerous impact cones (Van Gijn, 2010a, p. 18). For the analyses, a stereomicroscope (5–100x) was indispensable.

Flint from VLC assemblages has been studied by different scholars (e.g.: Asmussen & Moree, 1987; Houkes, 2021b; Houkes et al., 2017; Van Veen, 1989; Verhart, 1983; 1992). It is possible that different scholars come to different interpretations regarding raw materials. Therefore, in the setup of the *Putting Life into Late Neolithic Houses* project it was envisioned

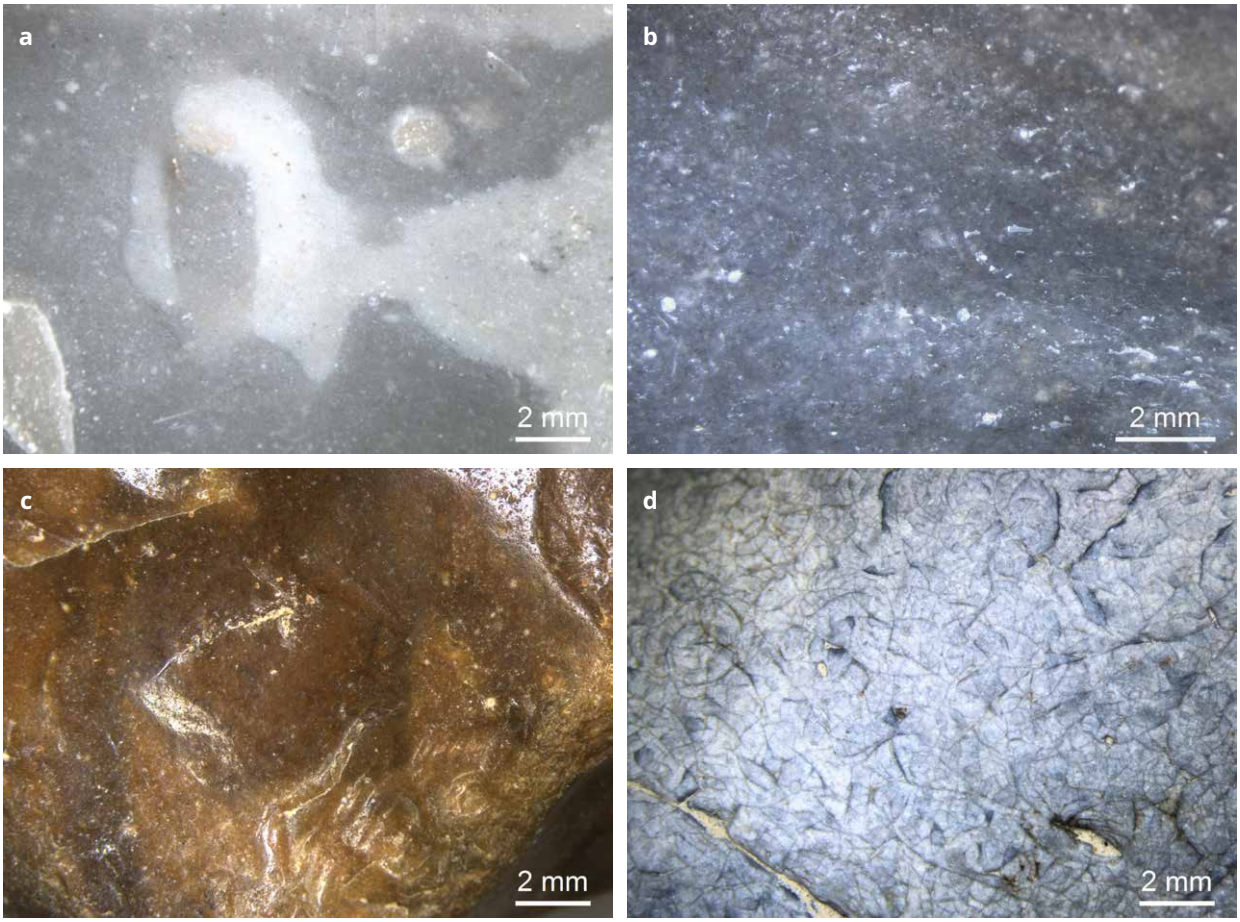


Figure 4.1 Reference photos of flint from the Lithotheque in Leiden: a) Hesbaye flint from Latinne; b) Rijckholt flint; c) terrace flint (cortex) from Lunteren; d) Meuse-egg (cortex) from Meuse gravels.

that 'one pair of eyes' would study the raw materials. For Zandwerven, Hekelingen III, and Vlaardingen Arij Koplaan the raw materials were now studied by the author. The assemblage of Den Haag Steynhof was recently analysed by R. Houkes, who was instrumental in teaching the author how to identify different raw materials (Houkes, 2021b). Therefore, for this site the original interpretations by Houkes are incorporated. Although the wish to have 'one pair of eyes' studying the raw materials is understandable, this perspective is also limiting. Contract archaeology in the Netherlands produces vast amounts of data. Often this includes a study of lithic raw materials (Drenth, 2019; Houkes, 2021b; 2023; Houkes et al., 2017). Not using this data, because it is not acquired by 'one pair of eyes', would limit the present dataset to a study of several key sites. However, although minor differences in interpretations are to be expected, specialists generally use the same methodology and overall their results are likely comparable. Therefore, in the discussion chapter (see chapter 11) published data from commercial reports is also incorporated. Including this data allows a better assessment of general trends in raw material procurement. The wish to include this data also stems from the idea that lithic specialists should have faith in the capabilities of fellow specialists. This perspective seems to be commonsense among archaeobotanists, archaeozoologists, and osteoarchaeologists, but it does not seem to be commonly accepted among lithic specialists. This clearly affects the faith archaeologists have in the quality of the data produced by lithic specialists. Whereas bioarchaeological data gathered by different specialists is deemed comparable, archaeologists are remarkably hesitant to compare results produced by different lithic specialists (note the differences between Amkreutz, 2010, p. 22; and Dusseldorp & Amkreutz, 2020). Unless there is reason to doubt the quality of specific studies, I will presume that different specialists produce reliable inter-comparable data.

4.1.2 ED-XRF

While the visual inspection of the flint is generally sufficient to assign lithics to raw material groups, the distinction between Rijckholt and Spiennes flint is notoriously difficult based on visual inspections. Regarding these flint types

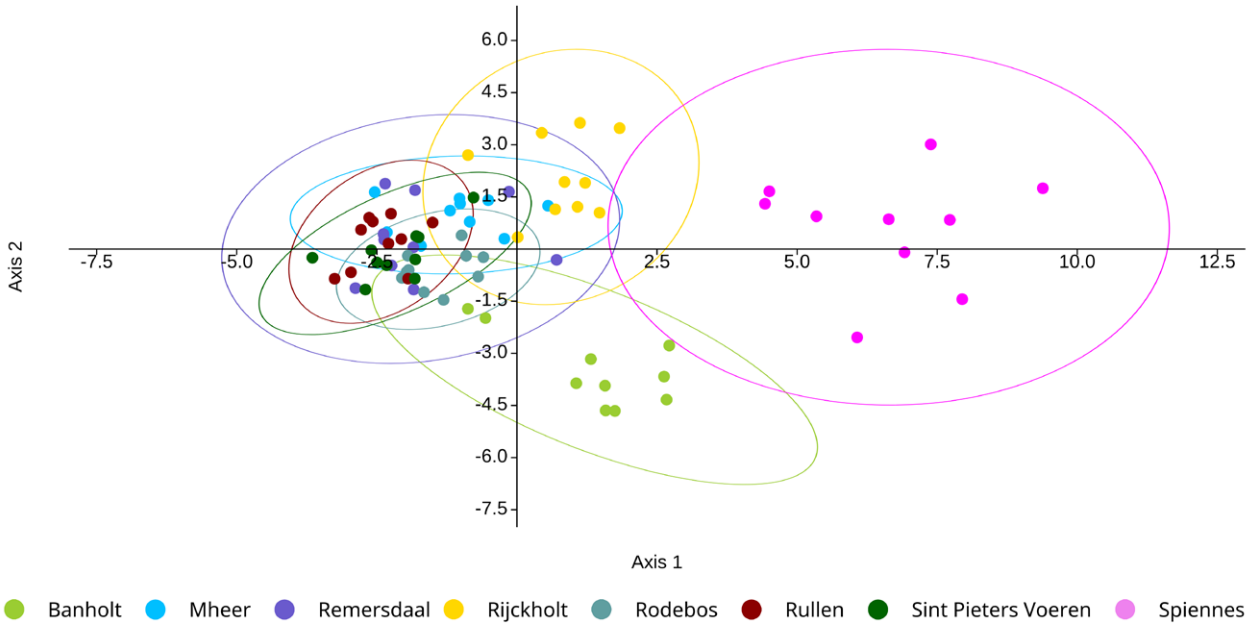


Figure 4.2 Canonical score plot based on the discriminant analysis of the reference sample (average per sample of the Rh normalised intensities for the elements Al, Si, P, S, K, Ca, Ti, Fe, Cu, Rb, Sr, Y, Zr, Nb) indicating the different groups with 95% confidence ellipses (Van den Dikkenberg & Braekmans, 2025).

De Grooth concludes that *"I think it pretty hazardous to distinguish between Spiennes and Rijckholt/Lanaye flints in archaeological samples, even with the help of a reference collection"* (De Grooth, 2011, p. 125). It was also my impression that a visual distinction generally could not be made between these flint types. It should be noted that Rijckholt is derived from the Lanaye member of the Gulpen formation (Maastrichtian), Spiennes flint originates from the Spiennes Chalk formation of the Campanian. Although Rijckholt and other Lanaye members have a similar geological origin, Spiennes flint thus originates from a different geological layer. Therefore, it was expected that the Lanaye and Spiennes flint potentially display chemically distinct signatures (McDonnell et al., 1997; Robaszynski et al., 2001; Van den Dikkenberg & Braekmans, 2025). Hence, to overcome this problem a study was conducted, together with D. Braekmans, to attempt to use chemical analyses to distinguish between Spiennes and Lanaye flint.

This study was conducted through non-destructive ED-XRF analysis done on eighty reference samples from the lithotheque at Leiden University. These included samples of Spiennes (n=10) and Rijckholt (n=10) flint, as well as sixty samples of flint from eluvial Lanaye sources (ten each) such as Banholt and Rullen flint. The analyses were conducted using a Bruker Tracer 5g handheld unit (resolution of <140eV @ 250000 cps at Mn Kα). The analyses were conducted at the Laboratory for Material Culture Studies at the Faculty of Archaeology in Leiden. The ED-XRF unit is equipped with a large area silicon drift detector (SDD) utilising a 1µm graphene detector window. Measurements were run in air using an ~8 mm beam collimator for 30 seconds at 50kv, 17.7 µA and with a 25µm Ti, 300µm Al filter in place, followed by a measurement of the exact same location under 15kV and 22.2 µA conditions for 60 seconds with no filter in place to optimise for the detection of lighter elements (Van den Dikkenberg & Braekmans, 2025). A discriminant analysis on the reference data demonstrated that statistically significant differences exist in the chemical composition of Spiennes flint as opposed to Lanaye flint (Fig. 4.2). Within the latter group distinctions between Rijckholt and most other Lanaye flint types are not possible based on the chemical signatures of the flint, due to the significant overlap in values.

The main elemental differences between Spiennes and Lanaye flint lie in the ratios of phosphorus (P) and strontium (Sr). For archaeological sites where Spiennes/Lanaye flint was identified the archaeological artefacts belonging to these groups were subsequently analysed with the ED-XRF. In the respective site chapters these measurements are plotted in bivariate plots with P and Sr along with the reference data. This allows us to assess the relative importance of Spiennes and Lanaye type flints on the different VLC sites under study (Van den Dikkenberg & Braekmans, 2025).[8]

8 A more extensive discussion on the ED-XRF analysis results and methodology can be found in the publication in the journal *X-Ray Spectrometry*. The raw data from the analyses can be found there as supplementary materials (Van den Dikkenberg & Braekmans, 2025).

4.2 Technological analysis of lithics

In terms of lithic technology several variables are included in the present study. If technological data is available from previous studies, as is for example the case with Den Haag Steynhof and Hekelingen III, the data from these studies is included (Houkes, 2021b; Verhart, 1983). This data included the type of percussion used. Regarding the percussion types usually only three variants are distinguished at VLC sites: hard hammer, soft hammer, and bipolar (Houkes, 2021b; Houkes & Drenth, 2017; Houkes et al., 2017; Verhart, 1983). For the sites where no data on percussion types is available, Zandwerven and Vlaardingen, the analyses were done by the author. Occasionally, it was possible to distinguish, in addition to the aforementioned percussion types, the use of soft stone percussion. This can be recognised based on the presence of a lip in combination with a fairly pronounced, occasionally double bulb of percussion (Moos et al., 2024; Pélegrin, 2000; Pélegrin & Inizan, 2013). For these sites a distinction is thus made between organic soft percussion which is recognised by the lack of pronounced bulbs of percussion, thin platforms and a prominent lip, and soft stone percussion with pronounced (occasionally double) bulbs of percussion in combination with a lip. If a distinction could not be made, they were classified in the broader category of 'soft percussion'. In addition to percussion types, flake terminations (feather, hinge, step, plunging terminations etc.) were recorded. These were included because they provide insights into the knapping skills of those producing these artefacts (Shelley, 1990).

Blades are generally defined as flakes which are twice as long as they are wide. This category therefore inevitably also included byproducts of flake core reduction. They also include blades with cortex or flake negatives. However, blades with trapezoidal or triangular cross-sections can be considered to be indicative of blade core reduction (Sain & Goodyear, 2016, p. 117). Therefore blade types are recorded to distinguish between elongated flakes and blades which can be linked to blade core reduction. Lastly, the finishing traces on ground and polished flint axes are recorded. These are recorded based on a microscopic comparison (using a metallographic microscope) with experimentally replicated traces (see section 5.1; Van den Dikkenberg, 2024a).

4.3 Use-wear analysis

Before delving into the methodology it is worth briefly clarifying the choice in terminology employed here. This field of study is variably referred to as traceology, functional analysis, use-wear analysis, or micro-wear analysis (Clemente-Conte et al., 2024; Keeley & Newcomer, 1977; Van Gijn, 1990b, 2010a, 2014c). Traceology is arguably the broadest definition. Traceology encompasses the study of macroscopic and microscopic wear, as well as the analysis of residues. The term refers to traces in a broad sense; it encompasses traces from use, production and also post-depositional traces. The term micro-wear analysis refers similarly to traces resulting from use, production, and taphonomy. However, the designation 'micro' refers specifically to microscopically observed and studied traces. Strictly speaking it would exclude the analysis of macroscopic traces such as battering traces or edge removals. Finally, use-wear analysis refers to all traces resulting from use (macro and micro). The term is similar to functional analysis, although this latter term also doubles as a mathematical term making it less suitable. Use-wear analysis excludes the study of post-depositional traces or traces from production. This term highlights the goal of the analyses, the reconstruction of tool use. Although this is the main goal it should be stressed that I also consider other uses, which are not directly functional, as being important topics of study. For the Dutch Neolithic it has for example been extensively demonstrated that tools may also have been subjected to ritual treatment prior to deposition (Van Gijn, 2010a, 2014a, 2014b; Van Gijn & Wentink, 2013; Wentink et al., 2011). However, I do not seek to explain all observed traces. For example, I do not discuss taphonomic processes, even though I also observe post-depositional traces on the artefacts. I do study microscopic production traces on axes, this can be called micro-wear analysis, but not use-wear analysis. But beyond this my main focus is on tool use, which is reconstructed by looking both at macroscopically and microscopically observed wear traces. Therefore, when I refer to the analysis of tool functions by analysing wear traces I employ the term use-wear analysis.

Use-wear analysis provides a unique tool for analysing interactions between diverse materials. It thus not only provides information about the use of flint objects, but also about activities involving materials such as hide, bone, antler, wood, ceramics, and plant fibres. It gives us insight into the missing majority of material culture, which consists of perishable objects (Hurcombe, 2008). This is especially important in the context of this study because of the variation in the preservation of organic materials on Vlaardingen Culture sites in different environmental settings. The use-wear analysis was done combining high-power and low-power microscopy, following the methodology proposed by Van Gijn (1990b, 2010a, 2014c). Several microscopes were used in this study, their use depended on the specific requirements of the pieces under study (the need for a camera to photograph traces, the size of the artefacts etc.). The microscopes are listed in Table 4.1. Analyses with the metallographic microscope were mostly conducted at 100× and 200× magnifications. The stereomicroscopes listed here were also employed in the study of the raw materials.

The study employed stereomicroscopes and metallographic microscopes, rather than confocal microscopes. It is thus based on interpretation, rather than quantifica-

Microscope	Camera
Stereomicroscopes	
Leica M80 (7.5–60x)	Leica M120HD
Nikon SMZ645 (8–50x)	
Nikon SMz-2T (5–60x)	
Metallographic microscopes	
Leica DM6000M (50–500x)	Leica DFC450
Leica DM2700 (50–200x)	Leica M120HD
Leica DM1759 (50–200x)	Leica M120HD
Nikon Optiphot-2 (50–1000x)	

Table 4.1 List of microscopes used in this study.

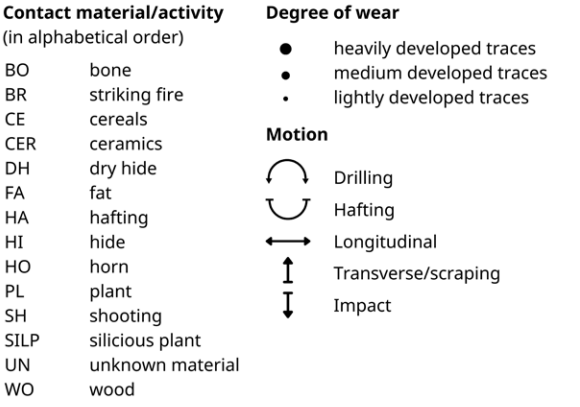


Figure 4.3 Symbols used in the figures to represent use-wear traces (after Van Gijn, 2010a, p. XV).

tion (Van Gijn, 2014c). Confocal microscopy has recently provided promising results when it comes to the quantification of use-wear traces (Evans, 2014; Evans & Donahue, 2008; Ibáñez et al., 2016a; Ibáñez et al., 2014; Pichon et al., 2021). A major problem with confocal microscopy however resides in the fact that it is only able to quantify one aspect of use-wear traces, namely polish. Usually, use-wear analysis also includes the study of aspects such as striations, edge-removals, and edge rounding (Keeley, 1980; Keeley & Newcomer, 1977; Van Gijn, 1990b). These aspects are vital for the interpretation of tool motions, and in some cases contact materials. Furthermore, confocal microscopy only deals with polish textures, namely the roughness of polishes. Other aspects, such as the distribution of polish, are not accounted for. Furthermore, it is presently unclear to what extent confocal microscopy can cope with the complex archaeologically observed use-wear traces which also involve traces resulting from multiple uses, resharpening, repair, rejuvenation, reuse, and even intentional destruction (Van Gijn, 2014b, 2014c). I therefore agree with Ibanez et al. that confocal microscopy should not be seen as a potential substitute for 'traditional' use-wear analysis (Ibáñez et al., 2019). Rather it should be seen as a tool which could contribute to detailed questions. This has proven to be especially successful with activities which result in extensive polish formation. Notably the exploration of diversity in cereal harvesting traces through confocal microscopy proved to be fruitful (Ibáñez et al., 2016a; Ibáñez et al., 2014; Pichon et al., 2021). Due to the time consuming nature, and the problems with the method as mentioned before, confocal microscopy was not used in the present study. The use of traditional high and low power microscopy was deemed more suitable for the aim of the present study: to study a large number of diverse artefacts to grasp the inter-site variability of activities at VLC settlements.

The cleaning protocol was as follows: all tools were received more or less clean, as they came from older published excavations. To remove any remaining greasy residues the tools were generally cleaned with water and soap, and when necessary they were cleaned with alcohol to remove any finger grease. Only when these methods proved to be insufficient were the tools additionally chemically cleaned. This was done by submerging them in a 10% HCl (hydrochloric acid) solution for several minutes (usually ten to thirty minutes depending on the condition of the artefact). Prior to submerging them in the HCl solution they were soaked for ten minutes in water. Afterwards the artefacts were rinsed with water and they were again submerged for ten to thirty minutes in a 10% KOH (potassium hydroxide) solution. The cleaning protocol is based on the work done by Van Gijn (1990b, 2010a).

Microscope photographs were taken using a z-stack feature in the Leica software. This is in line with recommendations made to increase the depth of field in microscope photographs (Plisson & Lompré, 2008; Van Gijn, 2014c). For the depiction of wear traces in photographs and drawings the symbology developed by Van Gijn is used (Fig. 4.3).

4.4 Experimental archaeology

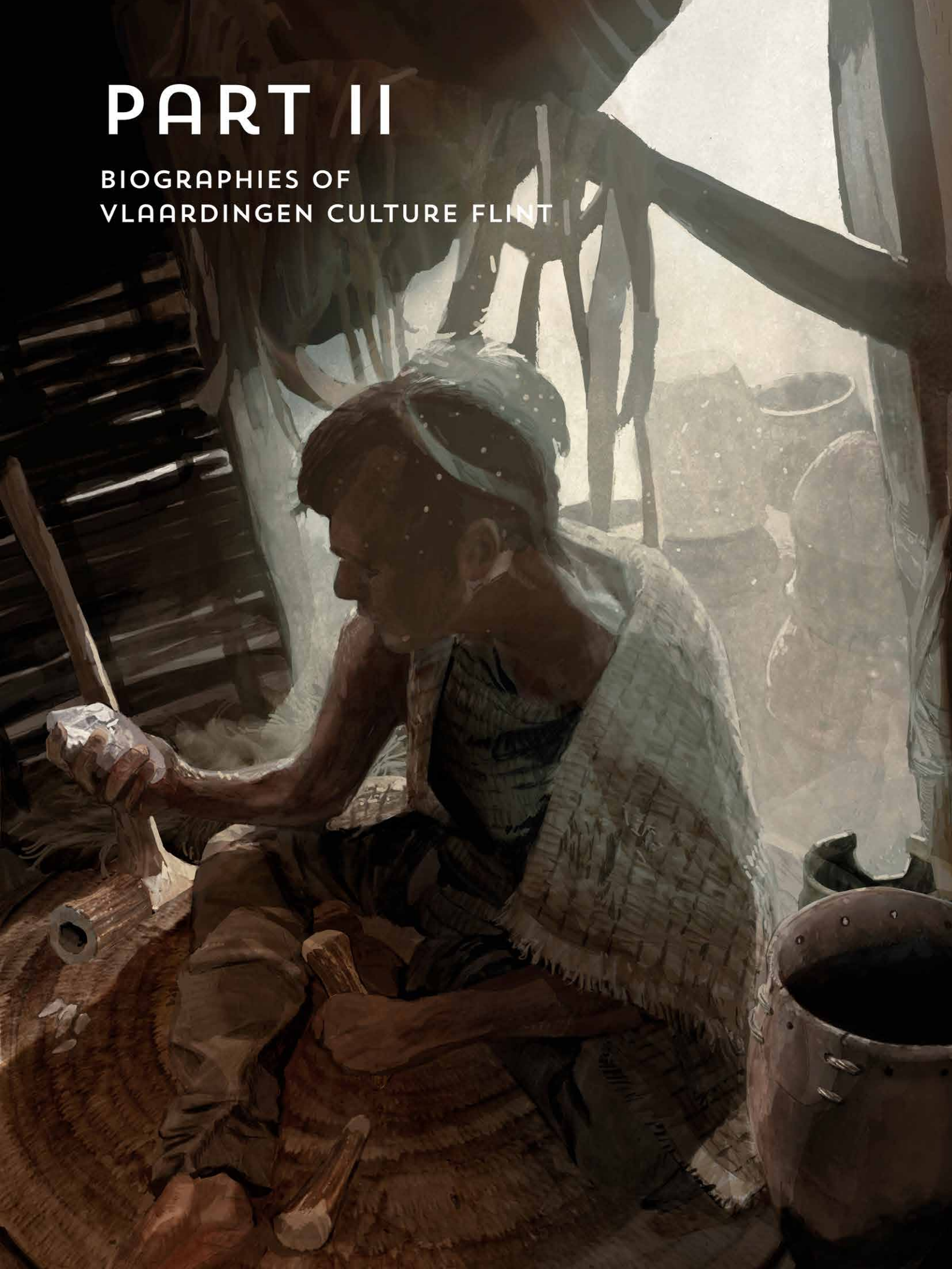
Experimental archaeology is vital for use-wear analysis (Van Gijn, 2010a, pp. 30–31). Similarly, it is essential for technological analyses of lithics (Whittaker, 2009). The present study therefore also included technological experiments, focused on the production traces on flint axes (Van den Dikkenberg, 2024a), as well as use-wear experiments (Van den Dikkenberg et al., 2024b). Lastly, an experiment was carried out by Diederik Pomstra to better assess the importance of the recycling of flint axes at VLC sites (Van den Dikkenberg et al., 2024a). All experiments carried out as part of this study were incorporated in the reference collection of the Laboratory for Material Culture Studies in Leiden University. The use-wear experiments were recorded in a standardised manner using the experimental forms available in the laboratory. Many of the

experiments were carried out in Masamuda, often together with local volunteers (Van den Dikkenberg et al., 2024b). Complicated experiments which require experience in either knapping or using stone tools were carried out by D. Pomstra, an experienced craftsperson with years of experience in working with Stone Age technology. Simpler experiments, involving activities such as the grinding or polishing of flint, were carried out by the author (Van den Dikkenberg, 2024a).

4.5 Computer programs

All data were recorded in Microsoft Access databases, using the standard databases of the Laboratory for Material Culture Studies in Leiden (Van Gijn, 1990b, 2010a). Graphs (bar charts, scatterplots, pie charts, and triangular plots) were made using Microsoft Excel. All distribution maps and digitised excavation plans were created using QGIS. Statistical analysis for the ED-XRF data was conducted using the PAST version 4.12b software (Hammer et al., 2001; Van den Dikkenberg & Braekmans, 2025). Digital figures were composed in Canva (www.canva.com). The overview of VLC sites was compiled based on a literature study along with queries in ARCHIS, DANS Data Station Archaeology, and AGNES (Archaeological Grey literature Named Entity Search) (Van den Dikkenberg & Brandsen, 2025). For data presentation network graphs were used occasionally. These networks consist of nodes (points) and edges (lines). Edges represent the connections between nodes, for example between archaeological sites and flint sources. Weights can be assigned to edges to indicate the strength of these ties. In this way, networks not only show which connections exist but also their relative importance. The network visualisations were created in Visone.

Part II. Recycling. Visualisation by Kelvin Wilson.



PART II

BIOGRAPHIES OF VLAARDINGEN CULTURE FLINT

5

Experiments

Understanding object biographies inevitably depends on the replication of the lifecycles of objects. Technological and use-wear analyses therefore heavily rely on experimental archaeology. These experiments are therefore indispensable for analysing the archaeological assemblages presented in Chapters 6–10. Although the archaeological objects were studied using the extensive experimental collection at the Leiden Laboratory for Material Culture Studies, certain wear traces could not be interpreted and required additional experimental explorations. This chapter addresses these new experiments starting with technological experiments, focused on grinding and polishing traces on flint axes. The use-wear experiments were predominantly focused on a detailed understanding of hide working processes, as previous studies on VLC assemblages highlighted that hide working can inform us about site functions (Petrogiannaki & Van Gijn, 2024; Van Gijn, 1990a; 1990b). In addition to the hide working experiments, a series of horn working experiments is presented. Whereas use-wear traces from hard animal materials such as bone and antler are well documented, experiments on horn are rare, potentially leading to an underrepresentation of traces from this activity in archaeological use-wear studies. A final set of experiments provides new insights into the importance of recycled flint axes at VLC sites. Three of these experiments, the grinding and polishing experiments, the hide working experiments with sealskin, and the recycling experiments, have been published elsewhere, so a summary is presented here (Van den Dikkenberg, 2024a; Van den Dikkenberg et al., 2024a, 2024b). The unpublished experiments will be dealt with in more detail.

A final section (5.7) presents a brief reflection on the use of experiments in this study. The tools used for the dehairing experiments, the seal scraping experiments, and the experiments involving flint axes were made by D. Pomstra. The scrapers for the salmon skin experiments, the flakes for the horn scraping experiments, and the blanks for the experiments with production traces were made by the author. The seal skin scraping and dehairing experiments were carried out with the help of volunteers from Masamuda, as part of a public demonstration.[9]

5.1 How to finish your Neolithic axe?

During the use-wear study of the material of Hekelingen III and Den Haag Steynhof it was noticed that the axes and fragments from Hekelingen III showed different finishing traces than those from Steynhof. The former generally appeared heavily polished, whereas the Steynhof fragments had a matt appearance with macroscopic striations. The polish on the axe fragments from Hekelingen III often reached into the deeper flake negatives of the axes. This recalls observations made by Van Gijn and Wentink about axes from the CWC (Van Gijn, 2010a, p. 144; Wentink, 2020, pp. 104–105). Based on experiments, they linked the presence of polish in deeper flake negatives

9 The experiments numbers mentioned in the text refer to their number in the experimental reference collection of the Laboratory for Material Culture Studies in Leiden.

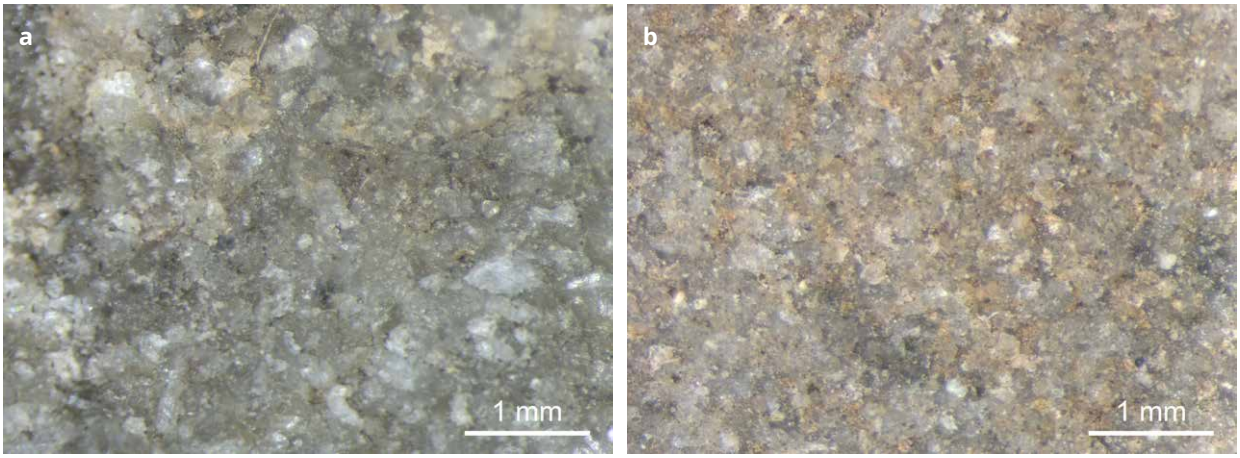


Figure 5.1 Stereomicroscopic photos of the grinding stones used in the experiments: a) compact grey sandstone; b) fairly compact red sandstone.

Exp. number	Experiment	Duration (min)
3310	Grinding flint on red sandstone	10
3325	Grinding flint on grey sandstone with coarse sand (0.6 mm)	10
3327	Grinding flint on grey sandstone with fine sand (0.05–0.25 mm)	10
3334	Grinding flint on grey sandstone	10
3336	Grinding flint on slate	10
2250	Grinding flint on grey sandstone and polishing with slate	10 (2)
2623	Grinding flint on grey sandstone and polishing with ashes and leather	10 (10)
2624	Grinding flint on grey sandstone and polishing with charcoal and leather	10 (10)
3131	Grinding on red sandstone and polishing with fine sand (0.05–0.25 mm) and leather	10 (10)
3317	Grinding on red sandstone and polishing with fine sand (0.05–0.25 mm) and leather	10 (2)
4292	Grinding on grey sandstone, polishing with slate, finally polishing with leather and fine sand	5 (4) (1)

Table 5.1 Setup of the grinding and polishing experiments. For the polishing experiments the duration is first noted for the grinding process and secondly between brackets for the polishing phase.

to polishing with leather and sand (Van Gijn, 2010a, p. 144; Wentink, 2020, pp. 104–105). To better understand these finishing traces on axe fragments an experimental program was set up. The experiments were analysed using a metallographic microscope. In VLC assemblages we often deal with highly fragmented axes, displaying small facets with a ground or polished surface (Van den Dikkenberg et al., 2024a; Van Gijn, 2010b). It was therefore deemed more fruitful to attempt to distinguish different production processes on a microscale, rather than relying on macroscopic observations.[10]

10 The experiments were published in the *Journal of Archaeological Science: reports* and will briefly be summarised here, as they provide essential reference material used in the interpretation of the archaeologically observed finishing traces on flint axe fragments (Van den Dikkenberg, 2024a).

5.1.1 Setup of the experiments

Eleven grinding and polishing experiments were carried out in order to better understand the variation in production traces observed on VLC flint axe fragments (Tab. 5.1). The experiments were conducted briefly (2–10 minutes). The aim was to create a small ground and/or polished surface which could be used for reference. The objective was not to replicate entirely polished or ground tools. The experiments aimed to test whether the use of different types of stone affected the production traces. Two sandstone grindstones were used (Fig. 5.1), a fairly compact red sandstone with well rounded grains (grain size: 150–210 µm) and a very compact grey sandstone, also with well rounded grains (grain size: 210–300 µm). In all grinding and polishing experiments water was used as an additive to facilitate the grinding/polishing process.

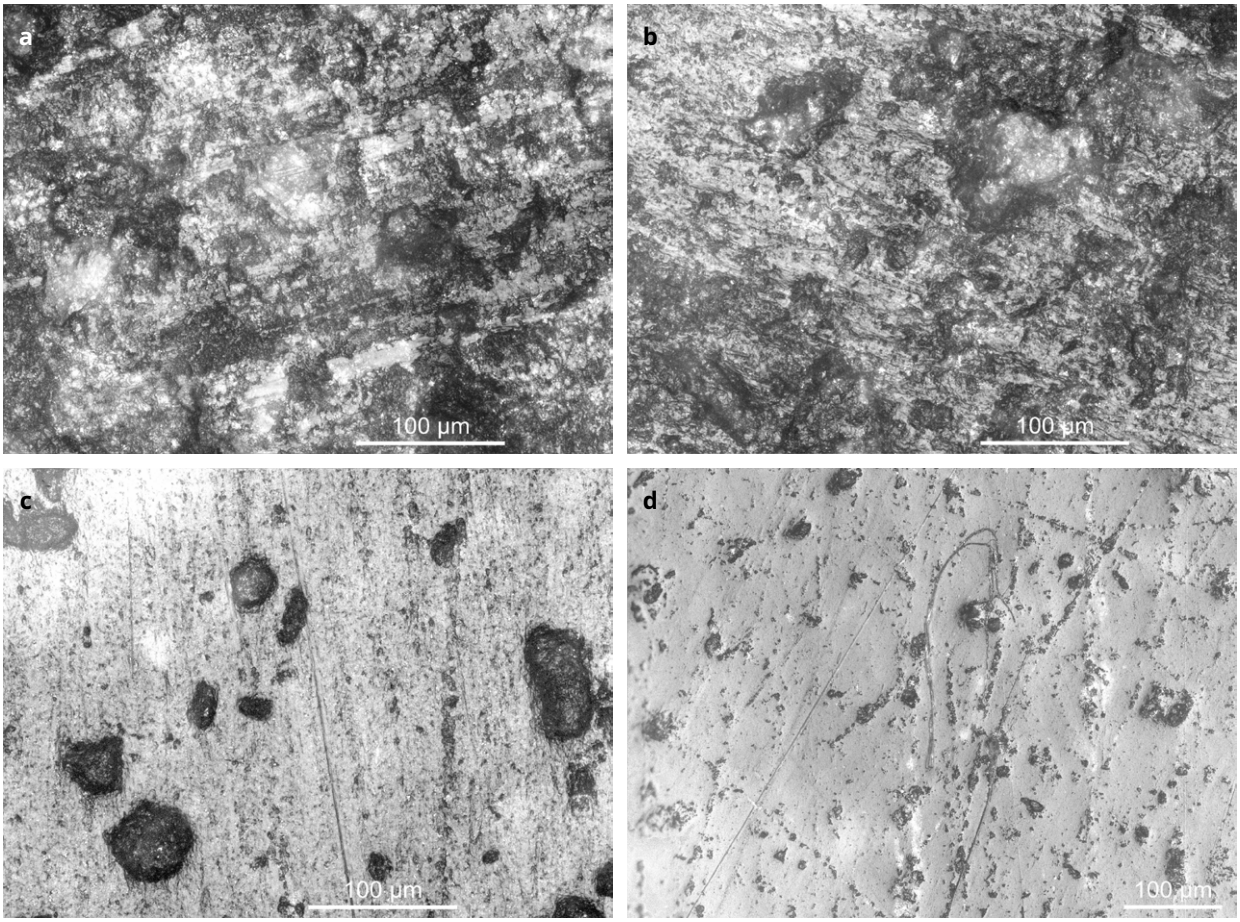


Figure 5.2 Grinding and polishing experiments; a) Exp. 3334 grinding flint on sandstone; b) Exp. 3327 grinding flint on sandstone with sand; c) Exp. 3336 grinding flint on slate; d) Exp. 3317 grinding flint on sandstone and polishing with leather and sand (Van den Dikkenberg, 2024a).

In addition to these, a piece of slate was used to see whether the use of softer stones would result in different traces. Furthermore, the effect of using additives (in the form of sand) in the grinding process was investigated. Lastly, the experiments aimed to assess whether the use of different polishing agents: sand, ash, or charcoal, affected the development of polishing traces.

5.1.2 Results of the grinding and polishing experiments

Grinding on sandstone results in streaks of smooth and matt polish which is intersected by broad deep striations (Fig. 5.2a). These experiments display macroscopically visible striations, combined with a matt white sheen (Van den Dikkenberg, 2024a). The white sheen appears to be a 'crushed' surface rather than a polish, and it is especially prominent in the broad striations. When the flint is washed the white sheen disappears, but it reappears as soon as the flint dries. If sand is added to the grinding process the micro-polish becomes rougher and more matt, while the striations are finer compared to the experiments in which no sand was added (Fig. 5.2b). The experiment in which flint is ground on slate presents very different results. The polish is highly linked, with a rough and matt texture, intersected by many fine striations (Fig. 5.2c). Macroscopically, the flint looks polished, and does not have a white sheen as seen in the other grinding experiments with sandstone grindstones. The polishing experiments with leather and additives all produce similar production traces, irrespective of the type of additives (sand, charcoal, or ash) used. They display smooth and matt polish which, in the highly-linked parts, has very few striations (Fig. 5.2d). Macroscopically, this flint looks well-polished and it could be observed that the polish often extended beyond the originally ground surface. This confirms the earlier observations by Wentink and Van Gijn that this polish likely also reaches into the deeper flake negatives on flint axes (Van Gijn, 2010a, p. 144; Wentink, 2020, pp. 104–105).

The experiments provide a suitable framework for interpreting production traces on archaeological flint

Production type	Microscopic traces
Ground on sandstone	Isolated spots or streaks of smooth and matt polish with broad and deep striations
Ground on sandstone with sand	Rough and matt polish spots, broad and deep striations, as well as many fine striations
Ground on slate	Extensive highly-linked rough and matt polish with many fine striations
Ground on sandstone and polished with leather and additives	Smooth and matt highly-linked polish, in well-developed parts with only few fine striations

Table 5.2 Description of the four main categories of finishing traces based on the experiments (Van den Dikkenberg, 2024a).

axes (in chapters 6–10). The traces on these experiments can be divided into four main categories, depending on the use of additives and the type of polishing (Tab. 5.2). Experiment 4292 furthermore demonstrated that it might also be possible to identify flint which was initially polished on slate, after which it was polished with leather and additives. In this case the polish resembled that from polishing with leather and additives, but in the less well-developed areas fine, polished striations were still visible, indicating that slate was used prior to the polishing with leather (Van den Dikkenberg, 2024a). It should be noted that the stone types used in these experiments are limited to the use of sandstone and slate. Sandstones (Mohs scale 6–7) can be seen as representatives of hard homogenous grindstones, while slate (Mohs scale 2.5–4) represents the use of soft grindstones. Because the experiments did not include the full breadth of possibly used grindstones, the archaeological interpretations will be kept broad, referring either to hard grindstones (resembling traces resulting from grinding on sandstone) and soft grindstones (resembling the traces resulting from grinding on slate). Varying grain sizes of stones will likely also have an effect on the grinding process, in this case it can be noted that the sandstones are moderately fine grained and slate is very fine grained.

5.2 Making leather from seal skin

Together with volunteers from Masamuda we conducted a series of experiments to scrape seal skins of young common seals (*Phoca vitulina*). The experiments provide insights in the use-wear traces created by scraping fatty skins with additives (Van den Dikkenberg et al., 2024b). VLC scrapers are often interpreted as having been used to scrape hides with (mineral) additives (Houkes et al., 2017, p. 187; Mullaart, 2016, p. 56; Petrogiannaki, 2022, p. 57; Van Gijn, 1990b, p. 129). The wear traces relating to this activity are either described as a matt polish with considerable edge rounding (Van Gijn, 1990b, p. 129), or as 'typical' hide working traces associated with isolated spots of smooth and matt polish (Houkes et al., 2017, p. 187). Presently suitable reference material, demonstrating the association between such traces and the use of mineral additives in hide scraping experiments is scarce. A complicating factor is furthermore that the isolated spots of smooth and matt polish are also known from dehairing experiments (Petrogiannaki & Van Gijn, 2024). Published experiments involving hide scraping with mineral additives (ochre for example) often displayed more heavily developed polishes where the smoothness extends over a wide area, and is not restricted to small isolated spots (Van Gijn, 1990b, p. 29). For these experiments it was deemed important to use additives which would be readily available. Therefore, we chose to scrape two hides with different additives, one with sand and the other with clay. We used seal skins as these are notoriously fat, and because it is assumed that additives are only necessary when dealing with fatty hides (Van Gijn, 1990b). Furthermore, seal bones are occasionally encountered at VLC sites indicating that seals were likely hunted during this period (Buitenhuis & Veldhuis, 2020; Clason, 1967; Groenman-van Waateringe et al., 1968; Prummel, 1987). The skins were donated by Zeehonden Centrum Pieterburen and they belonged to two young seals that had died of natural causes. The experiments are published in more detail in the *EXARC-Journal* (Van den Dikkenberg et al., 2024b).

5.2.1 Setup of the seal scraping experiments

Before the seal skins could be scraped the thick layer of blubber had to be removed from the skins. For this part the blubber was cut away using unmodified flint flakes (Exp. 2252, 2256, 2257, and 2258). After the blubber was removed the remaining fat had to be scraped from the hides. Therefore the hides were scraped with flint scrapers which were hafted in a wooden haft with leather bindings. The hides were framed in a wooden frame and laid flat on the grass where they were sprinkled with additives. For each hide two scrapers were used, one hide was scraped with sand (Exp. 2253 and 2259), while the other was scraped with clay (Exp. 2254 and 2262).

5.2.2 Results of the experiments

Despite the long duration of use, the flakes which were used to cut away the thick layer of blubber on the skins did not display distinct wear traces. The tools display a band of generic weak polish, occasionally some diagonal directionality could be noted, hinting at a cutting motion (Fig. 5.3). In general, the polish looked similar to polish which is attributed to cutting soft animal material. Therefore, we can conclude that cutting such

Exp. number	Duration of use	Additives	Polish	Directionality
2252	152 (min)	None	Band of rough and greasy polish	No clear directionality
2253	58 (min)	Sand	Wide band of smooth and matt polish with a rougher and more matt polish along the edge combined with heavy rounding. Also with parallel striations.	Transverse directionality
2254	48 (min)	Clay	Wide band of smooth and matt polish. Rougher and more matt near the edge. Heavy edge rounding.	Transverse directionality
2256	142 (min)	None	Thin band of rough and greasy polish, gradually fading, meat/fresh hide-like	Diagonal directionality
2257	142 (min)	None	Thin band of rough and greasy polish, gradually fading, meat/fresh hide-like	Diagonal directionality
2258	152 (min)	None	Weakly developed rough and greasy polish	No clear directionality
2259	58 (min)	Sand	Wide band of rough and matt polish gradually fading. Heavy edge rounding.	Transverse directionality
2262	48 (min)	Clay	Wide band of smooth and matt polish with heavy edge rounding. Polish rougher and more matt and cratered near the edge.	Transverse directionality

Table 5.3 Results of the seal skin experiments with additives experiments (Van den Dikkenberg et al., 2024b).

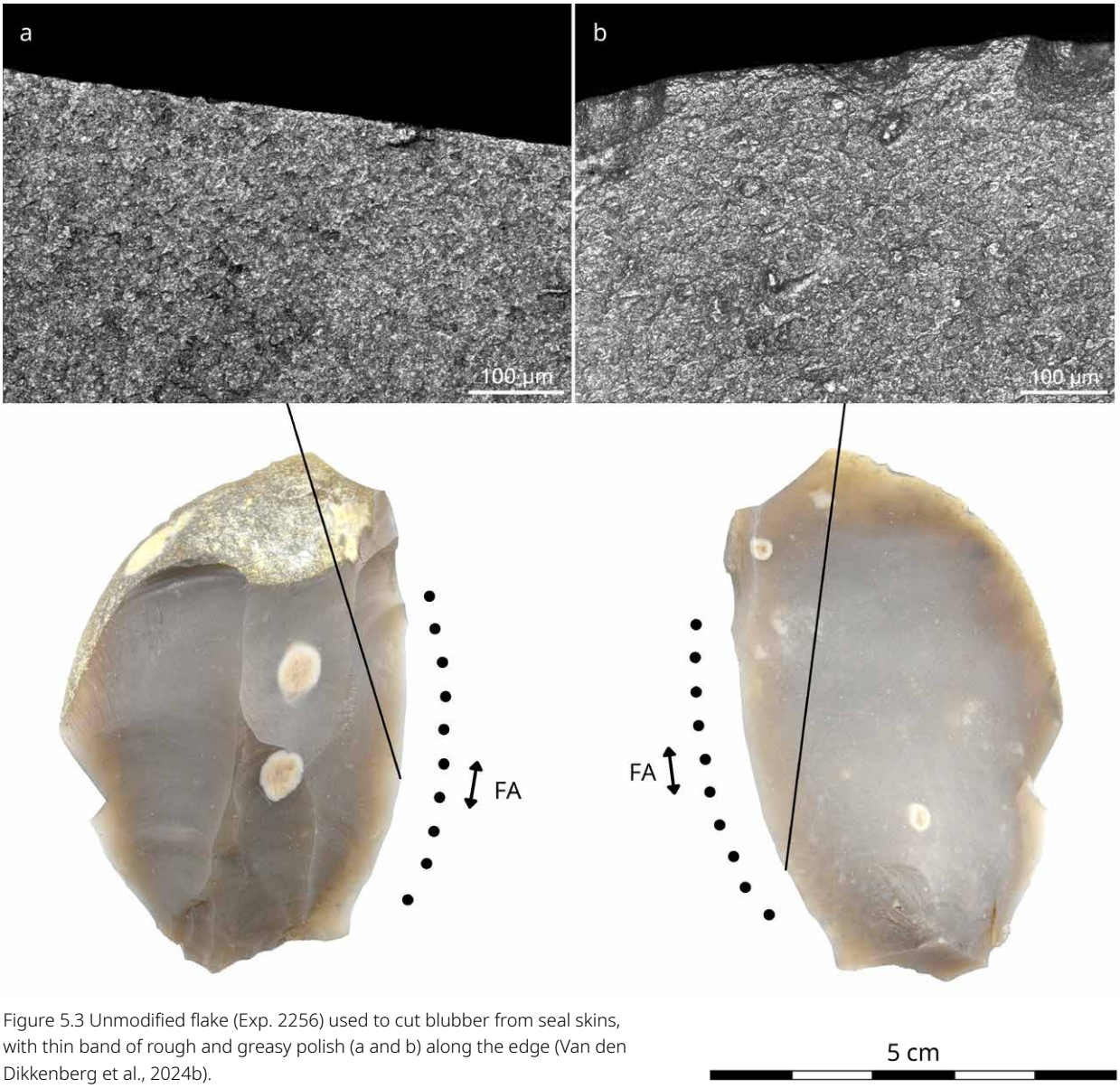


Figure 5.3 Unmodified flake (Exp. 2256) used to cut blubber from seal skins, with thin band of rough and greasy polish (a and b) along the edge (Van den Dikkenberg et al., 2024b).

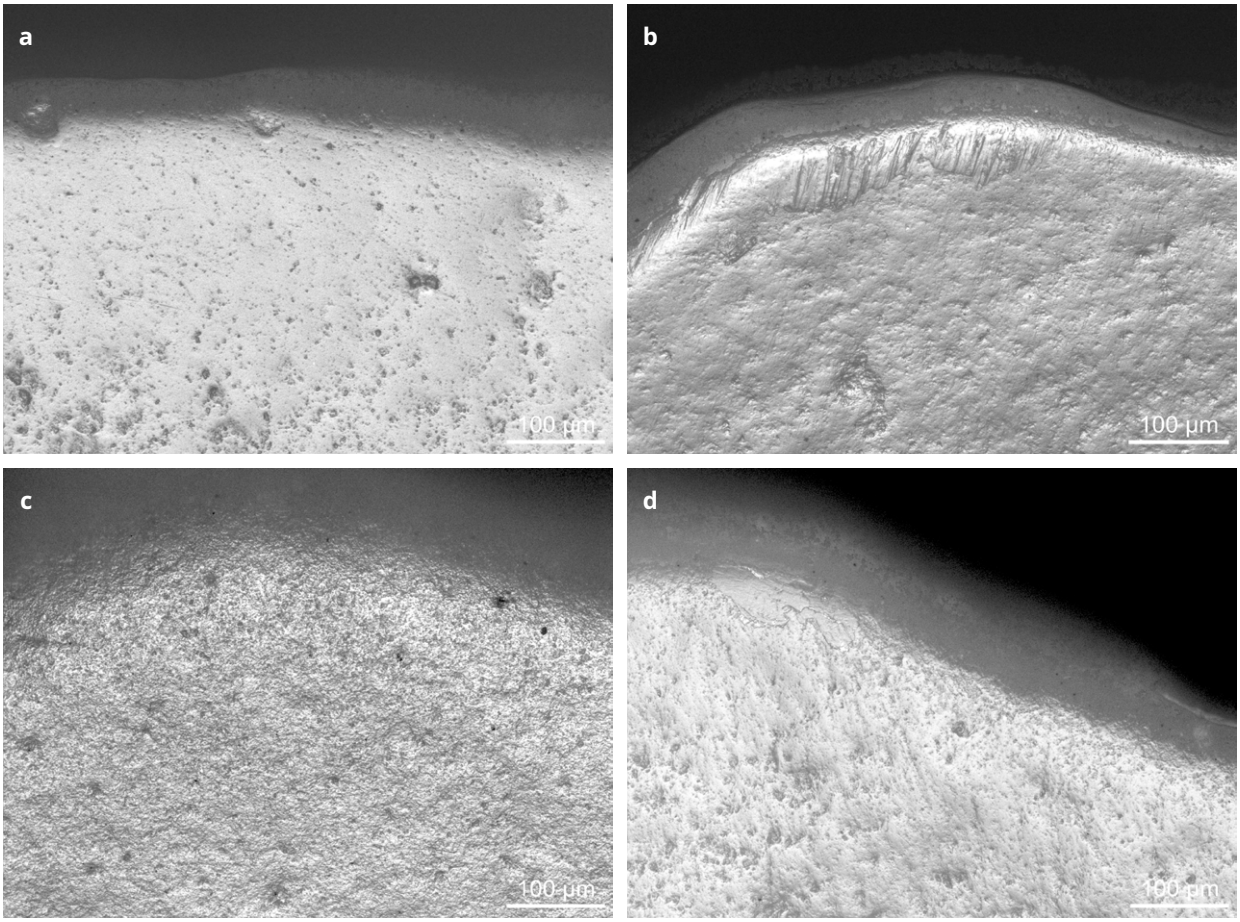


Figure 5.4 a) Highly-linked smooth and matt polish, rougher and more matt near the edge on scraper 2262 used to scrape hide with clay; b) Highly-linked smooth and matt polish with perpendicular striations on scraper 2253 used to scrape hide with sand; c) Highly-linked rough and matt polish scraper 2259 used to scrape hide with sand; d) Highly-linked smooth and matt polish, rougher near the edge with clear transverse directionality on scraper 2254 used to scrape hide with clay (Van den Dikkenberg et al., 2024b).

blubber layers does not result in distinctive wear traces. Archaeologically, such traces would likely be classified as meat cutting polish, or generic weak polish (Van den Dikkenberg et al., 2024b).

After 48–58 minutes all scrapers displayed a wide zone with macroscopically visible gloss along the edge. This confirmed earlier observations by Van Gijn that hide scraping with mineral additives can lead to a band of macroscopically visible polish, resembling 'sickle gloss' (Van Gijn, 1994a). The edges of all scrapers are extremely rounded. The polish can be characterised as either a smooth and matt, or a rough and matt highly-linked polish. Often the rough and matt polish was observed directly on the edge while the polish became smoother further from the edge. Experiment 2253, used to scrape hide with sand also displayed zones with clear perpendicular striations. On all experiments a clear transverse directionality could be observed (Tab. 5.3 and Fig. 5.4).

A distinction between the scrapers used to scrape hide with clay and those used to scrape hide with sand could not be made. Both are characterised as highly-linked smooth and matt and/or a rough and matt polish with heavy edge rounding, transverse directionality, and occasionally by the presence of striations. The traces on all tools are extremely well developed, but they display a great deal of variation. Traces range from very smooth polish (Fig. 5.4b) to rough polish (Fig. 5.4c). It is not clear what caused this variation in traces, considering the tools are used on the same kinds of hides with the same additives (Fig. 5.4b and 5.4c are both related to sand). As a group these traces can be clearly distinguished from other hide working processes, such as fresh hide scraping, softening of hides, and dehairing. The extreme rounding in combination with a very wide band of polish, which is visible macroscopically, is not observed on other types of hide working experiments (Keeley & Newcomer, 1977, pp. 39–42; Petrogiannaki, 2022, pp. 48–50; Petrogiannaki & Van Gijn, 2024; Van Gijn, 1990b, pp. 28–30).

Species ethnographically documented	Vlaardingen Culture sites where these fish species are present
Burbot *(Lota lota)*	The Hazendonk (VL1b)
Salmon *(Salmonidae)*	Barendrecht Zuidpolder; Leidschendam Berberis
Eel *(Anguilla anguilla)*	Barendrecht Zuidpolder; Den Haag Wateringse Binnentuinen; the Hazendonk (VL1b); Hekelingen III; Hellevoetsluis Ossenhoek; Leidschendam Berberis
Catfish *(Siluris glanis)*	Barendrecht Zuidpolder; the Hazendonk (VL1b); Hekelingen III; Hellevoetsluis Ossenhoek
Plaice *(Pleuronectus platessa)*	Hellevoetsluis Ossenhoek; Leidschendam Berberis
Cod *(Gadidae)*	Barendrecht Zuidpolder; Hellevoetsluis Ossenhoek; Leidschendam Berberis
European flounder *(Platichthys flesus)*	Hellevoetsluis Ossenhoek; Leidschendam Berberis
Sturgeon *(Acipenser sturio)*	Barendrecht Zuidpolder; Den Haag Steynhof; Den Haag Wateringse Binnentuinen; the Hazendonk (VL1b); Hekelingen I; Hekelingen II; Hekelingen III; Hellevoetsluis Ossenhoek; Leidschendam Berberis; Leidschendam Prinsenhof; Rijswijk de Schilp; Vlaardingen Arij Koplaan; Voorschoten Boschgeest; Zandwerven

Table 5.4 Fish species ethnographically known to have been used for fish leather and VLC sites where these fish species have been found (Boomert, 1974; Brinkkemper et al., 2011; Buitenhuis & Veldhuis, 2020; Van Dijk, 2021; Van Dijk et al., 2017; Van Regteren Altena & Bakker, 1961; Vávra, 2020).

5.3 Scraping salmon skins

Hide working experiments traditionally focus on the use of mammal skins (Keeley, 1980; Petrogiannaki & Van Gijn, 2024; Schultz, 1992; Van den Dikkenberg et al., 2024b; Van Gijn, 1990b). An underexplored topic concerns the use of fish skins. While the use of fish skin is not known from prehistoric archaeological sources, it is well documented ethnographically (Vávra, 2020). In Europe the use of fish leather is known from Sweden, Denmark, Norway, Russia, Ireland, Germany, France, Estonia, England, and Finland (Vávra, 2020). Its use was widespread in historical times, but presently the use of fish leather remains archaeologically invisible (Vávra, 2020). Vávra notes several commonalities among societies that use fish leather. They are 1) located close to the water; 2) have an economy in which fishing is important; 3) preferably have access to sizeable fish (Vávra, 2020). The Neolithic VLC fulfils these prerequisites as these sites are generally located close to the water, and in the case of the levee sites fishing was clearly an important subsistence strategy in this period (Brinkkemper et al., 2011; Clason, 1967; Louwe Kooijmans, 1987; Prummel, 1987; Raemaekers, 2003). Furthermore, people had access to large fish, which is especially true for the large specimens of sturgeon caught at Hekelingen III, Hellevoetlsuis Ossenhoek, Leidschendam Berberis, and Vlaardingen Arij Koplaan (Beerenhout, 2009, p. 153; 2010, p. 63; Buitenhuis & Veldhuis, 2020, p. 208; Louwe Kooijmans, 1986, p. 18). Most of the species known to have been used for the processing of fish leather are known from VLC sites (Tab. 5.4).[11] Resources for making fish leather would therefore have been readily available during this period. Furthermore, use-wear traces resulting from processing fish have occasionally been encountered on flint objects from the VLC (Houkes et al., 2017; Mullaart, 2016; also see chapter 6 and 9). One scraper from Den Haag Wateringse Binnentuinen was used to scrape fish, which could potentially be related to the processing of fish skins for the production of fish leather (Mullaart, 2016, p. 58).

Because it seems plausible, based on ethnographic sources, that fish skins might have been processed in the VLC period an experiment was set up to replicate use-wear traces resulting from the processing of fish skin into leather. Salmon was used because these skins were relatively easy to obtain for the experiments, and because it is known from the VLC sites of Barendrecht Zuidpolder and Leidschendam Berberis (Brinkhuizen, 2001; Buitenhuis & Veldhuis, 2020; Moree et al., 2011).

5.3.1 Setup of the salmon skin experiments

The *chaîne opératoire* for making fish leather consists of three main steps in which flint tools could be used. Namely, the descaling of fish, the cleaning of the flesh side of the fish skin, and finally the scraping of dried fish skin during the softening stage. Descaling skins does not directly indicate the production of fish leather as this step can also be related to fish consumption (Van Gijn, 1986a). The other two steps are not related to consumption. If these steps can be identified in the archaeological record they provide evidence for the production of fish leather. In the experimental program we used flint scrapers for all three steps; the descaling, defleshing (removing the remaining fat and tissue from the flesh side), and the scraping of dried fish skin. The scrapers were handheld during use, i.e. they were not hafted. The salmon skins were acquired from a fish processing company. The fish were thus already skinned, and the skins we got were halves (the fish was cut in half lengthwise along the spine and belly). The heads and tails of the fish had been removed.

11 Only four marine fish species which have been ethnographically documented to have been used for fish leather are not known from Vlaardingen Culture sites: wolffish; porbeagle, lumpfish, and shark (Vávra, 2020).

Exp. number	Process	Duration (minutes)
2983	Descaling fresh salmon skin	17
3070	Descaling fresh salmon skin	135
2973	Defleshing fresh salmon skin	71
3034	Defleshing fresh salmon skin	87
4270	Defleshing dry salmon skin	30

Table 5.5 Fish descaling and defleshing experiments using flint scrapers.

Exp. number	Distribution of polish	Brightness	Polish	Directionality	Non-polished isolated spots	Linear streaks of polish
2983	Broad band along the edge	Bright	Rough and matt	None	Yes	No
3070	Broad band along the edge	Bright	Rough and matt	Transverse	Yes	No
2973	Band along the edge	Bright	Rough and matt, fairly smooth	Transverse	No	No
3034	Broad band along the edge	Bright	Rough and matt, fairly smooth	Transverse	Yes	Yes

Table 5.6 Resulting wear traces observed on the scrapers used on fresh salmon skin.

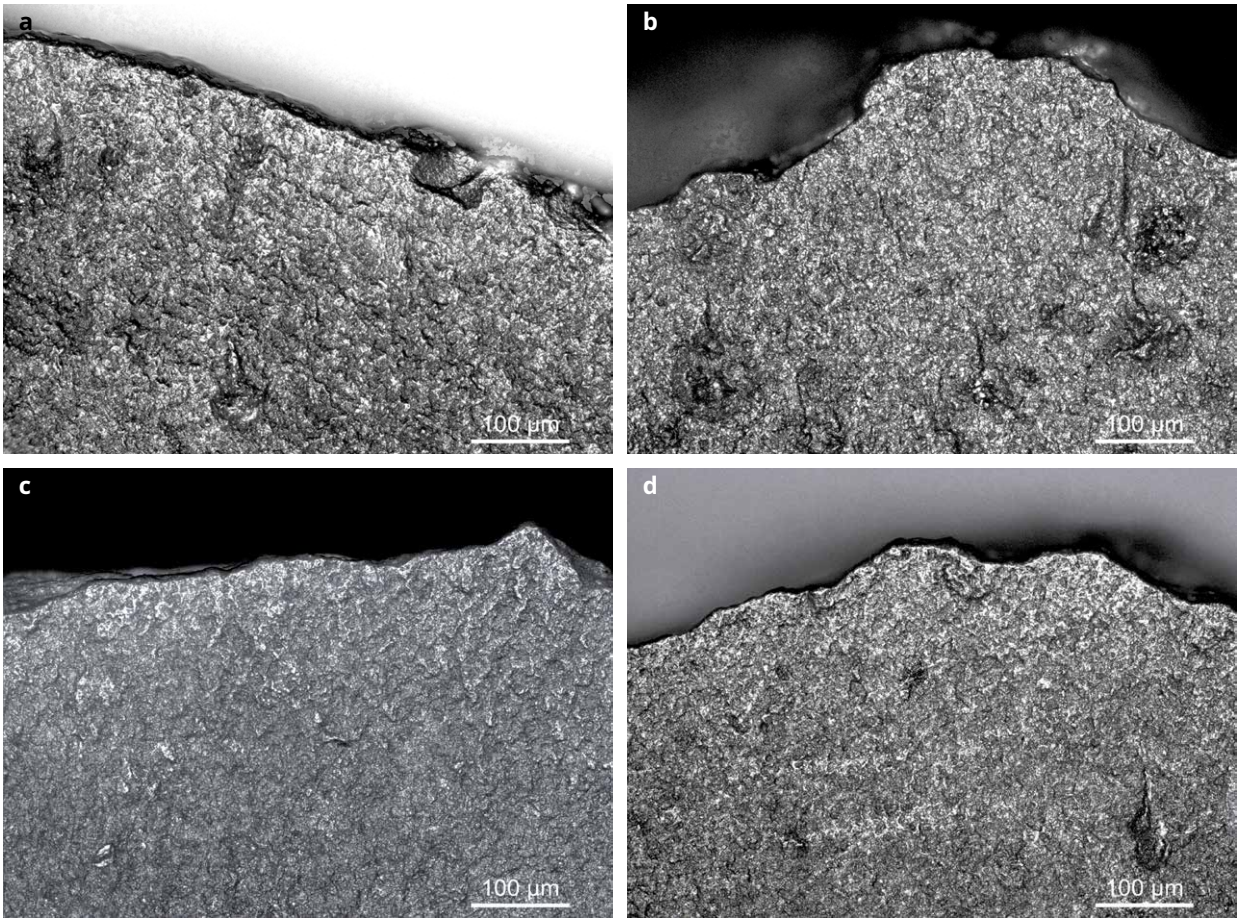


Figure 5.5 Results of the descaling and defleshing experiments: a) band of rough and matt bright polish on experiment 3070; b) weakly developed band of polish and isolated spots which are not polished on experiment 2983; c) band of bright polish on experiment 2973; d) band of bright polish and streaks of polish behind the edge on experiment 3034.

To create leather from fish skins the first step is to remove the scales. This can partially be done while washing the skins in water (at least in the case of salmon, this varies per species). When the skin is stretched the scales largely pop out after which they can be removed by hand. However, not all scales are removed in this process. Therefore the skin needs to be scraped to remove the remaining scales. They were laid on a small smooth log after which the scales were scraped off with handheld flint scrapers. After descaling the skin was washed again. Next they were again put on the log with the inside out, to remove the meat, fat and hypodermis. Different scrapers were used for these different stages (descaling and defleshing). After this the fish skins were dried. One experiment was carried out in which a dried salmon skin was scraped to understand dry skin scraping traces resulting from scraping dried fish skin.

In total four scrapers were used for defleshing and descaling (Tab. 5.5). It could be noted that descaling of skins was done rapidly. After washing it took about 4–10 minutes to descale one (half) skin. By contrast it took us approximately one hour on average to deflesh one fresh (half) skin. Because of time constraints we decided to, at least, descale all skins and to only deflesh them as far as we could. The remaining descaled skins were dried. In addition to these experiments we also conducted an experiment in which we used shell to descale the skins. It was noted that a blunt shell was far more effective (presumably because of its larger working surface, and because the blunt edge did not damage the skins). With a shell it only took about 2 minutes to descale one skin. Shell was only used for descaling as the shell seemed to be too blunt to be used for defleshing. After the skins were dried two were further defleshed with a scraper in a dried state.

5.3.2 Results defleshing and descaling fresh salmon skin

In three cases (Exp. 2973, 3034, and 3070) the experiments display distinctive polishes. For experiment 2983 the polish was less well developed, most likely because it was only used for 17 minutes. On the other scrapers, both those used in defleshing and descaling, the polish is distributed as a band along the edge (Fig. 5.5 and Tab. 5.6). The polish of both processes can be characterised as a bright, rough, matt polish, sometimes with a greasy appearance. The polish is brighter and smoother than typical polish resulting from hide working. In three instances (all except Exp. 2983) a transverse directionality can be observed, indicating a scraping motion. Often isolated spots in the band, which are not polished, can be seen. These appear to be linked to descaling, possibly these are caused by parts of scales sticking to the tool, preventing those areas from becoming polished. In one case linear streaks of polish are observed, which are thought to be characteristic of fish processing (Van Gijn, 1986a; 1990b, p. 44). Interestingly, these are observed on a scraper (Fig. 5.6d) that was used for defleshing, while previous experiments linked these streaks to descaling fish (Van Gijn, 1990b, p. 44).

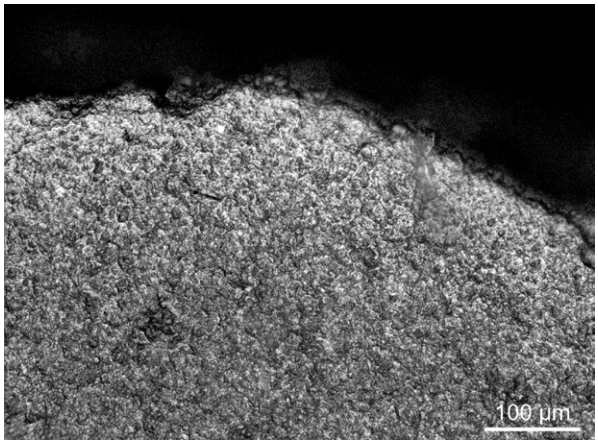


Figure 5.6 Band of rough and matt polish with clear edge rounding on experiment 4270.

In general, the polishes observed on the experimental tools match those observed on experiments aimed at processing fish for consumption (Van Gijn, 1986a; 1990b). As such, they cannot specifically be linked to the production of fish leather as these traces could either result from processing fish for consumption or from processing fish for leather production.

5.3.3 Defleshing dry salmon skin

Experiment 4270 was used for thirty minutes to deflesh dried salmon skins. It was noted that after 15 minutes the edge became noticeably blunt, which hampered the effectiveness of the tool. After thirty minutes the experiment was ceased due to the ineffectiveness of the tool.

On the edge a clear band of rough and matt, occasionally more greasy, bright polish can be observed. The polish has a clear transverse directionality and the edge is moderately to heavily rounded (Fig. 5.6). The polish can also be observed on the dorsal ridges. The polish resembles typical dry hide polish (Keeley & Newcomer, 1977; Van Gijn, 1990b). The scraper does not display characteristic aspects which we expect on fish processing tools. The polish was not corrugated, it did not have typical streaks of polish, or isolated spots which were not polished (Van Gijn, 1986a)[12]. Archaeologically tools used to scrape dry fish skins are therefore likely classified as 'dry hide' scraping tools, rather than as tools which are used to process fish skin.

12 See figure 5.5b for the non-polished isolated spots which appear to be a feature related to the descaling of fish skins.

5.3.4 Concluding remarks on the fish skin experiments

Unfortunately, a distinction between descaling and defleshing of fresh fish skin could not be made. Traces resulting from these processes seem to overlap. Processing fresh fish skins will leave a characteristic fish polish which can be distinguished from typical hide polish. Nevertheless, it is not possible to distinguish between processing fish for consumption and processing fish to make fish leather. Regarding the defleshing of the dry salmon skins it can be noted that these traces cannot be distinguished from other dry hide scraping traces.

5.4 The unusual suspects: hide working with axes

Several axes and axe fragments in the archaeological assemblages display traces resembling those from hide working. To better understand these traces two experiments were conducted.

5.4.1 Using an axe butt for softening dry hide

An interesting case is an axe butt fragment from Hekelingen III (Findnr. A1g/2066) which displays heavy rounding and a rough and matt polish, thought to be related to dry hide working. Since defleshing, dehairing, cutting and piercing hide require sharp edges or a sharp point, it is unlikely that the axe butt was used in these processes. The only process in which a blunt object, like an axe butt, can conceivably be used is the softening stage in hide-processing. As part of the *Putting Life into Late Neolithic Houses* project an oak dugout was replicated in Masamuda using reconstructed Neolithic tools (Van Gijn, 2021b). During these experiments, several flint axes broke. These broken tools often display a characteristic end-shock fracture (similar to the butt end from Hekelingen III). It was decided to use one of these axe butts (Exp. 3572) for the experiment.

A dry fat cured red deer hide was used for the experiment. The hide was soaked and dried again, because such hides will stiffen after they get wet, and therefore they need

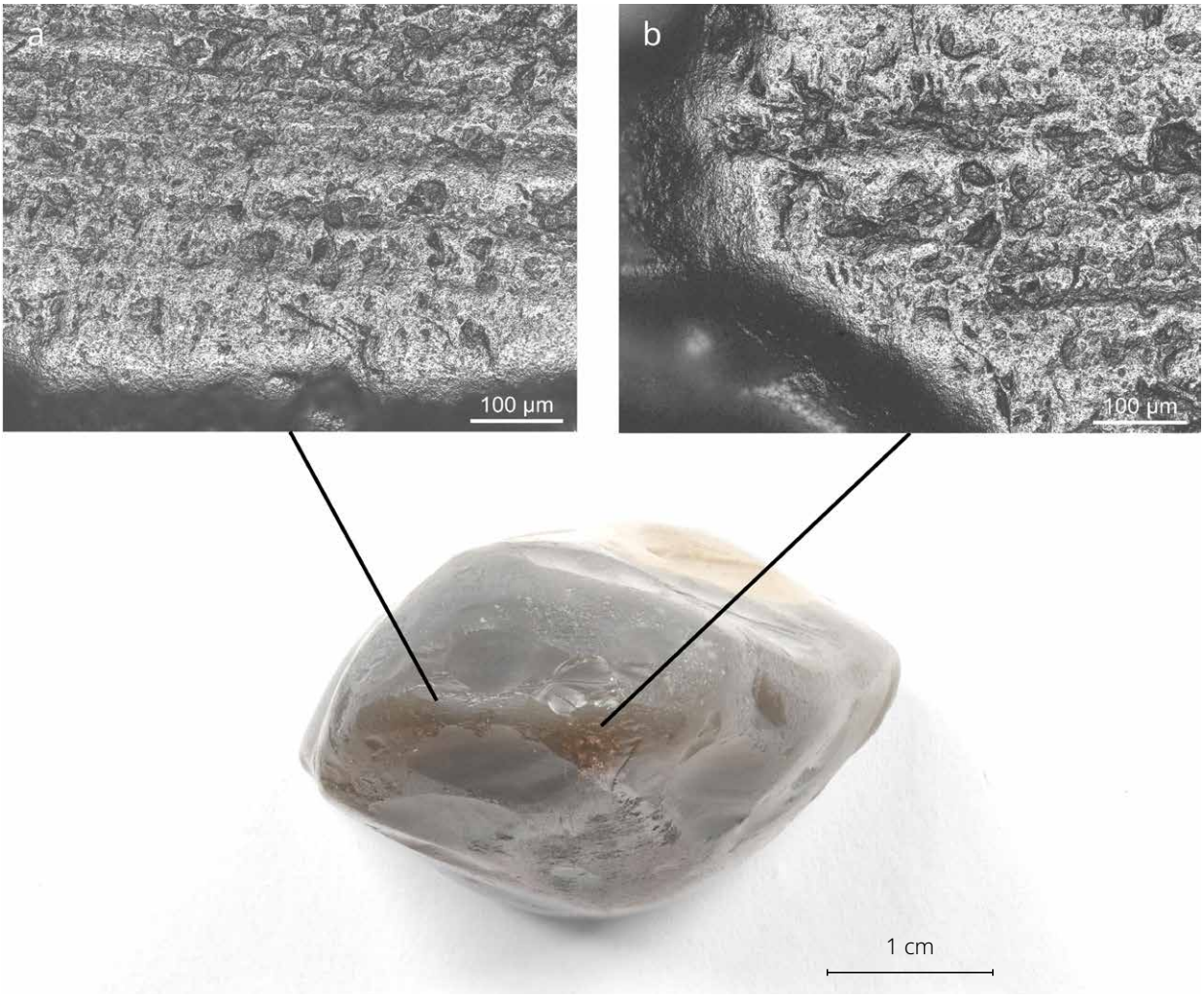


Figure 5.7 Axe butt (Exp. 3572) with a and b) rough and matt polish and heavy rounding from softening a fat cured red deer hide.

to be softened after soaking. To soften the hide, it was first soaked for one night, after which it was stretched between two poles and a beam in Masamuda. While the hide was drying it was forcefully rubbed with the axe butt in multiple directions. Occasionally, the butt end was dipped in sunflower oil to add some fat to facilitate the softening. In the process the hide frequently needed to be stretched further, for which the ropes were increasingly tightened to keep the hide stretched. The axe butt was used for a total of 68 minutes. Halfway through the process the hide was already more or less dry but the softening was continued after this.

After use, the axe butt displayed heavy edge rounding on all sides of the butt, along with a clear band of rough and matt polish. The polish does not have a clear directionality, but the band of polish is gradually fading (Fig. 5.7). The axe butt was used in multiple directions which explains the absence of clear directionality in the polish. Although the grinding traces from manufacturing the axe were well visible, they can easily be distinguished from the use-wear traces. The latter are generally confined to the edges where they are associated with heavy rounding (Fig. 5.7a and b).

5.4.2 Axes for hide scraping

To better understand the potential hide scraping traces observed on cutting edges of axes and axe fragments from Hekelingen III, Den Haag Wateringse Binnentuinen, and Den Haag Gavi Kavel another experiment was conducted using an axe to scrape a tannin-tanned fallow deer hide (experiment 4349). The flint axe was made by D. Pomstra, and it was used for 72 minutes to scrape the hide, aided by olive oil to soften it. The edge of the experiment displays extensive edge rounding and a band of rough and matt polish with transverse directionality (Fig. 5.8). As such it resembles typical dry hide polish (Van Gijn, 1990b). The polish is confined to the working edge and clearly associated with the rounding. The traces can be distinguished from the production traces, which are generally more smooth and matt and associated with striations running parallel to the working edge (Fig. 5.8).

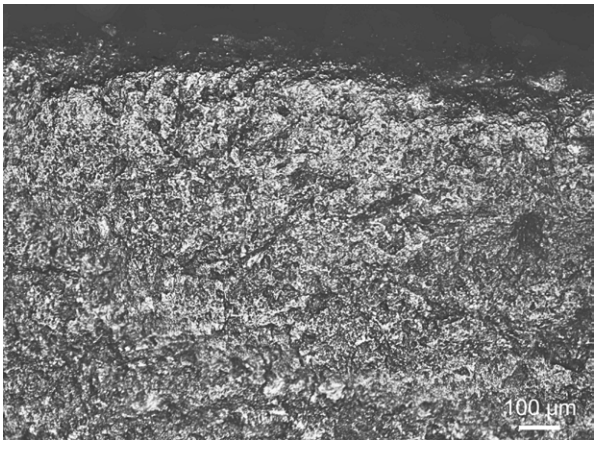


Figure 5.8 Microscope photo of the cutting edge of experiment 4349 displaying edge rounding and a band of rough and matt polish with transverse directionality.

5.5 Experiments with horn

An underexplored category of use-wear traces are those resulting from working horn. Compared to antler or bone, horn preserves poorly in prehistoric contexts. The earliest archaeological finds of horn in the wider region come from ritual depositions in the peatlands of Drenthe, where they date back as far as the early Neolithic Swifterbant Culture. Several horns from these peatlands date back to the FBC and CWC phases, and are thus contemporary with the VLC period (Prummel & Van der Sanden, 1995). These horns constitute intentional depositions, but these horns do not appear to have been worked or further processed. Nevertheless, they do signify the importance of horn for Neolithic societies (Prummel & Van der Sanden, 1995). The earliest cited example of worked horn in the Netherlands is the early Bronze Age dagger from Bargeroosterveld which has a well-preserved 'horn' handle (Butler & Van der Waals, 1966; Van Vilsteren, 1987). However, in their recent overview of osseous and keratinous objects in the Netherlands Rijkelijkhuizen et al. cast doubt on the identification of the handle as horn. They consider it likely that the haft was in fact made from antler, rather than horn (Rijkelijkhuizen et al., 2024, p. 39).[13] Excluding the dagger handle, the first undisputed horn artefacts in the region consist of several Iron Age combs from the terp in Ezinge and a small tube or ring made from cattle horn from the terp at Kimswerd (Rijkelijkhuizen et al., 2024, pp. 39–42). A final, albeit indirect, prehistoric example is provided by the golden decorated band of a drinking horn which was found in Eigenbilzen (BE) which is dated to the Early La Tène period (Creemers et al., 2024; Mariën, 1987). From later Roman, Medieval and Post-Medieval times horn artefacts are more often preserved, and being used to make a wide variety of objects including combs, hafts, spoons, and frames for glasses (Kinmonth, 2018; Riddler et al., 2012; Rijkelijkhuizen, 2013; Rijkelijkhuizen et al., 2024; Van der Kamp, 2003, p. 30; Van Vilsteren, 1987).

Horn is thermoplastic, which means it becomes soft and malleable when heated (Rijkelijkhuizen, 2013). With Stone Age tools it would be relatively easy to work with, and it can be employed for a wide variety of purposes. During the Neolithic we can expect the material to be widely available, as virtually all VLC sites have cattle bones (Brinkkemper et al., 2011). Especially on sites in the coastal dune area

13 In Dutch the term *hertshoorn* (literally deer horn) is occasionally used to refer to antler. It is possible that their use of the term *hoorn* thus refers to *hertshoorn* rather than cow or unicorn horn.

Exp. number	Motion	Duration of use (min)	Hafting	Edge removals and rounding	Striations	Polish
3951	Cutting	33	Not hafted	Bi-directional edge removals fine. Edge rounding	Few parallel striations	Smooth and matt domed pitted polish, longitudinal directionality, isolated spots, 'fingering' polish
3952	Scraping	30	Not hafted	Unifacial edge removals, fine. Edge rounding	No clear striations	Band of rough and greasy polish, with isolated spots of domed smooth pitted polish, transverse directionality
3953	Scraping	30	Not hafted	Unifacial edge removals, fine. Edge rounding	No clear striations	Band of rough and greasy polish
3954	Scraping	30	Not hafted	Very fine mostly unifacial edge removals	Few perpendicular striations	Band of rough and greasy polish, with isolated spots of domed smooth pitted polish, transverse directionality
3955	Boring	30	Not hafted	Fine edge removals	No clear striations	Isolated spots of smooth domed bright polish. With bright rough polish
3956	Graving	41	Not hafted	Fine edge removals, edge rounding	Few striations	Domed smooth and matt pitted polish, 'fingering' rough and greasy further from the edge
3957	Scraping	60	Not hafted	Fine edge removals	No clear striations	Bright rough polish, with isolated spots of smooth and matt polish. Transverse directionality
3598	Graving	40	Not hafted	Fine edge removals	No clear striations	Bright rough polish, with isolated spots of smooth and matt polish
3959	Sawing	60	Not hafted	Fine edge removals	Frequent parallel striations, edge rounding in parts, non-continuous	Smooth and matt domed, pitted polish band along the edge. Band not continuous, mainly on higher parts of the retouches. Some parts with a more rough and greasy polish. With streaks of polish behind the edge
4444	Shaving	30	Hafted in bark strip	Unidirectional fine edge removals	Few small perpendicular striations	Smooth and greasy domed pitted polish
4445	Scraping	15	Not hafted	Few fine edge removals	Few small perpendicular striations	Small isolated spots of smooth and greasy domed polish

Table 5.7 Results of the soaked horn working experiments.

the faunal assemblages are dominated by cattle (Kooistra et al., 2024; Van Dijk, 2021; Van Dijk et al., 2017). It seems therefore plausible that horn was worked in prehistoric times, and it is occasionally mentioned as a material which could have been used by Neolithic communities (Van Gijn, 2010a, p. 97). However, due to the poor preservation of horn, we need to rely on use-wear analysis to demonstrate its use in Stone Age societies. Although several tools which were used on horn are present in the reference collection of the Laboratory for Material Culture Studies in Leiden, the use-wear traces resulting from working horn are not described in seminal use-wear publications (Keeley & Newcomer, 1977; Van Gijn, 1990b). Therefore, a series of experiments was conducted in an attempt to characterise use-wear traces resulting from working horn using flint tools.

5.5.1 Experimental setup and results

For these experiments complete cow horns as well as cow horn fragments were soaked overnight. They were worked with unmodified flint flakes, and for the sawing motion with a retouched blade. Three experiments were conducted by the author and R. Houkes. An additional eight experiments were conducted during the experimental archaeology days organised by the student association L.A.S. Terra in Leiden on the 3rd of April 2025. The experiments were conducted by students, colleagues, and other interested visitors, as well as by the author. The experiments included cutting, graving, sawing, scraping, shaving, and boring motions (Tab. 5.7).

The traces resulting from scraping horn can be characterised as a smooth, occasionally domed and pitted polish, but sometimes the polish is described as rough and greasy (Tab. 5.7, Fig. 5.9 and 5.10e and f). The polish tends to have few fine striations indicating the motion in which the tools were used. Macroscopically, small edge removals are observed. In the case of scraping motions these tend to be unifacial.

5.5.2 Can we recognise wear traces from the working of horn on flint?

Polish resulting from working horn shares many characteristics with polishes resulting from other activities. The smooth and pitted, sometimes domed, polish resembles traces produced by working bone, and especially antler. The rough and greasy polish and linked distribution (when well developed) of the polish is more akin to polish resulting

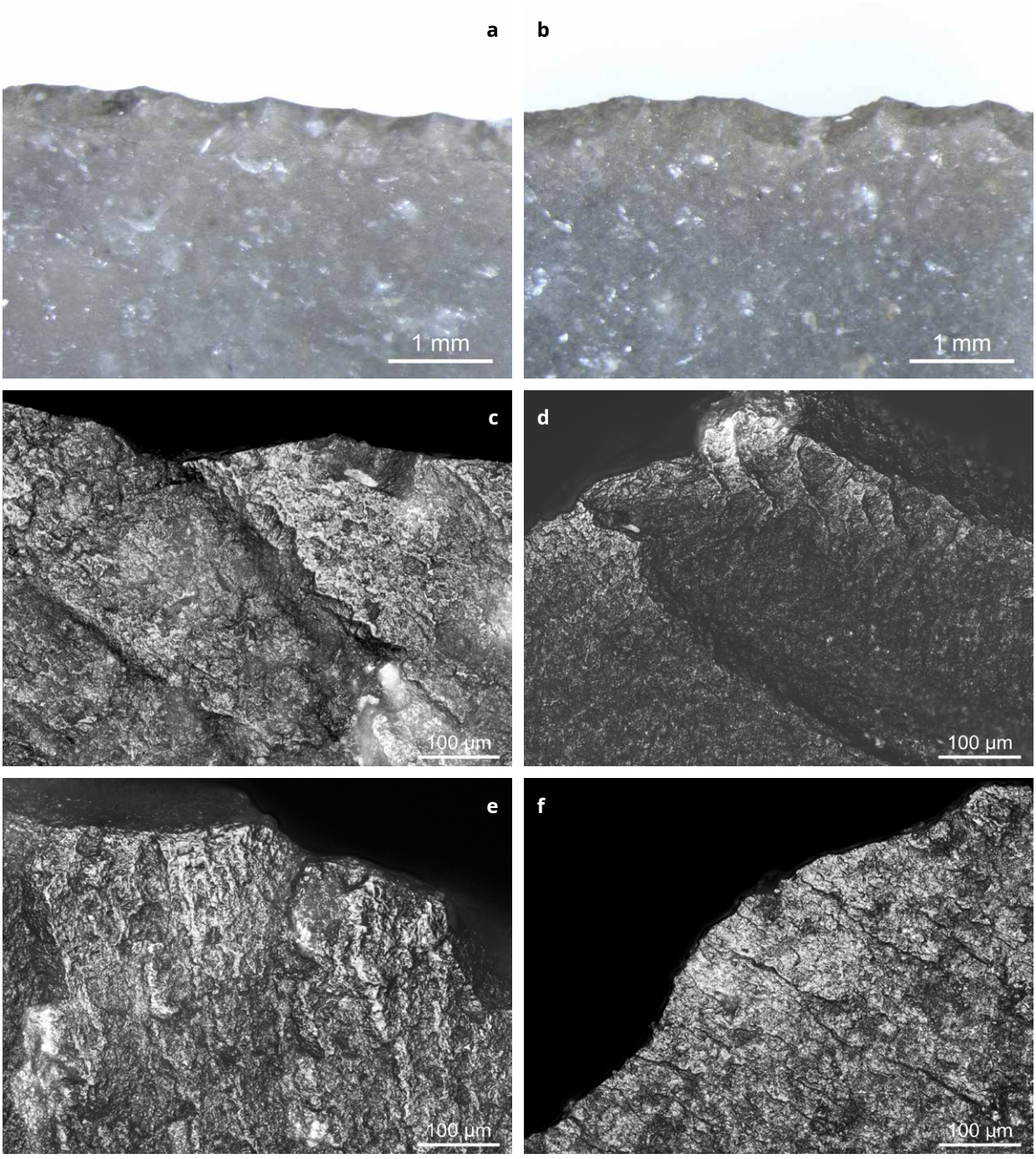


Figure 5.9 Use-wear traces on experiments with horn; a) small unifacial edge removals on Exp. 3954; b) small unifacial edge removals on Exp. 4444 c) smooth and greasy polish from scraping horn, Exp. 4444; d) domed smooth and greasy polish from carving horn on Exp. 3956; e) smooth and greasy polish with parallel striations resulting from cutting horn on Exp. 3951; f) band of smooth greasy polish resulting from scraping horn on Exp. 3952.

from hide working (Keeley & Newcomer, 1977, pp. 39–42; Van Gijn, 1990b, pp. 28–36). Macroscopically horn working leaves many fine edge removals (Fig. 5.9a and b). These are finer than those created by bone working or antler working. Considering such features tend to be absent in hide working traces, they are an important defining trait (Van Gijn, 1990b, p. 28). In Figure 5.10 the horn working experiments are compared to bone and antler working experiments from the reference collection of the Laboratory for Material Culture Studies. It can be observed that the horn working

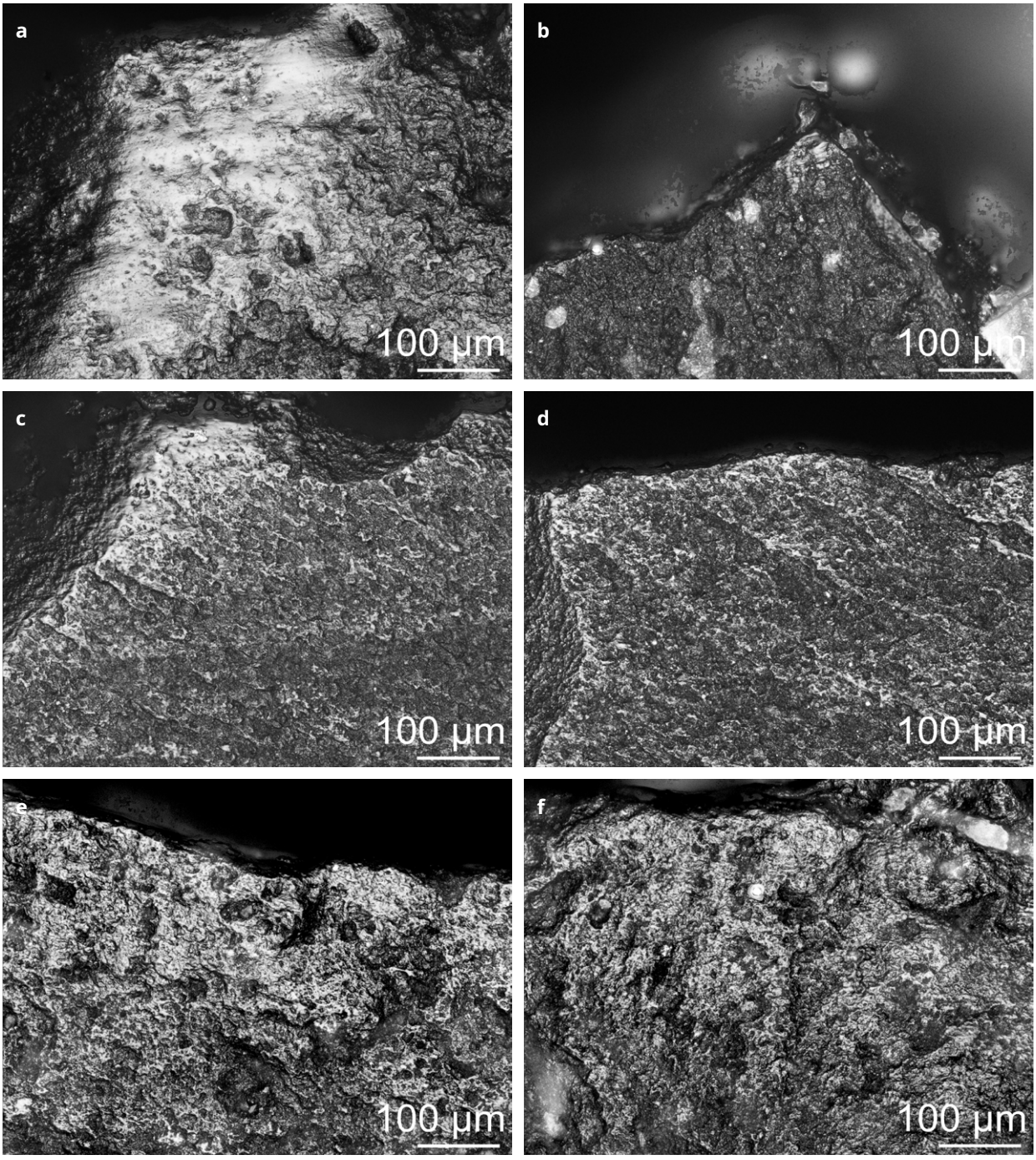


Figure 5.10 Comparing polish resulting from working bone, antler, and horn: a) bone working traces: domed, smooth, matt, heavily striated polish on Exp. 109; b) isolated spot of domed, smooth, matt striated bone polish on Exp. 48; c) domed, smooth, matt, 'fingering' antler polish on Exp. 903; d) smooth, matt, 'fingering' antler polish on Exp. 901; e) horn working traces: smooth, greasy band of polish with fine striations on Exp. 3959; f) horn working traces: edge rounding and a band of smooth and greasy with fine striations on Exp. 3959 (Laboratory for Material Culture Studies).

Axe number	Length x width x thickness (cm)	Weight (g)	Fragments with polished surface (n)	Fragments without polished surface (n)	Total	Percentage with polished surface
1	16.9x6.5x2.8	342	31	83	114	27.2%
2	18.1x5.9x2.7	327	35	53	88	39.8%
3	17.8x6.6x2.8	434	49	69	118	41.5%
4	20.8x6.8x3.2	848	75	71	146	51.4%
Total	-	-	190	276	466	40.8%

Table 5.8 Dimensions and results of the experiments, percentages of fragments with a polished or ground surface per axe (Van den Dikkenberg et al., 2024a).

experiments display rougher, greasier, and more linked polish than the bone and antler experiments (Fig. 5.10). Therefore, based on these features it should be possible to identify horn working tools in the archaeological record, if the traces are well developed. The polishes resulting from horn working to some degree also resemble polishes from hide working activities, but they can still be distinguished from the latter due to the smoothness of the polish and the systematic presence of edge removals (indicating that the tools were used on a harder contact material).

5.6 Recycling Neolithic axes

Axe fragments and flakes, resulting from the recycling of flint axes, are a ubiquitous feature at VLC sites (Van Gijn, 2010b; Van Gijn & Bakker, 2005). These axe fragments can be recognised because they have a remnant of the ground or polished outer surface of the original axe. This outer surface can be envisioned as an artificially created pseudo-cortex. As with flint nodules, if a nodule is knapped, only the flakes struck from the outside will display cortex; similarly, only those struck from the outside of the axe will display grinding or polishing traces. It is obvious that during the initial recycling process all flakes struck from broken flint axes will have a remnant of this ground or polished surface. But, as with the decortication of nodules, we can expect that in further stages of the reduction sequence flakes and waste products might no longer display facets of this recognisable outer surface. This could indicate that our counts of axe fragments, as published in archaeological reports, do not represent the total number of axe fragments, since they only include flakes with a polished facet. To assess the representativity of these 'archaeologically visible' axe fragments, and to assess to what extent axe fragments remain 'archaeologically invisible', a series of experiments were set up (Van den Dikkenberg et al., 2024a). Below the key takeaways of the experiments are presented; the experiments are published in more detail in an article in *Lithic Technology* (Van den Dikkenberg et al., 2024a).

5.6.1 Setup of the experiments

For the experiments D. Pomstra replicated four oval flint axes, based on descriptions of typical Buren axes as provided by Bakker (2006). Three of the axes were created specifically for these experiments. A fourth axe was later added. This axe broke during the dugout building experiment in Masamuda (Van Gijn, 2021b). This axe provided an excellent addition, because we assume that archaeological axes which were flaked also likely broke during use, prior to them being recycled. Before the recycling experiments we decided to break two of the flint axes in halves, prior to flaking, to replicate an 'end-shock fracture', something that is often observed on archaeological axe fragments (Houkes et al., 2017). In the experiments D. Pomstra used the axes and axe fragments to create flakes which could have provided suitable tools, or blanks for suitable tools (Van den Dikkenberg et al., 2024a). In the experiments we aimed to reduce the axes to represent axe cores as we know them from VLC sites (Houkes et al., 2017; Houkes, 2021). Our results thus reflect 'an average VLC assemblage'. We also incorporated the micro-debitage of the experiments. This was analysed by T. Crombeen as part of her internship (Crombeen, 2021). The micro-debitage was analysed for the presence of potential polished or ground facets. This was done with the help of a stereomicroscope and a metallographic microscope.

5.6.2 Results of the experiments

The experiments resulted in a total of 466 flakes and fragments which were longer than 1 cm (Tab. 5.8). In addition 1870 fragments of micro-debitage (10–1 mm) were collected and analysed. It could be observed that only 190 out of 466 axe fragments >1 cm still have a ground facet. The other 276 axe fragments (40.8%) could no longer be recognised as axe fragments.

It seemed that the problem of archaeological invisibility is enhanced in the micro-debitage (Crombeen, 2021). Of the 1870 axe fragments (10–1 mm) only 497 have a ground facet (Tab. 5.9). The other 1373 fragments do not have a remnant of the outer surface of the axe. The micro-debitage is split into two fractions, one of 10–1 mm and another for 4–1 mm. It can be observed that archaeological visibility of axe fragments decreases with size. In the 10–4 mm fraction 23% of the axe fragments have a ground facet. For the 4–1 mm fraction this percentage dropped to 21%.

Axe number	Fraction	Flakes with polished surface	Flakes without polished surface	Percentage with polished surface
1	10–4 mm	20	58	26%
	4–1 mm	175	489	26%
2	10–4 mm	8	16	33%
	4–1 mm	119	540	18%
3	10–4 mm	11	56	16%
	4–1 mm	164	711	19%
Total	10–4 mm	39	130	23%
	4–1 mm	458	1740	21%
Total	10–1 mm	497	1870	21%

Table 5.9 Presence of polished surfaces on micro-debitage flakes by fraction (Crombeen, 2021; Van den Dikkenberg et al., 2024a).

5.6.3 Recycling, an underestimated practice

The experiments demonstrate that the importance of recycled flint axes in the VLC technological system has been severely underestimated. Listed counts and percentages of axe fragments in publications only represent an estimated ca. 41% of the total number of axe fragments on these sites (Van den Dikkenberg et al., 2024a). Based on these experiments we are now able to account for this invisible majority of axe fragments which cannot be recognised archaeologically. In previous estimates it was suggested that up to 10 or 20% of the VLC lithic assemblages consisted of axe fragments (Van Gijn & Bakker, 2005). Based on the present experiments it can be suggested that on some sites these percentages are much higher, more than 30% or even 40% (Van den Dikkenberg et al., 2024a). The experiments not only provide insight into the importance of recycling. In chapter 11 the experiments will also be used to estimate for several sites to what extent Hesbaye flint was imported as flint axes, rather than as nodules (see section 11.3.2).

5.7 Concluding remarks

The experiments presented in this chapter provide essential tools for the interpretation of the archaeological assemblages. The grinding and polishing experiments revealed new details about the production of flint axes (Van den Dikkenberg, 2024a). The hide working experiments highlight both the possibilities and, in the case of the salmon-skin experiments, the limitations of our interpretations. The horn working experiments suggest that horn should seriously be considered as a separate contact material. Polish resulting from horn working can now potentially be identified in the archaeological record. Presumably this category tends to be overlooked, or included in broadly defined groups such as ‘hard animal material’. Overall, we can conclude that actualistic experiments provide new angles for research. While the extensive reference collection in the Laboratory for Material Culture Studies provides a wealth of suitable reference materials, the traces for some categories such as horn working still deserve to be explored further. Better descriptions of traces, accompanied by clear microscope photos, should provide new interpretative possibilities in the future.

6

The coastal dune site of Den Haag Steynhof

The site of Den Haag Steynhof was selected for analysis because it is the most recent, large-scale, excavation of a presumably permanently inhabited VLC settlement in the coastal dune area (Van Zoolingen & Bulten, 2021b). The results in this chapter are presented from a biographical perspective (see chapter 3), starting with the raw material acquisition, followed by the technological analysis, and finally the functional analysis of flint artefacts. The study of raw materials and, for the most part, flint technology, was based on the work by Houkes (Houkes, 2021b).

6.1 Excavation and landscape setting

The site of Den Haag Steynhof was excavated between 2012 and 2019. It is situated on a coastal dune at the intersection of three landscape zones: the peatlands to the east, the dunes and beaches to the west, and a marine clay area to the south (Rieffe & Van Duijvenboden, 2021, p. 33). After 4000 BCE the North Sea receded, allowing the beach barriers to consolidate. Alluvial sands formed the first rows of coastal dunes. These dune rows were intersected by lower salt marsh plains that the sea could still flood, leaving behind marine clay deposits. By 2000 BCE the hinterlands were largely closed off from the sea, allowing extensive peatlands to develop in the lower parts of the landscape (Rieffe & Van Duijvenboden, 2021, p. 34). The site of Den Haag Steynhof is located on the oldest row of these coastal dunes (Fig. 6.1). Near the site several other VLC sites have been excavated: Den Haag Wateringse Binnentuinen, Den Haag Rhyenhof, Den Haag Noordweg 76, Rijswijk de Schilp, Rijswijk Schaapweg, and Rijswijk De Strijp are all located in a range of less than one kilometre from the site. The area has been inhabited since the beginning of the 4th millennium BCE (Lenoir & Van Zoolingen, 2021, p. 14–16).

6.2 Features, finds, and material selection

The site is interpreted as a permanently inhabited site dating between 2900–2550 BCE (Van Zoolingen & Bulten, 2021b, p. 309). The evidence for permanent occupation consists of the presence of robust structures and a dietary focus on agricultural products, as opposed to wild animals. The site is similar to the nearby site of Den Haag Wateringse Binnentuinen (Bulten & Stokkel, 2017; Van Zoolingen & Bulten, 2021b). The retouched tool assemblages on both sites are dominated by scrapers, which is thought to relate to an emphasis on hide working, something that, for the site of Den Haag Wateringse Binnentuinen, is supported by use-wear analysis (Houkes et al., 2017, p. 188; Mullaart, 2016; Van Zoolingen & Bulten, 2021b, pp. 291–309).

Three complete house plans of the type Den Haag were excavated at Steynhof (Fig. 6.2). Furthermore, a burnt layer was recovered, representing the remains of a funerary pyre. Lastly, eleven water pits were discovered (Van Zoolingen, 2021b, pp. 43–67). In terms of archaeological finds the site mainly has pottery, flint, and some non-flint stone artefacts (Bloo, 2021; Houkes, 2021a; 2021b). Evidence for subsistence strategies consists of animal bones, plant remains, and food residues (Kooistra et al., 2021; Kubiak-Martens

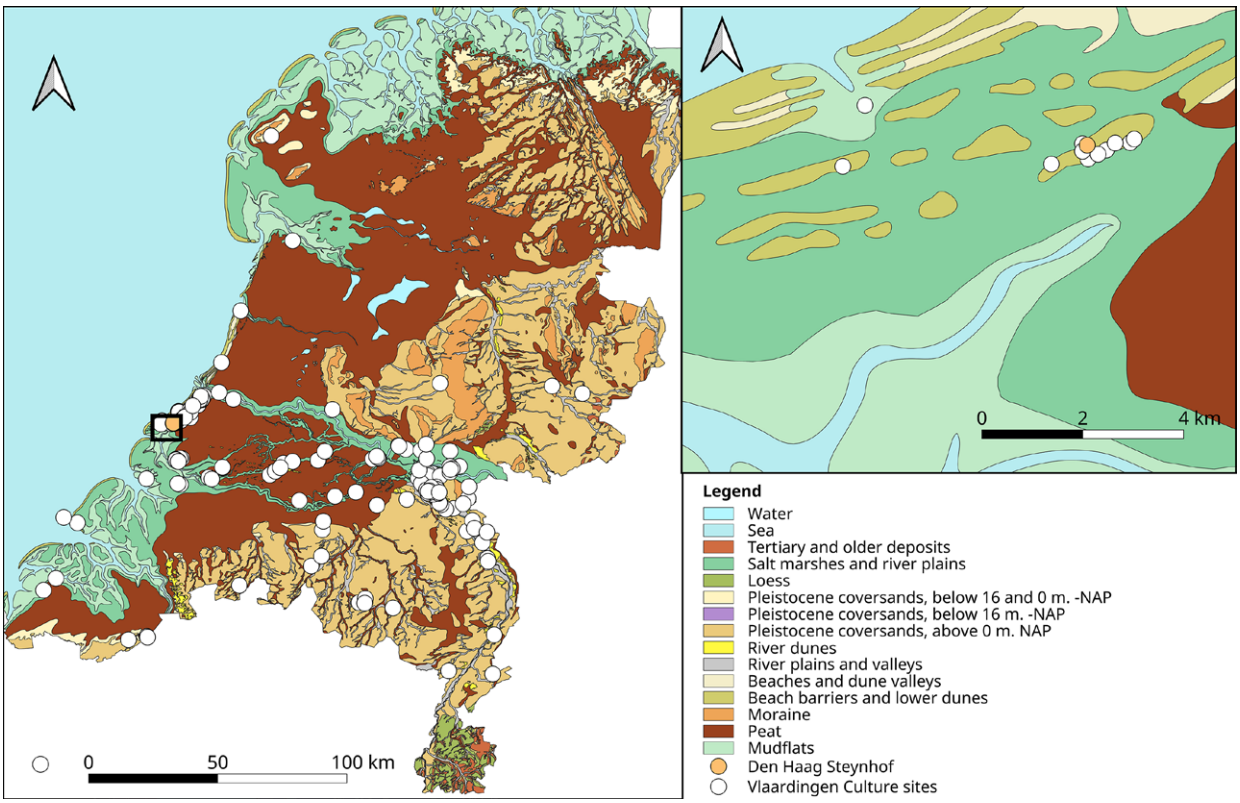


Figure 6.1 Site location of Den Haag Steynhof plotted on the palaeogeographic map of the Netherlands ca. 2750 BCE. The dune on which Steynhof is located was recently more accurately reconstructed in the publication by Kooistra et al. based on recent archaeological data. The new data are now incorporated in the palaeogeographic map depicted here (after Kooistra et al., 2024, p. 23; Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020).

Figure 6.2 Three house plans of the type Den Haag, found at Den Haag Steynhof (after Van Zoolingen, 2021b).

& Oudemans, 2021; Van Dijk, 2021). A study of the food crusts demonstrates that crushed, or ground, emmer wheat (*Triticum dicoccum*) was consumed at Steynhof. Furthermore, a fragment of naked barley (*Hordeum vulgare var. nudum*) was found (Kubiak-Martens & Oudemans, 2021, p. 248). Wild plants such as apples (*Malus sylvestris*), sloe (*Prunus spinosa*), hazelnut (*Corylus avellana*), blackberry (*Rubus fruticosus*) and elderberry (*Sambucus sp.*) were gathered near the site for consumption (Kooistra et al., 2021, p. 231). Zooarchaeological evidence revealed the importance of husbandry, mainly cattle herding. Hunting and fishing formed a minor contribution towards the diet of the inhabitants (Van Dijk, 2021, p. 195).

In total 2335 flint artefacts were recovered at the site (Fig 6.3). Most of the flint was found in the best-preserved part of the excavation around house plan 2 (Fig. 6.4). Due to the abundance of artefacts, and the association with a clear house plan, it was decided to focus the analysis on the flint found in and around house plan 2 (Fig. 6.5).

It is surprising that the finds are also concentrated inside the house (Fig. 6.4). At the centre of the house there seems to be an area largely devoid of finds. The analysis by Van Gijn

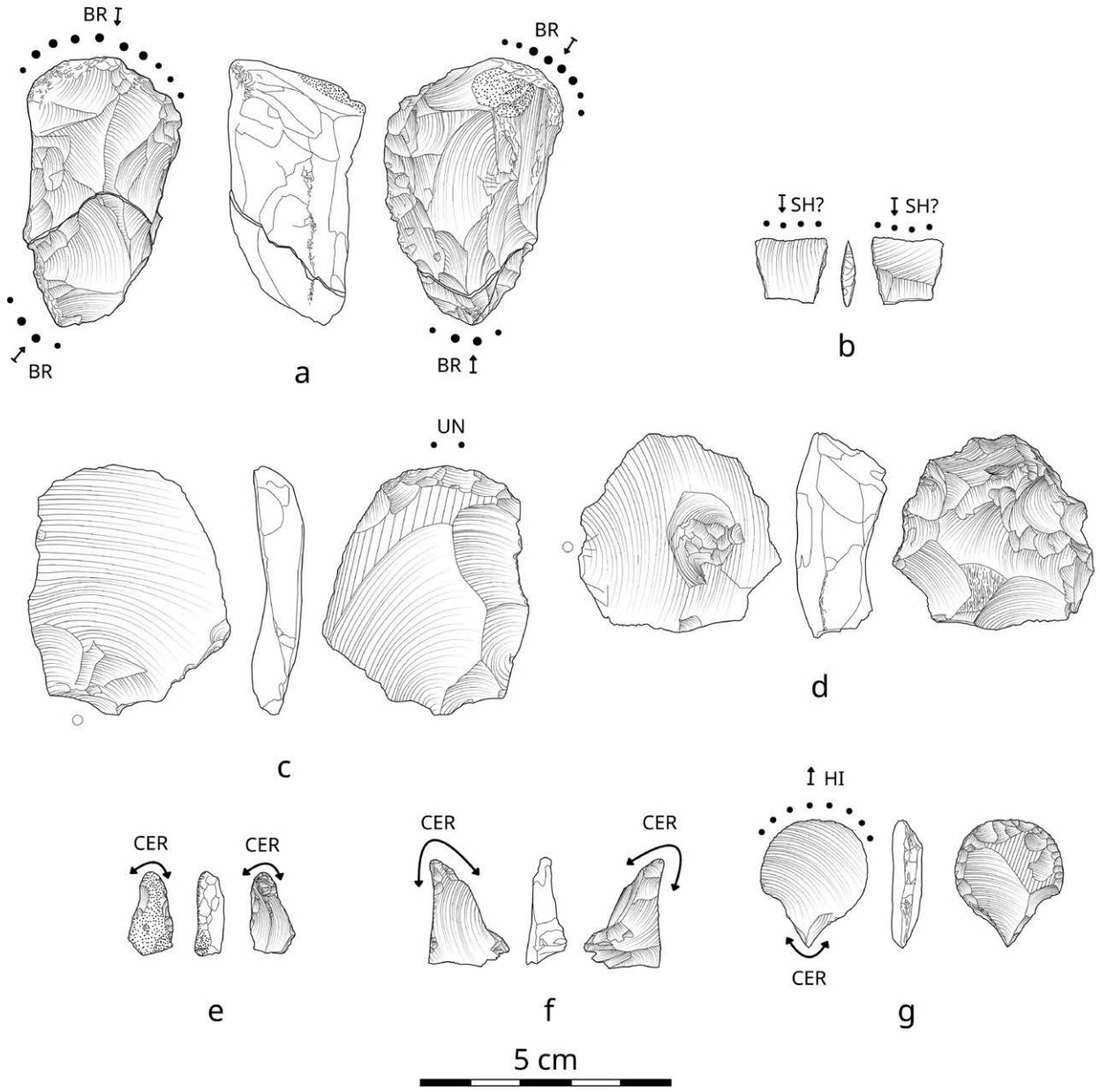


Figure 6.3 Flint artefacts from Den Haag Steynhof: a) strike-a-light used for pounding pyrite (STY17o.000422STN.1); b) transverse arrowhead, possibly used for shooting (STY17o.001538STN.1); c) scraper, used on unknown material (STY17o.001366STN.1); d) scraper with no interpretable use-wear traces (STY17o.001364STN.1); e) borer used to drill ceramic (STY17o.001249STN.4); f) borer used to drill ceramic (STY17o.000711STN.8); g) scraper/borer combination tool used to scrape hide and drill ceramic (STY17o.001591STN.2) (after Houkes 2021a, pp. 156–160, drawings by Marjolein Laan).

of the flint from trench 4, of the excavation at Leidschendam Prinsenhof, revealed that the central section of the trench was largely devoid of finds. Based on ethnographic parallels Van Gijn suggested that this was probably indicative of a long duration of occupation wherein the central structure was regularly cleaned (Van Gijn, 1986b; 1990b, p. 138).[14]

The empty zone in the central part of the house plan at Den Haag Steynhof, however, cannot be related to cleaning activity. Unlike the surrounding zones, this area was mechanically rather than manually excavated. The empty zone thus reflects methodological choices made during the excavation, rather than the actual Neolithic situation (Lenoir & Van Zoolingen, 2021, p. 21). Further on the distribution of artefacts will be analysed by plotting tools with use-wear traces on distribution maps. It should be noted that I do not assume that the distribution of tools with use-wear traces necessarily reflects activity areas. They could well represent

14 The interpretation was based on observations from ethnographic research she did in Djenné (Mali). Here it could be observed that more intensively used rooms were left cleaner upon abandonment (Van Gijn, 1986b, 177).

Figure 6.4 Distribution of flint artefacts at Den Haag Steynhof (after Rieffe & Van Duijvenboden, 2021, p. 44).

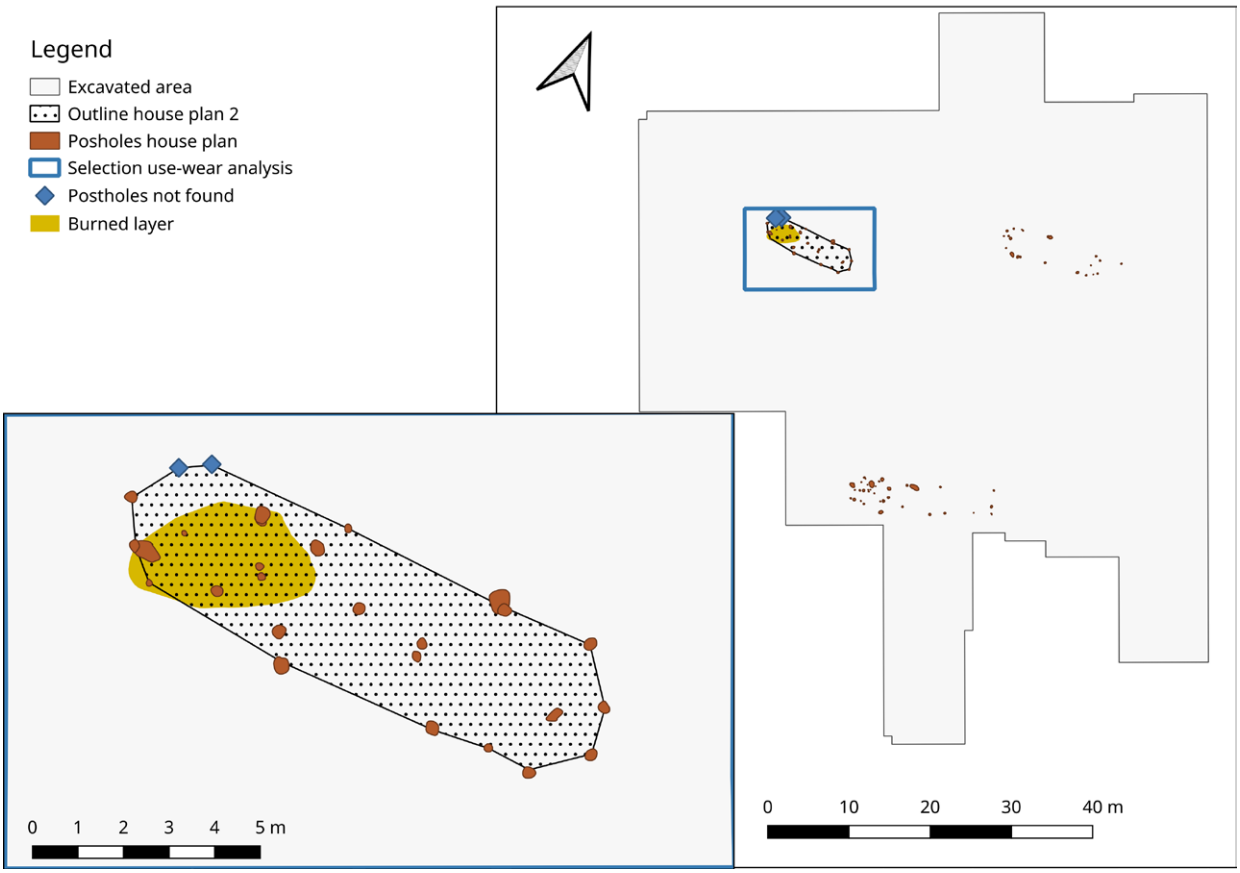


Figure 6.5 The selected zone around house plan 2 with the burnt layer indicated in yellow (after Rieffe & Van Duijvenboden, 2021, p. 44).

Assemblage	Number of artefacts
Total flint assemblage	2335
Number of artefacts in selected zone around house plan 2	1240
Selected for use-wear analysis	448

Table 6.1 Den Haag Steynhof, selection of artefacts for use-wear analysis.

refuse dumps. However, in the case of refuse dumps I would expect artefacts, regardless of their past use, to be located in the same areas across the site. If certain activities take place only in certain zones but not in others, this might be indicative of activity areas.

The house plan is also associated with a burnt layer which was interpreted as a funerary pyre. The house was dated to 2835–2350 cal BCE. The funerary pyre was dated 2559–2340 cal BCE. However, the cremation remains in the funerary pyre were dated 2891–2676 cal BCE (Van Zoolingen, 2021a, p. 287). It is surprising that the cremation remains appear to be older than the funerary pyre, an interpretation which seems stratigraphically impossible, likely indicating an error (although, in theory it is possible that older human remains, possibly dug-up from an older grave, were cremated the funerary pyre).

The selected zone in and around house plan 2 contains a total of 1240 flint artefacts (Tab. 6.1), comprising 53% of the total lithic assemblage (n=2335). The assemblage presents a typologically representative selection, mainly consisting of unmodified flakes, scrapers, and retouched flakes. Other tools such as borers, strike-a-lights and transverse arrowheads are present, but scarce (Tab. 6.2). In addition to a study of the raw materials, typology, and technology, a limited use-wear study had previously been carried out. Several borers and scrapers were studied by Carter, Petrogiannaki, and Van Gijn (Carter, 2021; Petrogiannaki & Van Gijn, 2024; Van Gijn, 2021a). Most of the flint (n=1044) comes from layer S960 which represents the prehistoric floor level (Houkes, 2021b, p. 142).

For the use-wear analysis all retouched tools were selected. In addition, all artefacts with macroscopically

	House plan		Burnt layer			Other						
	Housefloor (S38)	Postholes house 2 (S31, S34, S52, S54, S90, S97)	Burnt layer (S36)	Pit burnt layer (S37)	Postholes burnt layer (S46, S48, S89)	Pit predating house plan (S60)	Ground level (S960)	Water pit (S2)	Pits (S53, S87, S40, S105, S108)	Posthole other (S86)	S106 discoloration	Total
Blade unmodified	-	-	1	-	-	-	6	-	2	-	-	9
Block	2	-	1	1	-	-	94	1	-	-	-	99
Borer	-	-	-	-	2	1	13	-	1	-	-	17
Scraper/borer	1	-	-	-	-	-	-	-	-	-	-	1
Flake core	1	2	-	-	1	-	13	-	-	-	-	17
Core rejuvenation blade	-	-	-	-	-	-	1	-	-	-	-	1
Core rejuvenation flake	-	-	-	-	-	-	4	-	-	-	-	4
Flake unmodified	8	10	35	1	3	-	497	11	25	2	1	593
Notched flake	-	-	-	-	-	-	1	-	-	-	-	1
Notched waste	-	-	-	-	-	-	1	-	-	-	-	1
Transverse arrowhead	-	-	1	-	-	-	1	-	-	-	-	2
Potlid	1	1	1	-	-	-	35	-	-	-	-	38
Retouched blade	-	-	-	-	-	-	3	-	-	-	-	3
Retouched flake	-	-	4	-	-	-	41	-	-	-	-	45
Retouched waste	-	-	1	-	-	-	5	-	-	-	-	6
Strike-a-light	-	-	-	-	-	-	2	-	-	-	-	2
Scraper	7	1	23	-	4	-	185	-	3	1	-	224
Splintered piece	-	-	1	-	-	-	4	-	-	-	-	5
Unmodified nodule	-	-	-	-	-	-	15	-	-	-	-	15
Waste	-	11	3	1	3	-	123	3	11	-	2	157
Total	20	25	71	3	13	1	1044	15	42	3	3	1240

Table 6.2 Flint typology by context for the area selected (after Houkes, 2021b).

	Number of artefacts	Burnt	Unburnt	Indet	% Burnt	Patinated	Unpatinated	Indet	% Patinated
Zone selected for use-wear analysis	1240	374	791	75	30.2%	169	962	109	13.6%
Total assemblage	2335	755	1576	13	32.3%	329	1819	187	14.1%

Table 6.3 Burning and patination at Den Haag Steynhof, based on the total flint assemblage at the site (after Houkes, 2021b).

visible wear traces, points, and/or edges with a straight cross-section >1 cm were selected. The selection criteria are based on the criteria proposed and applied by Van Gijn for the assemblage of Hekelingen III (Van Gijn, 1990b, p. 104).

6.3 Flint preservation

The flint assemblage is relatively well preserved. In terms of burning and patination, the artefacts in the zone selected for use-wear analysis are comparable to those in the total assemblage (Tab. 6.3).

6.4 Flint procurement

Flint does not occur naturally in the coastal area of the Netherlands. Flint was therefore imported from other regions. The closest flint sources are found in the glacial deposits of the Utrechtse Heuvelrug (ca. 100 km from the site)[15]. Another regional source would be the glacial

15 Van Gijn noted that secondary flint deposits may also occur in ridges in the area of Bergen op Zoom, these however have not been studied and it is unknown how these flints should be characterised (personal communication A.L. Van Gijn, 2024).

	None	Indet	Chalk	Rough	Weath-ered	Eluvial	Smooth	Rolled	Old surface	Axe	Total	Total %
Indet	1119	84	13	207	25	17	9	37	7	87	1605	81.1%
Unknown	3	-	-	-	-	-	-	-	-	18	21	1.1%
Lanaye	5	-	-	1	-	-	-	-	-	-	6	0.3%
Hesbaye	149	-	-	-	-	-	-	-	-	62	211	10.7%
Northern flint	16	-	-	12	5	-	-	1	3	-	37	1.9%
Cape Blanc Nez	-	-	-	-	-	-	-	4	-	-	4	0.2%
Meuse-egg	-	-	-	-	-	-	-	83	-	-	83	4.2%
Terrace	-	-	-	-	-	-	-	10	1	-	11	0.8%
Total	1292	84	13	220	30	17	9	135	11	167	1978	100%
Total %	65.3%	4.2%	0.7%	11.1%	1.5%	0.9%	0.5%	6.8%	0.6%	8.4%	100%	

Table 6.4 Flint sources and cortex types of the lithic assemblage (only artefacts larger than 1 cm) from Den Haag Steynhof (after Houkes, 2021b).

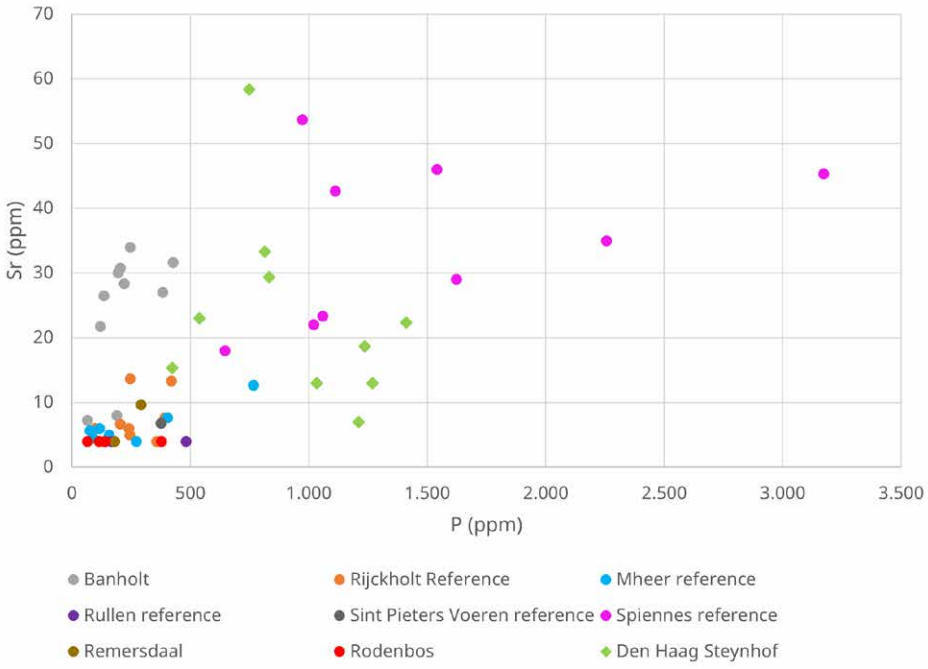


Figure 6.6 Spiennes and Lanaye flints: scatterplot of phosphorus (P) and strontium (Sr) values for reference sources, and for the Spiennes/Lanaye flints from Den Haag Steynhof (after Van den Dikkenberg & Braekmans, 2025).

deposits of Wieringen in the northern part of Holland (ca. 125 km from the site). Other flint sources are the flint mines in Belgium and Dutch Limburg. Flint from Hesbaye, located approximately 300 km from the site (Tab. 6.4),[16] constituted approximately 10.7% of the flint assemblage (Houkes, 2021b, p. 148).

In addition to Hesbaye flint, mined flint was imported from the flint mines of Spiennes and Rijckholt (Houkes, 2021b).

In total 26 artefacts were classified as Rijckholt or Spiennes flint (although none of these attributions can be made with certainty). Many of these flakes had a ground surface, which means that flint was often imported in the form of flint axes (or axe fragments). Although Rijckholt and Spiennes flint cannot be distinguished visually (De Grooth, 2011), chemical ED-XRF analysis demonstrated that Spiennes flint has higher phosphorus (P) and strontium (Sr) concentrations than Rijckholt and other Lanaye flints (Van den Dikkenberg & Braekmans, 2025). In Figure 6.6 the reference data for Spiennes and Lanaye flints are plotted along with the data from Steynhof. The assemblage contains both flints with high

16 Distances are based on reconstructed water-based routes, reconstructed using the palaeogeographic map of the Netherlands ca. 2750 BCE (Vos *et al.*, 2020).

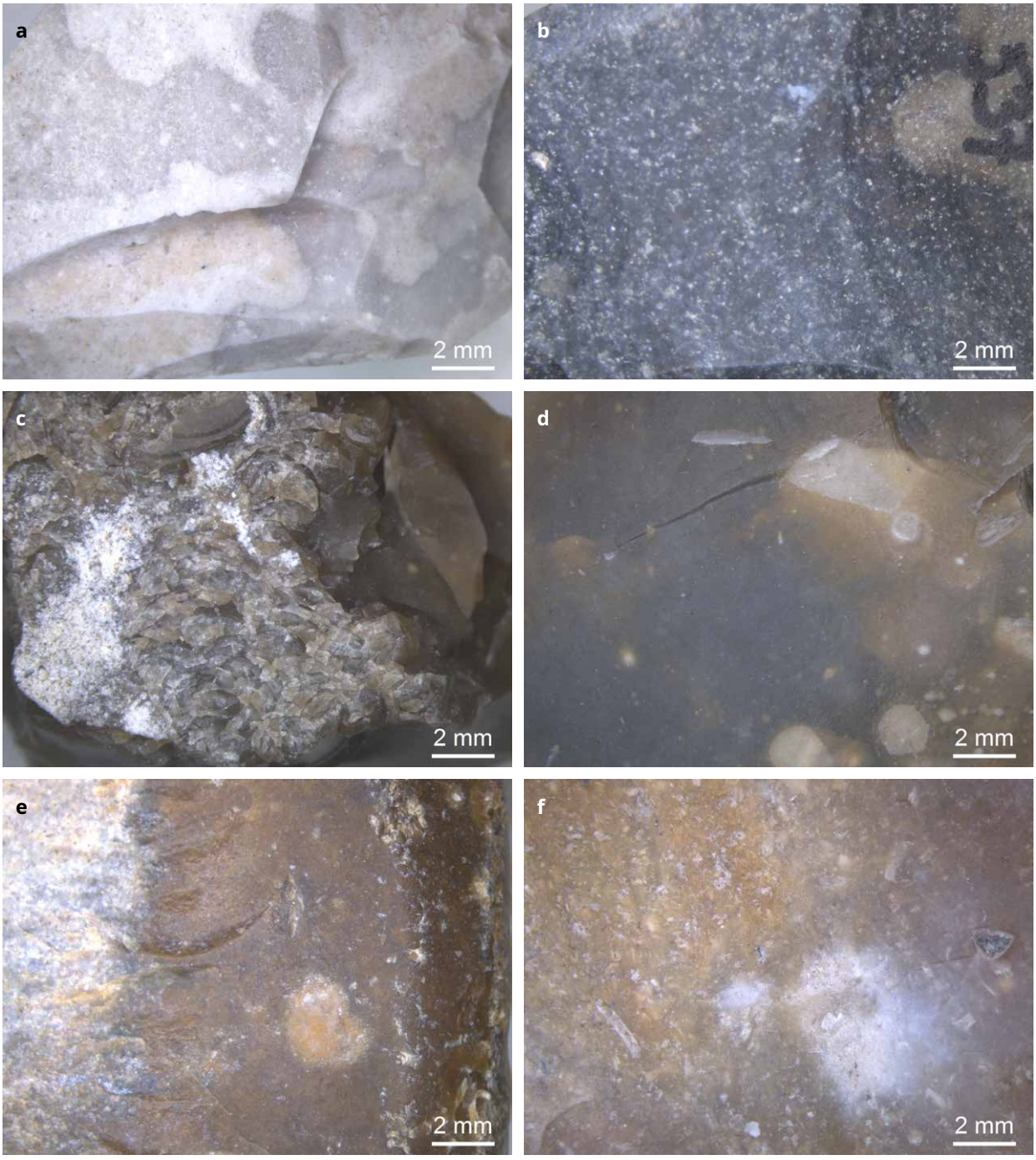


Figure 6.7 Flint sources at Steynhof photographed with a stereomicroscope; a) Hesbaye flint (STY17o.000186STN.9); b) Spiennes/Lanaye flint (STY17o.000537STN.5); c) Cap Blanc Nez flint cortex (STY17o.000575STN.1); d) Cap Blanc Nez flint matrix (STY17o.000575STN.1); e) terrace flint (STY17o.001273STN.1); f) northern bryozoan rich flint (STY17o.000702STN.4).

Sr and P values, comparable with Spiennes flint, as well as flint with low Sr and P values, similar to Rijckholt and other Lanaye flints (Fig. 6.6). The ED-XRF analysis thus demonstrates that both Spiennes and Rijckholt/Lanaye flint are present (Van den Dikkenberg & Braekmans, 2025).

In addition to flint imported from mining areas, Cap Blanc Nez flint, terrace flint, and Meuse-eggs were also found (Fig. 6.7). The northern flint in the assemblage is characterised by a high frequency of bryozoan fossils (Fig. 6.7f). Flint was extracted from a wide range of sources

Table 6.5 Terminations at Den Haag Steynhof, based on the total assemblage at the site (Houkes, 2021b).

	Feather	Step	Hinge	Plunging	Indet	Total
Counts	564	35	109	21	414	1143
Percentage	49.3%	3.1%	9.5%	1.8%	36.2%	100%

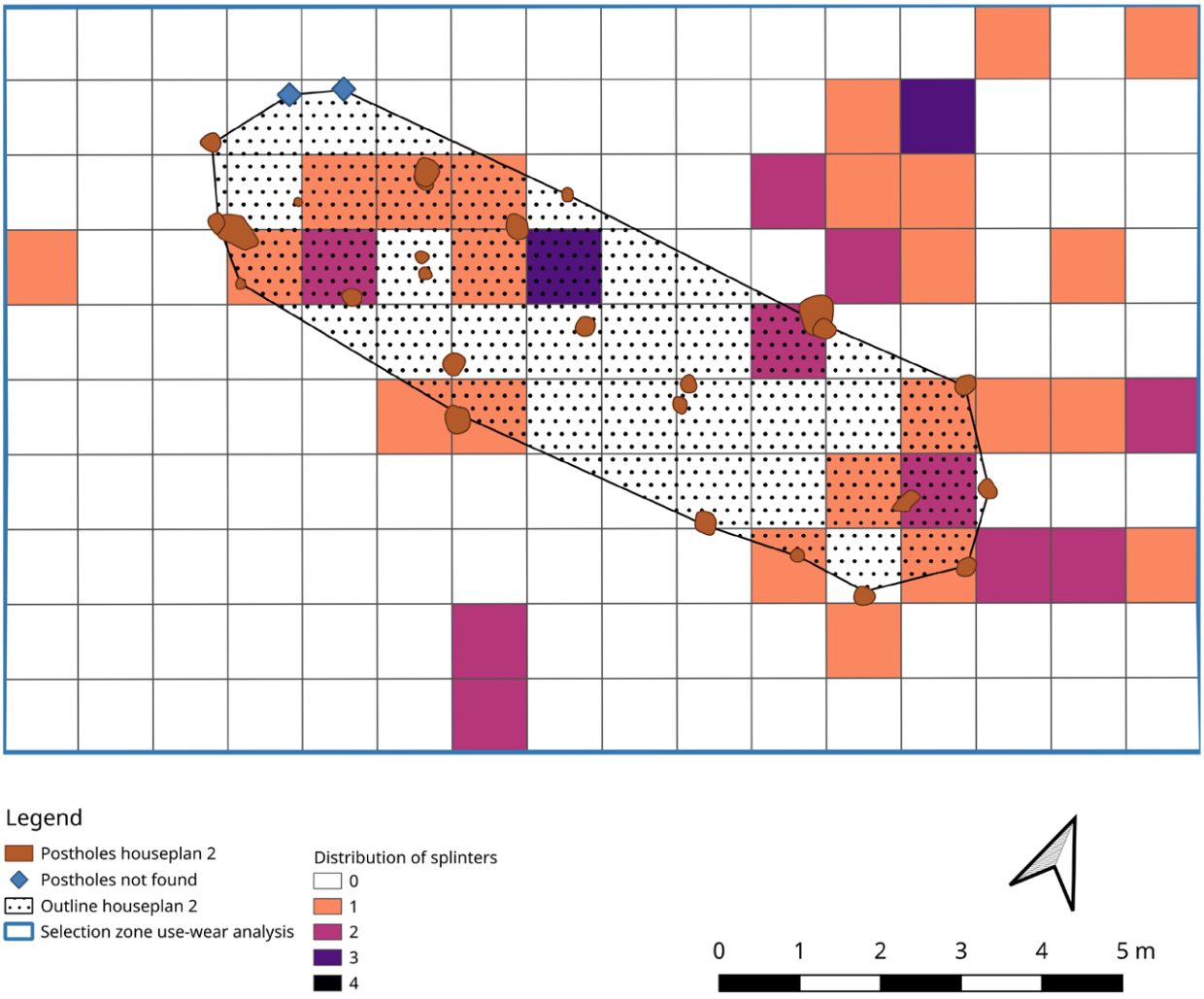


Figure 6.8 Distribution of flint splinters in the zone selected for analysis (after Rieffe & Van Duijvenboden, 2021, p. 44).

including flint collected in coastal regions to the south, flint from the ice-pushed ridges of the Utrechtse Heuvelrug or the Veluwe, and lastly flint from southern mining areas both in Limburg, Hesbaye, and in the Spiennes area (Houkes, 2021b).

6.5 Flint technology

Flint technology focused heavily on simple flake core reduction. Axes were imported as finished products, as indicated by the lack of production waste and axe roughouts. Blade cores are absent and blades in general are scarce. Most of the objects classified as blades were not produced in blade-core reduction, but were likely accidental byproducts of flake production. Only ten out of 45 blades had triangular or trapezoidal cross-sections, indicating true blade-core reduction (Sain & Goodyear, 2016). It is likely that those blades, like the axes, were imported as finished products to the site considering the overall absence of blade cores (Van den Dikkenberg, 2024b).

6.5.1 Percussion types and terminations

Most flint (80.2%) was worked using hard hammer percussion (n=830). On only 11.7% of the flakes, a soft hammer percussion technique (n=123) appears to have been applied (Houkes, 2021b). A bipolar technique was

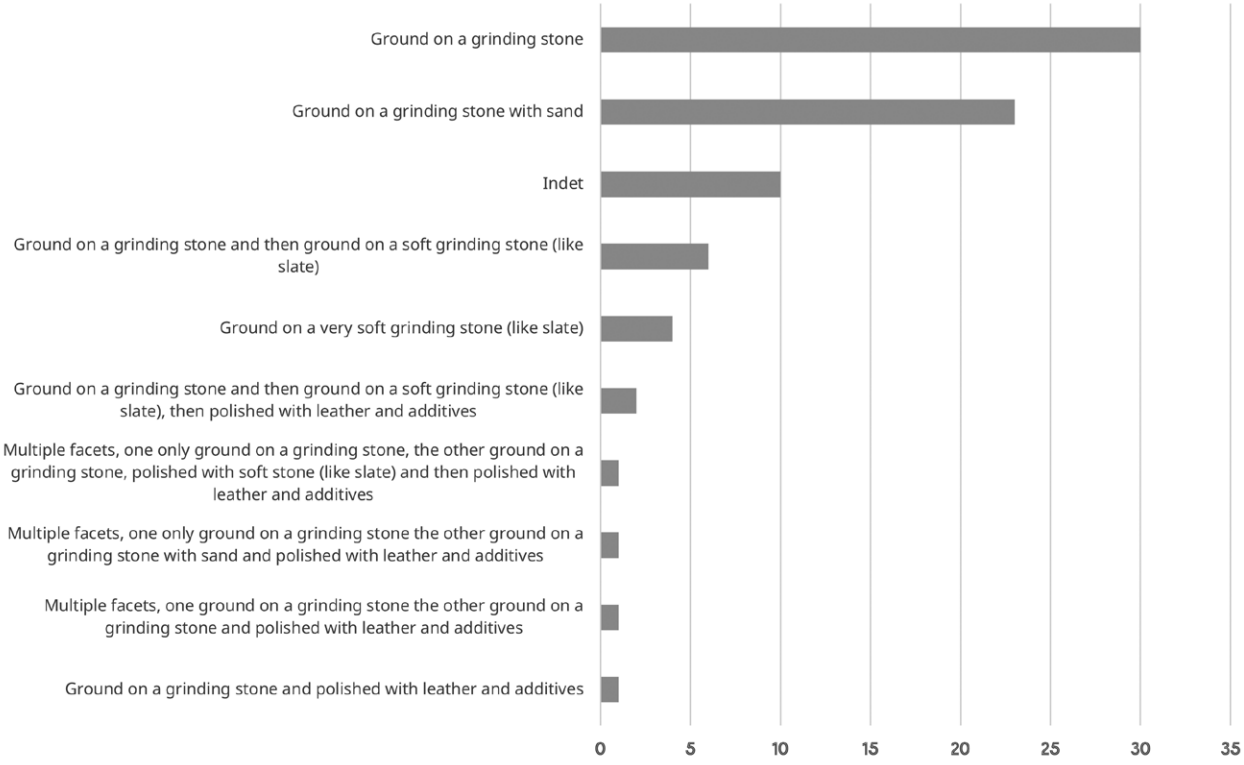


Figure 6.9 Axe finishing traces at Den Haag Steynhof.

identified on 8% (n=83) of the flint. The presence of splinters and tiny waste flakes (smaller than 10mm) indicates that flint was knapped on site (Houkes, 2021b, pp. 151–152). The dominance of hard percussion and the focus on the production of flakes corresponds with general observations on flint technology in the VLC (Van Gijn, 2010b, p. 83). Feather terminations dominate the assemblage, although hinge, step, and plunging terminations are also common (Tab. 6.5).

Because sieving was part of the excavation strategy, small flint artefacts, such as splinters, were also retrieved. Such small objects are unlikely to have been transported deliberately by prehistoric people. Therefore, they provide a strong indication of knapping areas (Clark, 1986). In Figure 6.8 the distribution of flint splinters is visualised. Splinters are present both inside house plan 2 and outside of the house. This potentially indicates that flintknapping likely took place both outdoors and indoors. The distribution does not indicate a specific area designated for flint knapping.

6.5.2 Axe production traces

The finishing traces observed on axe fragments predominantly display grinding traces, either resembling traces from grinding flint on sandstone or traces from grinding flint on sandstone with the inclusion of sand (Fig. 6.9 and 6.10b). Polishing traces are scarce, mostly resembling those resulting from polishing on soft stone (Fig. 6.10d). Polishing traces rarely resembled those produced by polishing with leather and additives (Fig. 6.10f). As such, the assemblage is comparable to the assemblage from the nearby site Den Haag Wateringse Binnentuinen (Van den Dikkenberg, 2024a; see chapter 7).

It is unclear to what extent the grinding traces resemble traces from resharpening. Sandstone grinding stones were also found at the site, which might have been used to resharpen axes (Houkes, 2021a, p. 127). Occasionally, multiple types of production traces were found on a single axe fragment (Fig. 6.10b and f). In one case this could explicitly be linked to resharpening, because polishing traces occurred only in deeper flake negatives, while the higher surfaces displayed only grinding traces (Van den Dikkenberg, 2024a).

6.6 Results of the use-wear analysis

Following the selection criteria mentioned in section 6.2 a total of 448 artefacts were selected for use-wear analysis, 317 of which displayed wear traces (Tab. 6.6). Thus, 25.6% of all artefacts in the selected zone (n=1240) showed use-wear traces. Most tools displayed a single used zone, but several tools showed multiple used zones (Tab. 6.7).

Scrapers were the most commonly used artefacts (Tab. 6.8). Unmodified flakes, retouched flakes, and borers were also frequently used (Tab. 6.8). Of the total assemblage 20.2% consists of unretouched tool types, such as unmodified flakes and waste pieces. This

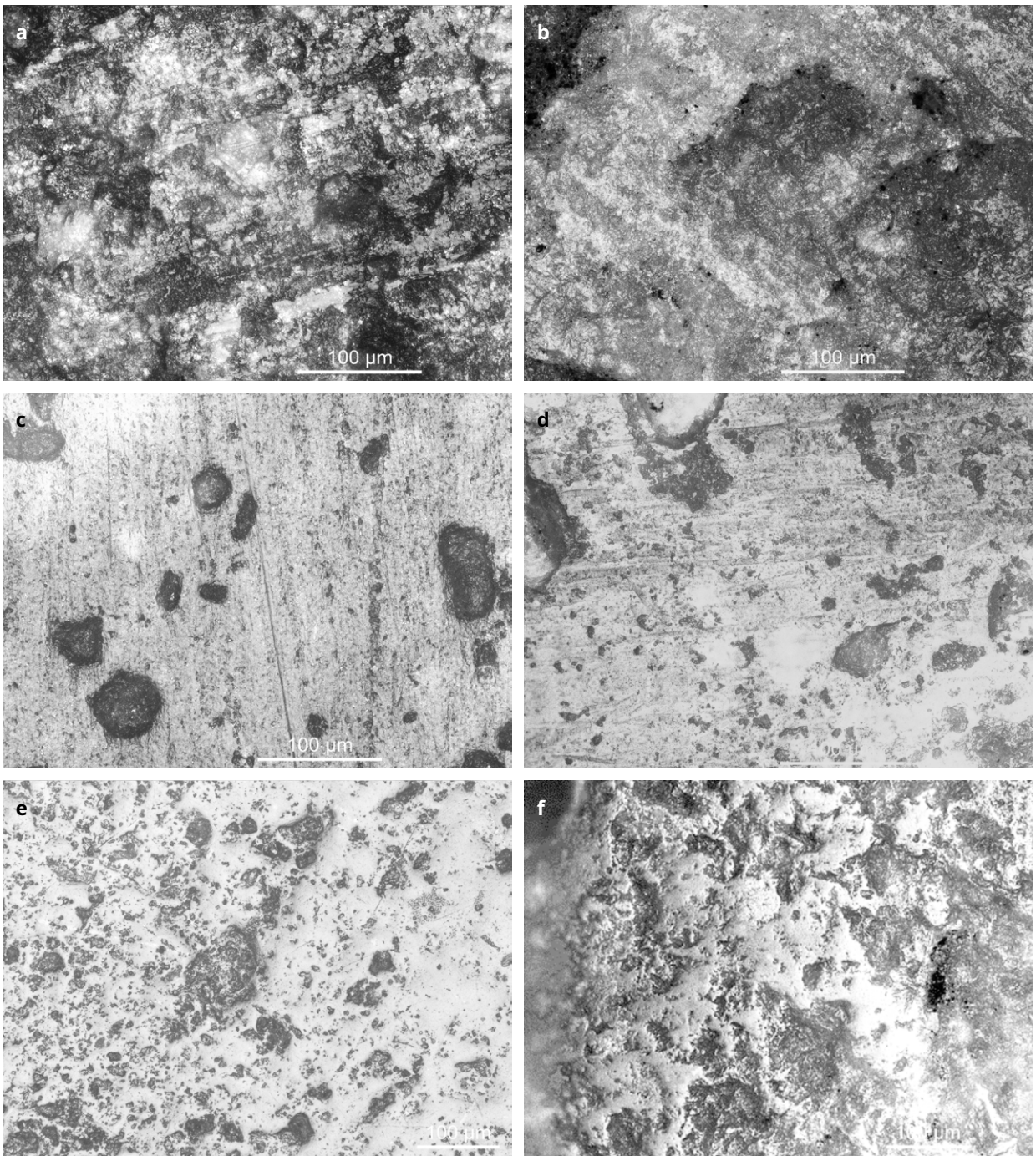


Figure 6.10 Finishing traces on axe fragments compared to experimental equivalents; a) Exp. 3334 grinding flint on a hard sandstone; b) matching grinding traces on a flake made from a recycled axe (STY17o.001376STN.6); c) Exp. 3336 grinding flint on slate; d) matching traces on a flake made from a recycled axe (STY17o.000710STN.8); e) Exp. 3131 polishing with sand and leather; f) matching polishing traces in the deeper flake negatives on a flake made from a recycled axe (STY17o.001376STN.6) (after Van den Dikkenberg, 2024a).

Interpretation	Number of artefacts	Percentage
Use-wear traces	317	70.8%
Not interpretable	100	22.3%
No use-wear traces	31	6.9%
Total	448	100.0%

Table 6.6 Interpretability of use-wear traces at Den Haag Steynhof.

Number of AUAs	Number of artefacts	Percentage
1	210	66.2%
2	98	30.9%
3	8	2.5%
4	1	0.3%
Total	317	100.0%

Table 6.7 Number of Actually Used Areas (AUAs) of the artefacts from Den Haag Steynhof.

Typology	Total	Percentage
Borer	16	5.0%
Scraper/borer combination	1	0.3%
Flake core	1	0.3%
Core rejuvenation flake	3	0.9%
Unmodified flake	54	17.0%
Notched flake	1	0.3%
Transverse arrowhead	2	0.6%
Potlid	1	0.3%
Retouched other	3	0.9%
Retouched blade	3	0.9%
Retouched flake	26	8.2%
Strike-a-light	2	0.6%
Scraper	194	61.2%
Splintered piece	5	1.6%
Waste	5	1.6%
Total	317	100.0%

Table 6.8 Typology of artefacts with use-wear traces from Den Haag Steynhof.

	Boring	Carving	Chopping	Cutting	Diagonal	Indet/unsure	Longitudinal	Longitudinal + transverse	Piercing	Pounding	Transverse/ scraping	Shooting?	Wedging?	Total
Animal														
Bone	1	-	-	-	-	-	-	-	-	-	4	-	-	5
Fresh bone	1	-	-	-	-	-	1	-	-	-	-	-	-	2
Bone or antler	-	-	-	-	1	1	1	-	-	-	-	-	-	3
Horn	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Dry hide, dehairing	-	-	-	-	-	-	-	-	-	-	5	-	-	5
Dry hide	-	-	-	-	-	1	-	-	-	-	69	-	-	70
Fresh hide	-	-	-	-	-	-	-	-	-	-	26	-	-	26
Hide with additives	-	-	-	-	-	-	-	-	-	-	5	-	-	5
Hide & bone	-	-	-	-	-	-	6	-	-	-	-	-	-	6
Hide indet	-	-	-	2	-	1	9	-	-	-	103	-	-	115
Fish	-	-	-	2	-	-	1	-	-	-	-	-	-	3
Animal hard	-	-	-	-	-	-	2	-	-	-	-	-	-	2
Animal medium hard or hard material	-	-	-	1	-	1	-	-	-	-	-	-	-	2
Animal medium hard	-	-	-	2	-	-	1	-	-	-	1	-	-	4
Animal medium hard or soft material	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Animal soft material	-	-	-	1	-	1	1	-	-	-	-	-	-	3
Animal indet	-	-	-	-	-	-	1	-	-	-	-	-	-	1

Table 6.9 Crosstab with motions (x-axis) and contact materials (y-axis) for flint from Den Haag Steynhof, excluding hafting traces (after Carter, 2021; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024; Van Gijn, 2021a).

	Boring	Carving	Chopping	Cutting	Diagonal	Indet/unsure	Longitudinal	Longitudinal + transverse	Piercing	Pounding	Transverse/ scraping	Shooting?	Wedging?	Total
Plant														
Bark	-	-	-	2	-	-	-	1	-	-	2	-	-	5
Wood	-	1	1	-	-	1	3	-	-	-	-	-	-	6
Plant indet	-	-	-	-	3	-	4	-	-	-	2	-	-	9
Inorganic														
Pottery	14	-	-	-	-	1	-	-	-	-	-	-	-	15
Pyrite	-	-	-	-	-	-	-	-	-	4	1	-	-	5
Shell	2	-	-	-	-	-	-	-	-	-	-	-	-	2
Mineral indet	-	-	-	-	-	1	1	-	-	-	-	-	-	2
Unknown material														
Hard material	1	-	-	-	-	1	-	-	-	-	1	-	2	5
Medium hard or hard material	1	-	-	-	-	2	1	-	-	-	-	-	-	4
Medium hard material	-	-	-	-	-	3	-	1	-	-	-	-	-	4
Soft material	1	-	-	-	-	-	-	-	2	-	-	-	-	3
Indet	-	-	-	-	-	7	2	-	-	-	-	1	-	10
Possibly used	-	-	-	-	-	21	-	-	-	-	-	-	-	21
Total	21	1	1	10	4	42	35	2	2	4	220	1	2	345

Table 6.9 continued.

Contact material and motion	Count
Animal	
Fish cutting	1
Fresh bone drilling	1
Hide and bone longitudinal	1
Hide longitudinal	1
Animal hard longitudinal	1
Plant	
Plant longitudinal	3
Plant diagonal	2
Wood carving	1
Inorganic	
Pottery drilling	1
Indet	
Soft material drilling	1
Soft material piercing	1
Indet	1
Total	15

Table 6.10 Use of pointed flakes and other pointed functional edges (excluding borers).

confirms the earlier observations by Van Gijn that there appears to be a focus on functional edges, rather than on the production of specific morphologies (Van Gijn, 2010a, p. 135).

6.6.1 Contact materials and motions

In total 434 used areas (AUAs) were found on the tools. On 24 AUAs a reddish residue was found. These could potentially be ochre, but this could not be established with any certainty. In eight cases these residues were not associated with other traces. It is possible that these are actually post-depositional features rather than actual AUAs. In one instance however the residue is associated with an unidentified mineral polish. In this case it is plausible that the residue is related to the use of the artefact (see section 6.6.6).

The 81 used areas which are related to hafting will be discussed separately in section 6.6.7. In 21 instances it could not be established with certainty that the traces were related to use. These are classified as 'possibly used' areas. Of the other 324 AUAs related to the use of the artefacts the vast majority (n=227) could be related to contact with hide (Tab. 6.9, and Fig. 6.11). This confirms the notion, which was previously noted because of the large number of scrapers on the site, that hide working was important at the site (Van

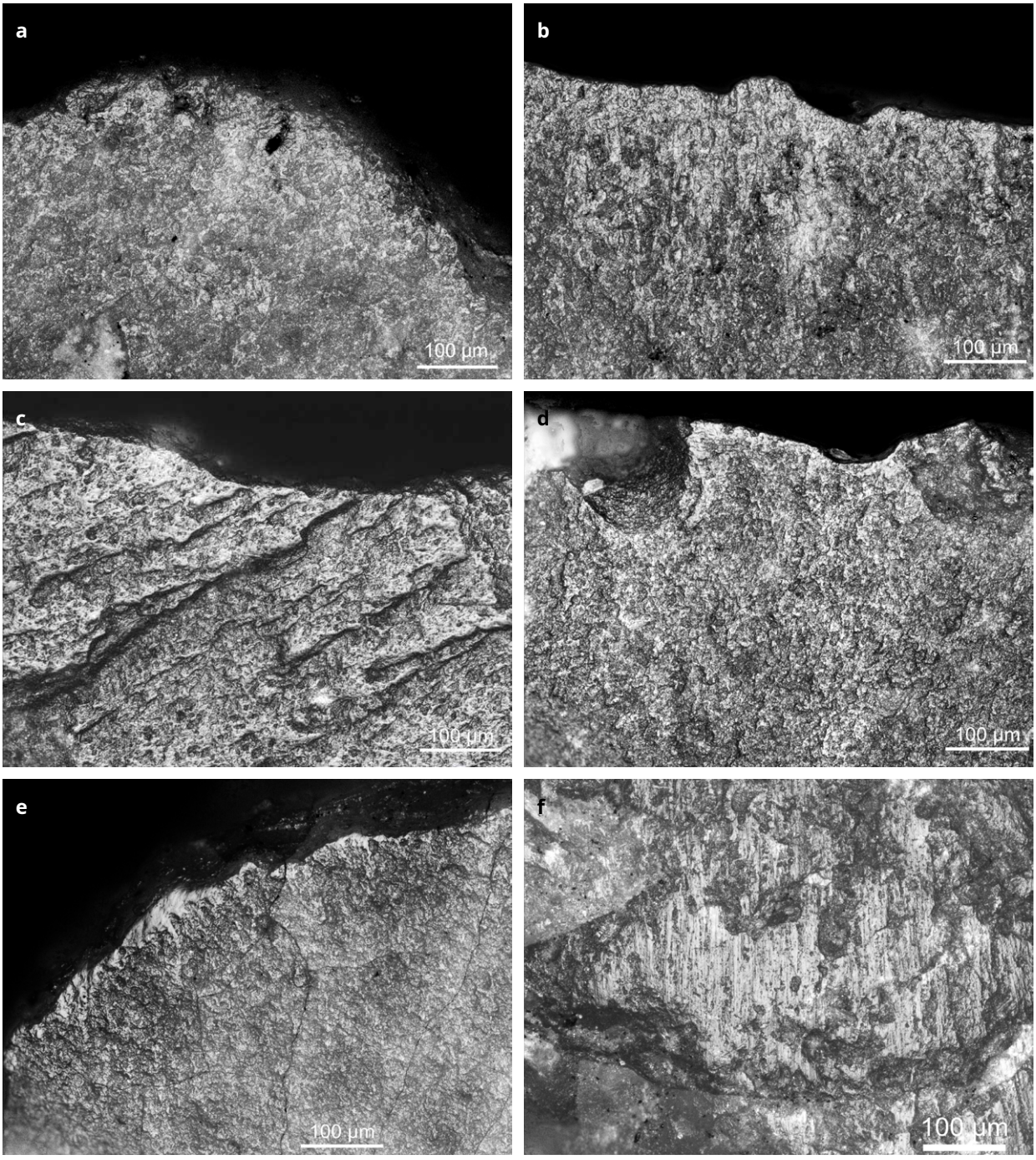


Figure 6.11 Use-wear traces on artefacts from Den Haag Steynhof, a) dry hide scraping traces on scraper (STY17o.000526STN.4); b) fresh hide scraping traces on scraper (STY17o.000595STN.1); c) bark cutting traces on a retouched blade (STY17o.000553STN.4); d) fish cutting traces on a pointed unmodified flake (STY17o.000705STN.2); e) bone scraping traces on a scraper which was used for scraping bone and dry hide (STY17o.001364STN.11); f) traces from scraping pyrite on a strike-a-light (STY17o.000708STN.1).

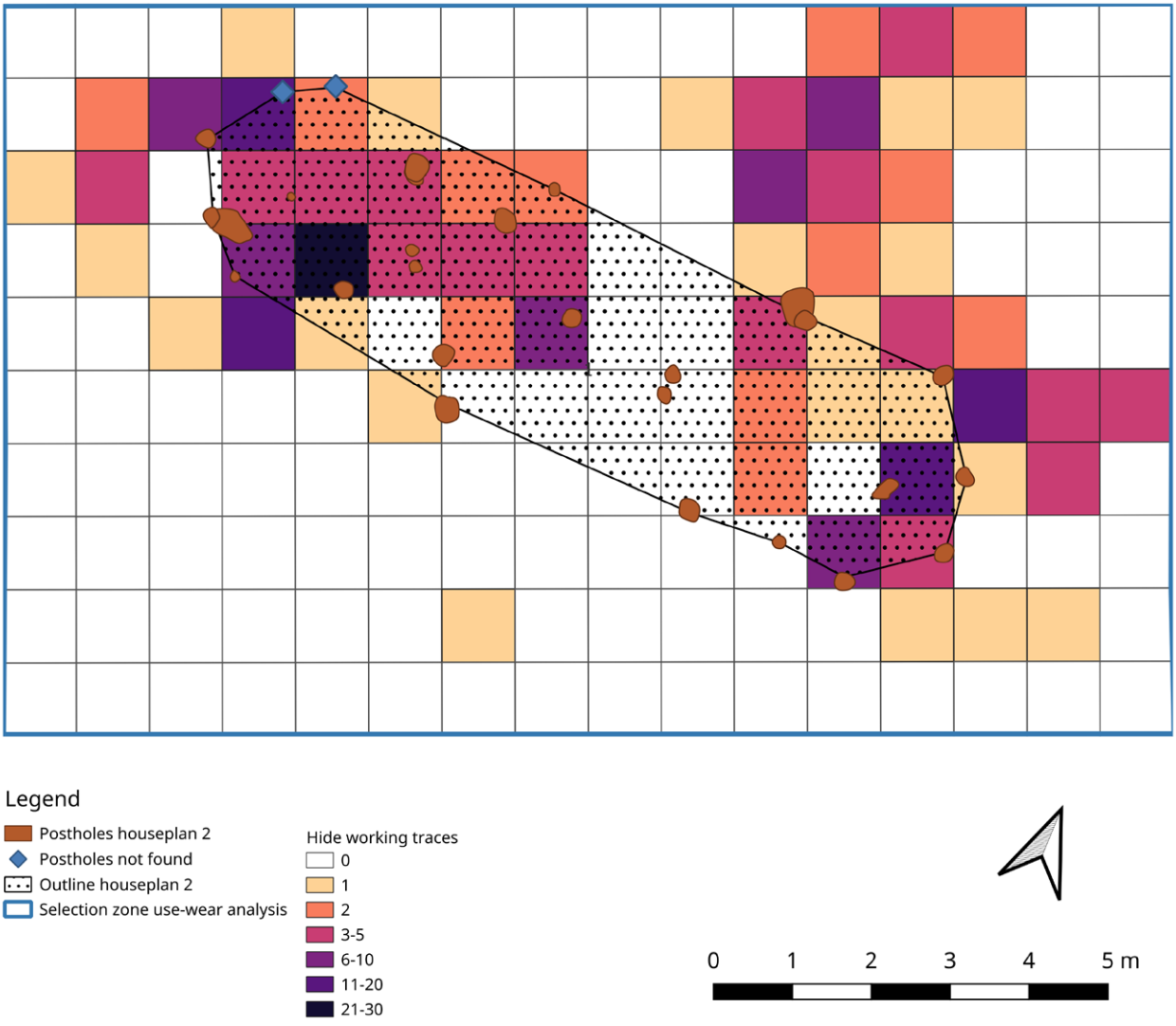


Figure 6.12 Spatial distribution of hide working AUAs (after Rieffe & Van Duijvenboden, 2021, p. 44).

Zoolingen & Bulten, 2021b, p. 302). In terms of motions transverse/scraping motions were most common (n=220), generally relating to the scraping of hides.

A specific group of objects which was selected consisted of pointed flakes. Van Gijn observed that at Hekelingen III these objects were specifically selected for plant working, because these points provide suitable functional edges for this task (Van Gijn, 1990a, p. 81; 1990b, pp. 109–110; 2010a, p. 90). Of the 61 unmodified and retouched points (excluding borers) from Steynhof fifteen displayed clear use-wear traces and another three were possibly used. The other edges either did not display any wear traces (n=20), or they could not be interpreted due to post-depositional surface modifications or burning (n=23).

The unmodified points were used in a variety of ways. Most commonly they were used in plant working, in line with the observations made by Van Gijn for Hekelingen III (Van Gijn, 1990b, pp. 109–110; 2010a, p. 90). In addition, the points were also used as borers and as cutting or carving tools (Tab. 6.10). They thus seem to be used for a somewhat wider range of activities than those at Hekelingen III.

6.6.2 Hide working

As noted before, the most common activity at Steynhof is hide working. The hide working traces are highly varied, indicating that a wide variety of hide working processes took place. These include fresh hide scraping or defleshing (n=26), dry hide scraping, presumably the softening of hide

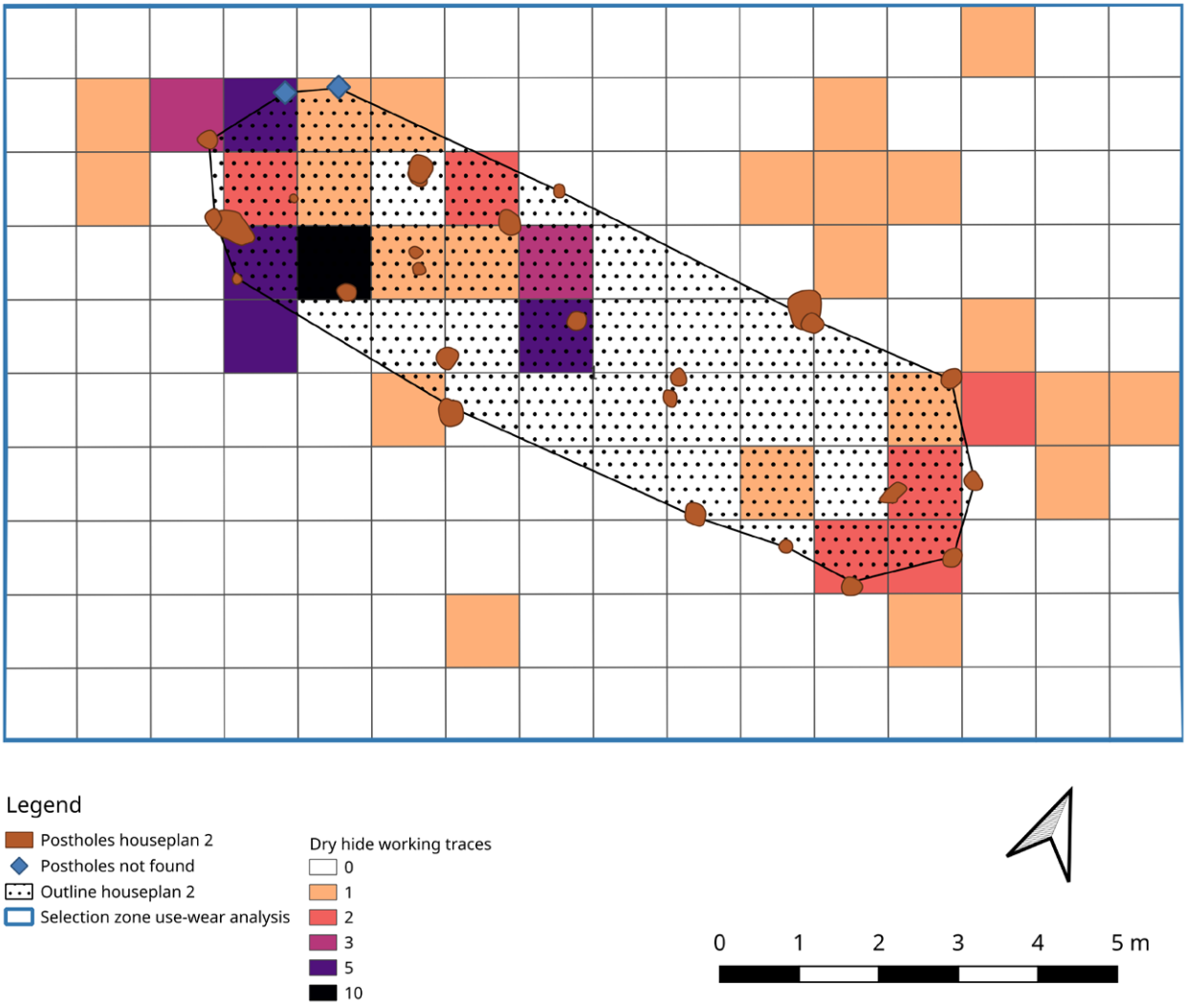


Figure 6.13 Spatial distribution of dry hide working AUAs (after Rieffe & Van Duijvenboden, 2021, p. 44).

(n=70), dehairing of hides (n=5), cutting of hide (n=2), and occasionally the scraping of hides with an unknown type of additive (n=5) (Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024). The additives were occasionally described as 'mineral additives', but they do not resemble traces resulting from scraping hide with ochre, sand or clay (Van den Dikkenberg et al., 2024b; Van Gijn, 1990b, p. 29). The diversity in traces suggests that the entire hide working *chaîne opératoire*, from skinned hide to finished products took place at the site. Six used zones displayed traces resulting from cutting hide and bone; these can be interpreted as butchering traces. The animal bone spectrum at the site is heavily dominated by cattle, and it seems reasonable to suggest that the hide working traces should therefore be linked to the processing of cow hides (Van Dijk, 2021, pp. 188–189).

The large sample of hide working tools in and around the house provides the opportunity to study the spatial distribution of hide working processes at the site. Figure 6.12 visualises the overall distribution of hide working traces at Steynhof. Objects with traces from contact with hide are found both inside and outside of house plan 2. The tools with traces resulting from dry hide and fresh hide working are plotted individually, to see whether these activities occurred in the same zones (Fig. 6.13 and 6.14). Both types of hide working traces are found in the eastern and western parts of the house as well as outside of the house. The fact that fresh hide scrapers are found inside the house is remarkable, as this is a typical outdoor activity that requires space and involves a lot of organic waste. It is possible, however, that this distribution is to some extent related to retooling activities as experiments showed that scrapers wore down quite quickly and needed to be resharpened frequently.

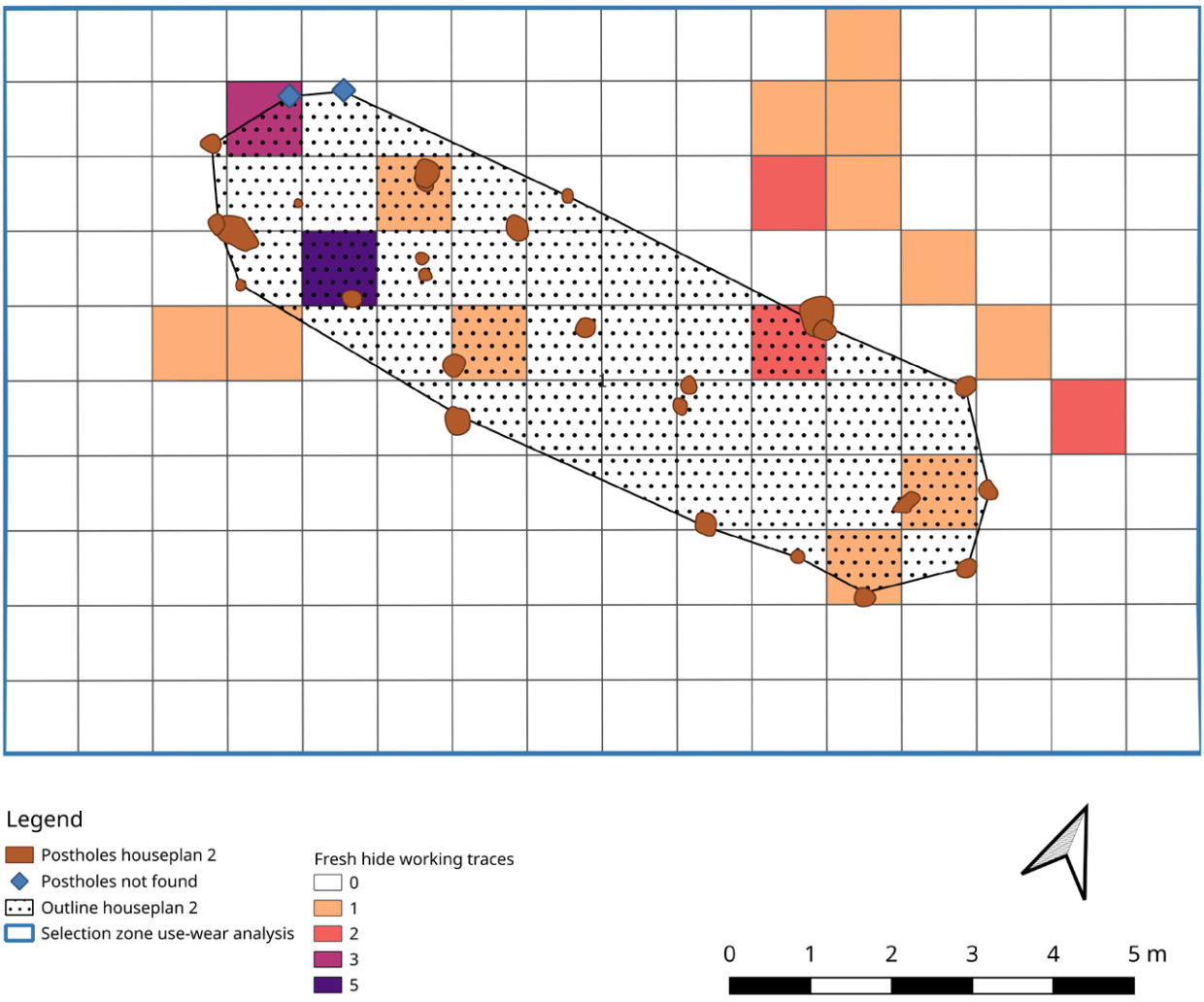


Figure 6.14 Spatial distribution of fresh hide working AUAs (after Rieffe & Van Duijvenboden, 2021, p. 44).

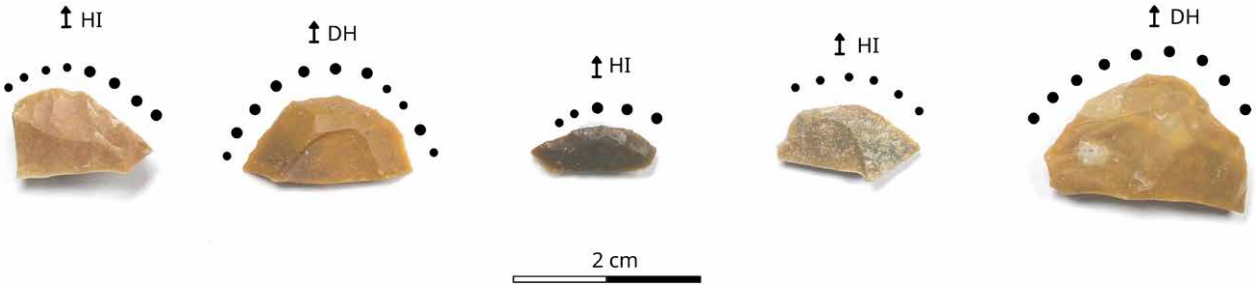


Figure 6.15 Scraper ends with typical bending fractures used for hide working (from left to right: STY17o.000043STN.1, STY17o.000710STN.4, STY17o.000710STN.5, STY17o.000710STN.7 and STY17o.0001565STN.4).

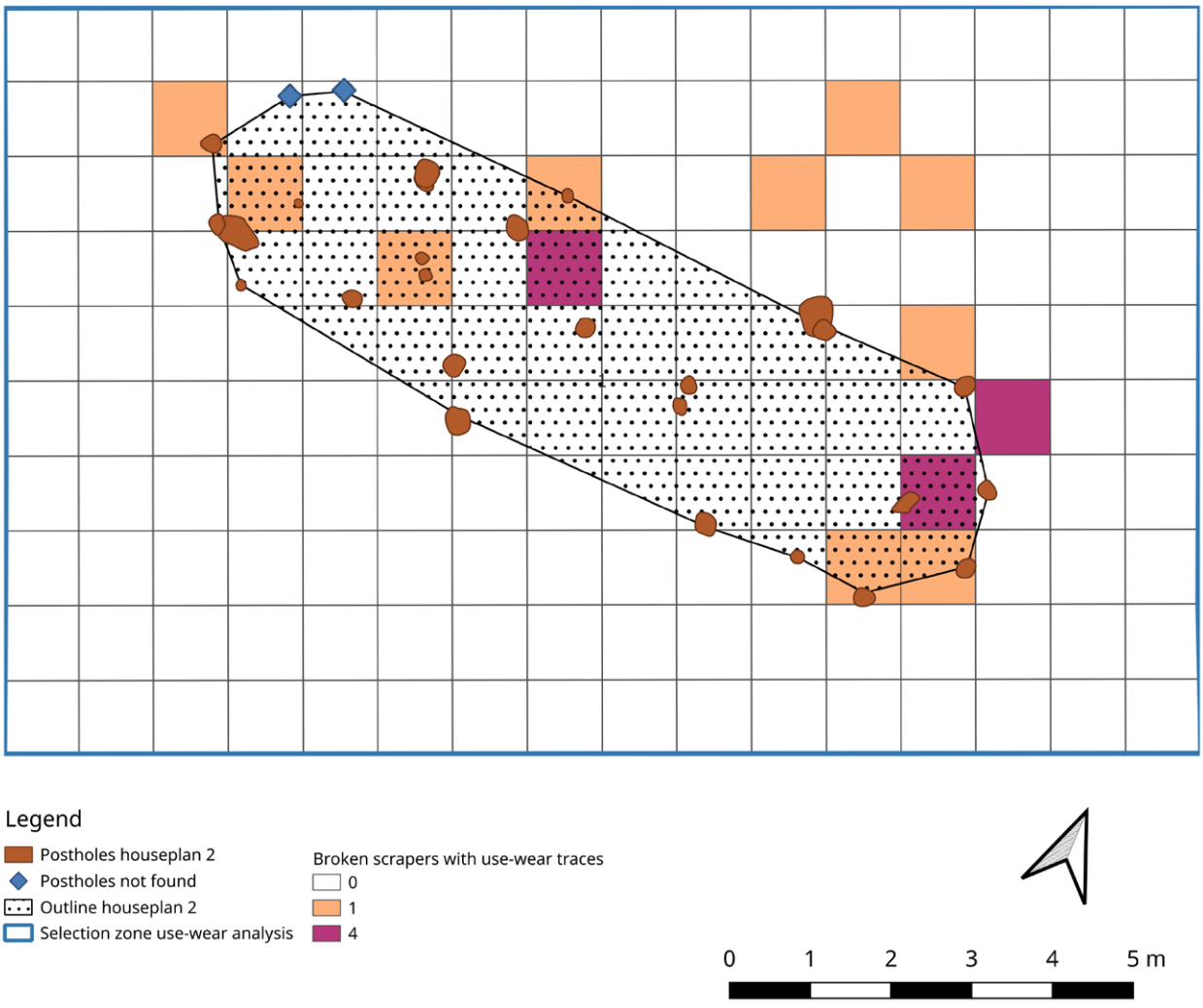


Figure 6.16 Distribution of broken scrapers with use-wear traces on their working edges at Steynhof (after Rieffe & Van Duijvenboden, 2021, p. 44).

6.6.3 Broken scraper heads

The distribution of scrapers on a site can potentially be related to retooling. After use, scrapers could be taken back to the house still hafted, where they were subsequently replaced. Fifteen of the scrapers in the assemblage display characteristic bending fractures (Fig. 6.15). Bending fractures are created when too much pressure is exerted, either during hafting, through use, or while resharpening in the haft. Similar fractures have been observed on a wide variety of archaeological sites, dating from the Upper Palaeolithic to the Neolithic (Aleo et al., 2021, p. 137; Van Gijn, 1990b, p. 79; Van Gijn & Mazzucco, 2013, pp. 114–115; personal communication D. Pomstra, 2022). After breakage these tips are detached from the haft, thus their accumulation cannot be linked to retooling. For scrapers with clear wear traces, it can be excluded that they broke during hafting of the scrapers. Hence, these must have been broken during use or resharpening.

The broken scrapers were nearly exclusively used for hide working, one of them bore traces from working an unknown medium hard animal material. A similar link between these bending fractures and hide working was also observed on Linear Bandkeramik scrapers from Beek Molensteeg and Elsloo (Van Gijn, 1990b, p. 79; Van Gijn & Mazzucco, 2013). In addition to hide working traces which could not be specified further, the scrapers were also used for scraping dry hide, and for dehairing of hides. The spatial distribution of these broken scrapers seems to indicate that these activities took place inside and near the house (Fig. 6.16). It cannot be excluded that these activities also take place further from the house (outside of the selected area).

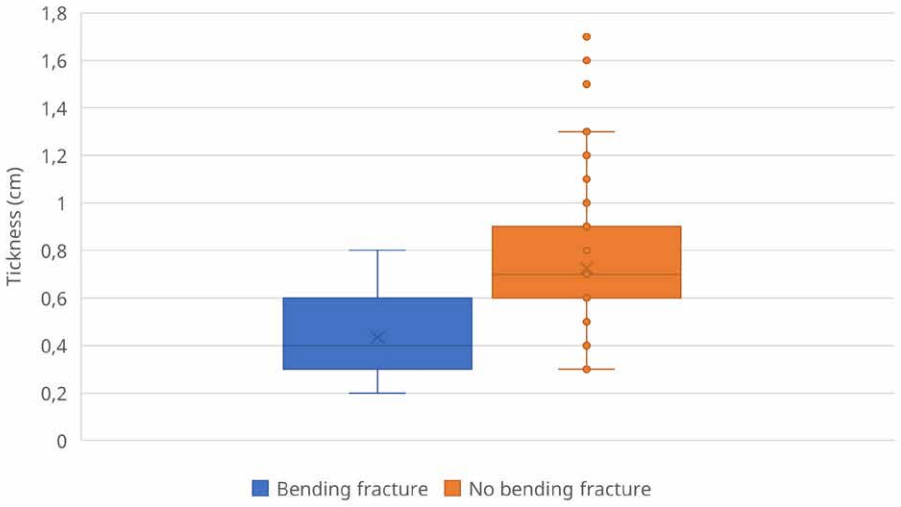


Figure 6.17 Boxplot of scraper thickness (cm) for scrapers with bending fractures, and scrapers without bending fractures.

An ethnographic study by Weedman on Gamo hide-workers from Ethiopia provides further insights into the significance of these bending fractures. Weedman noted that these breaks mainly occur when inexperienced users make, and use scrapers (Weedman, 2002). Although these fractures are not manufacturing mistakes, they do mainly occur when scrapers are made 'too thin', making them prone to breakage. Weedman noted that experienced Gamo hide-workers also made thin scrapers, but that those were less prone to breakage due to the experience of the leatherworkers, who were generally capable of using thin scrapers without breaking them (Weedman, 2018, pp. 164–166). The notion that the thickness of the scrapers is related to their frequency in breakage is clearly observed at Den Haag Steynhof (Fig. 6.17).

When the scraper assemblage is considered as an artefact population, in analogy with the human population using them, the percentage of bending fractures can be used to assess the skill level of the users. This relationship between bending fracture frequency and user skill is well documented ethnographically (Weedman, 2018). The percentage of broken scrapers at Steynhof (6.7%) can therefore be compared with those documented ethnographically by Weedman. It was noted that among Ethiopian Gamo hide-workers, experienced individuals (with more than eight years of experience) produce between 0-3.8% of broken scrapers, while novice and competent hide-workers (i.e., with up to 8 years of experience) produce between 0-21.1% of broken scrapers (Weedman, 2018, p. 164). It should be noted that such differences might in part be related to other variables such as differences in raw material. Nevertheless, the fact they consistently occur with scrapers which were made 'too thin' seems to suggest a poor assessment of the suitability of flakes. Hence, it seems likely that the assemblage at Steynhof was not only produced by experienced hide-workers. The high percentage of breaks suggests that novices were likely also scraping hides at the site. This suggests that hide working was presumably a practice of which the skills and knowledge were transferred in and around the house.

6.6.4 Traces from contact with animal material

In terms of animal-related traces other than those resulting from hide working, it is noteworthy that antler working appears to be absent, although in three instances the traces were classified as either antler or bone working traces. Bone working is only marginally represented. As noted earlier, the six AUAs with traces of both bone and hide working should probably be interpreted as butchering tools. Bone was worked by cutting, boring and scraping motions, and in one instance by working it in a diagonal motion. The scarcity and limited diversity in bone working traces seems to suggest that bone working was restricted to ad hoc bone tool production (Van den Dikkenberg & Van Gijn, 2024). It is interesting to note that traces relating to the use of the metapodium technique, which are well documented at Hekelingen III and Vlaardingen Arij Koplaan, are lacking (Van den Dikkenberg & Van Gijn, 2024; Van Gijn, 1990b, 2010b). The traces from drilling could potentially be related to ornament production. Two drills which were used to drill shell also suggest that ornaments were produced locally. Spatially, the bone working traces are confined to the zone inside, and directly surrounding the house (Fig. 6.18). Their distribution is more limited than the distribution of hide working traces. These traces mainly occur inside and near the house, suggesting that bone working may have been an indoor activity.

The use-wear analysis provided limited evidence for the processing of fish at the site (n=2; Fig. 6.11d). These traces were scarce, something that is often observed on archaeological sites, even if, as is the case at Hekelingen III, zooarchaeological evidence clearly indicates that fish was abundant (Van Gijn, 1986a; 1990b, pp. 119–120). Their

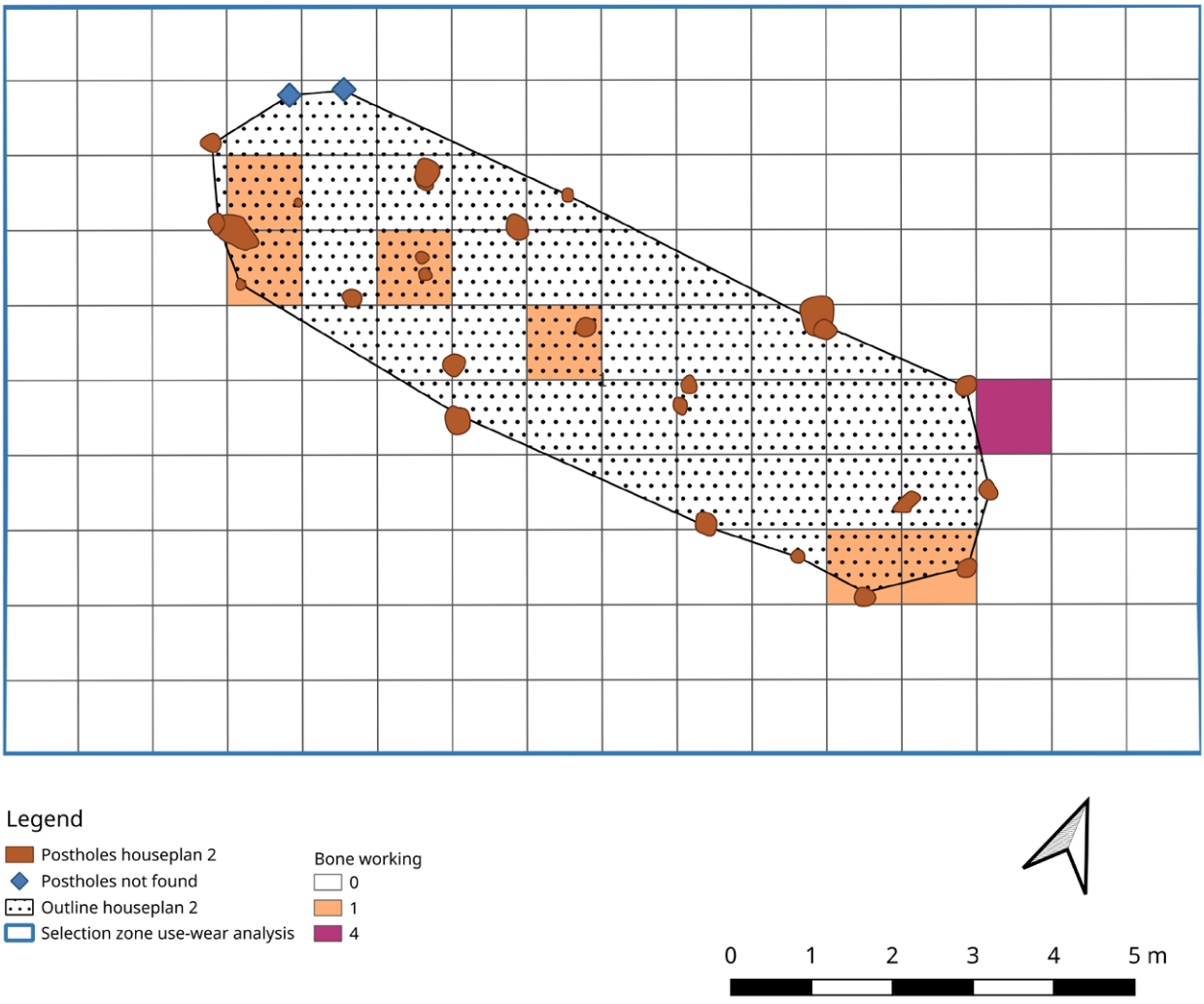


Figure 6.18 Spatial distribution of bone working AUAs, excluding the tools which are interpreted as butchering tools. The distribution map also includes AUAs interpreted as bone or antler working (after Rieffe & Van Duijvenboden, 2021, p. 44).

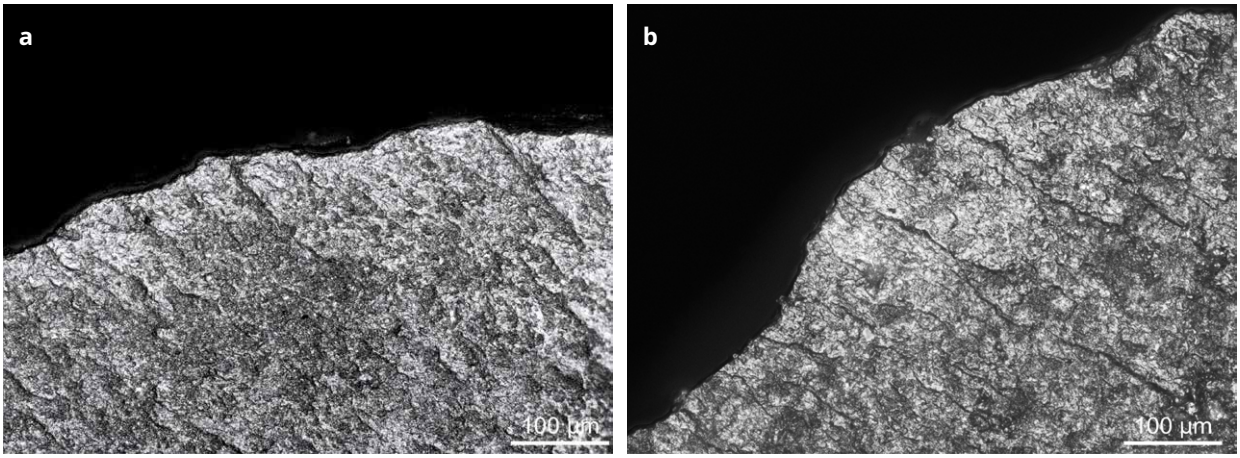


Figure 6.19 a) Smooth and greasy polish on a retouched flake (STY17o.000551STN.4), b) matching wear traces observed on EXP3952, which was used to scrape horn.

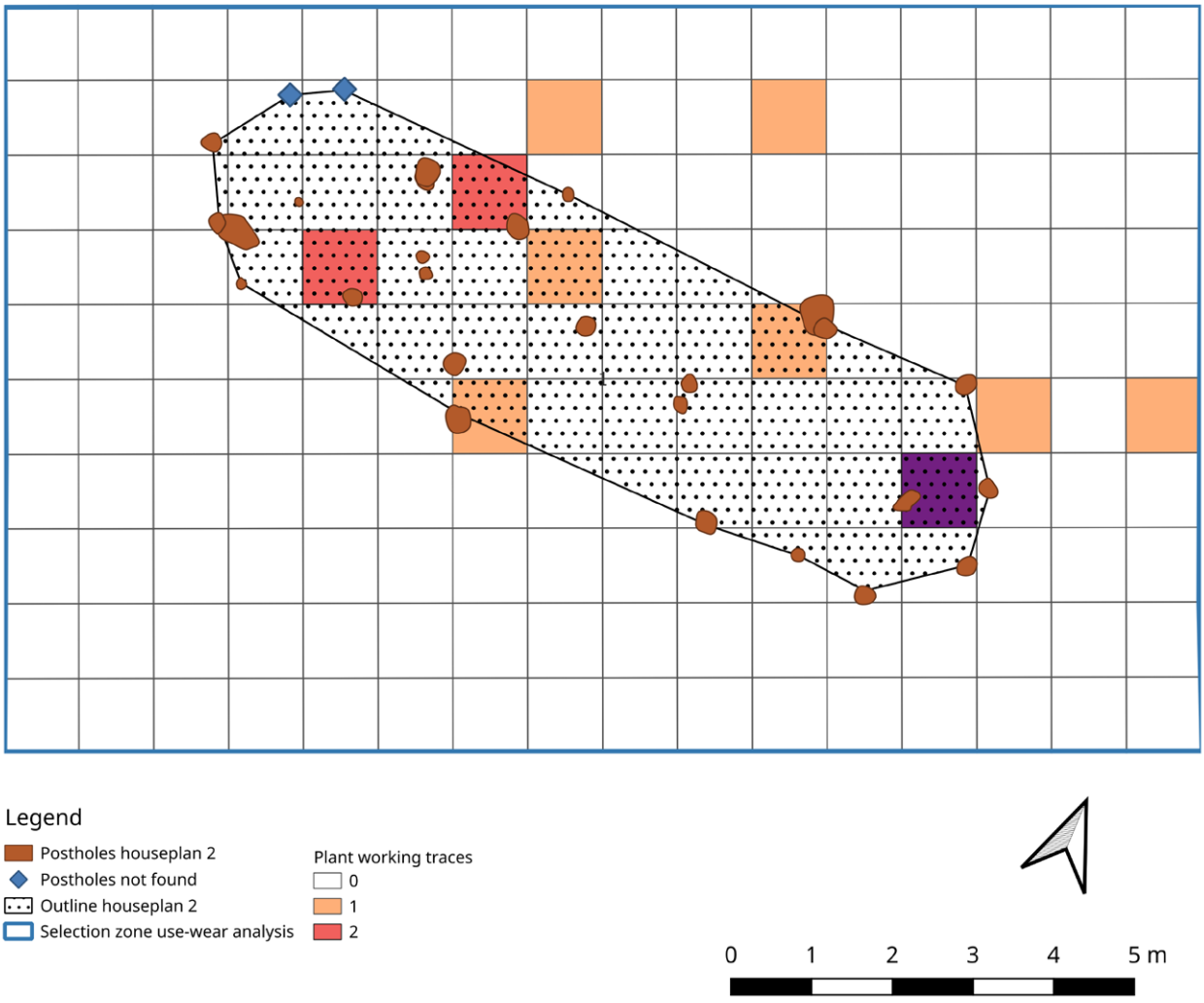


Figure 6.20 Spatial distribution of plant working AUAs, excluding wood working traces (after Rieffe & Van Duijvenboden, 2021, p. 44).

scarcity can be explained by the fact that tools used in fish processing often display uncharacteristic use-wear traces, and because such tools are likely to have been used only briefly, thus too short for characteristic use-wear traces to develop (Van Gijn, 1986a).

A remarkable find consisted of a small retouched flake which was used for scraping horn (STY17o.000551STN.4). The tool displays fine edge removals and a band of rough and greasy polish, though in some areas the polish appeared smoother (Fig. 6.19a). Horn working has so far not been recognised in archaeological assemblages. The experiments presented in this study now allow us to recognise such traces (see chapter 5). The find demonstrates that the use of horn in craft activities can be traced back much earlier than was possible so far as, until now, the earliest evidence for the use of horn in crafting activities in the Netherlands dates back to the Iron Age (Rijkelijkhuizen et al., 2024).

6.6.5 Use-wear traces from plant processing

The third largest group of wear traces is related to processing soft plants (n=14). In five instances these traces could be specified as traces resulting from contact with bark (Fig. 6.11c). These traces likely relate to the processing of plant fibres, for example to make cordage. These materials have not been found at Steynhof, but at Vlaardingen Arij Koplaan fragments of cordage were found in the creek, where they were well preserved (Van Iterson Scholten, 1977). Spatially, plant working traces are found both inside, and just outside of the house (Fig. 6.20).

Wood working traces are scarcely represented (n=6). It seems likely that wood working was often done with flint axes. This is indicated by a fragment of an axe cutting-edge which shows traces from wood chopping. Axe fragments are well represented at the site; therefore, it seems likely that wood working was a common activity. This notion is supported

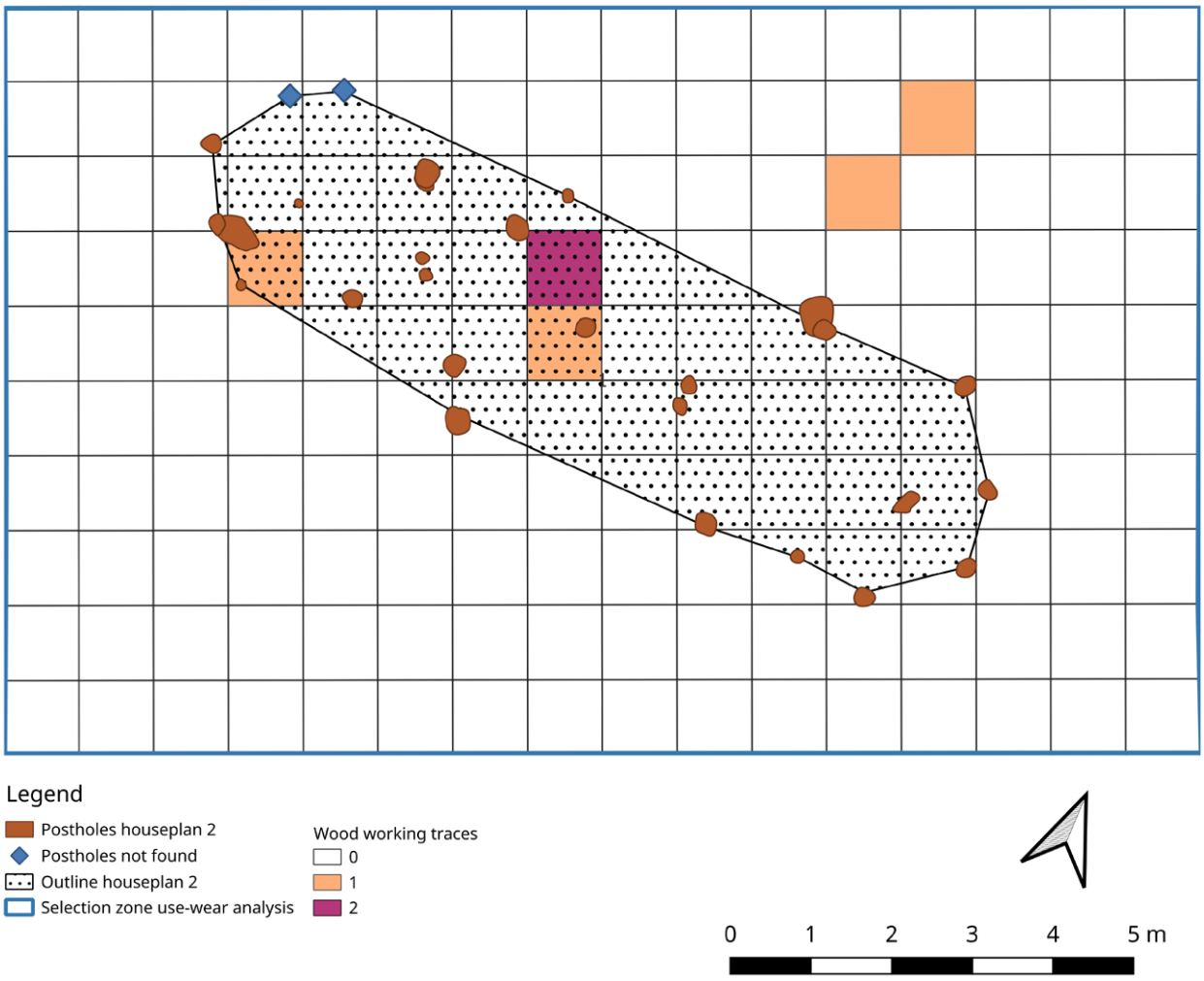


Figure 6.21 Spatial distribution of wood working AUAs (after Rieffe & Van Duijvenboden, 2021, p. 44).

Hafting/hafting as axe	Interpretation contact material	Count
Hafting	Bone	1
Hafting	Hide	1
Hafting	Bark	1
Hafting	Wood	4
Hafting	Hard material	38
Hafting	Indet	13
Hafting	Possibly hafted	15
Hafting previous use-life, axe ground surface	Hide	1
Hafting previous use-life, axe ground surface	Wood	3
Hafting previous use-life, axe ground surface	Hard material	3
Hafting previous use-life, axe ground surface	Indet	1
Total	**Total**	81

Table 6.11 Hafting traces at Den Haag Steynhof.

by the study of the wooden artefacts at the site (Vorst & Vermeeren, 2021). It is also possible that organic tools such as bone chisels were used for these activities, but these have not been found, possibly due to poor preservation conditions (Van Dijk, 2021). Artefacts with wood working traces are found both inside and outside of the house (Fig. 6.21).

6.6.6 Traces from inorganic materials

After hide working the second most prominent activity at the site was drilling ceramics (n=15). These traces were related to the repair of pottery, something that was noted in previous studies as well (Carter, 2021; Van Gijn, 2021a). Another inorganic group consisted of tools used on pyrite. These traces were related to fire-making (n=5). One of these strike-a-lights also displayed isolated spots of flat smooth and matt polish which were presumably related to hafting (STY17o.001334STN.1). Two used zones were used on an unknown type of mineral. One of these had a reddish residue, possibly ochre (STY17o.001364STN.15). It is possible that this tool was used to process ochre, but considering chemical analyses were not conducted this interpretation remains tentative.

One arrowhead was possibly used for shooting. Shooting experiments indicate that shooting does not always result in the formation of characteristic MLITS (linear streaks of polish). If those traces are absent it cannot be determined with certainty that arrowheads were used for shooting (Van Gijn, 1990b, pp. 45–46). Despite the ambiguous wear traces, it seems likely that the few arrowheads found at Steynhof are related to hunting, or possibly conflicts.

6.6.7 Traces from hafting

The assemblage from Steynhof includes 81 used areas with hafting traces (Tab. 6.11). Fifteen of these consisted of possibly hafted tools. In eight instances these traces were found on the ground surface of axe fragments. These hafting traces could be linked specifically to the use-life of these axes (prior to breakage). Hafting traces were

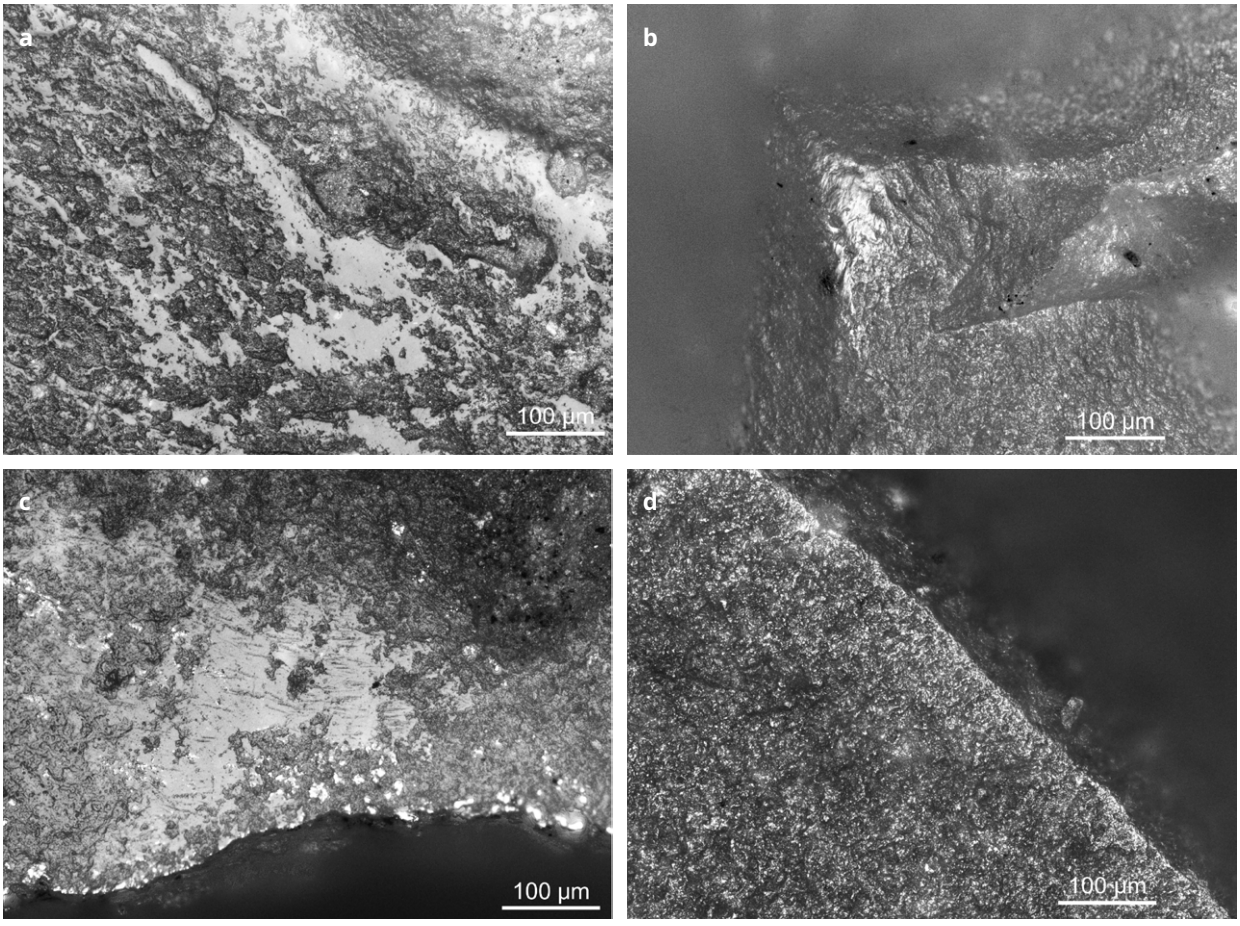


Figure 6.22 Hafting traces on artefacts from Den Haag Steynhof, a) flat, and in parts domed, smooth and matt polish from hafting in wood on STY17o.000599STN.1; b) domed smooth and matt polish with striations from hafting in bone on STY17o.000526STN.9; c) flat smooth and matt polish with striations from hafting in hard material on STY17o.000537STN.2; d) rough and greasy polish band from hafting in hide on STY17o.000711STN.1.

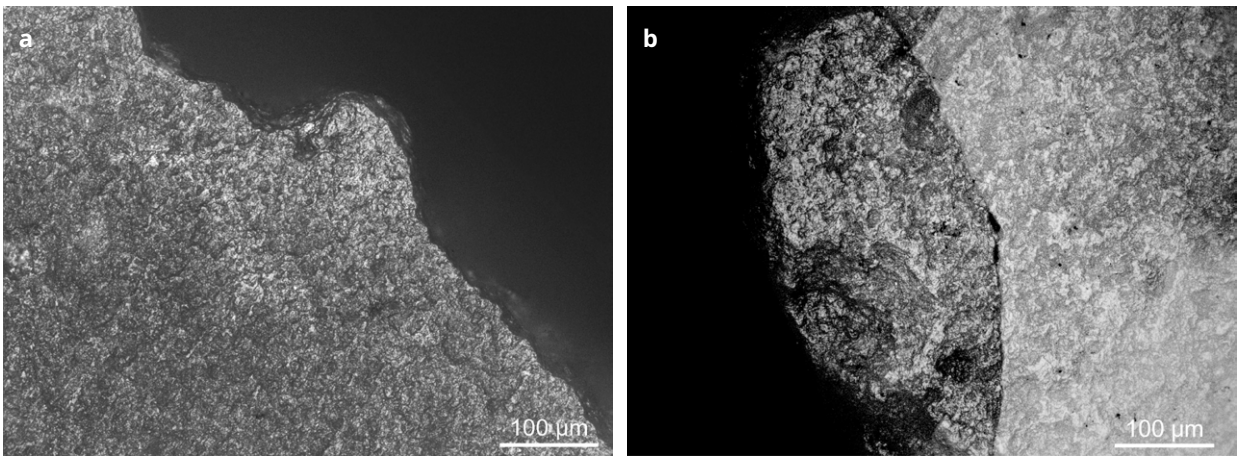


Figure 6.23 Resharpening traces on scrapers from Den Haag Steynhof: a) band of polish and edge rounding is intersected by resharpening retouch on scraper STY17o.000429STN.4; b) non-detached resharpening flake on scraper STY17o.000526STN.4.

generally related to hard contact materials (Fig. 6.22c). Often tools were hafted in wood (Fig. 6.22a), but a variety of other contact materials was identified as well. In two instances hafting traces were interpreted as being related to contact with hide (Fig. 6.22d). These traces probably result from the use of hide bindings or wrappings in the hafting arrangements. The same applies to the hafting traces interpreted as hafting in bark. Besides the previously mentioned axes, hafting traces were mainly found on scrapers (n = 62). These were usually hafted in unknown hard materials (n=32). Other hafting traces on scrapers included hafting in wood (n=3), bark (n=1), and bone (n=1; Fig. 6.22b). Besides on scrapers, hafting traces are often found on retouched flakes (n=7). These often appeared to be ad hoc scraping tools. Although typologically these were not classified as scrapers, they should probably be seen as belonging to the same category of objects. In addition to scrapers and retouched flakes, hafting traces are found on the previously mentioned strike-a-light (STY17o.001334STN.1).

We can conclude that a wide variety of hafting materials was used at Steynhof, although wood was clearly preferred. Bindings or wrappings were also used to secure hafts. In terms of tool types hafting traces are mainly found on scrapers, axes, and retouched flakes. Hafting traces are not found on unmodified flakes or blades. Overall we can conclude that a wide variety of hafting arrangements was used at Steynhof.

6.6.8 Resharpening of tools, a frequently occurring phenomenon

Many of the scrapers at Steynhof display signs of resharpening (n=85). Furthermore, one axe fragment was resharpened. The fragment was originally polished using leather and additives. The outer surface of the fragment displays grinding traces, while the polishing traces were confined to the deeper flake negatives, indicating that the fragment was resharpened or reshaped by grinding on a grinding stone (Van den Dikkenberg, 2024a).

Resharpening on the scrapers could be attested in various ways. Many scrapers (n=25) were heavily resharpened as evidenced by the presence of overhanging dorsal ridges, similar to what Van Gijn previously noted for the scrapers from the site of Leidschendam Prinsenhof (Van Gijn, 1990b, p. 135). Often it can be observed that the band of polish, as well as the rounding of the working edge, is intersected by resharpening retouches (n=48; Fig. 6.23a). This is regarded as an indication of resharpening (Aleo et al., 2021, p. 137). Another common feature is the presence of non-detached, or failed, resharpening flakes (n=26; Fig. 6.23b). These flakes have better developed wear traces than the surrounding parts of the working edge (Aleo et al., 2021, p. 137).

6.6.9 Potential cereal harvesting tools

The use-wear analysis did not present any evidence for cereal harvesting (Tab. 6.9). Such evidence is scarce for the VLC, only six (possibly seven) tools are known which display use-wear traces which could be linked to cereal harvesting (Houkes et al., 2017; Van Gijn, 1984; 1990b). Because of our scarce knowledge on the subject, and because no cereal harvesting tools were found during the initial study of the flint, a new selection was made to specifically look for cereal harvesting tools outside of the area surrounding house plan 2. The cereal harvesting tool from Den Haag Wateringse Binnentuinen was burnt, and the working edge was retouched. This kind of (possibly ritual) treatment of cereal harvesting tools is also known from the Hazendonk-3 group site Ypenburg (Van Gijn, 2014b; Van Gijn & Verbaas, 2008). It is thought that this

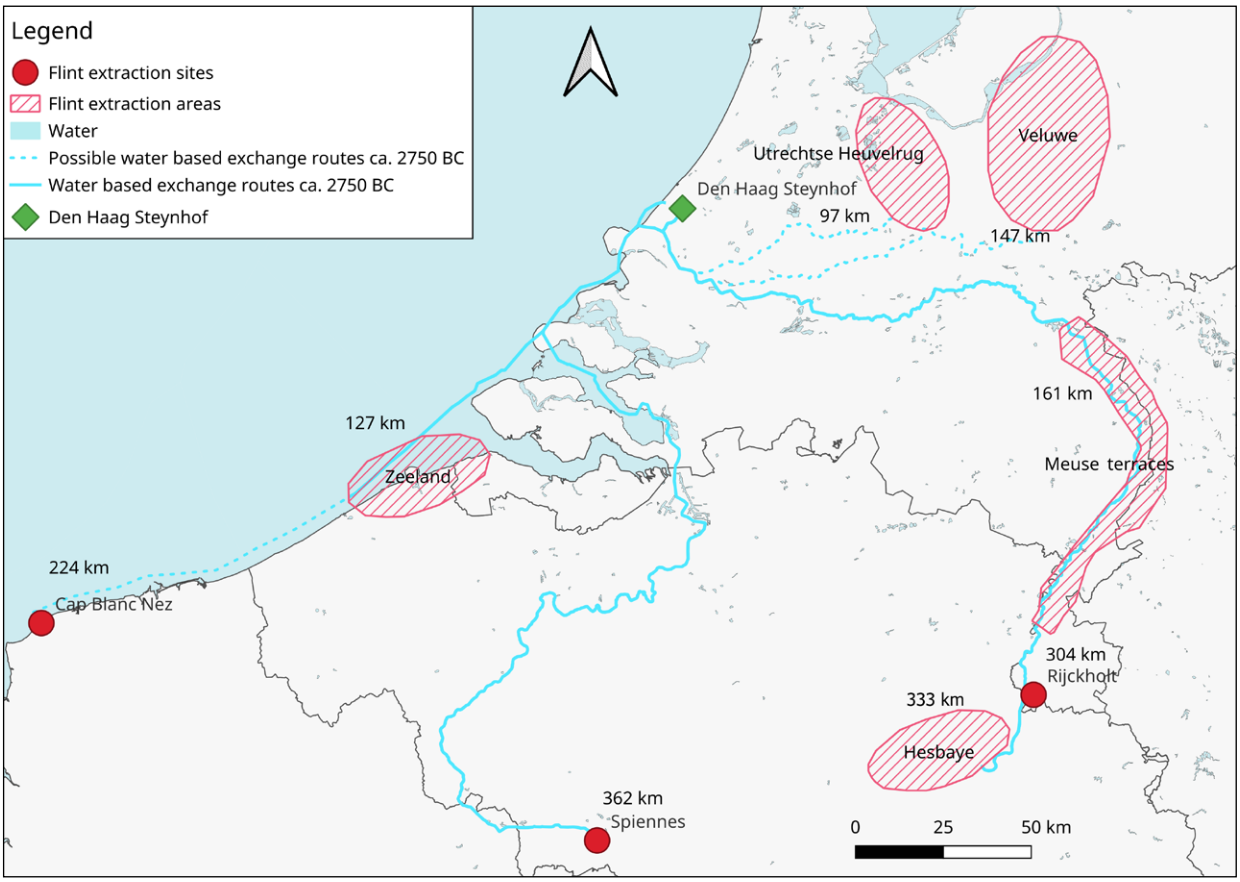


Figure 6.24 Den Haag Steynhof and water-based routes with calculated distances between the sources and the site, reconstructed based on the Palaeogeographic map of the Netherlands ca. 2750 BCE (after Van Gijn et al., 2006; Vos et al., 2020).

represents a long-term tradition where cereal harvesting tools were systematically destroyed by retouching and burning (Houkes et al., 2017). Because it is expected that harvesting tools might have been deliberately destroyed through burning and retouching all burnt and retouched flakes and blades were selected for analysis. Furthermore, at Den Haag Wateringse Binnentuinen blades were apparently selected for harvesting cereals. Blades are scarce in VLC assemblages, so focusing on blades was thought to provide better chances for discovering these traces. Therefore, the remaining blades from the other parts of the excavation were selected for analysis. Based on these morphological characteristics 52 artefacts were selected.

These artefacts were scanned using both a stereo-microscope and a metallographic microscope. The tools were only fully analysed if traces related to contact with silicious plants were present. If other use-wear traces were encountered these were not noted down, as the present study aimed at finding wear traces related to cereal harvesting. Other types of silicious plant working traces were noted down as it is not always possible to distinguish between harvesting cereals and the harvesting of other types of silicious plants.

Even after expanding the selection specifically to find cereal harvesting implements, these were not encountered. Archaeobotanical evidence clearly indicates that cereals were present and consumed locally (Kooistra et al., 2021; Kubiak-Martens & Oudemans, 2021). The site does not have ard marks and as such, the actual cultivation plots have not been found. It is possible that cereal harvesting tools were left on the locations where the harvesting took place. Alternatively, recent experiments indicate that cereal harvesting could also be done with tools made from perishable materials such as shell (Häg, 2023, pp. 140–141; 2024).

6.7 Discussion and conclusion

The inhabitants of Den Haag Steynhof were well connected to other areas via a network of water-based routes (Fig. 6.24). High-quality flint was procured from the area of the mines in Rijckholt and Spiennes, and from Hesbaye (Houkes, 2021b). For other sources the exact extraction locations are often uncertain. Cap Blanc

Nez flint could have been collected from the beaches in Zeelandic Flanders. It is also possible that this flint was procured directly from the area of Cap Blanc Nez. The use-wear analysis revealed that strike-a-lights were used in combination with pyrite. This mineral does not occur naturally in the Rhine-Meuse delta, and the closest source where pyrite could be collected is on the beach near Cap Blanc Nez. Alternatively, pyrite could have been collected in the eastern Netherlands in the Achterhoek, or further south in the Ardennes region (García-Díaz, 2017, p. 256). Meuse-eggs could have been collected from the terraces along the Meuse. Possibly they were also collected on the Utrechtse Heuvelrug, or the Veluwe. These areas also provided terrace flint, and possibly also northern bryozoan rich flint. In addition to flint procurement, it seems that the recycling of flint axes was also an important strategy for obtaining raw materials.

In terms of technology the assemblage indicates a low degree of knapping skills. Elaborate objects such as flint axes were imported as finished products while other objects were generally crudely produced from flakes. Local technology was focused on ad hoc tool production with a clear emphasis on functional edges, as is observed elsewhere at VLC settlements (Van Gijn, 2010b). Production traces on axes are dominated by grinding traces, only rarely do the axes display polishing traces.

The use-wear analysis indicates a strong focus on hide working, while other activities only played a marginal role. This is highly surprising as the settlement is considered a permanently inhabited site. It is often assumed that sites with a strong focus on a specific activity should be considered temporary extraction camps (Amkreutz, 2013b, pp. 375–376; Van Gijn, 1990b, p. 129). Yet, the robustness of the structures and the focus on domesticates in subsistence activities seems to preclude such an interpretation (Amkreutz, 2013b, pp. 375–376). Furthermore, the large number of scrapers with hide working traces suggest that large quantities of hides must have been processed. Even if, as it is documented ethnographically, multiple scrapers were required for a single hide, we are still dealing with large quantities. Gallagher documented in Ethiopia that four scrapers were required to fully scrape a single cow hide (Gallagher, 1977).[17] It is clear that dozens of hides must have been processed at the site, specifically by the household occupying house plan 2. The importance of hide working at Steynhof will be further discussed in the discussion chapter as its significance is best discussed in relation to the use-wear results of other sites (see section 12.2.2).

In terms of other activities, it is interesting to note that there appears to be no evidence for the wide application of the metapodium technique. Bone tool production was directed at the production of ad hoc tools. It is possible that bone chisels and awls were imported to the site. The absence of this technique seems to be related to the fact that deer were hardly hunted at Steynhof (Van den Dikkenberg & Van Gijn, 2024). Similarly, the absence of antler working traces can be related to the negligible importance of deer hunting at Steynhof. It cannot be excluded that some activities, which are currently underrepresented, might have been conducted outside of the selected area (thus further away from the house).

17 Based on the use of obsidian scrapers, which might be different from the use of flint, as noted by Van Gijn (1990, 129).

7

Pioneers and hide-workers on the coastal dunes

This study is primarily based on an intensive study of the flint assemblages from the four key sites discussed in chapters 6, and 8–10. Nevertheless, for specific topics artefacts from three other sites in the region of The Hague were also included in the study (Fig. 7.1). The site of Den Haag Wateringse Binnentuinen was selected for further analyses because, like Den Haag Steynhof, it represents a well-documented large-scale excavation of a permanently inhabited settlement, with multiple house plans, in the coastal dune area (Bulten & Stokkel, 2017; Stokkel, 2017b). To gain further insights into the biographies of flint axes (notably the finishing traces), and hide working processes (through use-wear analysis), the assemblage was included in this study. A second site which was selected was Den Haag Gavi Kavel, which is the oldest known VLC site in the coastal dune area (Bulten, 2010; Houkes & Dorenbos, 2004; Lammertsma & Grabowski, 2025; Van den Dikkenberg, 2025). The site contained an intentionally deposited flint axe, which provided an opportunity to study wear traces on axes from a depositional context in the western Netherlands. Axe depositions in the eastern Netherlands have been analysed through use-wear analysis, but counterparts in the western Netherlands remain understudied (Van Gijn, 2010a; Wentink, 2006, 2008). Finally, the assemblage of Den Haag Noordweg 76 was selected for use-wear analysis. This site is thought to represent a temporary settlement (Van Zoolingen & Rieffe, 2023). This is interesting because the site is located in the coastal dune area, an area traditionally associated with permanently inhabited settlements (Raemaekers, 2003). The study aimed to provide insight into the function of the site. Are we dealing with a pioneer camp, a temporary extraction camp, or special activity site? It is expected that a special activity site would present evidence for a specific 'special activity' such as plant working, hide working, fishing or hunting. On a pioneer camp, established to explore the area and identify a suitable location for permanent habitation, we would expect a more general spectrum of activities (Amkreutz, 2013b).

7.1 The site of Den Haag Wateringse Binnentuinen

The site of Den Haag Wateringse Binnentuinen was interpreted as a permanently inhabited site. It produced evidence for cereal cultivation and consumption (Bulten & Stokkel, 2017; Houkes et al., 2017; Kooistra, 2017). The animal bone spectrum was dominated by cattle (Van Dijk et al., 2017). The subsistence strategies at the site were thus focused primarily on the exploitation of domesticated resources. The site contains 314 axe fragments, including flake cores. Two bags could not be located, which meant that two axe fragments were not analysed. The finishing traces on all other 312 fragments were studied, but these were not selected for further use-wear analysis, except when the cutting edge of the original axe was still present. If the ground or polished surface of the axes displayed hafting traces these were documented. The hafting traces are assumed to be related to the use of the axes themselves, rather than

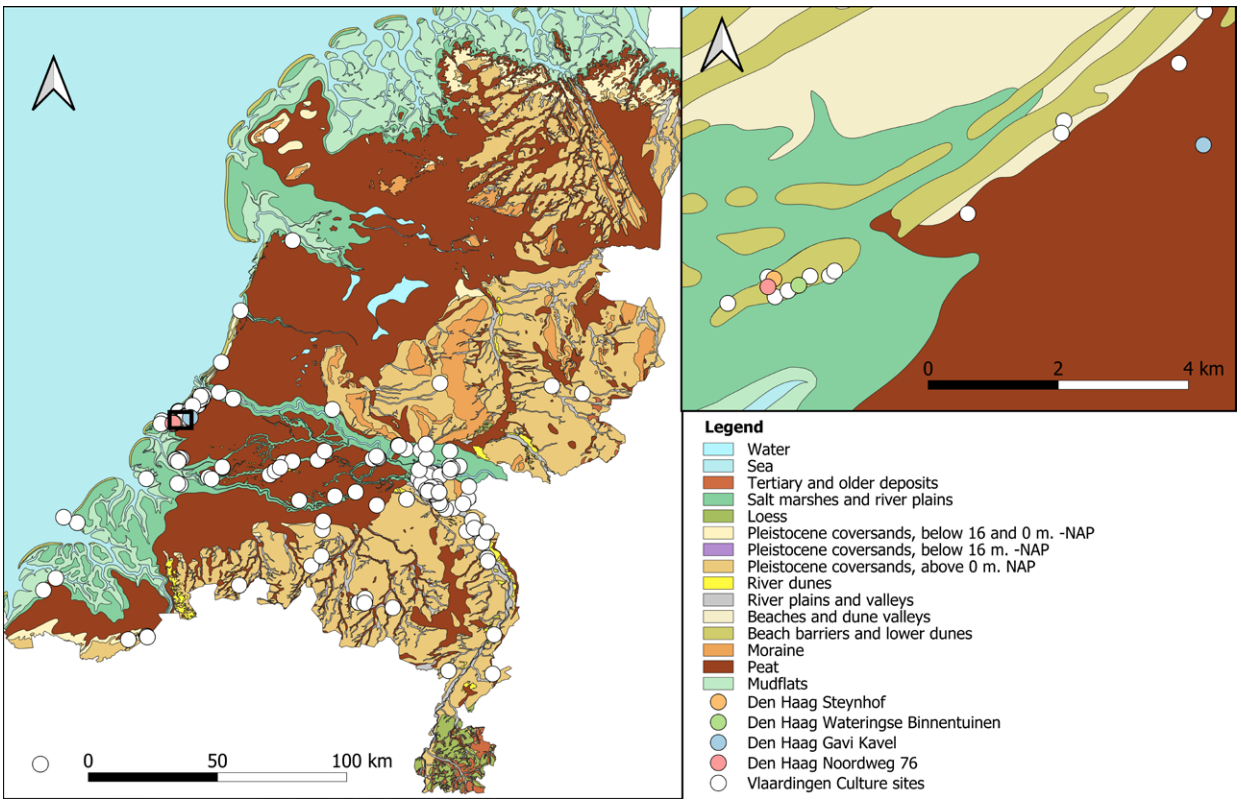


Figure 7.1 The three sites discussed in this chapter, as well as Den Haag Steynhof, are plotted on the Palaeogeographic map of the Netherlands ca. 2750 BCE. Den Haag Gavi Kavel is actually also located on a coastal dune, the peatlands visualised here partially date from after the occupation phase which makes it erroneously appear as if the site is located in the peatlands. The dune on which the sites of Steynhof, Noordweg 76, and Wateringse Binnentuinen are located was recently reconstructed in the publication by Kooistra et al. based on new archaeological data. This data is now incorporated in the palaeogeographic map depicted here (after Kooistra et al., 2024, p. 23; Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020).

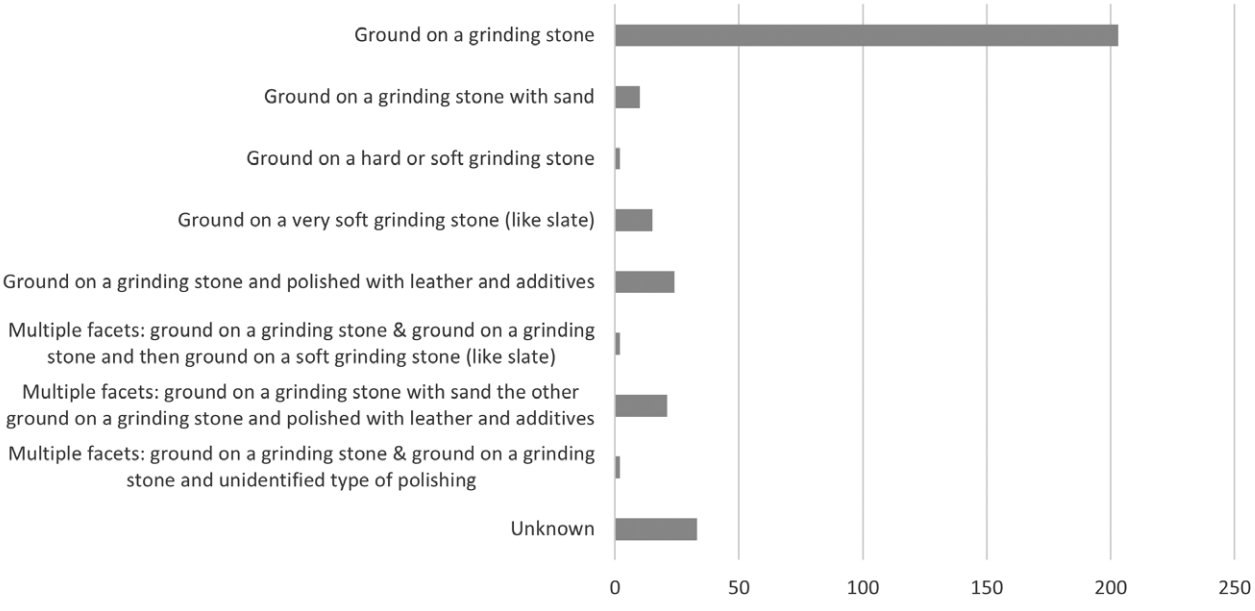


Figure 7.2 Axe finishing traces on the axe fragments from Den Haag Wateringse Binnentuinen.

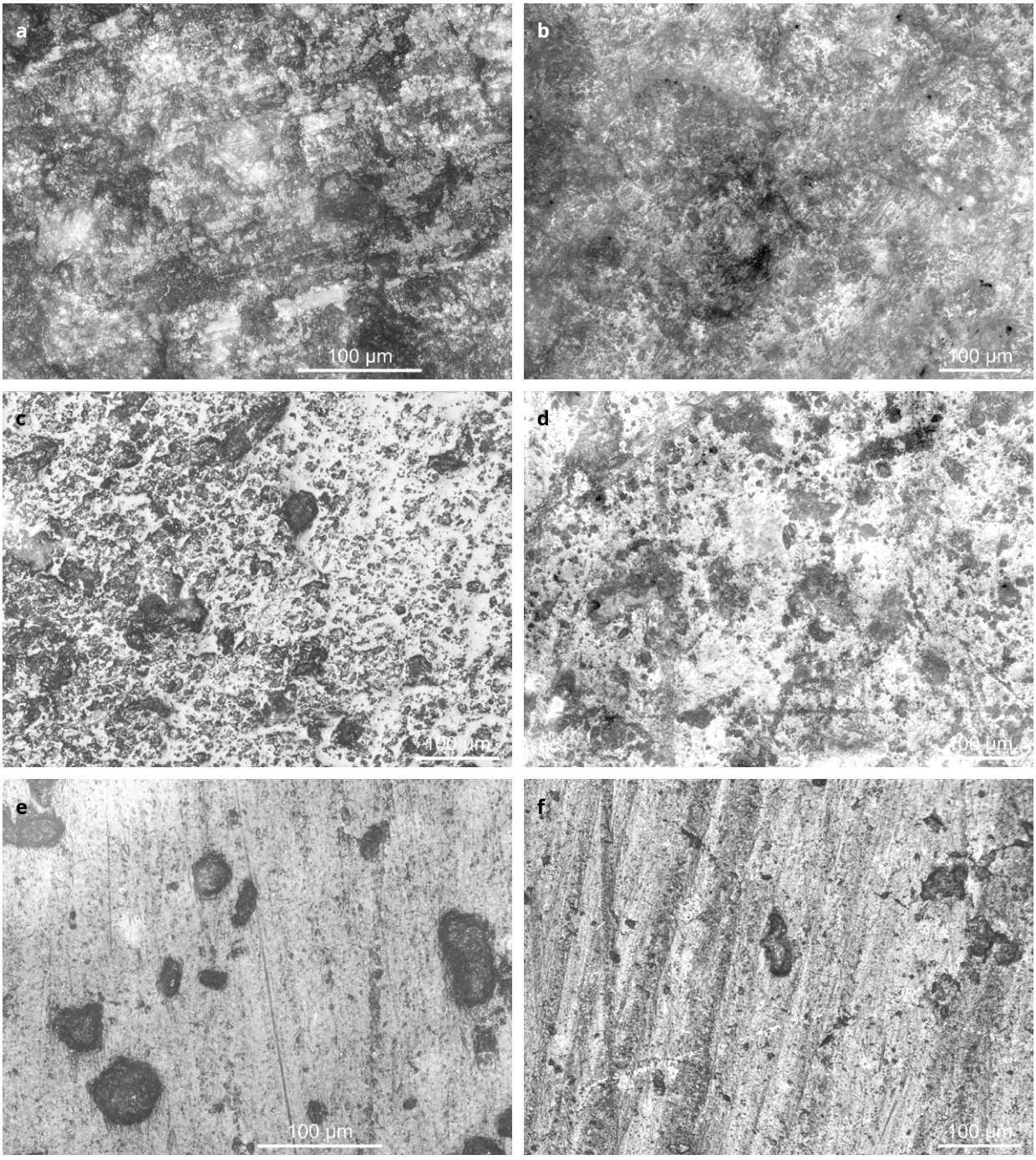


Figure 7.3 Den Haag Wateringse Binnentuinen: axe grinding and polishing traces with comparable traces on experiments; a) Exp. 3334 grinding flint on a hard sandstone; b) matching grinding traces on a scraper made from a recycled flint axe (WBTo.001322.1); c) Exp. 3131 polishing with sand and leather; d) matching traces on a flake made from a recycled flint axe (WBTo.001279.2); e) Exp. 3336 grinding flint on slate; f) matching traces on an axe cutting edge fragment (WBTo.001218.1) (after Van den Dikkenberg, 2024a).

Findnumber	Raw materials	Axe finishing traces	Use-wear traces
403.1	Belgian flint	Ground on a hard grinding stone, polished with soft stone	Wood chopping/hide scraping on reworked scraper edge
428.1	Indet	Grinding on hard grinding stone, polishing with leather and additives	Wood chopping
441.3	Indet	Grinding on a hard grinding stone	Wood chopping/hide scraping both on axe cutting edge
818.2	Belgian flint	Grinding on hard grinding stone, polishing with leather and additives	Wood chopping, resharpened cutting edge
1218.1	Indet	Grinding on soft stone	Wood chopping/hide scraping on reworked scraper edge
1642.2	Belgian flint	Grinding on a hard grinding stone	Wood chopping
1655.2	Indet	Indet	Wood chopping

Table 7.1 Axe cutting edges at Den Haag Wateringse Binnentuinen, raw materials, finishing traces, and use-wear results.

the reuse of the axe fragments.[18] Previously part of the lithic assemblage at Wateringse Binnentuinen was subjected to use-wear analysis (Houkes et al., 2017; Mullaart, 2016). The use-wear analysis of the scraper assemblage raised several questions which will be addressed in section 7.1.3.

7.1.1 Finishing traces on axe fragments

The analysis of finishing traces on the axe fragments revealed a broad spectrum of employed finishing techniques (Van den Dikkenberg, 2024a). At least two different types of grinding stones were used to grind the flint axes from Den Haag Wateringse Binnentuinen; a hard grinding stone (presumably a kind of sandstone) and a type of very soft stone (similar to slate). Occasionally, it was noted that the grinding traces showed similarities to the grinding of flint using sand as an additive. It was unclear whether sand was deliberately added to facilitate the grinding process, or if particles of the stone came loose, after which they would have acted as an additive, much in the same way the sand did during the experiments (Van den Dikkenberg, 2024a; see chapter 5).

The majority (68%) of the axe fragments only display grinding traces (Fig. 7.2; Fig. 7.3). A mere 7% of the axe fragments display traces resulting from polishing with leather and additives. Grinding on a very soft stone, like slate, can presumably also be linked to polishing; these traces are present on 5% of the axe fragments. Occasionally, the finishing traces cannot be matched with previous experiments. Some of these traces seem to resemble traces from polishing with additives, because occasionally the polish also reaches into the deeper flake negatives, suggesting that this procedure was also done using leather. This unknown type of polish is more rough than the polish resulting from polishing with sand, ash or charcoal, suggesting a different type of additive was likely used. The spectrum of finishing traces resembles that of the nearby site of Den Haag Steynhof, as on both sites unpolished axe fragments, which only display grinding traces, dominated the assemblages (Van den Dikkenberg, 2024a).

7.1.2 The use of flint axes

The assemblage contains seven fragments of axes with intact parts of the cutting edge, which were subjected to use-wear analysis (Tab. 7.1). Because complete axes from this period are scarce, this provided an opportunity to study the biography of axes.

Interestingly, all of the cutting edge fragments were struck off from the cutting edge, which provided an ideal platform angle for flaking (Fig. 7.4). When axes were recycled this was often utilised to initiate a reduction sequence.

The axes were consistently used for wood chopping. In one instance, however, the cutting edge also displayed hide scraping traces, similar to those on the axes from Hekelingen III and Den Haag Gavi Kavel, further confirming the multifunctionality of these tools (Van den Dikkenberg, 2025; also see chapter 8 and section 7.2). Two of the cutting edge fragments were reworked into a scraper edge which was used for hide scraping (Fig. 7.5). The scraper edges were previously analysed by Mullaart (Houkes et al., 2017; Mullaart, 2016).

7.1.3 Scraper assemblage

A substantial selection of scrapers from Wateringse Binnentuinen was previously analysed by Mullaart to gain insights into the variability of hide working traces at the site (Houkes et al., 2017; Mullaart, 2016).[19] The site is ideally suited for a comparison with Den Haag Steynhof, as the

18 This cannot always be stated with certainty, for example it is known from the assemblage of Steynhof that scrapers were frequently hafted. As such, if scrapers made on axe fragments display hafting traces on their ground or polished facets these hafting traces could theoretically also be related to the use of the scraper, rather than the previous use-life of the axe.

19 There are some discrepancies between the reported data in the thesis and publication and those in the database. The thesis mentioned 74 analysed scrapers but the database only listed 60 analysed scrapers. Likewise, the number of AUAs in the database does not correspond to the number of AUAs mentioned in the earlier publications (Houkes et al., 2017; Mullaart, 2016). Because it could not be established how these discrepancies came to be the reanalysis is based on the data reported in the original database.

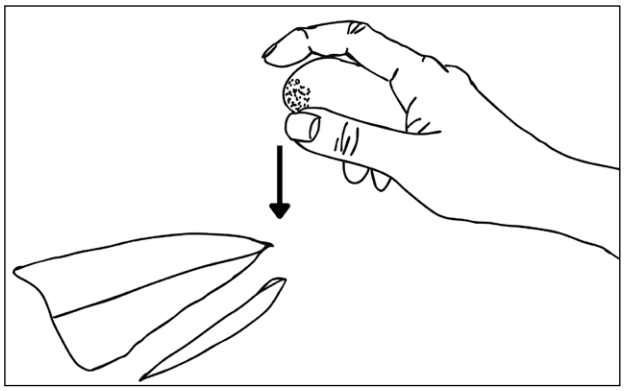


Figure 7.4 Initiating a reduction sequence utilising the cutting edge of a broken flint axe.

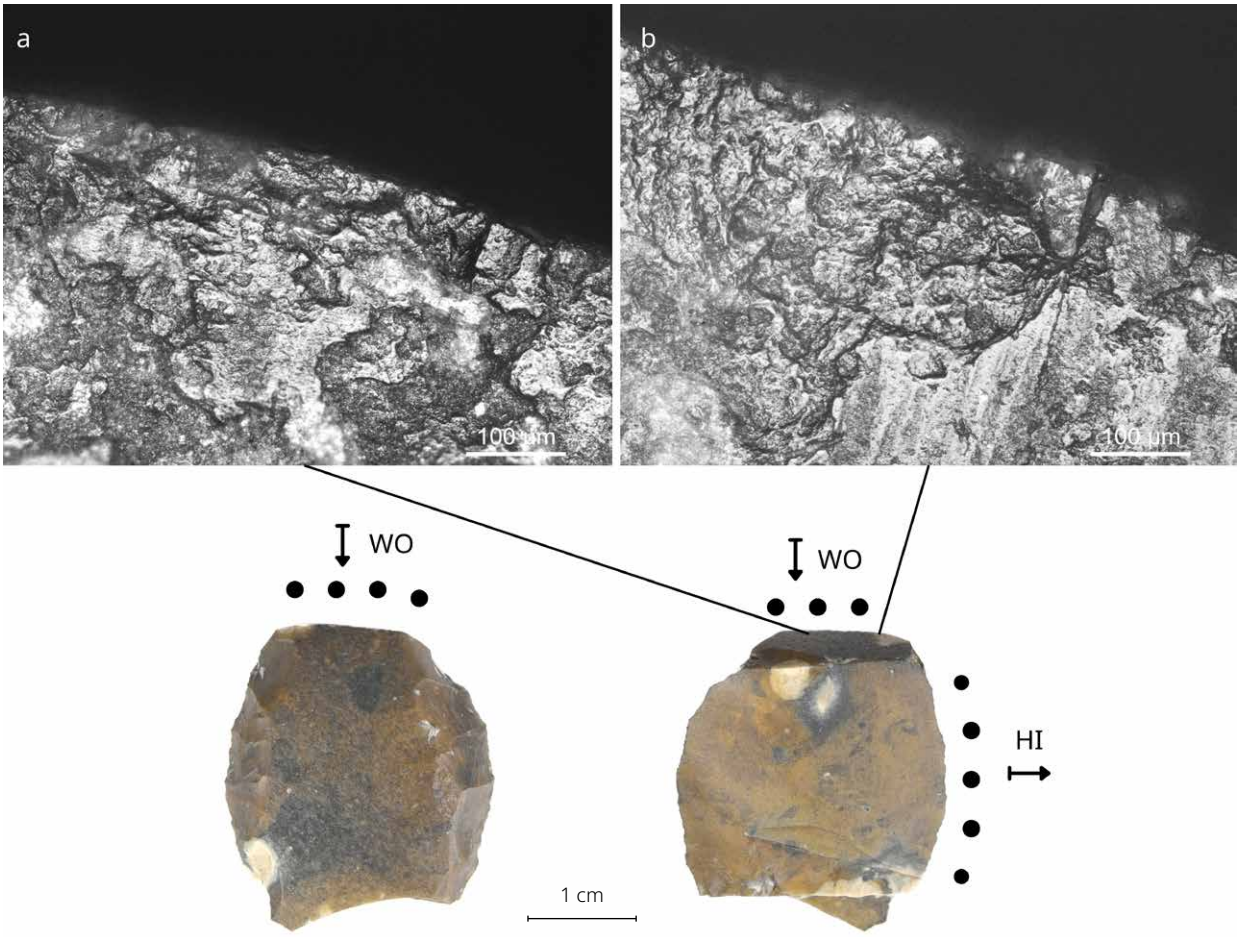


Figure 7.5 Axe fragment with a remnant of the cutting edge, reworked into a scraper (403.1): a and b) use-wear traces on the cutting edge of the axe, edge removals and flat, smooth and matt polish.

sites are located close together, and because they are very similar in terms of house plans and subsistence strategies (Kooistra, 2017; Kooistra et al., 2021; Kubiak-Martens & Oudemans, 2021; Stokkel, 2017b; Van Dijk, 2021; Van Dijk et al., 2017; Van Zoolingen, 2021b; Van Zoolingen & Bulten, 2021b). The initial use-wear analysis on the scrapers left several questions open which need to be addressed before a comparison could be made.

In the thesis by Mullaart four new types of hide working traces were introduced, in an attempt to better grasp the variability of hide working processes on the site (Houkes et al., 2017; Mullaart, 2016). However, in the publication these types are not correlated with specific processes. After several dehairing experiments conducted by Petrogiannaki the suspicion arose that 'type 1' hide working traces in the typology of Mullaart might be related to dehairing, because

	Chopping	Diagonal	Hafting	Indet/unsure	Transverse	Total
Animal						
Dry hide	-	-	-	-	4	4
Fresh hide	-	-	-	-	19	19
Hide with mineral additives	-	-	1	-	3	4
Hide indet	-	-	1	-	44	45
Fish	-	-	-	-	1	1
Animal indet.	-	-	-	1	-	1
Plant						
Silicious plants	-	1	-	-	-	1
Wood	1	-	-	-	-	1
Unknown material						
Hard material	-	-	3	-	-	3
Unsure	-	-	1	5	1	7
Total	1	1	6	6	72	86

Table 7.2 Contact materials and motions for different AUAs of the scraper assemblage of Den Haag Wateringse Binnentuinen.

it is mentioned that the hide polish is intersected by isolated spots of smooth polish (Mullaart, 2016; Petrogiannaki, 2022, p. 68; Petrogiannaki & Van Gijn, 2024). For 'type 2' which is characterised by heavy rounding, it is expected that these traces could potentially be classified as dry hide scraping traces. The description of type 3 and 4 seemingly matches those of fresh hide scraping (Mullaart, 2016, pp. 56–58). Because the typology for these hide working traces is not linked to specific stages in the hide working *chaîne opératoire*, and because the typology is not used in other publications, it was decided to check the use-wear traces on these scrapers in an attempt to link them to known stages in the hide working *chaîne opératoire* such as dehairing, dry hide scraping, or fresh hide scraping. It was decided not to reanalyse the scrapers with traces classified as 'hide indet', or those with other traces. Remarkably, one of the tools which was analysed by Mullaart consisted of a transverse arrowhead (1147.1), the arrowhead was for some reason included in the analysis of the scraper assemblage (Mullaart, 2016). Surprisingly the traces on the arrowhead were interpreted by Mullaart as hide scraping traces. Since it was part of the original analysis the arrowhead is now also included in the results.

A total of 86 AUAs was found on sixty flint scrapers from the site. The traces described in the publication as 'type 1' have isolated spots of smooth polish, as noted previously by Mullaart (Mullaart, 2016). Although these might be related to dehairing, based on the presence of the isolated smooths spots (Petrogiannaki & Van Gijn, 2024), this remained speculative. The 'type 1' scrapers were heavily affected by post-depositional processes. Therefore, it was impossible to determine whether the smooth spots on the edge were related to use, or to post-depositional processes. The notion that the smooth spots are related to the use of mineral additives could not be confirmed or refuted. Experiments with mineral additives generally display very well developed traces (see for example Van den Dikkenberg et al., 2024b; Van Gijn, 1990b, p. 29). Surprisingly, the type 2 scrapers could generally not be linked to dry hide scraping. Overall the scrapers in the assemblage have fairly little edge rounding, and dry hide scraping traces are scarce.

Not all used zones in the assemblage are related to the use of the scraper edges. Several scrapers were made from recycled flint axes; in some cases, the axe fragments still displayed traces of their previous use-life as axes. For example, the used zone related to chopping wood corresponds to the former cutting edge of an axe (as discussed in section 7.1.2). An interesting case is provided by a scraper with a zone with traces from contact with silicious plants. These could be related to either hafting, or binding, where the scraper was used as an ornament, this scraper had a natural cavity in which these traces were located. The hole was therefore used for binding the scraper, possibly to a haft (Mullaart, 2016, pp. 58–67). One tool displayed polish interpreted as being related to contact with fish (WBT11o.001196.14). These fish scraping traces were thought to be related to processing fish for consumption (Mullaart, 2016, p. 96). As explained in chapter 5 these traces can also be related to the processing of fish skin to make a kind of leather. It is interesting to note that the polish on some of the fish skin processing experiments (for example with defleshing or dry scraping) occasionally resembled more typical hide-like polish, while other experiments (notably descaling) resembled typical 'fish polish'. Considering in this case the traces from fish scraping are found also in association with typical hide scraping traces (on the same tool) it is possible that this tool

was actually used for processing fish skin, with the aim to make fish leather. Nevertheless, it cannot be excluded that the tool should be seen as a multitool which was used for two different activities; scraping fish and scraping hide.

All other interpretable zones were related to hide working processes (Tab. 7.2). Four used zones were interpreted as being related to dry hide scraping. Nineteen scrapers were used for fresh hide scraping. The results are surprising because, unlike Den Haag Steynhof or Hekelingen III, fresh hide scraping is more common than dry hide scraping. Softening of dry hides is more flint consuming than fresh hide scraping, therefore it is expected that dry hide scraping traces would be more common than fresh hide scraping traces (Gallagher, 1977; Van Gijn, 1990b). The scarcity of dry hide scraping at the site came as a surprise, as it is expected that permanent settlements generally present more evidence for dry hide scraping (Petrogiannaki & Van Gijn, 2024; Van Gijn, 1990b).

The scarcity of dry hide traces on the scrapers at Wateringse Binnentuinen demands an explanation. It seems unlikely that the hides were softened elsewhere, since it is ethnographically well documented that the softening of hides usually takes place at permanent settlements (Binford, 1978, p. 494). Based on the frequent occurrence of fresh hide scraping traces it was also clear that hides were processed here, and after defleshing these hides must have been softened again. The most likely explanation is that softening in Den Haag Wateringse Binnentuinen was usually not done with flint scrapers. Interestingly, one quartzite axe fragment from the site displayed hide working traces which were thought to relate to the softening of hides (Houkes & Verbaas, 2017, pp. 150–151). Some of the axe fragments with remnants of a cutting edge from the site also displayed hide working traces (see section 7.1.2). For Hekelingen III and Den Haag Gavi Kavel it was also demonstrated that axes were occasionally used as hide working tools for the softening of hides (see chapter 8 and section 7.2). This could also have been the case at Den Haag Wateringse Binnentuinen. In addition to axes (or axe fragments), organic tools were likely also used.[20] Whereas fresh hide scraping and dehairing require a sharp edge, for which scrapers are thus an ideal tool, the softening of hides can also be done with fairly blunt tools. It is therefore also possible that other, for example wooden tools, were used for this purpose (Little & Van Gijn, 2017). This notion is further supported by the analyses of the wooden 'digging stick' from Vlaardingen Arij Koplaan which displayed traces which also resembled those relating to the softening of hide (Van Gijn et al., 2025).

We can conclude that scrapers were used for a variety of hide working processes such as defleshing and softening. However, since there is more evidence for defleshing than for softening, it seems that most hides were softened with tools other than flint scrapers. Softening of hides was also done with (broken) axes, and possibly also with organic tools. This is remarkable since the assemblage from Den Haag Steynhof actually presented a lot of evidence for the softening of hides with flint scrapers (see previous chapter). We can conclude that even on similar sites, which are located very close together, different technological choices were made regarding the preferred tool types for specific activities (Lemonnier, 1986).

7.1.4 Hafting traces and fractures

Hafted tools consisted of scrapers and axe fragments. The axes from Den Haag Wateringse Binnentuinen only displayed hafting traces related to an unidentified hard material (N=27).

Eight scrapers displayed evidence of hafting. In one instance, the traces indicated hafting in wood (Fig. 7.6b), and in another, hafting in an unknown hard material. In two cases, the traces pointed to hafting in hide; one of these was noted by Mullaart as hafting in hide with additives. This seems unlikely; it presumably relates instead to hafting with leather bindings (Mullaart, 2016). In one case the hafting traces were noted as 'possibly hafted' (560.2). Lastly, in three cases characteristic bending fractures are observed. These scrapers were broken in a haft made from hard material either during use or resharpening (Aleo et al., 2021, p. 137; Van Gijn, 1990b, p. 79; Van Gijn & Mazzucco, 2013, pp. 114–115). Considering three out of the sixty scrapers in the analysed assemblage displayed such fractures we can conclude that the percentage of bending fractures (5%) is fairly similar to, though slightly lower than that of Den Haag Steynhof (6.7%). As noted in the previous chapter a low percentage of bending fractures likely indicates that hide working was done by experienced hide-workers (Weedman, 2018, p. 164). Like at Den Haag Steynhof it therefore seems plausible that the assemblage is not only produced by experienced hide-workers. The percentage of breaks suggests that hide working was a practice for which the skills and knowledge were transferred at the site. Although in this case it should be noted that the above is based on a smaller assemblage of analysed scrapers, it would be worthwhile to document these breaks more systematically for the entire assemblage, something that was unfortunately not possible at this time due to time constraints.

Both end-shock and bending fractures are related to the use of a haft. On two of the axe cores (794.1 and 1519.1), an end-shock fracture could be identified. These fractures clearly indicated that these axes were broken during use, notably in a dynamic chopping motion. After breakage they were repurposed and reused as a flake core.

20 Softening can even be done a tree stump as it does not require sharp edges.

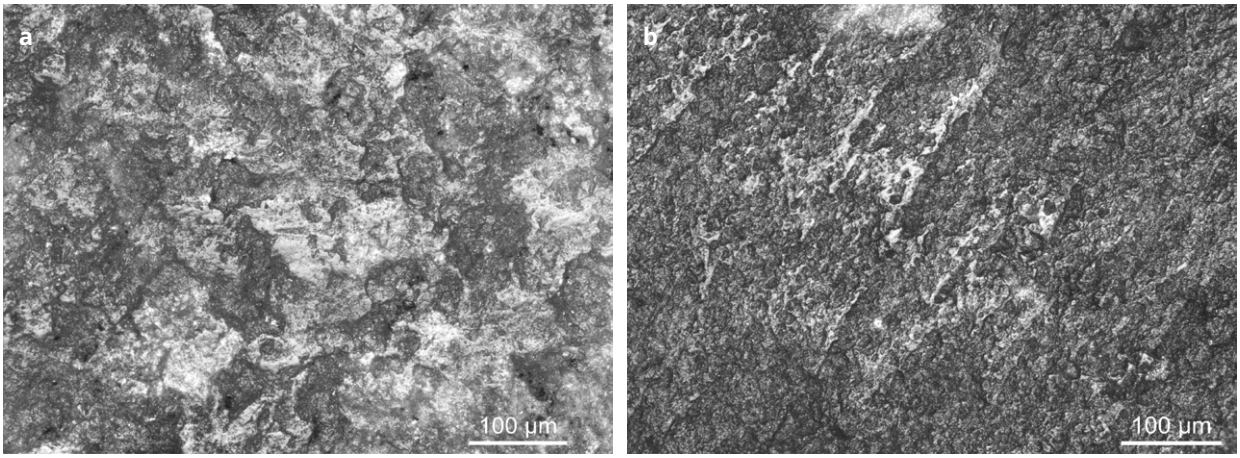


Figure 7.6 Hafting traces: a) isolated spots of flat, smooth and matt polish related to hafting of the axe in hard material found on axe fragment 1196.5; b) isolated spots of domed, smooth and matt polish on scraper 573.5, evidencing hafting in wood.

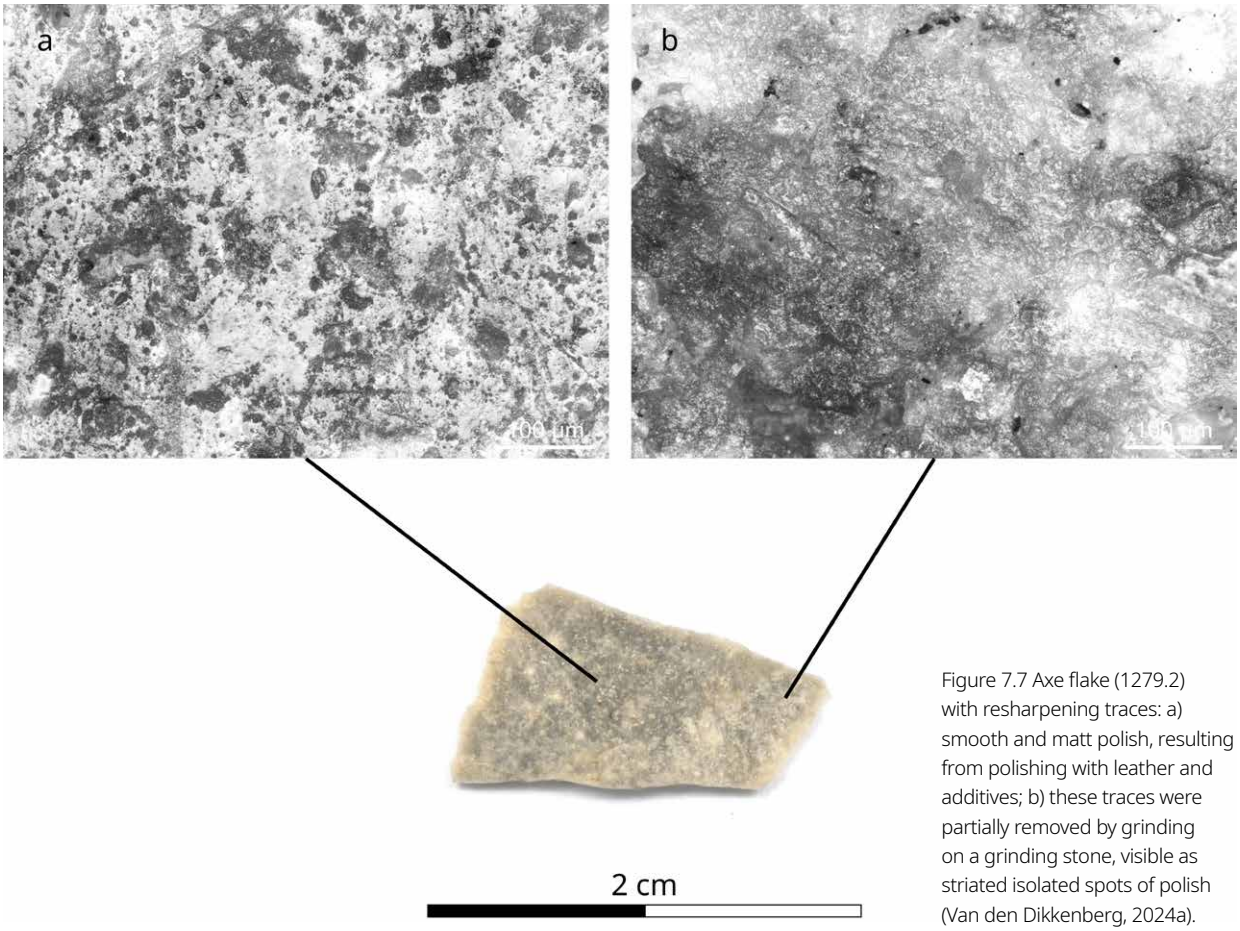


Figure 7.7 Axe flake (1279.2) with resharpening traces: a) smooth and matt polish, resulting from polishing with leather and additives; b) these traces were partially removed by grinding on a grinding stone, visible as striated isolated spots of polish (Van den Dikkenberg, 2024a).

7.1.5 Resharpening

Four scrapers displayed evidence for resharpening because they displayed overhanging dorsal ridges (Van Gijn, 1990b). Evidence for resharpening of scrapers is thus relatively scarce. This is not surprising because resharpening at Den Haag Steynhof was mainly linked to softening and dehairing of hides (see chapter 6 and Petrogiannaki, 2022, p. 76). At Den Haag Wateringse Binnentuinen these activities are comparatively scarce.

In contrast, axe fragments more frequently revealed signs of resharpening and reshaping (n=16). These often consisted of axe fragments which were originally polished using leather and additives, after which they were resharpened, or reshaped, on a grinding stone. In one

instance resharpening is observed on an axe fragment with a remnant of the original cutting edge, the axe was originally polished with a soft stone after which the cutting edge was resharpened on a harder type of grinding stone (403.1). Resharpening could often be observed when the polishing traces were visible in the deeper flake negatives, while the surrounding areas only displayed grinding traces (Fig. 7.7). In these cases the axe was originally polished using leather and additives (which also reached into the deeper parts), after which the axe surface was reground (resharpened or reshaped), removing the polish on the higher parts of the axe (Van den Dikkenberg, 2024a).

7.1.6 Conclusions on axes and scrapers

The assemblage from Den Haag Wateringse Binnentuinen provides interesting insights into the biographies of axes and scrapers. The axe fragments mainly display grinding traces. Polishing, when it was done, was done either with a soft type of stone or with leather and additives. The axes were usually hafted in hard materials, presumably wood or antler. In terms of production and hafting traces the assemblage is very similar to that of Den Haag Steynhof (Van den Dikkenberg, 2024a; and see chapter 6). The axes were mainly used to chop wood, although several of them were also used as hide working tools. All seven axe fragments with a remnant of the cutting edge were struck from the direction of the cutting edge, indicating that this edge (which provides an ideal platform because of its angle) was often employed to initiate the reduction sequence through which broken flint axes were reused.

The scraper assemblage displayed traces related to different stages of hide working. It is remarkable that dry hide scraping, which is related to the softening of hides, is scarce. Softening of hides therefore was presumably done mainly with tools other than scrapers. Some of the axes or axe fragments were reused for this purpose, and it seems likely that other tools were also employed for this purpose.

The original use-wear analysis furthermore presented evidence for wood working, hide working, plant working, cereal harvesting and drilling holes in pottery and amber (Houkes et al., 2017; Mullaart, 2016). The assemblage thus presents evidence for a wide variety of activities, which can reasonably be expected on a permanent settlement. The assemblage resembles that of Den Haag Steynhof, but the scarcity of dry hide scraping represents a striking difference, indicating that technological choices in hide working varied even between nearby contemporaneous sites.

7.2 An axe from the site of Den Haag Gavi Kavel

Excavations at Den Haag Gavi Kavel in 2001 uncovered the remains of a VLC site. Charcoal collected during the first campaign was radiocarbon dated between 3494–3101 BCE (Bulten, 2010; Bronk Ramsey, 2009; Reimer et al., 2020).[21] The site thus presents the oldest VLC site in the dune area. A new campaign in 2022 presented additional radiocarbon dates. These now spanned a much broader date range from 3364–3099 BCE to 2831–2466 BCE. Activities at the site thus potentially span the entire VLC period (Lammertsma & Grabowski, 2025).

During the 2001 excavation three poorly visible features were discovered, possibly all part of a single larger pit. In the pit a flint axe, along with a beaver jaw and a bone fragment of a large mammal were found. Neolithic pottery sherds, flint, stone, burnt bone, one fragment of burnt loam, and several pieces of charcoal were also found (Bloo & Van den Helm, 2025; Houkes, 2025; Houkes & Dorenbos, 2004; Lammertsma & Grabowski, 2025). The ceramics included sherds of a baking plate (Houkes & Dorenbos, 2004, pp. 18–22). For the present study the flint axe was selected for use-wear analysis and ED-XRF analysis (Van den Dikkenberg, 2025). During excavation the axe was damaged, accidentally removing a flake from the cutting edge. Luckily, this flake was retrieved during the excavation. For the ED-XRF analysis this provided an opportunity to analyse a fresh unpatinated surface.

7.2.1 ED-XRF analysis

The ED-XRF analyses on reference samples from the Lithotheque in Leiden revealed that Rijckholt and other Lanaye flints have low phosphorus (<500 ppm) and strontium (<20 ppm) concentrations. By contrast, Spiennes flint contains high phosphorus concentrations (1000–3500 ppm) as well as elevated strontium concentrations (20–60 ppm). These concentrations of trace elements can be used to determine whether Lanaye/Spiennes flints should be assigned to the Rijckholt/Lanaye group or the Spiennes group (Van den Dikkenberg & Braekmans, 2025). To account for variability in the stone four locations were measured with ED-XRF (see appendix 4). The low phosphorus and strontium concentrations confirm the initial attribution by Houkes (Houkes & Dorenbos, 2004). The elemental composition suggests that the axe is indeed made of Rijckholt/Lanaye flint (Tab. 7.3).

7.2.2 Finishing traces and use-wear traces

The finishing traces reveal that the axe was originally polished using leather and additives. The polish resulting from this process was mostly present in the deeper flake negatives. Often these traces were removed in subsequent grinding episodes. This indicates that the axe was heavily resharpened and reshaped, suggesting a long use-life prior to deposition (Van den Dikkenberg, 2024a). This is

21 Date recalibrated with the IntCal2020 calibration curve.

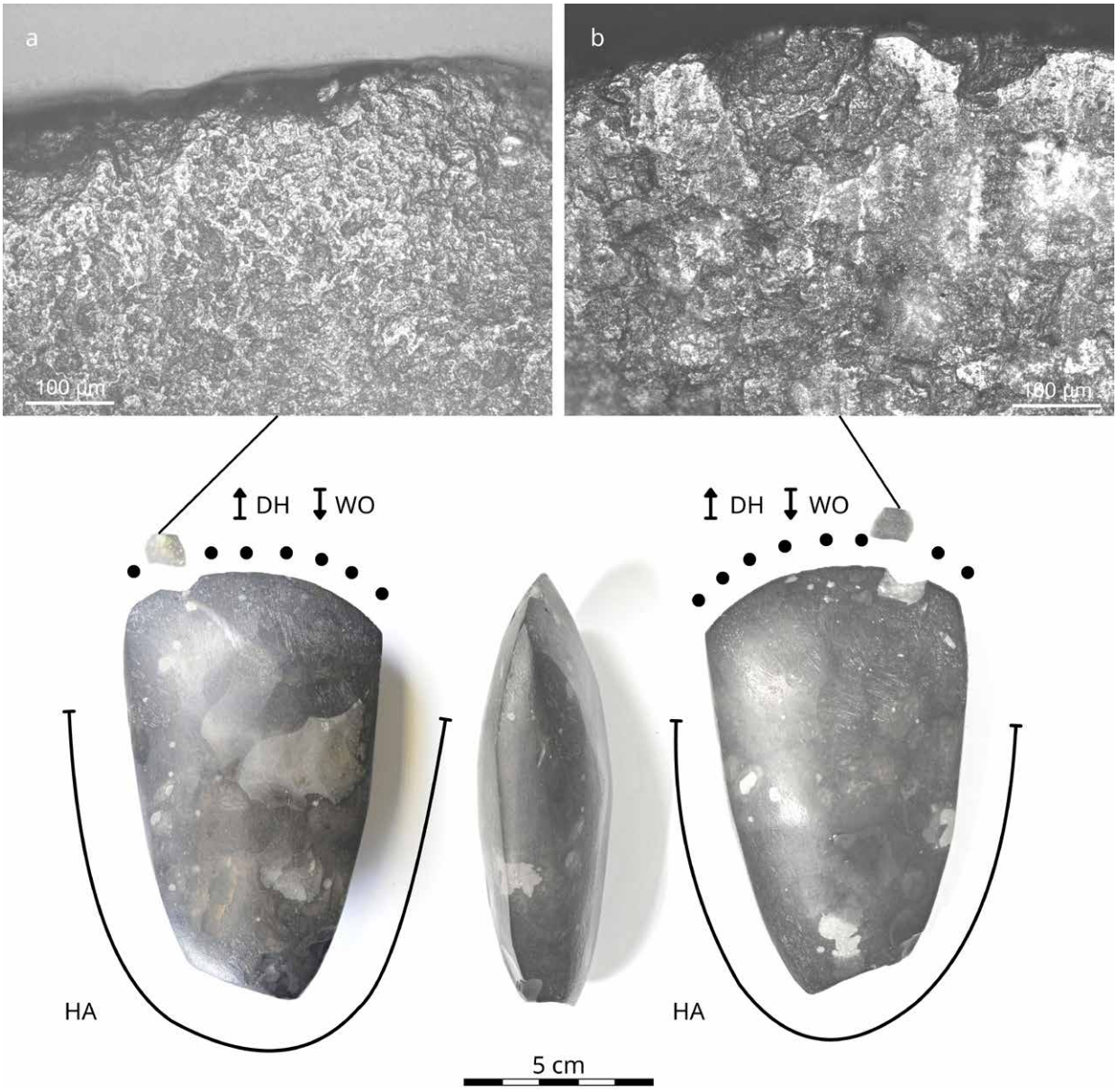


Figure 7.8 Axe of Den Haag Gavi Kavel with wear traces on the cutting edge: a) band of rough and matt polish resulting from scraping dry hide; b) smooth and matt polish and edge removals resulting from chopping wood.

	XRF-file number	Phosphorus (ppm)	Strontium (ppm)
Location 1	1802	Below detection level	6
Location 2	1803	72	Below detection level
Location 3	1804	97	Below detection level
Location 4	1805	Below detection level	Below detection level
Average	-	85	6

Table 7.3 Phosphorus and strontium concentrations (ppm) in the axe of Den Haag Gavi Kavel.

further highlighted by the asymmetrical cutting edge which indicated that the axe was repeatedly resharpened.

On the body of the axe extensive hafting traces are observed. These consist of smooth and matt spots of polish, with striations which overlay the finishing traces. The traces are likely related to the use of a wooden haft. Wear traces on the cutting edge reveal that the axe was used for multiple purposes. On parts of the cutting edge perpendicular streaks of smooth and matt polish with perpendicular striations, and edge removals can be observed. These indicate that the axe was used to chop wood. Other parts of the edge displayed a band of rough and matt polish with clear transverse directionality along the rounded edge. These traces match those observed on experiment 4349, an axe used to scrape dry hide (see section 5.4.2). The axe was thus used both for scraping dry hide and chopping wood (Fig. 7.8).

7.2.3 Interpretation of the find

The axe, combined with the beaver jaw and mammal bone fragment, appears to be a deliberate deposition. The broad date ranges of the new radiocarbon dates make it difficult to place the deposition at the Gavi-Kavel chronologically (Lammertsma & Grabowski, 2025). It is interesting that the deposition greatly differs from known FBC axe depositions. Funnel Beaker axes from wetland depositions never displayed use-wear traces. These ceremonial axes often displayed wrapping traces and thus did not serve a utilitarian purpose, but were intended for ceremonial display (Wentink, 2006, 2008). The axe from the Gavi Kavel is the only axe deposition from the Vlaardingen-Stein cultural sphere to have undergone use-wear analysis. It is interesting to note that during the CWC phase (2900–2500 BCE) axes from depositional contexts frequently display use-wear traces from wood working and from being hafted in wood (Van Gijn, 2010a, p. 185; Wentink et al., 2011). In terms of practices, the axe deposition at Gavi Kavel thus shows more affinity with those from known CWC depositions, rather than with those known from FBC depositions. It is presently unclear how the deposition should be placed chronologically. The date ranges from Gavi Kavel partially predate the CWC phase and are partially contemporary with the CWC. It remains unclear whether this CWC practice of depositing used flint axes has its roots in local VLC traditions. Recently a hoard of flint axes from the Middle Neolithic Michelsberg culture in Belgium also contained a used axe. This could well indicate that an older south/western tradition existed in which used axes were selected for deposition (Tomasso et al., 2025). The use-wear analysis on the Gavi Kavel axe clearly serves as food for thought and demonstrates that more extensive use-wear analysis on axe depositions in the western Netherlands could potentially present new insights into the ritual practices surrounding axe depositions in the region.

7.3 The site of Den Haag Noordweg 76

The site of Den Haag Noordweg 76 is located 130 m west of Den Haag Steynhof (Fig. 7.1). The site is interpreted as a potential special activity zone, exploited by the people living in Steynhof. The site is dated between 3014–2903 cal BCE, and is thus possibly contemporary with the earlier phase of occupation at Steynhof, although it is possible that Steynhof is of a slightly later date. The site contains two hearths as well as several postholes and pits. In terms of find material eighty sherds, seventy flint artefacts and eight stone artefacts were recovered. For the lithics the sourcing study, technological, and typological classifications were published by Houkes (2023). Most of the lithics consist of small, burnt fragments and splinters. Only three formal tools were found, a retouched blade, a retouched flake, and a flint hammerstone (Houkes, 2023). The latter was not available for study. Based on the limited number of finds and the temporary nature of the small structure the site was interpreted as a temporary site. Den Haag Noordweg 76 was selected for use-wear analysis because it was debated whether the site should be interpreted as a special activity site, or rather as a pioneer camp (Van Zoolingen & Rieffe, 2023). If the site should be interpreted as a special activity site this would beg the question what this supposed special activity was. The selection criteria for the use-wear analysis are based on previous work by Van Gijn on material from Hekelingen III and Leidschendam Prinsenhof (Van Gijn, 1990b). All retouched artefacts, flakes with a straight cross-section >1 cm, and pointed flakes and fragments were selected. Following these selection criteria only four artefacts were selected for use-wear analysis. In addition to the use-wear analysis the finishing traces on the two axe fragments were also studied.

Both axe fragments display finishing traces related to multiple grinding and polishing procedures. Both were originally ground and subsequently polished with leather and additives (Fig. 7.9a). Afterwards the axes were resharpened or reshaped on a grinding stone which removed most of the polishing traces. However, these polishing traces were still present in the deeper flake negatives. One of these axe fragments displayed traces related to hafting in a hard material.

The few use-wear traces which were observed are of a generic nature, and they are not well developed (Tab. 7.4). They were observed on two tools, one with a single AUA, the other with three AUAs. The observed activities consisted of hide and plant scraping, as well as scraping an unknown kind of medium hard material (Fig. 7.9b). In his definition of extraction camps Amkreutz, building on earlier studies by Binford, noted that we can expect a specific toolkit to be present, relating to this specific activity (Amkreutz, 2013b, p. 375; Binford, 1980). At Noordweg 76 such a toolkit could not be identified. The analysis of the flint artefacts only presented evidence for a limited range of activities. The assemblage fits

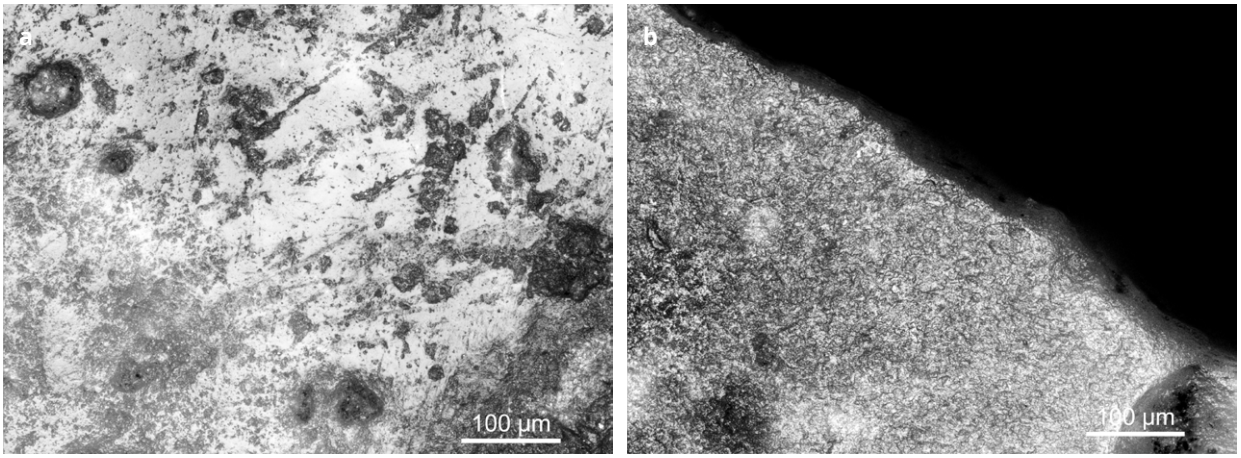


Figure 7.9 a) Polishing traces resulting from polishing with leather and additives on axe fragment 808.1; b) band of rough and greasy polish related to hide scraping on a retouched blade 922.1.

Table 7.4 Crosstab with use-wear results Den Haag Noordweg 76.

	Scraping	Hafting	Total
Hide indet	1	-	1
Plant indet	1	-	1
Hard material	-	1	1
Medium hard material	1	-	1
Total	3	1	4

best with the site type defined by Amkreutz as 'short-term sites' (Amkreutz, 2013b, p. 375). However, we cannot exclude the possibility that the site represents a special activity site, because special activities can also be conducted with non-lithic toolkits, or even without physical tools.

Nevertheless, the assemblage fits the range of activities we expect on a pioneer camp, from which the area was explored to identify suitable grounds for permanent settlement. In this case the site might be related to the permanent occupation at Steynhof, as these sites are located close together (Fig. 7.1). A similar zone was identified at Wateringse Binnentuinen, which also somewhat predates the permanent settlement. In the micro-region of the coastal dune area in The Hague a gap existed in habitation between 3300 and 3100 BCE. The only site dated in this period is Den Haag Gavi Kavel (Bulten, 2010; Houkes & Dorenbos, 2004; Kooistra et al., 2024, p. 21; Lammertsma & Grabowski, 2025). During this period the landscape became largely uninhabitable due to the development of extensive swamp vegetation (Kooistra et al., 2024, pp. 20–21). Around 3000 BCE a new saltmarsh area with dunes suitable for occupation developed in the area (Kooistra et al., 2024, p. 21). It is likely that Noordweg 76 and Wateringse Binnentuinen zone 8 represent pioneer camps from where people explored the potential of the newly formed landscape for permanent habitation.

8

The site of Hekelingen III: Life on the levees

Hekelingen III presents a remarkable VLC site, with several settlement clusters, potential round huts, and abundant remains of fish and wild animals. The site is generally considered a temporary extraction camp focused on the exploitation of wild resources (Louwe Kooijmans, 1987; Louwe Kooijmans, 1993; Raemaekers, 2003; Van Gijn, 1990a; 1990b). Nevertheless, the actual duration of occupation is disputed, as are the relationships with other VLC sites on the coastal dunes and the cover-sand area of Noord-Brabant (Amkreutz, 2010; 2013b; Louwe Kooijmans, 1993; Van Gijn, 1990b). The detailed studies of raw materials and renewed use-wear analyses presented here aim to shed light on this debate.

8.1 Excavation and landscape setting

Excavations at Hekelingen have been carried out since 1950, when the site of Hekelingen I was discovered (Modderman, 1953). Since then, three other VLC sites have been excavated. Hekelingen I was located on a levee along a freshwater creek. Behind the sandy levees, peatland was located (Bennema, 1953). The levees themselves were covered with shrubs and trees (Bennema, 1953). At Hekelingen I no actual house plans were found, but the rows of postholes are presumed to represent rectangular houses (Modderman, 1953). The flint artefacts are generally of a grey variety, belonging to a 'southern group'. The assemblage consists of fifty scrapers, three awls, one transverse arrowhead and a 'strike-a-light'[22], as well as at least three axe fragments, two of which are flake cores made from recycled flint axes (Modderman, 1953; 1974). Unretouched flakes were presumably also present, but these were not described. The well-preserved bone and antler artefacts include a perforated brown bear tooth, a worked boar canine, bone awls, a small bone axe and worked antler fragments (Modderman, 1953). Ceramics comprised typical VLC material, including a ceramic disc, but also later beaker ceramics, including a sherd of Early Bronze Age Barbed Wire pottery (Modderman, 1953; 1974).

In 1970, a second small VLC site was discovered: Hekelingen II. The site is located 660 m to the west of Hekelingen I. Finds include pottery fragments and 24 flint artefacts, including several axe fragments. Except for five scrapers, the assemblage contains no retouched tools. Animal bones of sheep/goat, pig, cow, red deer and sturgeon were recovered. One bone awl was found, but the species of the animal from which the awl is made could not be determined (Boomert, 1974; Verhart, 1983, p. 53).

Less than 300 metres to the east of Hekelingen I, a third site, Hekelingen III, was excavated in 1980. This site is by far the largest and best-studied of the four sites (Fig. 8.1). Artefact clusters and concentrations of postholes were discovered along the riverbank. Occasionally, the postholes seem to represent remains of round or oval huts (Verhart,

22 Modderman classified the artefact as a strike-a-light but no use-wear analysis has been done to confirm whether the object was actually used as such (Modderman, 1953, 7-9).

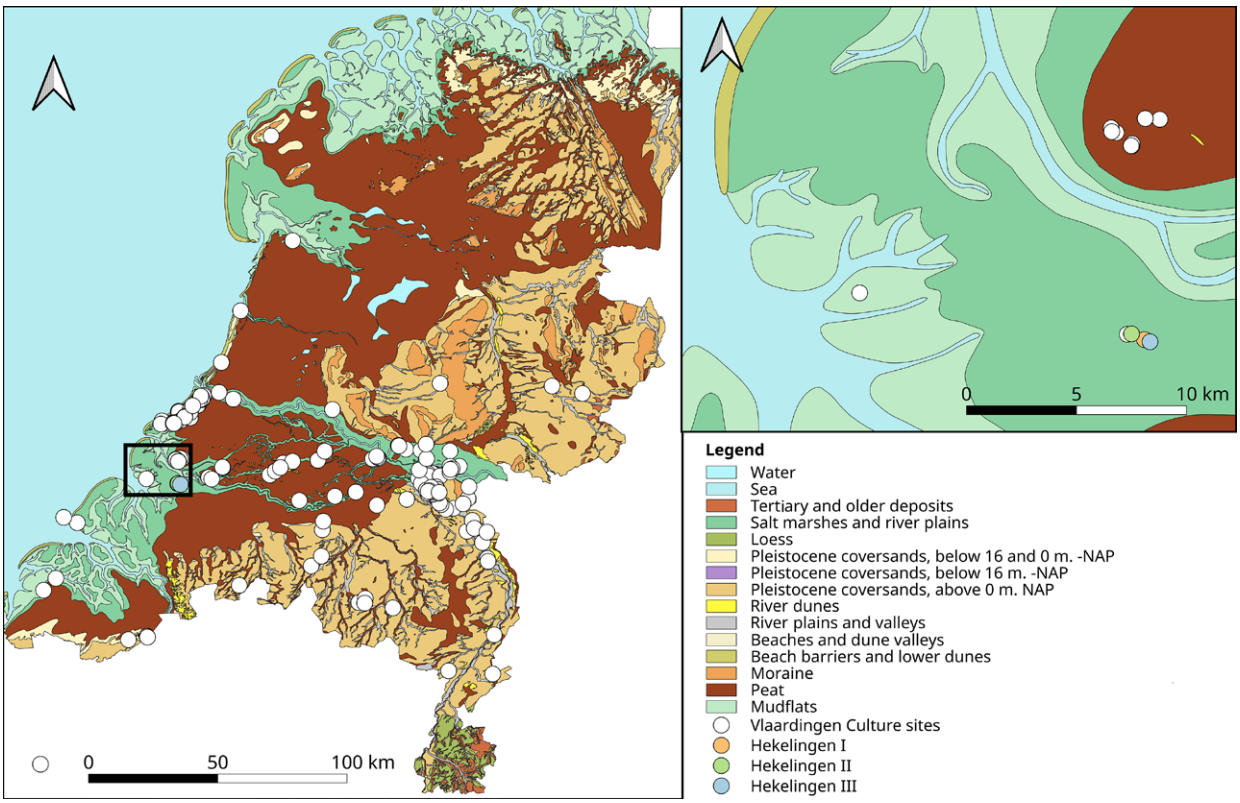


Figure 8.1 Location of Hekelingen I, II and III plotted on the palaeogeographic map of the Netherlands ca. 2750 BCE with other VLC sites illustrated in white (after Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020).

1990, p. 575). Abundant bone and antler artefacts and production waste were found (Maarleveld, 1985). The abundant ceramics also include three spindle whorl fragments. Animal bones notably include wild species, although cattle bones are present as well. Hunting and fishing are important activities at the site. Furthermore, charred remains of linseed and cereals (emmer and barley) were discovered (Louwe Kooijmans, 1987). Because Hekelingen III is the most extensively excavated, best-studied, and largest of the four Hekelingen sites, this site will be the focus of the current study.

On the western levee of the side-creek a small concentration of flint was found. This site was called Hekelingen IV, though it remains unclear why this small concentration was considered a separate site. Based on the raw material provenance, the flint seemed best comparable with the flint from occupation phase 1 of Hekelingen III which led Verhart to propose a similar date for this site (Verhart, 1983, p. 50).

8.1.1 Dating of the site and phases

The occupation at Hekelingen III is divided into four occupation phases (Louwe Kooijmans, 1985; Van Gijn, 1990b, p. 102). The earliest occupation phase dates between 3011–2885 cal BCE, in the Vlaardingen 1b phase (Fig. 8.2). The second and third phases date in the Vlaardingen 2a and Vlaardingen 2b phases. The fourth phase dates in the BB period (2460–2208 cal BCE).

The fact that the different archaeological units belong to different stratigraphical layers allows us to use the site to study chronological developments, something that is not possible on all VLC sites (Tab. 8.1).

8.1.2 Occupation duration

Hekelingen III is often considered to be a temporary settlement, focused on the exploitation of fish and other wild resources (Louwe Kooijmans, 1993; Van Gijn, 1990b). The round structures on the site are interpreted as temporary, rather than permanent, structures (Amkreutz, 2013b, p. 402; Louwe Kooijmans, 1986, p. 18). The focus on the exploitation of wild resources, hunting, fishing, and fowling, is often cited as one of the arguments for the temporary nature of the site (Raemaekers, 2003). The use-wear analysis by Van Gijn favoured such an interpretation, notably because of the lack of cereal harvesting traces, and because hide working traces seemed to be limited to the initial processing of fresh hides (Van Gijn, 1990a; 1990b). A problem with the interpretation of Hekelingen III as a temporary camp, exploited by people from the coastal dune area or the cover-sand area of

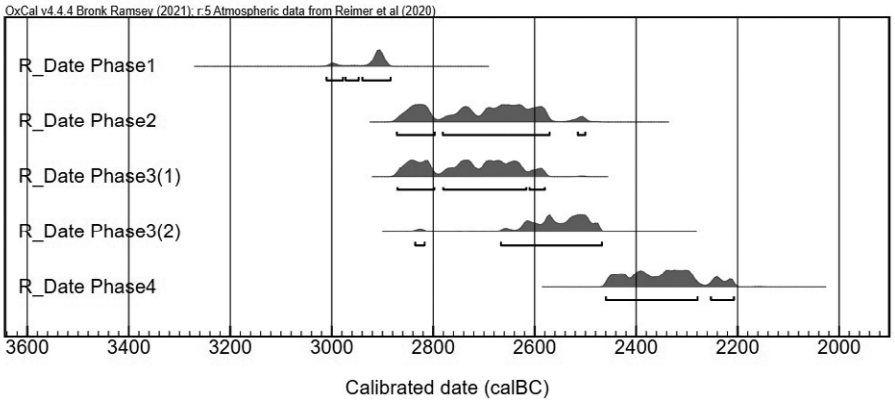


Figure 8.2 Hekelingen III ^{14}C dates, recalibrated with the Intcal2020 curve (after Louwe Kooijmans, 1985, p. 100; Bronk Ramsey, 2009; Reimer et al., 2020).

Brabant, is that the raw material procurement strategies at the site differ from those in the coastal dune area and Brabant (Amkreutz, 2010). An alternative hypothesis is that people came from different regions, bringing with them different raw materials, as suggested by Van Gijn (1990a). This hypothesis will be further explored in the final discussion. Considering the debate is shaped to a large degree by diverse arguments drawn from lithic studies, it seems fruitful to revitalise the debate through an in-depth study of the biographies of lithics from the site. This allows us to view the debate from a perspective which includes both the raw material procurement strategies, and the use of flint artefacts. The topic of the occupation duration at the site will therefore be discussed further in section 8.6.3.

Phase	Date	Archaeological units
1	3011–2885 cal BCE	A1, A1g, B1, C1, M1
2	2872–2501 cal BCE	B2a, B2a/b, H2
3	2871–2468 cal BCE	B3, C3, D3, E3, F3, M3, L3
4	2460–2208 cal BCE	D4, M4

Table 8.1 Phases and archaeological units of Hekelingen III (after Louwe Kooijmans, 1985, p. 100; Bronk Ramsey, 2009; Reimer et al., 2020; Van Gijn, 1990b, p. 101; Verhart, 1983).

8.2 Material selection

The flint of Hekelingen III (see Fig. 8.3) was previously studied, both in terms of technology, raw material procurement, and use-wear analysis (Van Gijn, 1990b; Verhart, 1983). In total 337 artefacts were studied through use-wear analysis (Van Gijn, 1990b, p. 104). For these analyses Van Gijn selected all archaeological units with at least ten modified artefacts. From these, all retouched tools, all artefacts with macroscopically visible wear traces, points, and/or edges with a straight cross-section >1 cm were selected for analyses (1990b, p. 104). Hekelingen III is up until now the most extensively studied VLC site in terms of use-wear analysis on flint artefacts. Nevertheless, because it was analysed during the early stages of the methodological development of use-wear analysis, it was considered necessary to reanalyse parts of the assemblage.

The aim of this current study is to provide a more in-depth understanding of the site based on new analyses and experimentation. The material selection for the present use-wear analysis is therefore made to shed light on specific themes, which are discussed below. Typological information on the flint from the site can be found in the publication by Verhart (1983). Verhart also studied the raw materials, however, this study focused on the grouping of raw materials in Raw Material Units (RMU's). These units were only provisionally linked to areas of origin (Verhart, 1983). Therefore, the flint raw materials were reanalysed. This study was limited to the artefacts which were selected for use-wear analysis (see section 8.4). The reanalysis is considered relevant because, since then, the Lithotheque (initially founded by Verhart) has expanded. Furthermore, our recent ED-XRF study demonstrates that it is now possible to distinguish between Spiennes and Rijckholt/Lanaye flints, something that was not possible during the initial study by Verhart (De Grooth, 2011; Van den Dikkenberg & Braekmans, 2025; Verhart, 1983). In addition to a study of the raw materials, and the use-wear analysis, finishing traces on the axes and axe fragments are studied in detail (based on the experiments presented in chapter 5).

The use-wear analysis focuses on four research themes: hide working, strike-a-lights, sickle gloss, and flint axes. The analysis of scrapers focuses on the scrapers with use-wear traces that were originally described as dry hide scraping traces. It came as a surprise that the use-wear analysis of scrapers revealed these traces (Van Gijn, 1990b). Dry hide scraping is generally believed to be related to the softening of hides and, considering that Hekelingen III was regarded as a temporary settlement, it was thought that this activity would not have taken place here. Ethnographically it is documented that in terms of hide working processes usually only fresh hides are scraped at temporary hunting camps (Binford, 1978). Often these are then dried and taken to a permanent

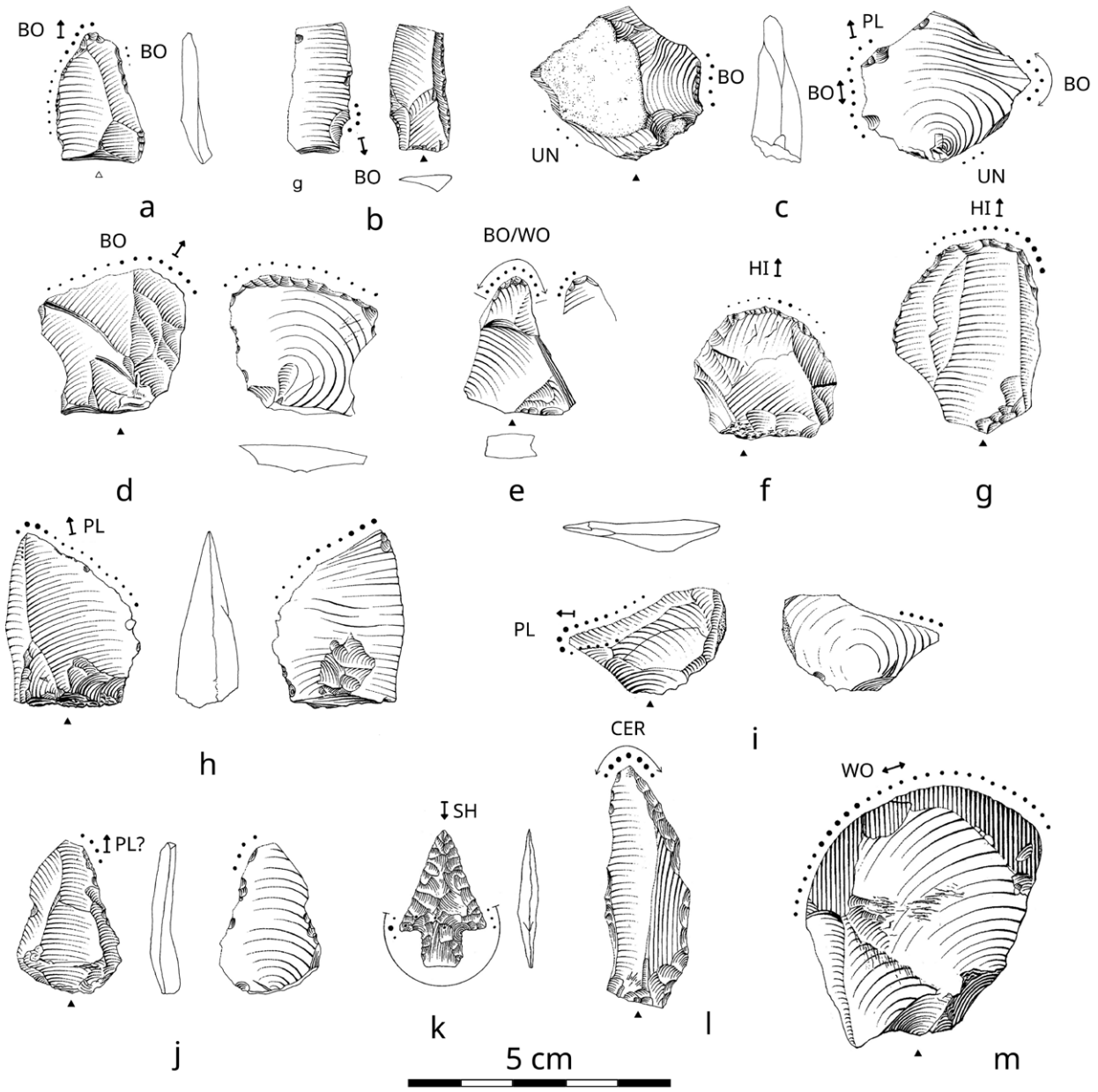


Figure 8.3 Flint artefacts from Hekelingen III: a) flake used to work bone (A1/1010); b) flake used on bone (M1/9005); c) flake used on bone and plant (B3/3015); d) scraper used to scrape bone (D3/5003); e) borer used to drill bone (B1/3013); f) scraper used to scrape hide (A1g/2044); g) scraper used to scrape hide (B1/3021); h) flake used to split plant (B3/3033); i) pointed flake to split plant (E3/6014); j) flake possibly used to split plant (H2/8031); k) tanged arrowhead used for shooting (B3/3005); l) borer used to drill ceramic (M1/9003); m) flake from a recycled flint axe used to cut wood (D3/5014) (after Van Gijn, 1990, 105–118).

settlement where they are further processed (Van Gijn, 1990b, p. 129). Hekelingen III presents evidence for hunting fur-bearing animals such as brown bear, fox or pine marten (Prummel, 1987). These animals have a lot of subcutaneous fat which is difficult to remove without some additive that can absorb the fatty substance. Removing the fat is necessary in order to prepare the skin for further processing. By using additives like fine sand or loam, it becomes easier to scrape away the fat. Van Gijn therefore suggested that it was likely that these traces, which resembled dry hide scraping, might actually have resulted from the scraping of fresh hides with additives, as this would also result in extensive rounding, which could be observed on these scrapers (Van Gijn, 1990b, p. 129). At the time the available reference collection only contained a few experiments of scraping hides with (only a limited number of different) additives. For the present study new experiments were conducted in which fatty

seal skins were scraped with mineral additives. It was expected that these would allow us to better distinguish between traces from softening and those from scraping fatty hides with mineral additives (Van den Dikkenberg et al., 2024b; also see chapter 5). Therefore, the scrapers which were previously interpreted as dry hide scrapers (n=22) are reanalysed (Van Gijn, 1990b).

A full study of all aspects of the flint axes was not possible in the 1980s, as the working distance of the microscopes in use at that time did not allow the detailed study of larger pieces. Therefore the three complete flint axes are now analysed. To the selection a butt end of a flint axe was added as well, along with two flake cores (made from recycled flint axes) which displayed macroscopic wear traces.

One borer from Hekelingen III displays traces of mineral polish. This initially led to the interpretation that it must have been used to drill holes in soft stone (Van Gijn, 1990b, p. 127). However, after the more systematic analysis of strike-a-light tools at Schipluiden Van Gijn suggested that this borer was probably a strike-a-light which was not recognised as such during the initial use-wear analysis (Van Gijn, 2010b, p. 85). To investigate this suggestion the borer is subjected to use-wear analysis.

In the initial report by Van Gijn it was noted that several tools displayed a type of polish which somewhat resembled 'sickle gloss.' The tools were not interpreted as being related to cereal harvesting (Van Gijn, 1990b, pp. 110–112). Nevertheless, considering the scarcity of silicious plant traces on VLC tools and considering the importance of studying potential cereal harvesting tools it was decided to reanalyse the ten soft plant cutting/splitting tools from Hekelingen. The tools with soft plant traces which are related to hafting were not reanalysed. Lastly, one axe fragment was included because it fitted the original selection criteria (a flake with an edge with a straight cross-section >1 cm), though it had not been included in the original analysis (A1g/2065).

8.3 Flint procurement

As noted previously by Verhart, the flint from Hekelingen appears to be of a non-local origin (Verhart, 1983). Meuse-eggs, terrace flint, and northern bryozoan rich flint are absent. When cortex is present it mainly consists of eluvial rolled cortex or fresh chalk. Overall, the assemblage seems to be of a southern origin (Tab. 8.2 and Fig. 8.4). Four sources could be identified; Hesbaye (Belgium), Spiennes/Lanaye (Belgium/Netherlands), Cap Blanc Nez (France), and Lousberg (Germany). For this study of flint origin, the assemblage selected for use-wear analysis was analysed (N=342). Although this could potentially create a selection bias, it can be noted that the present study corroborates the observations made by Verhart (1983). He mentioned the same range of flint sources as noted here. Therefore, it seems that these results are likely representative of the site at large.

Flint sources	Count	Percentage
Cap Blanc Nez	33	9.6%
Hesbaye	94	27.5%
Lousberg	1	0.3%
Southern	124	36.3%
Southern Eluvial	21	6.1%
Southern Eluvial?	1	0.3%
Southern primary chalk deposits	4	1.2%
Spiennes/Lanaye	47	13.7%
Unknown	17	5.0%
Total	342	100.0%

Table 8.2 Raw materials at Hekelingen III.

Cap Blanc Nez flint originates from the cliffs of Cap Blanc Nez in northern France. However, it is possible that this flint might have been collected closer to Hekelingen III, for example in Zeelandic Flanders (Van Gijn et al., 2006, pp. 132–133). However, the flint is believed not to have been transported beyond the mouth of the River Scheldt (Van Gijn pers. communication 2022). In addition to the previously mentioned sources southern eluvial flint is also present. This flint is sourced in eluvial deposits in Limburg and Belgium.

One blade (A1g/2014) is made of Lousberg flint. The flint is generally dark grey with many small white spots. The proximal part, however, has a characteristic dark red band (Fig. 8.4c and Fig. 8.5). Technologically the blade stands out, due to its well-prepared platform and the regularity of the three blade negatives on the dorsal face (Amkreutz & Verhart, 2024). Based on these characteristics the blade is not simply an elongated flake, but was struck from an intentionally prepared blade core (Sain & Goodyear, 2016). The blade was previously recognised as Lousberg flint by Verhart (1990, p. 577). Considering the scarcity of Lousberg flint at the site, and considering the near absence of blade technology in this period, it seems likely that this blade was imported in a finished state (as a blade, rather than as a core or nodule.). This notion is further supported by the fact that cores with blade negatives were absent on the site (Verhart, 1983, p. 15). Generally, the open-cast flint mines at Lousberg were used for the production of axes, but blades were occasionally also produced here (Beuker, 2010, pp. 49). The blade comes from unit A1g which is dated in the early phase of the occupation at Hekelingen. This is also the period during which the mining activity at Lousberg flourished (Beuker, 2010, pp. 47–49).

A large group of flint was tentatively assigned to the Spiennes/Lanaye group. Based on the ED-XRF analysis it

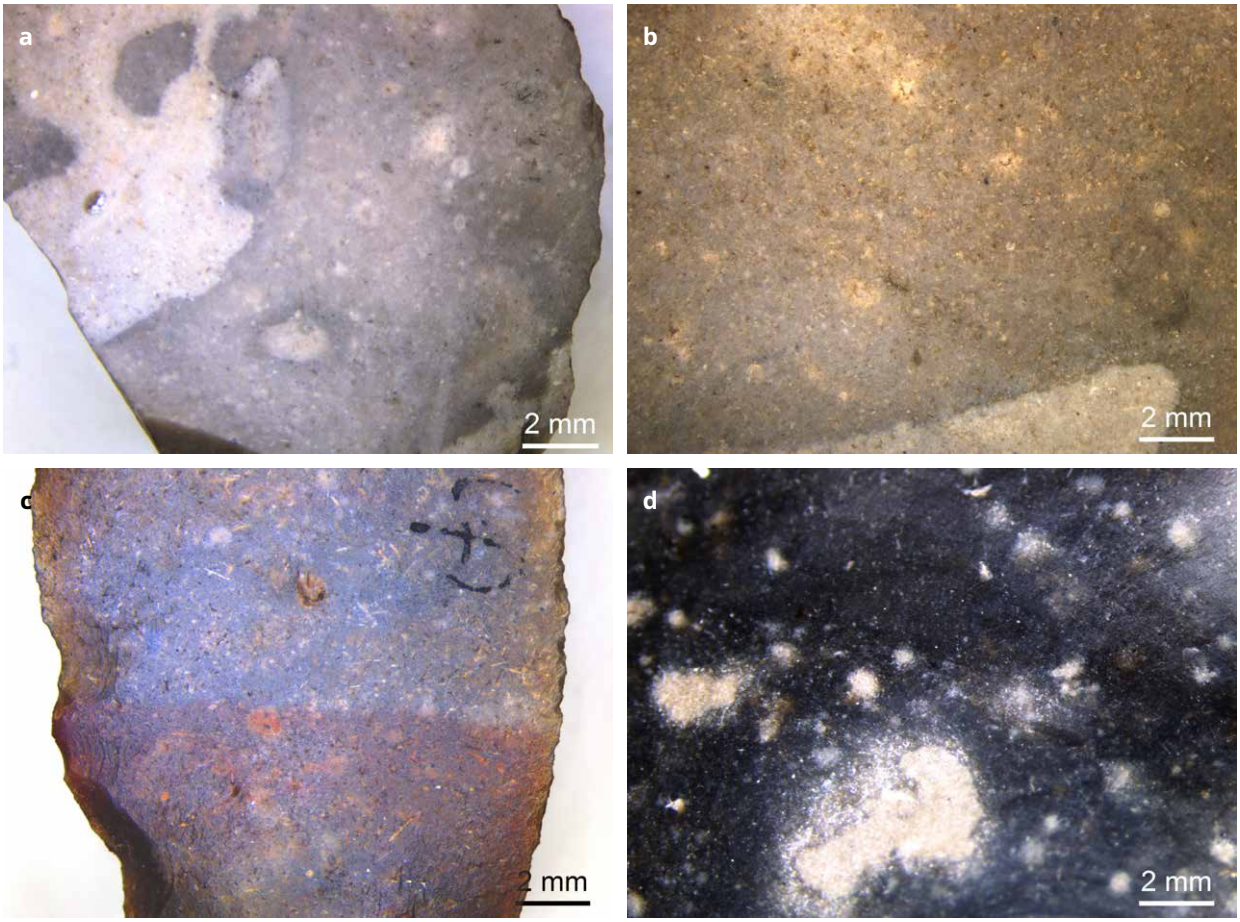


Figure 8.4 Raw materials at Hekelingen III; a) Hesbaye flint (unit A1g, number 2005); b) Spiennes/Lanaye flint (unit D3, number 5002); c) Lousberg flint (unit A1g, number 2014); d) Cap Blanc Nez flint (unit D3, number 5016).

Figure 8.5 Blade from Lousberg flint with the characteristic red band on the proximal end.

could be determined that the assemblage contained both flints with high Sr and P values, comparable with Spiennes flint, as well as flint with low Sr and P values, similar to Rijckholt and other Lanaye flints (Fig. 8.6). Both Spiennes and Rijckholt/Lanaye flint are thus present at Hekelingen III (Van den Dikkenberg & Braekmans, 2025).

Comparing the occurrence of the three main raw material groups (Hesbaye, Spiennes/Lanaye and Cap Blanc Nez) at the site allows us to trace procurement strategies across time. The study confirms earlier observations by Verhart, whose raw material units 1, 2 and 3 largely correspond with the aforementioned groups (Verhart, 1990). All flint types are found in all three phases. In phase 1 Hesbaye flint dominates while Spiennes/Lanaye and Cap Blanc Nez flint are relatively scarce (Fig. 8.7). In phase 2 and 3 the importance of Hesbaye flint rapidly declines in favour of these other groups. In phase 2 Hesbaye flint is still dominant, but in phase 3 Spiennes/Lanaye flint become dominant.

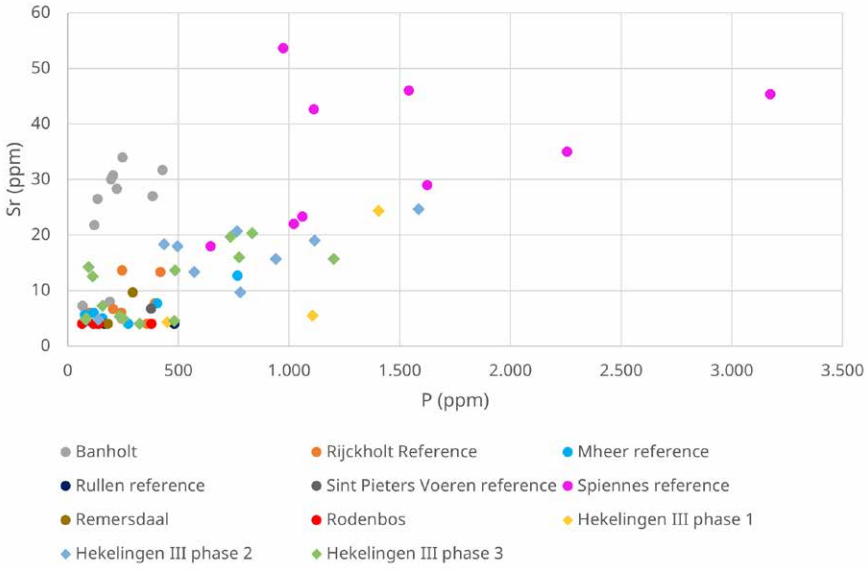


Figure 8.6 Spiennes and Lanaye flints: scatterplot of phosphorus (P) and strontium (Sr) values for reference sources, and for the Spiennes/Lanaye flints from Hekelingen III by occupation phase (after Van den Dikkenberg & Braekmans, 2025).

Throughout the occupation people had access to these three flint sources, but the relative importance of the sources changes through time (Fig. 8.7). For the Spiennes/Lanaye flint the different phases are visualised in Figure 8.6, throughout the occupation sequence both Rijckholt/Lanaye and Spiennes flint were used. It seems that high phosphorus and strontium values are more common in phases 1 and 2 than in phase 3. This may hint at a chronological trend in which Rijckholt/Lanaye flint became increasingly important relative to Spiennes flint. But considering the small sample size, and considering both flint types occur in all three phases this must remain tentative.

We can conclude that flint was procured from a geographically diverse range of sources, but in all cases it consists of good quality flint. Inferior rolled flint from riverine deposits is absent. In terms of procurement, the inhabitants of Hekelingen III maintained stable, diverse, and far-reaching networks that provided access to high-quality flint.

8.4 Flint technology

The site of Hekelingen III is atypical in terms of the technological aspects of flint. On this site, 63% of the flint was worked using a soft hammer technique (Verhart, 1983). Hinge terminations dominate the assemblage, followed by feather terminations (Tab. 8.3). Table 8.3 lists the terminations of flakes and blades at Hekelingen III (based on Verhart, 1983). The high percentage of hinge fractures in the assemblage indicates a low degree of skill, consistent with that of non-specialised flint knappers (Shelley, 1990).

The production sequence was geared towards the production of flakes; blades are scarcely represented. Blade cores, in general cores with blade negatives, are absent. The presence of blades on a site where blade cores are absent is noteworthy. Three blades in the assemblage have trapezoidal cross sections and four blades have triangular

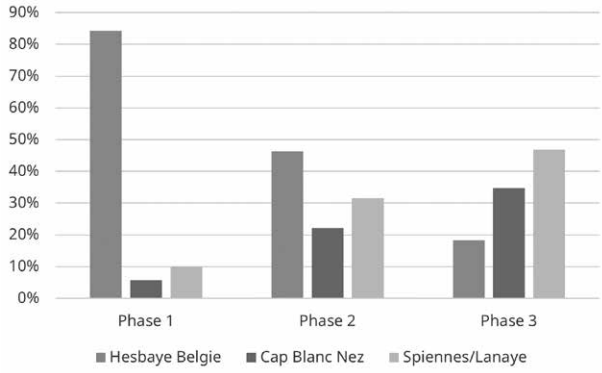


Figure 8.7 Percentages of the three main flint groups in occupation phases 1, 2 and 3 (other types and not specified flint are excluded here).

cross sections. These types of blades are generally not seen as byproducts of flake production, they can be linked specifically to blade production (Sain & Goodyear, 2016). Considering the absence of blade cores, and the general absence of a blade technology in the VLC, it seems that these blades were imported as finished products (Van den Dikkenberg, 2024b; Van Gijn, 2010b).

Axe fragments and axes from Hekelingen III display a wide variety of finishing traces (see chapter 5; Van den Dikkenberg, 2024a). Of the 71 axe fragments 49 display traces related to the polishing of axes (Fig. 8.8). The polishing traces resembled those observed in experiments in which flint was polished with leather and additives (Van den Dikkenberg, 2024a). Only 16 axe fragments exclusively show traces of grinding on a grinding stone, without polishing (23%). In total 11 axe fragments display traces of both polishing and grinding. In seven cases this could be linked to the resharpening or reshaping of the axes. It appears that the axe was originally polished, after which most of the polish was removed again by

	Feather	Step	Hinge	Plunging	Other/Indet	Total
Counts	161	18	309	2	41	531
Percentage	30.3%	3.4%	58.2%	0.4%	7.7%	100%

Table 8.3 Terminations at Hekelingen III, based on the total assemblage at the site (Verhart, 1983).

Phase	Date	Polished	Non-polished	Polished %	Non-polished %
1	3011–2885 cal BCE	14	2	87.5%	12.5%
2	2872–2501 cal BCE	10	7	58.9%	41.2%
3	2871–2468 cal BCE	15	2	88.2%	11.8%

Table 8.4 Hekelingen III: finishing traces on axe fragments through time.

Number of AUAs	Number of artefacts	Percentage
1	115	78.8%
2	21	14.4%
3	6	4.1%
4	3	2.1%
5	1	0.7%
Total	146	100.0%

Table 8.5 Number of AUAs of the artefacts from Hekelingen III.

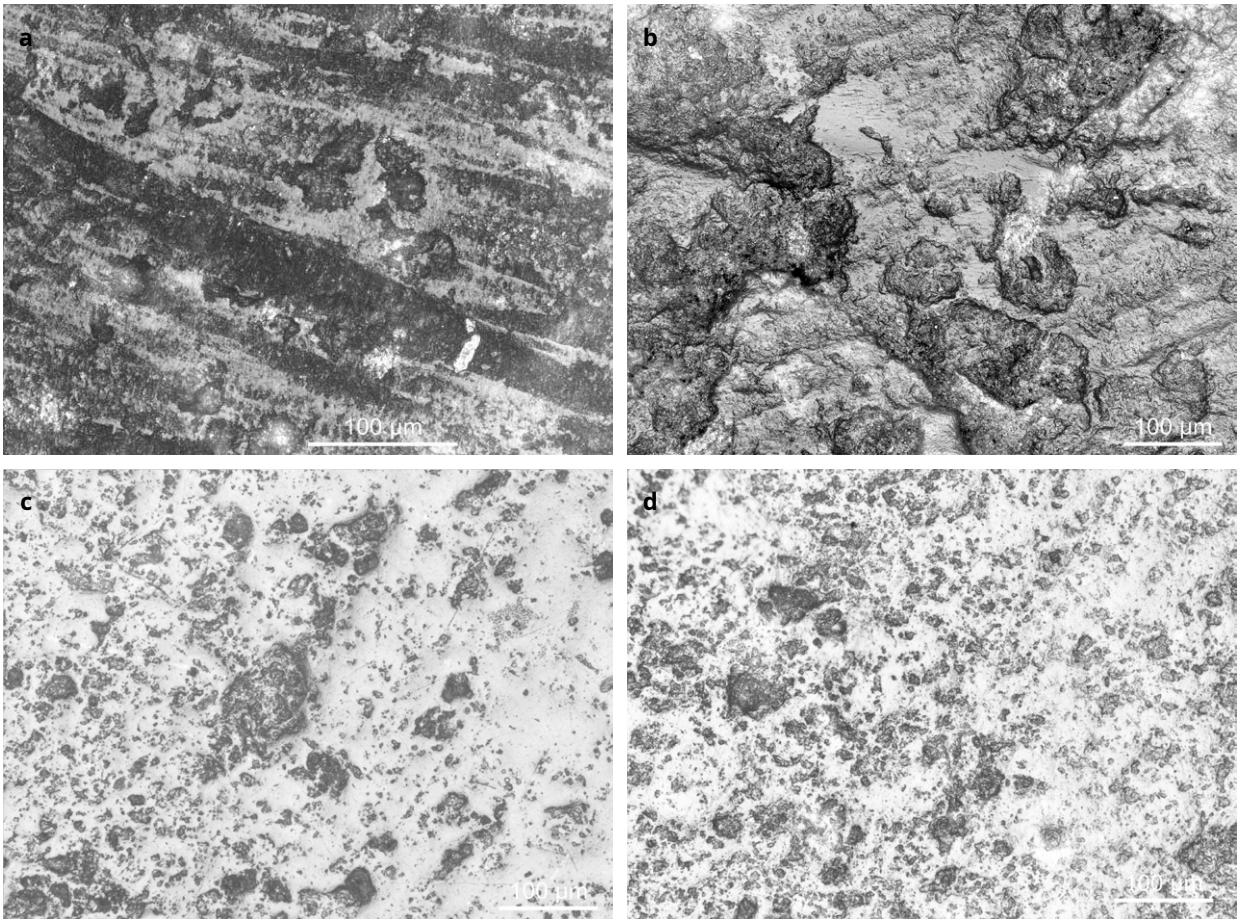


Figure 8.8 Hekelingen III: finishing traces on flint axes with comparable traces on experiments; a) Exp. 3310 grinding flint on sandstone; b) matching a flint axe B2a/3027, photograph also displays spot of flat smooth and matt polish with striations related to hafting; c) Exp. 3131 polishing with sand and leather in deeper flake negatives; d) matching traces on a retouched flake made from a recycled axe A1g/2003 (after Van den Dikkenberg, 2024a).

subsequent grinding. Sometimes this could be observed very clearly when the polishing traces are still present in the deeper flake negatives while the surrounding surface displayed only grinding traces (Van den Dikkenberg, 2024a). In one case a very soft grinding stone was used as the traces which were observed are similar to those on experiment 3336 (a flake ground on a piece of slate). All complete axes display traces of polishing, although they frequently have multiple facets, some of which are only ground, but not polished. It seems likely that most axes from Hekelingen III were originally polished, but that the polish was occasionally removed during resharpening or reshaping of the axes.

Because the archaeological units from Hekelingen III are tied to four chronological phases, this assemblage allows us to study the axe production traces from a chronological perspective. From the Bell Beaker phase 4 no material was studied, hence this study focuses on the first three phases. The dominance of fragments polished with additives can be observed for all phases (Tab. 8.4). In the eastern Netherlands it was observed that axes from the FBC were generally only ground, while those from the CWC were also polished (Wentink, 2020, pp. 104–105). In the western Netherlands polished axes clearly predate the emergence of the CWC as polished axe fragments were already dominant in Hekelingen III from phase 1 onwards. This notion is also supported by the axe fragment from Den Haag Noordweg 76 and possibly also the axe from Den Haag Gavi Kavel (see previous chapter).

The assemblage contains many axe fragments both from Hesbaye flint (N=23) and from Spiennes/Lanaye flint (N=25). Because both groups are well represented, it allowed us to make a comparison in terms of production traces between the two groups. In both groups, axes and axe fragments are generally polished, although some fragments are only ground. In both groups the traces occasionally resemble experimentally created traces resulting from grinding with sand while in other cases the traces seem to be the result of grinding without additives.

Of the 23 Hesbaye axes and axe fragments five are only ground, but not polished. The other 18 are polished with leather and additives, four of them have multiple facets, some of which are only ground and not polished. In one instance a very soft grinding stone was used. In one case it can be established that a grinding stone was used in combination with the addition of sand. Of the 25 axes and axe fragments made from Spiennes/Lanaye flint only five are ground, but not polished. Of the others 18 are polished with leather and additives. In four cases multiple facets are seen, some of which are only ground, but not polished. For three of these it can be established that the ground facets are caused by the resharpening or reshaping of the axes. In two cases the production traces cannot be interpreted. Sometimes the traces resemble grinding traces resulting from grinding with the use of sand as an additive (N=10).

We can conclude that the axes from Hesbaye flint and Spiennes/Lanaye flint are finished using similar techniques. Presumably most (or all) of the axes were originally polished using leather and additives after grinding. Grinding traces related to the use of a very soft grinding stone were observed on only one axe flake from Hesbaye flint. It is possible that these very soft grinding stones were used for resharpening or reshaping of the axes, considering the scarcity of such traces.

8.5 Results of the use-wear analysis

Of the 342 selected tools 146 showed use-wear traces; the other 196 displayed either no traces, or they were not interpretable due to post-depositional surface modifications. Several tools displayed multiple used zones (Tab. 8.5). In total 192 AUAs were found, 24 of these consist of hafting and handling traces which will be discussed in section 8.5.6. The use-wear results from Hekelingen III indicate that a wide variety of activities took place (Van Gijn, 1990b). Activities at the site included hide working, bone and antler working, wood working, and plant processing (Tab. 8.6; Fig. 8.9).

The main categories of wear traces encountered in the assemblage will be discussed individually below. The discussions focus on those tools which were reanalysed during the present study. For the parts which were not reanalysed I refer to the study by Van Gijn (1990b).

8.5.1 Hide working

Most of the reanalysed scrapers displayed traces resembling those from dry hide scraping (Fig. 8.9a). They did not resemble traces resulting from the scraping with mineral additives (Van den Dikkenberg et al., 2024b; see chapter 5; Van Gijn, 1990b; Van Gijn, 1994a).[23] They are likely related to the softening of dry hide. In one case (A1g/2036) the traces were interpreted as dehairing traces (Fig. 8.9b), based mainly on the presence of isolated bright spots in the polish band (Petrogiannaki, 2022, p. 49; Petrogiannaki & Van Gijn, 2024). Unexpectedly, hide working traces were also observed on the cutting edges of two flint axes and on the butt of a broken axe. These will be discussed separately in section 8.5.5.

Overall, we can conclude that the hide working traces encountered at Hekelingen III are more diverse than expected. It seems that the traces resemble the entire hide working *chaîne opératoire*, from defleshing, dry hide scraping, dehairing, to cutting and piercing hide. This suggests that hides were fully processed at the site. Such traces are generally expected at base camps rather than temporary extraction camps, based on ethnographic parallels (Binford, 1978; Van Gijn, 1990b).

23 Although more experiments would be advisable, the present experiments focused on seal skins, it would be worthwhile to repeat those experiments with land mammals with fatty hides such as beavers or foxes.

	Boring/drilling	Carving	Chopping	Cutting	Cutting/sawing	Graving	Indet/unsure	Longitudinal and transverse	Pecking motion	Rubbing?	Shaving	Shooting	Splitting	Transverse	Whittling	Total
Animal																
Antler	-	-	-	-	1	1	4	-	-	-	-	-	-	2	-	8
Bone	2	3	-	-	12	6	-	-	-	-	-	-	-	5	-	28
Bone or antler	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	3
Dry hide, dehairing hide	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Dry hide	1	-	-	-	2	-	1	-	-	-	-	-	-	16	-	20
Fresh hide	1	-	-	2	-	-	1	-	-	-	-	-	-	5	-	9
Hide indet	1	-	-	-	1	-	2	-	-	-	-	-	-	7	-	11
Hide indet?	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Animal hard	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Animal medium hard or hard material	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Animal soft material	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	5
Plant																
Cereal	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Silicious plants	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Soft plant	-	-	-	-	1	-	1	-	-	-	-	-	4	-	-	6
Wood	1	-	3	-	9	1	-	-	-	-	5	-	-	3	1	23
Inorganic																
Pottery	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Shell	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Unknown material																
Hard material	1	-	-	-	1	-	2	-	5	-	-	-	-	1	-	10
Soft material	3	-	-	-	-	-	4	-	-	-	-	-	1	1	-	9
Indet/unsure	5	-	-	-	3	-	9	-	-	-	-	3	-	4	-	24
Total	17	3	3	4	33	8	30	1	5	2	5	3	5	48	1	168

Table 8.6 Crosstab contact materials (x-axis) and motions (y-axis), excluding hafting traces for different AUAs in Hekelingen III (after Van Gijn, 1990b).

8.5.2 Traces from contact with bone, antler, wood, shell, and shooting

The artefacts used for bone and antler working, wood working and soft plant working have not been reanalysed. Therefore, it suffices here to summarise the results from the study by Van Gijn (1990b). After hide working traces from bone and antler working represent the largest group of traces. It is clear that this is an important activity at the site, which is further supported by the presence of bone tool production waste (Maarleveld, 1985, p. 60). Bone working was clearly geared towards the use of the metapodium technique, as is evidenced by the presence of bone working traces resulting from graving and cutting/sawing motions (Van Gijn, 1990b). Deer are clearly overrepresented in the assemblage of bone tools, 76% of all the metapodium tools was made from red deer or roe deer bone (44% red deer, 32% roe). Deer only represent 15% of the animal remains at the site, indicating that these species were clearly preferred for tool production. Metapodia of cattle were only used for 3% of the bone tools, even though cattle is more common on the site than roe deer (Maarleveld, 1985, p. 60; Prummel, 1987).

Wood working is the third largest group in terms of use-wear traces. Activities inferred are cutting, scraping, whittling and boring (Van Gijn, 1990b, p. 115). The use-wear analysis of the flint axes also indicated that these were used for chopping wood, as will be discussed in section 8.5.5. Three used zones were related to the shooting of projectile

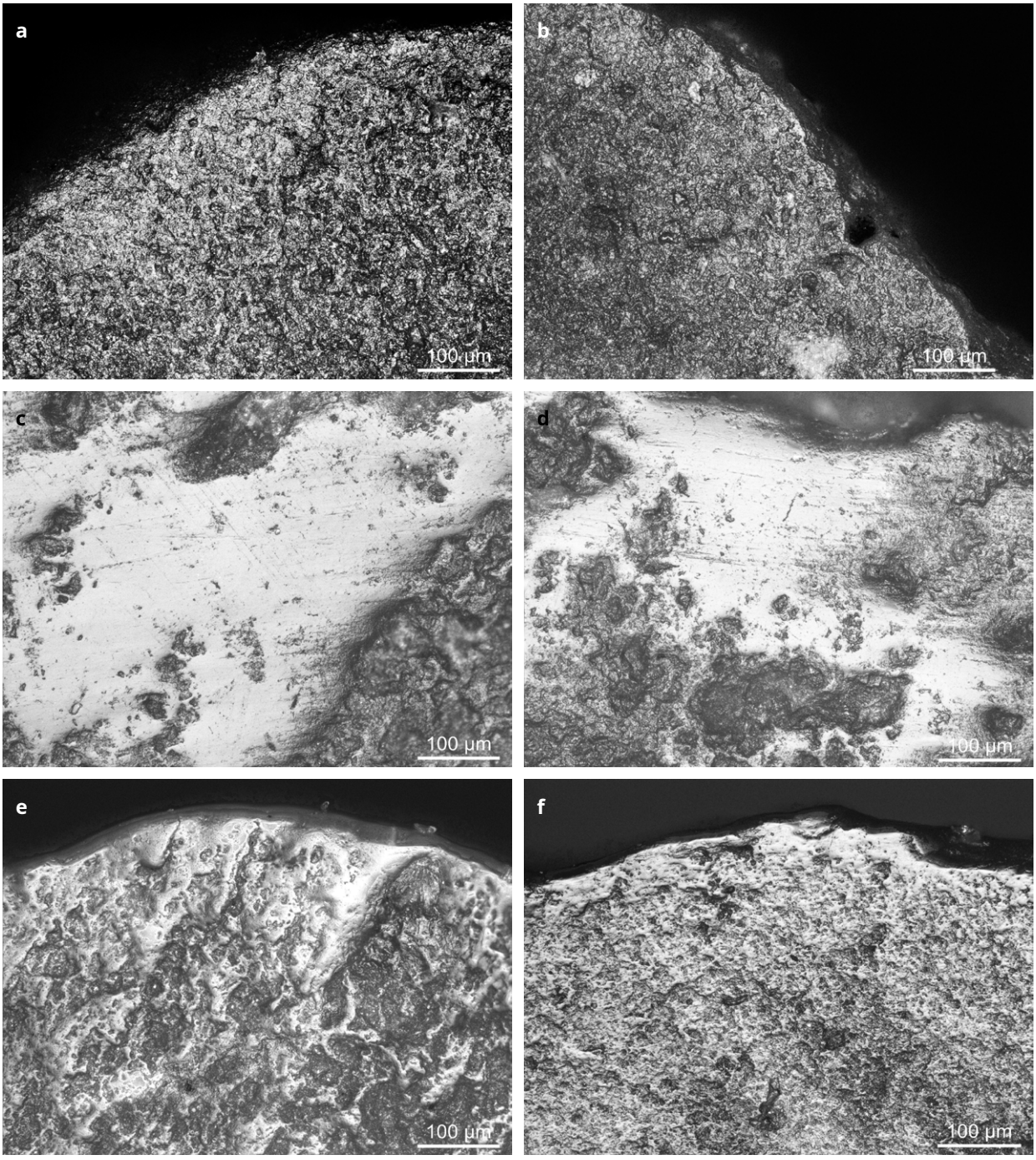


Figure 8.9 Hekelingen III, observed use-wear traces; a) heavy rounding and rough and matt polish on scraper A1/1003, resembling typical dry hide scraping traces; b) rough and matt polish band with isolated spots of smooth polish, interpreted as dehairing traces on scraper A1g/2036; c and d) smooth and matt domed polish with striations, interpreted as cereal harvesting traces on a retouched flake B2a/3043; e) smooth and matt silicious plant polish on tool B2b/4031; f) smooth and matt silicious plant polish on tool M1/9027.

points. These are likely related to hunting activities which, based on the zooarchaeological evidence, took place (Prummel, 1987). Lastly, one borer which was used on shell should be noted (Van Gijn, 1990b, p. 115).

8.5.3 Borer used to drill holes in pottery

The borer, originally interpreted as a tool for drilling holes in soft stone, produced surprising results. Upon re-inspection it turns out that the traces on the borer closely

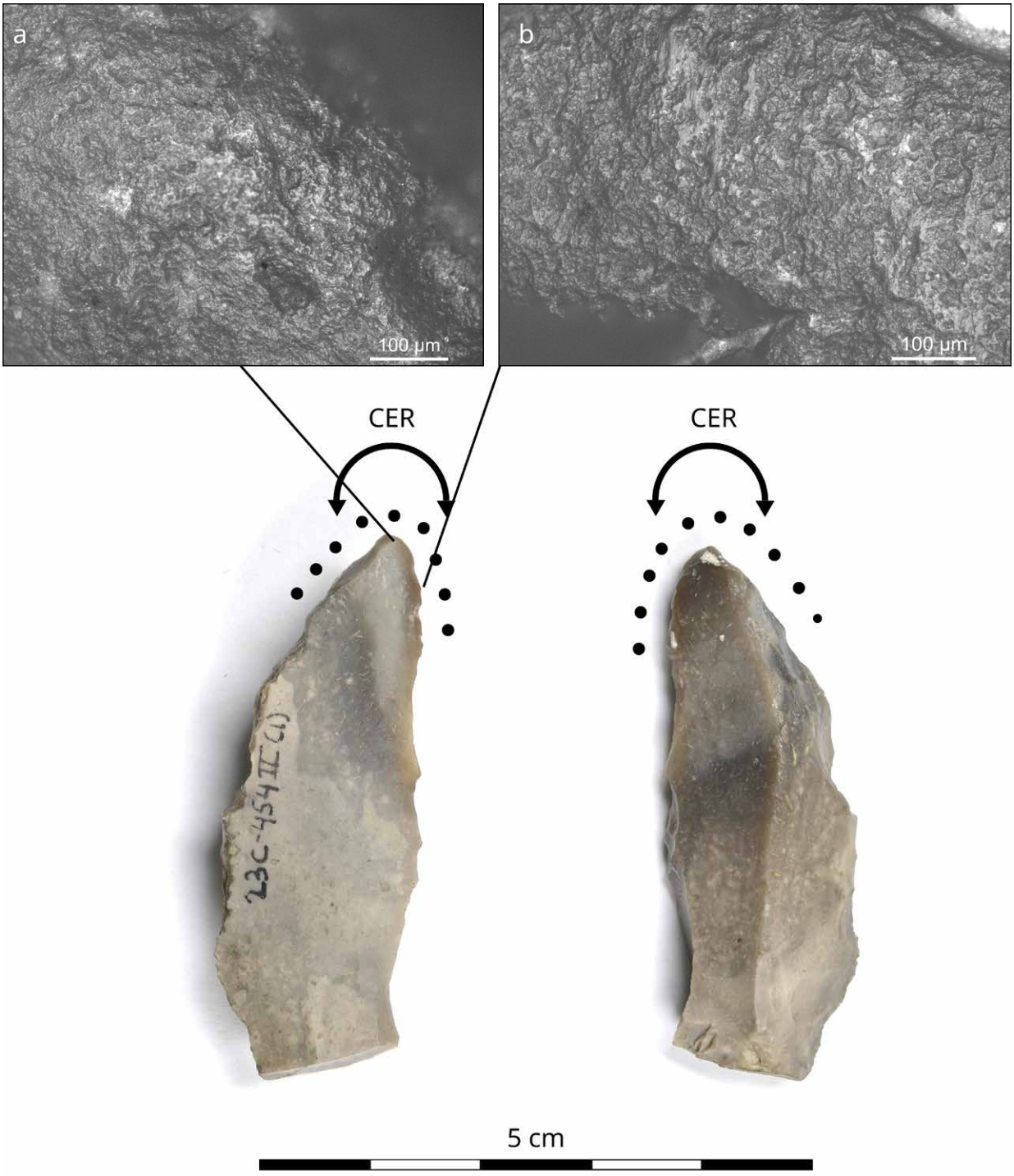


Figure 8.10 Borer M1/9003 with a and b) use-wear photographs of traces related to drilling ceramics.

resembled the traces found on several borers from Den Haag Steynhof, as well as those from the experiments conducted by Van Gijn and Carter (Carter, 2021; Van Gijn, 2021a). The borer is heavily rounded. Some parts display a bright flat polish, occasionally with striations (Fig. 8.10a+b). The traces could be linked to drilling holes in ceramics, most likely linked to the repair of broken pots (Carter, 2021; Van Gijn, 2021a).

8.5.4 Soft plant

The ten soft plant working tools reported by Van Gijn were reanalysed, with the hope of further disentangling the

Flint axe	Raw material	Finishing traces	Use-wear traces
B2a/3027	Lanaye/Spiennes	Polished with leather and additives, resharpened and reshaped on a grinding stone.	Cutting edge used for wood chopping and reused for dry hide scraping. Axe hafted in wood.
E3/6016	Hesbaye	Polished with leather and additives	Cutting edge used to chop wood
M1/9053	Hesbaye	Polished with leather and additives, resharpened and reshaped on a grinding stone.	Cutting edge used for wood chopping and reused for dry hide scraping. Axe hafted in hard material.

Table 8.7 Raw materials, finishing traces, and use-wear traces on the three complete axes from Hekelingen III.

diversity in plant working traces at the site (1990b). For seven of these the contact material could not be specified further than being related to 'soft plant'. As noted by Van Gijn these were likely mainly used for splitting plants in basketry making activities (1990b, pp. 109–110). Two were related to the cutting of silicious plants. Van Gijn noted that these traces might be related to cutting wild grasses for basketry activities (1990b, pp. 110–111). This indeed seems to be a plausible explanation.

The most surprising results came from one retouched flake. This tool displayed traces related to the harvesting of cereals (Fig. 8.9c and d). The polish is domed, smooth and matt with many striations. These striations are considered to be characteristic of the harvesting of domesticated cereals as they do not occur when harvesting other types of silicious plants such as reeds or wild grasses (Unger-Hamilton, 1985, p. 122). Much of the polish was removed by retouching after use. It seems that in this case the edge was deliberately damaged after use, something that is frequently observed on sickles from the Middle and Late Neolithic (Houkes et al., 2017; Van Gijn, 2014b, p. 313; Van Gijn et al., 2006; Van Gijn & Verbaas, 2008). The directionality in the polish and of the striations is both longitudinal and transverse. This suggests that the tool was possibly used in multiple motions, relating to cereal harvesting.

8.5.5 Flint axes and flake cores

All of the complete flint axes were originally polished using leather and additives, two were heavily resharpened and reshaped through subsequent grinding. All three flint axes displayed wood chopping traces on the cutting edge (Fig. 8.11). The two smaller axes also display traces relating to the scraping of dry hide (Tab. 8.7). One axe displayed hafting traces relating to hafting in wood, while another has traces relating to hafting in an unspecified hard material.

A heavily rounded axe butt fragment (A1g/2066) was added to the original selection. In addition to heavy rounding the butt end displayed a rough and matt polish (Fig. 8.12). Because the polish resembled dry hide scraping traces an experiment was conducted in which a similar butt end was used to soften dry hide (see chapter 5). The traces on the experiment closely matched those on the archaeological butt end, indicating that the axe butt was likely used to soften hide.

Two flake cores, made from recycled flint axes, bore macroscopic battering traces, indicating that they were reused as hammerstones. On both cores the battering traces were rounded and they displayed a rough and matt polish. This could indicate that the cores were reused for softening hides. Alternatively, these traces could also be related to handling. One of the cores (A1/1036) displayed a rough and matt polish with some rounding on all sides. In this case it seems likely that this polish was related to handling. Similar traces have also been observed on a flint hammerstone from Den Haag Wateringse Binnentuinen. That assemblage also contains a similar axe core which was reused as a hammerstone (Houkes et al., 2017, p. 176).

8.5.6 Hafting, handling, and resharpening

In total 24 used zones showed hafting or handling traces (Tab. 8.8). Two axes and one butt end bore traces of hafting in an unknown hard material. Two axe fragments also displayed hafting traces related to the use of the axe; in one case these consisted of traces related to the use of a hard material haft, in the other instance the traces were interpreted as traces resulting from the use of a wooden haft. As noted in section 8.5.5 one flake core displayed traces which were likely related to handling. One tanged arrowhead was interpreted as being hafted with hide bindings (Van Gijn, 1990b). A scraper showed traces relating to hafting in wood, and several flakes and a waste fragment displayed hafting traces which could be related to hafting in soft plant material. Overall we can conclude that the flint material from Hekelingen III presented a wide variety of hafting traces, on a diverse group of tools including arrowheads, scrapers and both retouched and unretouched flakes.

In terms of resharpening traces it can be noted that two axes and eight axe fragments displayed resharpening traces. These could be observed because the axes were originally polished using leather and additives, in these cases the polishing traces were largely removed by subsequent grinding. However, in the deeper flake negatives the original polish could still be observed, indicating that the axes were resharpened by grinding (Van den Dikkenberg, 2024a). Fourteen scrapers displayed evidence for resharpening. In nine instances the scrapers have overhanging dorsal ridges, indicating that the scrapers were heavily resharpened (Van Gijn, 1990b, p. 139). In five instances it can be observed that major differences existed in terms of rounding and polish along the working edges. Here it seemed that parts of the

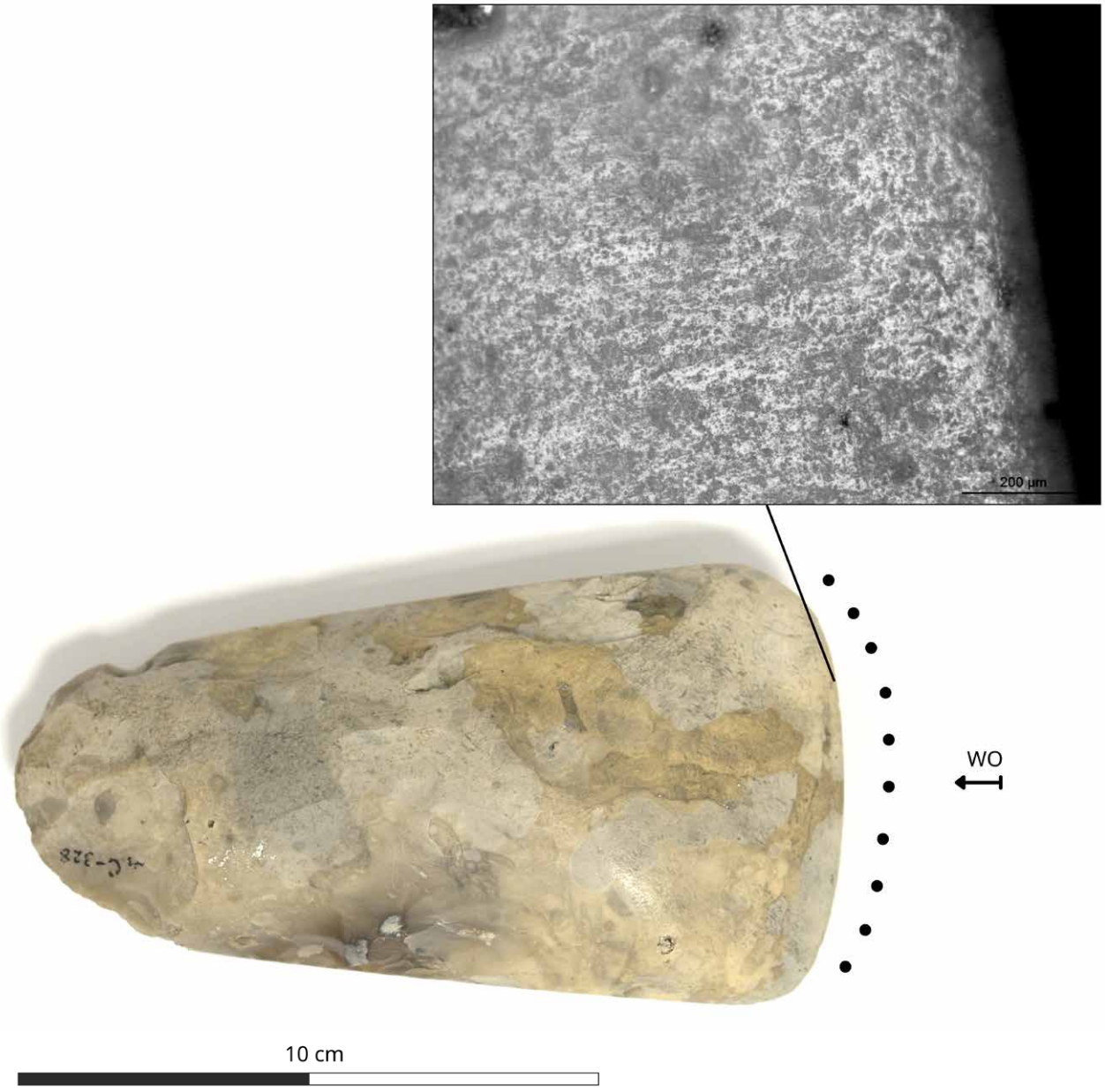


Figure 8.11 Axe E3/6016 with wood working traces on the cutting edge.

Hafting material	Count
Dry hide?	2
Handling?	1
Soft plant	1
Soft plant?	5
Wood	3
Hard material	10
Unsure	2
Total	24

Table 8.8 Hafting and handling traces.

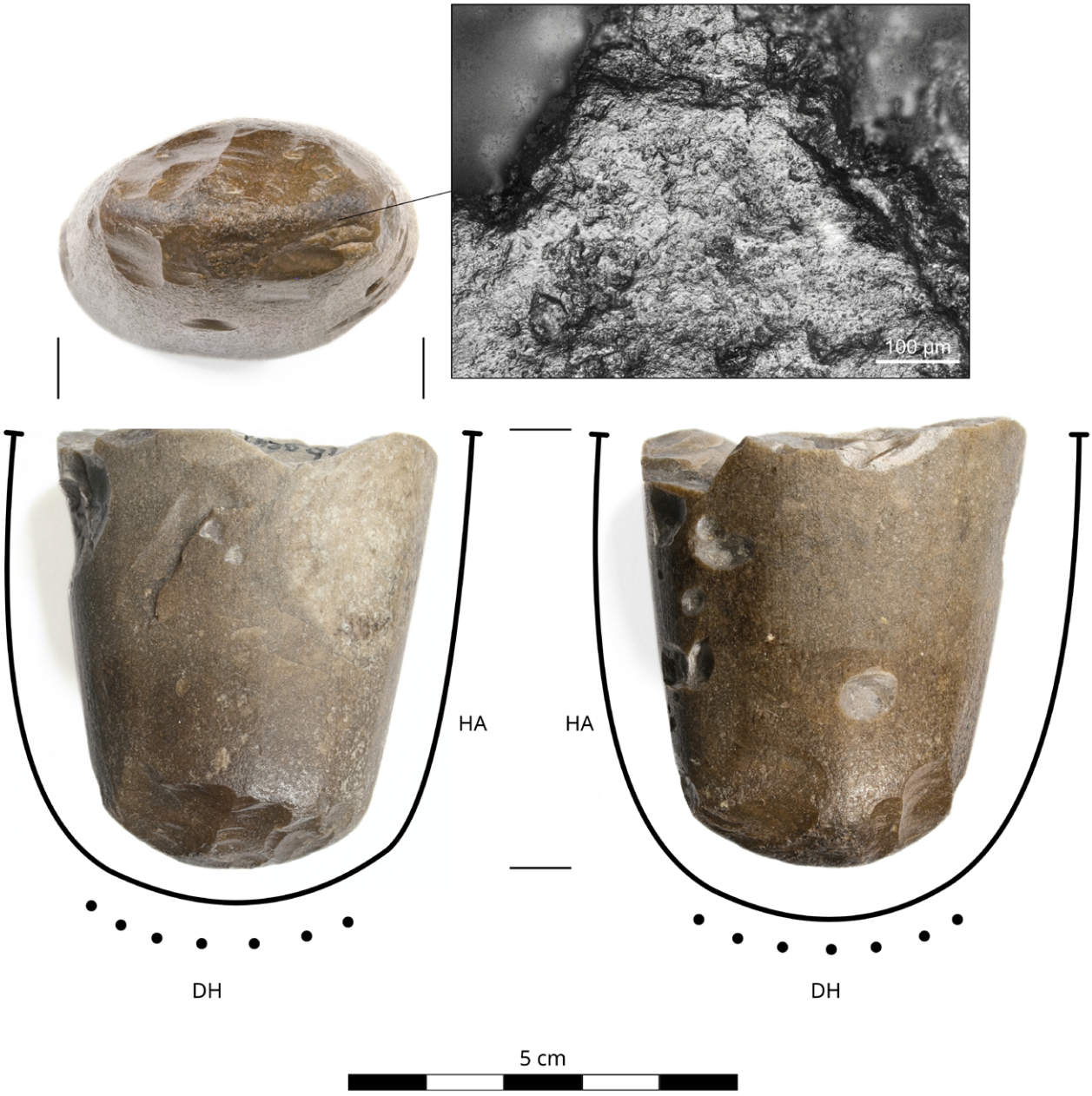


Figure 8.12 Axe butt A1g/2066 with rough and matt polish, likely resulting from dry hide softening.

well developed polish were removed by resharpening, leaving only patches with well developed traces along the edge. Resharpening traces were found on scrapers used for a wide variety of hide processing activities including fresh hide scraping (n=1), dry hide scraping (n=4) and dehairing (n=1).

8.6 Discussion and conclusion

The study of the raw materials notably confirmed what was already observed by Verhart (Verhart, 1983). All the flint was imported, the largest group came from the Hesbaye region in Belgium. Flint from Rijckholt/Lanaye, Spiennes and Cap Blanc Nez flint (which either came from France or closer along the coast of Zeelandic Flanders) were also common. Flint was imported in the form of finished axes, flint nodules (generally from eluvial deposits) and occasionally in the form of ready-made blades. It is clear that the inhabitants of Hekelingen III did not attempt to procure flint from the closest possible sources. Meuse-eggs and terrace flint are completely absent, an observation which is supported by the earlier study by Verhart (Verhart, 1983). Obtaining good quality flint was clearly important. It also seems that flint exploitation was less frugal than on the sites in the coastal dune area. The assemblage also contains complete axes and axe butts. These could easily have been turned into flake

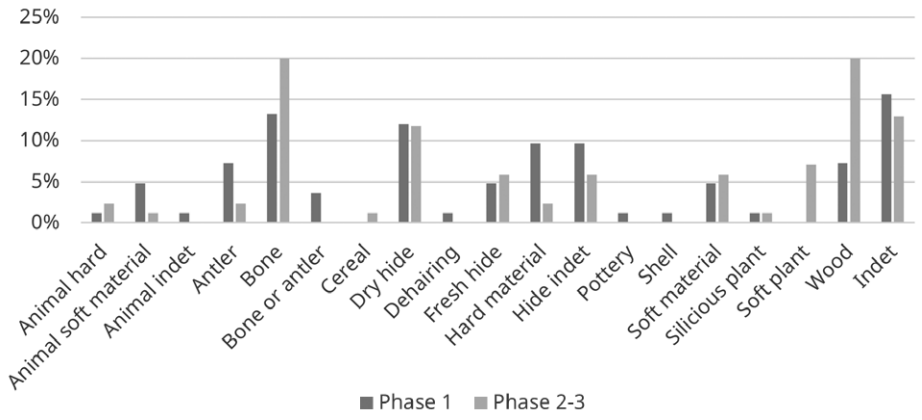


Figure 8.13 Percentages of different AUAs, contact materials in phase 1 and phase 2–3.

cores, but sometimes these were discarded even though they might have been reused. People clearly went to great lengths to maintain a steady supply of good quality flint. The fact that many cores and potential cores (such as the axes and broken axes) were not fully exhausted suggests that people managed to consistently bring more flint to the site than was strictly necessary. Although it makes sense to always maintain a proper supply of flint, it is not necessary to exclusively use the good quality flint. There is no practical reason to make scrapers from Hesbaye or Spiennes/Lanaye flint. The fact that also these simple tools, for which poor quality flint such as Meuse-eggs would have sufficed[24], were nonetheless made of good quality flint indicates that there was a desire to use high-quality flint for all activities conducted at the site.

8.6.1 Chronological differences in activities carried out

The well dated stratigraphy of Hekelingen III allows us to study developments at the site over time (Van Gijn, 1990b). For the use-wear traces the contact materials are visualised for phase 1 (N=85) and phase 2–3 (N=82) in Figure 8.13. The latter were grouped together because of their limited sample sizes (notably for phase 2) and because the absolute dates for these phases fell in more or less the same range (Louwe Kooijmans, 1985, p. 100; Bronk Ramsey, 2009; Reimer et al., 2020). Throughout the occupation phases a wide range of activities took place. In both phases there is evidence for dry and fresh hide processing, as well as wood, bone and antler working. In both phases there is also evidence for the reuse of axes for hide working. The absence of dehairing, pottery drilling and shell working in phase 2–3 seems to relate mainly to the fact that these activities are scarcely represented on the site. Therefore, their absence in phase 2–3 cannot be considered as evidence for absence of these activities. Van Gijn already pointed out that soft plant working and wood working were more prominent in phase 3 than in phase 1 (Van Gijn, 1990b, p. 132). This also seems to be true when comparing phase 1 with phase 2–3. Considering all these activities are present in both phase 1 and phase 2–3 it is uncertain whether this should be seen as a shift in focus in terms of activities which were conducted on the site. Overall, we can conclude that no major changes seem to take place between phase 1 and phases 2–3. In both phases a broad spectrum of activities took place on the site.

8.6.2 Spatial organisation of activities

The fact that the finds at Hekelingen III were distributed in distinct settlement clusters calls into question whether perhaps these represent specific activity zones. To test this, a network graph is compiled in which the contact materials are plotted for different settlement clusters within the site (Fig. 8.14).

As noted previously by Van Gijn, the differences between the clusters are minor, and due to the small size of the assemblages they are too minor to draw major conclusions (Van Gijn, 1990b). Overall it seems that the main activities taking place at the site (hide, bone, wood working etc.) are fairly evenly distributed across the site, as they all plot in the centre of the network graph. There are thus no strong indications to suggest that the clusters represent activity zones geared towards specific activities.

8.6.3 Occupation duration

A hotly debated topic is that of the occupation duration at Hekelingen III (Amkreutz, 2010; 2013b; Louwe Kooijmans, 1986; Louwe Kooijmans, 1987; Louwe Kooijmans, 1993; Out & Dörfler, 2017; Prummel, 1987; Raemaekers, 2003; Van Gijn, 1990a; 1990b). The main arguments against permanent occupation at Hekelingen III consist of the lack of robust structures, the lack of evidence for local cereal cultivation, the sole focus on exotic flint, and the notion that only initial hide working stages were present (Amkreutz, 2010; Louwe Kooijmans, 1986; Louwe Kooijmans, 1987; Out & Dörfler, 2017; Van Gijn, 1990b). The small round structures at the site indeed appear to be more likely related to temporary occupation phases, rather than permanent occupation. However, the

24 Although these would be less suitable they could clearly be used for this purpose judging from the assemblages in the coastal dune area where such tools were often made from Meuse-eggs.

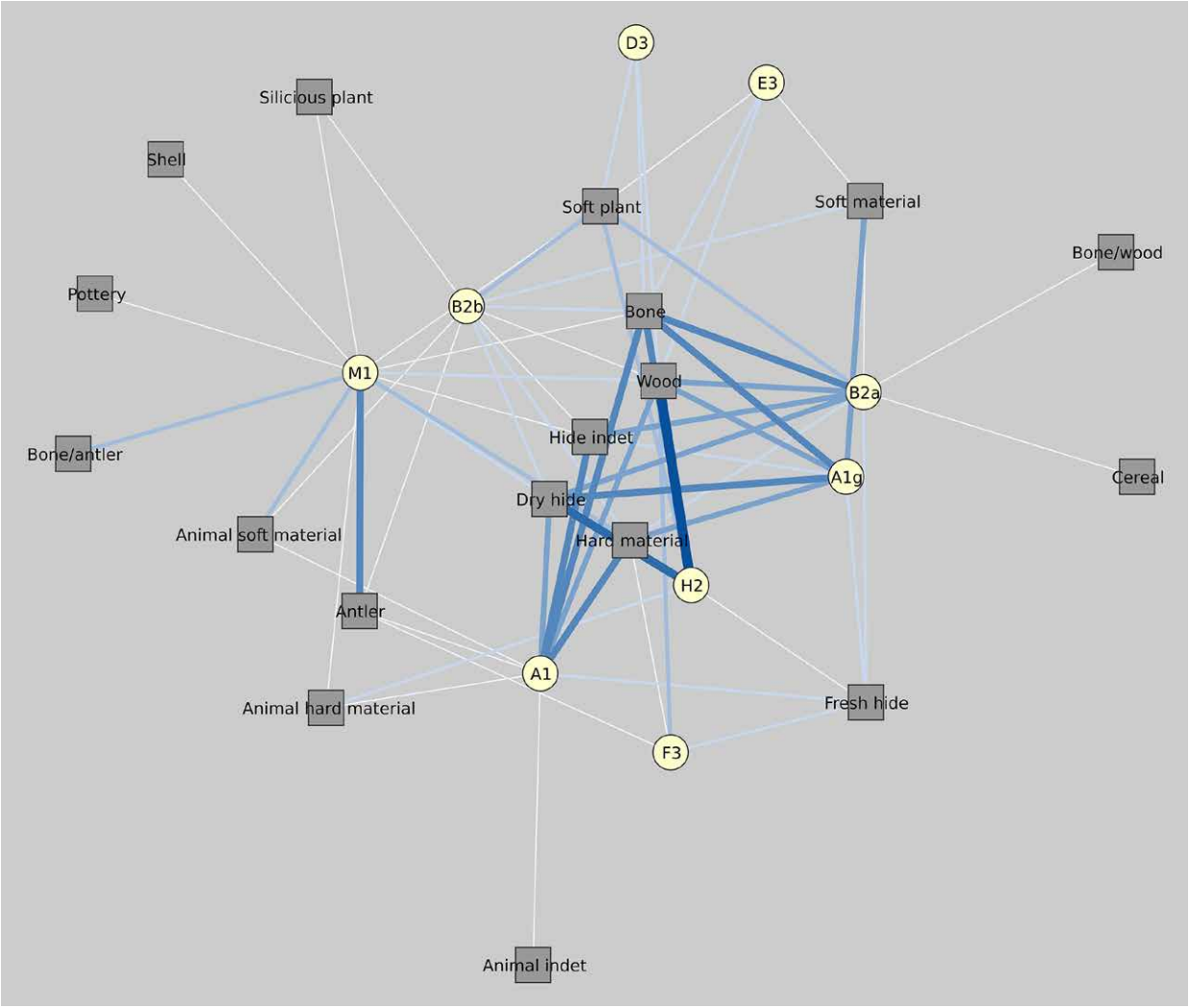


Figure 8.14 Network representation of contact materials (excluding traces from unknown contact materials) (squares) and settlement clusters (circles), the network is visualised in stress minimisation layout. The links are scaled according to their weight.

reanalysis presented here indicates that, in addition to initial hide working stages, dry hide softening and dehairing also took place at the site. As such a longer occupation duration thus seems more plausible. Also, the lack of evidence for local cultivation can be nuanced. The botanical analyses indicated the presence of cereal pollen and chaff from barley (Out & Dörfler, 2017). Out and Dörfler argued that these might have come to the site along with imported cereals (Out & Dörfler, 2017). The sickle fragment with cereal harvesting traces however seems to indicate that cereals were potentially harvested, and thus cultivated at the site.

Hekelingen III is often cited as being temporarily visited by inhabitants from the coastal dune area, or the cover-sand area of Brabant (Out & Dörfler, 2017; Raemaekers, 2003; Van Gijn, 1990b). However, as Amkreutz pointed out, the lithic procurement strategies of those sites differ significantly from those at Hekelingen III (Amkreutz, 2010). This notion is further supported by the present reanalysis of the raw materials at Hekelingen III. Indeed, these inhabitants uniquely had access to large quantities of high-quality raw materials. In this respect it seems more fruitful to consider Hekelingen III, and other levee sites in their own right, rather than as satellite settlements (Amkreutz, 2010; 2013b; Raemaekers, 2003).

A hypothesis proposed by Van Gijn is that the inhabitants of the site came from the south, potentially bringing their own raw materials with them from their region of origin (Van Gijn, 1990a, p. 85). Considering the wide variety of sources used at Hekelingen III it is possible that the different clusters have different raw material compositions. For example we can expect that people coming from Hesbaye bring Hesbaye flint with them, while people from the coastal regions of northern France or Zeelandic Flanders might bring Cap Blanc Nez flint. In Figure 8.15 pie charts with

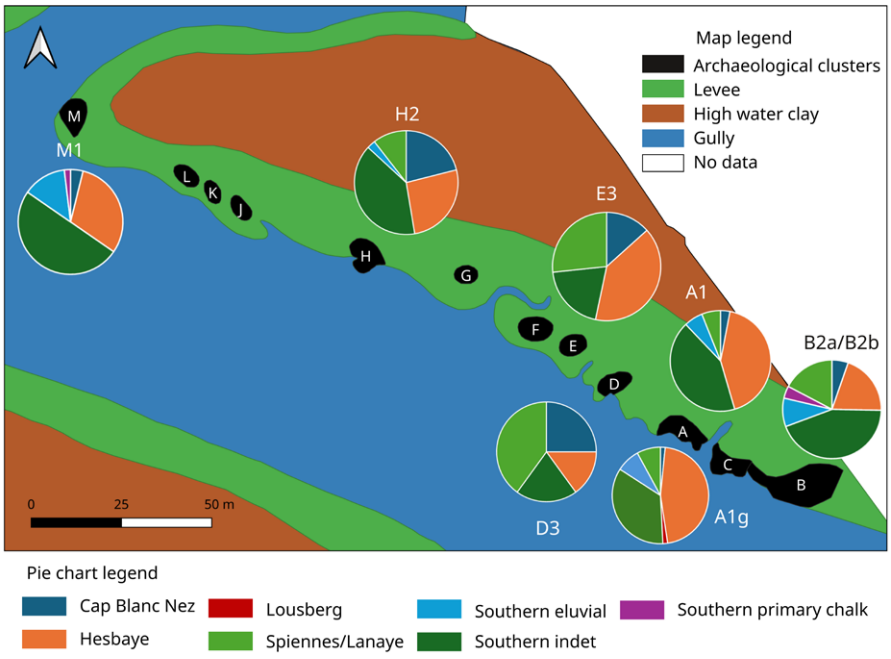


Figure 8.15 Hekelingen III, pie charts with raw materials for different clusters (after Van Gijn, 1990b, p. 100).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eurasian wigeon (*Anas penelope*)												
Crane (*Grus grus*)												
Red-throated loon (*Gavia stellata*)												
Whooper swan (*Cygnus cygnus*)												
Lesser celandine (*Ficaria verna*)												
Sowing cereals (*Cerealia*)												
Pike (*Esox lucius*)												
Common ivy (*Hedera helix*)												
Catfish (*Siluris glanis*)												
Eel (*Anguilla anguilla*)												
Sturgeon (*Acipenser sturio*)												
Hawthorn (*Crataegus monogyna*)												
Water chestnut (*Trapa natans*)												
Field maple (*Acer campestre*)												
Thin-lipped grey mullet (*Liza ramada*)												
Cleavers (*Galium aparine*)												
Reaping cereals (*Cerealia*)												
Hazelnut (*Corylus avellana*)												
Blackthorn (*Prunus spinosa*)												

Table 8.9 Seasonality of activities and food sources at Hekelingen III, most likely season of exploitation in dark green, possible seasons of occurence/exploitation in light green (Hoogenstein et al., 2017; Out & Dörfler, 2017; Prummel, 1987).

raw materials are plotted along with the different clusters. It can be observed that the differences in clusters mainly correspond to the chronological differences which were discussed in section 8.3, clusters dating to phase 1 have more Hesbaye flint and clusters dated to phase 2 and 3 have more Cap Blanc Nez and Spiennes/Lanaye flint. But, overall the lithic assemblages from all clusters have a similar range of employed raw materials. As such, the hypothesis that the diverse spectrum of southern raw materials relates to people from different regions coming to the site, is not supported by the data. Nevertheless, it should be noted that the hypothesis cannot be falsified based on this, considering it is also possible that people exchanged raw materials. Perhaps people initially brought their own raw materials with them, but due to subsequent exchange they leave a pluriform assemblage behind. It is also possible that the clusters were inhabited by people from multiple areas, hence resulting in the mixed signal we observe in Figure 8.15.

Seasonal indicators for the occupation at Hekelingen III indicate that the site was occupied in all four seasons (Tab. 8.9). It seems that two possible scenarios remain to explain the occupation duration at the site. On the one hand it is possible that the site was repeatedly visited throughout the year. This interpretation is favoured by the lack of permanent structures at the site, and the focus on hunting and fishing (Amkreutz, 2013b, p. 375). Alternatively, the site represents a permanent settlement, of which the actual house plans have not been excavated. This interpretation is slightly favoured from a use-wear perspective, as both the range of hide working activities as well as the presence of a cereal harvesting tool fit better with permanent occupation. Although the present analyses may not settle the debate, the new interpretations should be incorporated in further discussions. Hopefully new lines of evidence can provide more conclusive evidence in the future.

9

The site of Vlaardingen Arij Koplaan

The site of Vlaardingen Arij Koplaan was discovered in 1958 when, by chance, a complete flint axe was found. The subsequent archaeological excavations led the excavators to designate the remains to a new archaeological cultural group: the 'Vlaardingen Culture' (Van Regteren Altena et al., 1962a, p. 4). During the excavation multiple house plans, as well as large quantities of finds, including well-preserved organic remains, were uncovered (Glasbergen et al., 1961; Van Beek, 1990, pp. 78–208; Van Iterson Scholten, 1977). The results in this chapter are presented from a biographical perspective (see chapter 3). First, the raw material acquisition is discussed. Secondly, the lithic technology is analysed. Thirdly, the use-life of the artefacts is presented. The chapter concludes with a discussion and conclusion on the function of the site.

9.1 Excavation and landscape setting

Between 1959 and 1964 a total of 17 trenches[25] were excavated, including trial trench 0. Trench 3 was never excavated because pipelines prevented an excavation of the area (Van Beek, 1990, pp. 61–69; Van Regteren Altena et al., 1962a, p. 23; Verhart, 2010a, pp. 155-163). The site is located on the levees of an east-to-west oriented stream. The levees are located approximately one metre above the tidal area. This indicates that under normal conditions the levees remained dry throughout the year. Only in the case of extreme conditions such as storm floods would they have been flooded (Groenman-van Waateringe & Jansma, 1969, p. 114). The width of the levees varied between 15 and 16 metres. The higher parts of the levee were suitable locations for habitation. The levees were covered with oak, ash, willow, and elm. Closer to the water the vegetation consisted of reeds. Because of the wetland environment, the preservation conditions on the site are ideal, notably for the finds from the creek deposits (Van Regteren Altena et al., 1962a, pp. 23–31; Verhart, 2010a, pp. 155–156).

Unfortunately, the palaeogeographic map of the Netherlands inaccurately plots the site in the peatlands (Fig. 9.1). The creek system depicted on the palaeogeographic map presents a simplified version of the system, as the excavations at the site clearly demonstrated the presence of a creek at the site (Fig. 9.2).

9.2 Features at the site and material selection

Several zones at the site are interpreted as habitation zones. These consist of concentrations of finds and postholes, which in three instances include recognisable house plans (Van Regteren Altena et al., 1962a, p. 30; Verhart, 2010a, pp. 156–162). The presence of these structures suggests that the settlement was likely occupied for longer periods of time. This is also supported by the zooarchaeological analysis and the use-wear analyses that were previously conducted (Clason, 1967, p. 10; Van Gijn, 1984, p. 12).

25 Numbered as WP (*werkput* in Dutch, meaning 'trench'), ranging from 0–17.

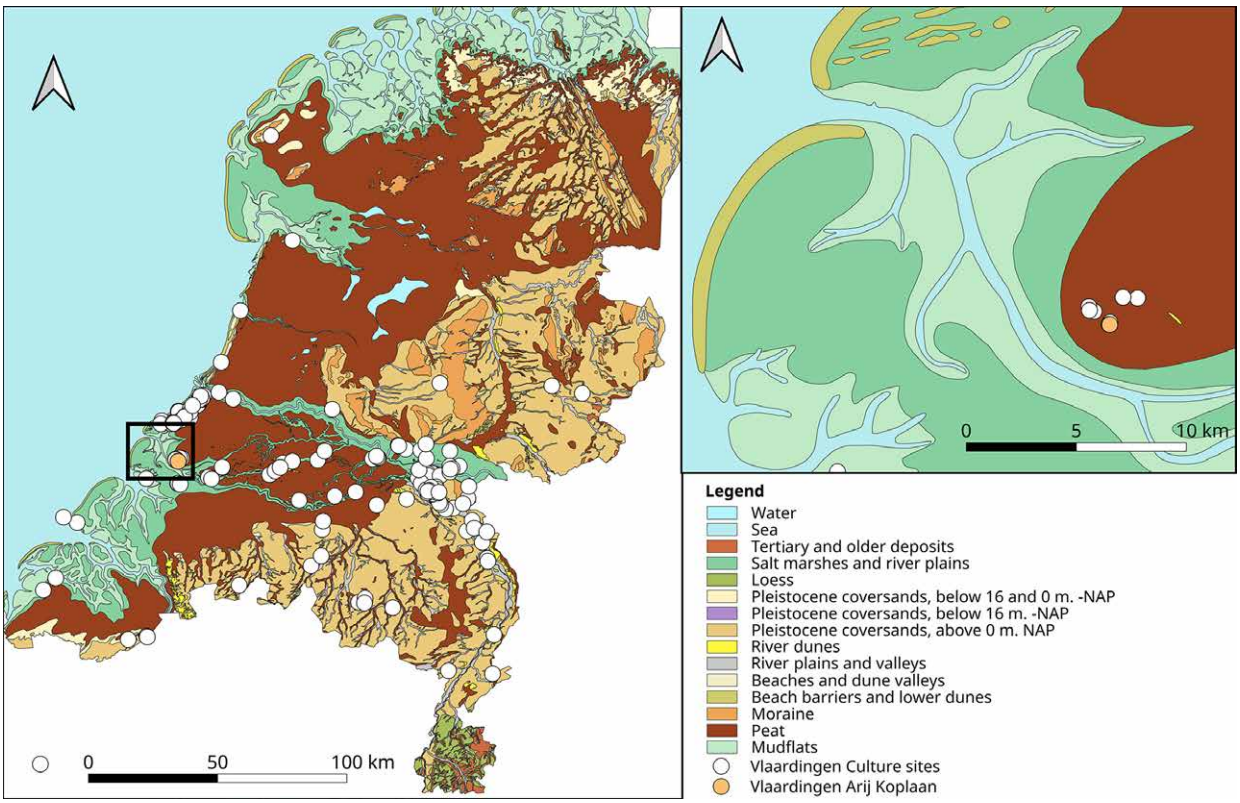


Figure 9.1 Site location of Vlaardingen Arij Koplaan plotted on the palaeogeographic map of the Netherlands ca. 2750 BCE (after Van den Dikkenberg & Brandsen, 2025; Vos et al., 2020).

9.2.1 Subsistence strategies

The subsistence economy at Vlaardingen is highly diverse. Zooarchaeological analysis indicates that wild species were more frequently exploited than domesticated species, although both formed an important contribution to the diet (Clason, 1967). Hunting mainly focused on red deer and wild boar. In addition, many other species such as beaver, otter and wild cat were also hunted. Domesticated animals consist mainly of cattle and pig. Fishing was important and mainly focused on catching migratory sturgeon. Birds, notably aquatic species, were also exploited. The age profiles of the animals indicate that the site was inhabited year-round (Clason, 1967, pp. 10–11, 31, 55–56). In addition to vertebrates, shellfish was also collected, as is evidenced by the presence of mussel shells (Van Regteren Altena et al., 1962a, p. 28). In terms of plant remains, both wild and domesticated plants were found. Cereal pollen, as well as use-wear traces on several implements, indicate that cereals were grown locally (Van Gijn, 1984; Van Regteren Altena et al., 1963a, p. 54). Remarkably, many of the burnt cereal grains consist of bread wheat (*Triticum aestivum*), a species not known from other VLC sites (Brinkkemper et al., 2011, p. 211; Van Zeist, 1968, pp. 55–57). Wild plants are not well documented, but it is noted that a hazelnut shell and a cherry stone were found (Van Beek, 1990, p. 63). Organic residue analysis conducted as part of the *Putting Life into Late Neolithic Houses* project has demonstrated that wild onions were frequently consumed (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31).

9.2.2 Chronology

Habitation at Vlaardingen spanned a long period starting in the Vlaardingen 1b phase, while the latest phases were dated in the BB period (Verhart, 2010a, p. 163; also see Fig. 9.3). In addition to VLC ceramics, pottery that was typologically affiliated to that of the CWC was discovered. The remains of a broken battle axe are also indicative of connections with the CWC (Van Beek, 1990, pp. 202–203; Van Regteren Altena et al., 1962c, pp. 226–227).

The Vlaardingen habitation phase is associated with an older, wider creek. At the end of the Vlaardingen occupation phase the creek silted up. The second, narrower, creek phase cut into the old creek deposits, initiating a new habitation phase associated with the BB occupation (Fig. 9.2).

9.2.3 Material selection and house plan in trench 15

The site contains several house plans (Van Regteren Altena et al., 1962a, p. 30). However, Verhart argues that especially

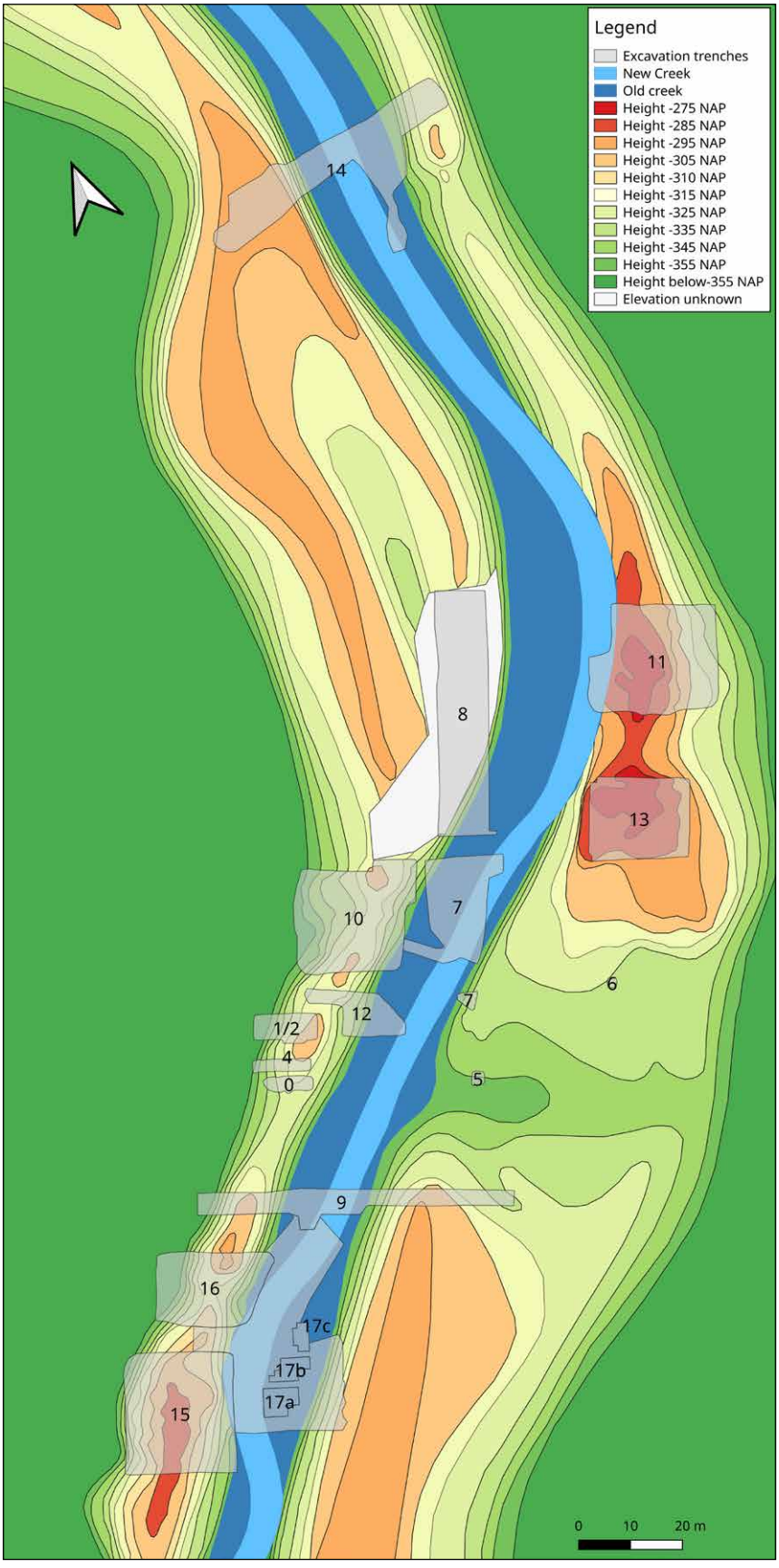


Figure 9.2 Vlaardingen Arij Koplaan, elevation map with excavated trenches and two creek phases (after Van Beek, 1990, fig. 49 and 53).

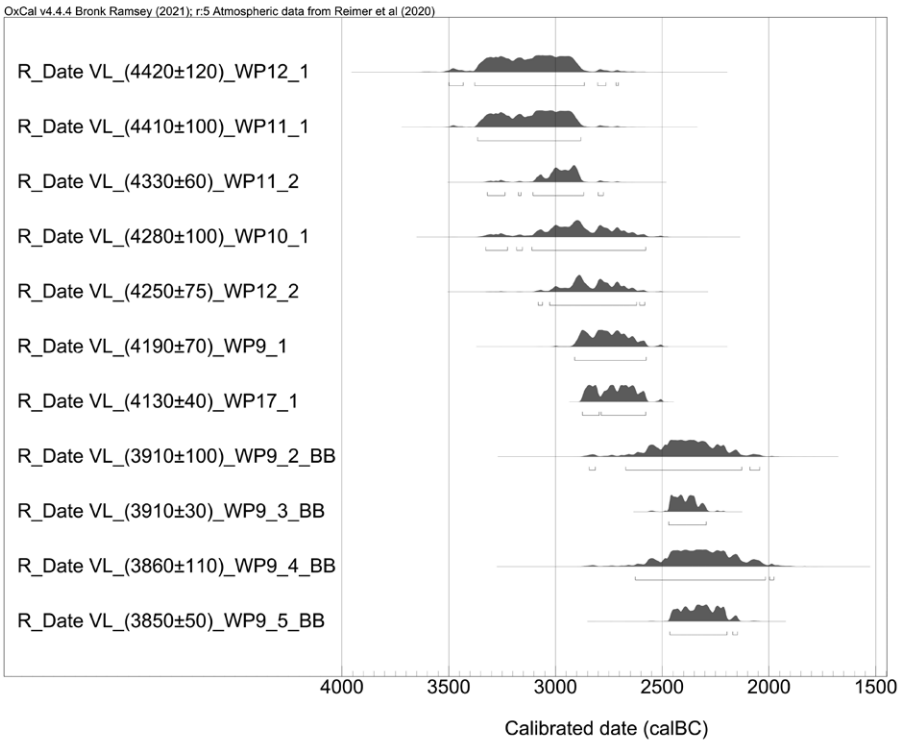


Figure 9.3 Calibrated ^{14}C dates from Vlaardingen Arij Koplaan, calibrated using the IntCal20 curve (after Lanting & Van der Plicht, 1999/2000, pp. 69–82; Bronk Ramsey, 2009; Reimer et al., 2020).

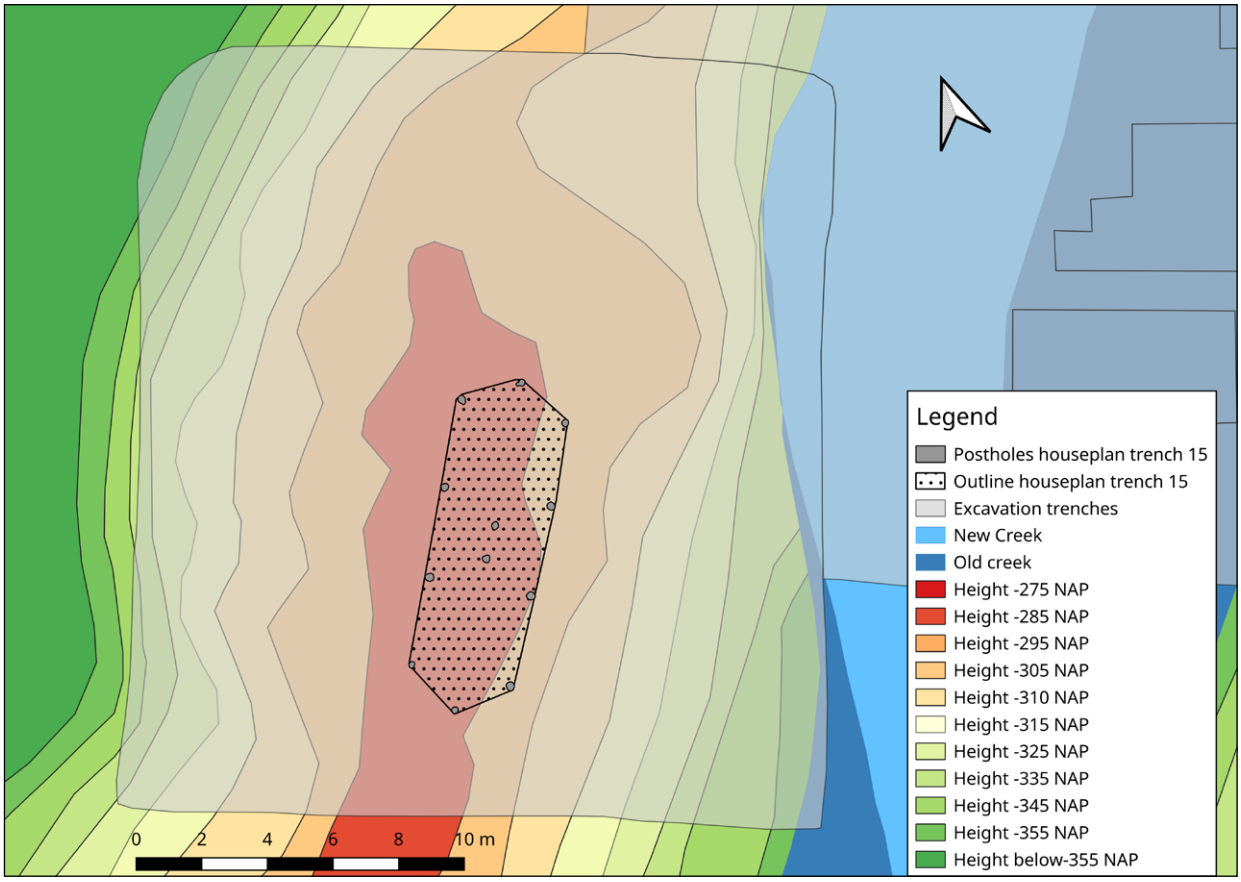


Figure 9.4 Digital elevation model with the house plan of trench 15 plotted (after Van Beek, 1990).

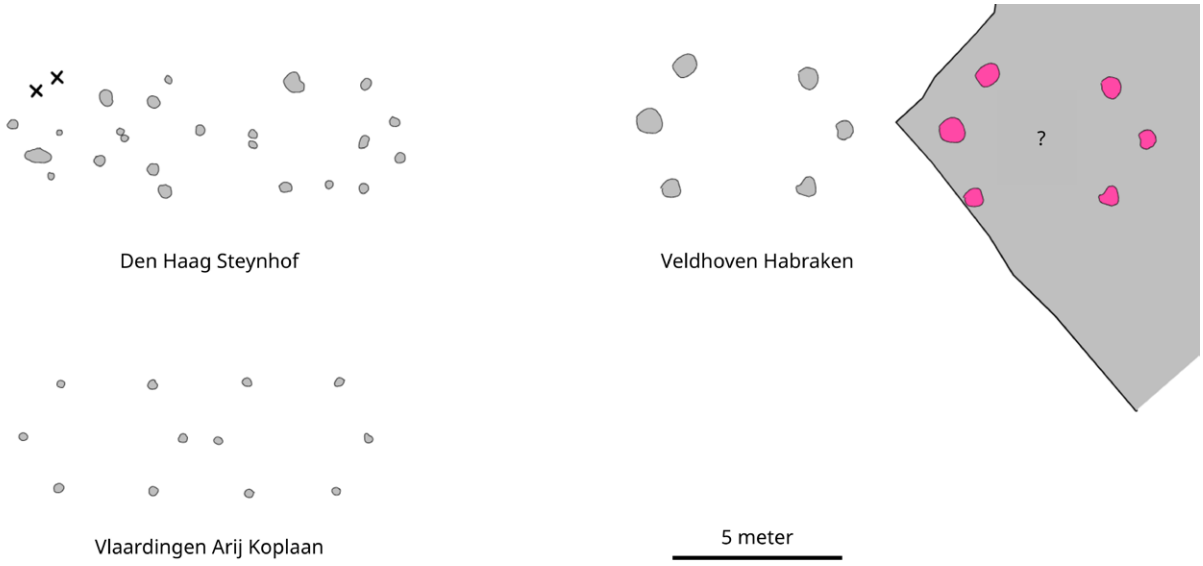


Figure 9.5 House plans of the provisional 'Vlaardingen type' houses: house plan 2 from Den Haag Steynhof and the house plan in trench 15 from Vlaardingen Arij Koplaan. On the left, the six-post structure from Veldhoven Habraken is depicted. The plan was uncovered at the edge of the excavation (the dark grey area lies outside the excavation plan). In pink, the possible continuation of the house plan is indicated, suggesting it may have extended beyond the excavated area (after Van Beek, 1990, fig. 96; Van Kampen, 2013, p. 40; Van Zoolingen, 2021b, p. 51).

the posthole cluster in trench 10, in which initially a house plan was identified, should be seen more as a series of successive habitation phases. The rows of postholes which were initially interpreted as belonging to a single dwelling appeared to extend also beyond its supposed boundaries, casting doubt on the identification of this particular house (Verhart, 2010a, p. 164). In trench 15 a complete house plan was uncovered (Van Beek, 1990, fig. 96–97; Verhart, 2010a, pp. 164–165). Because trench 15 contains the most complete house plan it was selected for the lithic analysis. For the ceramic analysis in the project samples were taken also from trench 17. Therefore, it was decided to add this material to the selection. The house in trench 15 is located on the highest part of the western levee (Fig. 9.4).

The main part of the house is constructed of two hexagons, creating three rows of posts, a central row and two outer rows. The plan includes more postholes, but based on the drawings provided by Van Beek, it is unclear which of the depicted postholes are actually part of the house plan (1990; fig 96). The plan is remarkably similar to house plan 2 from Den Haag Steynhof (Fig. 9.5). The latter house plan is described as a 'type Den Haag' house plan. However, these plans consist of opposing rows of posts (Van Zoolingen, 2021b, pp. 50–52). The structure of these houses is not supported by a central row of postholes (Stokkel, 2017b, pp. 58–61). Therefore, house plan 2 from Den Haag Steynhof should perhaps not be seen as a 'type Den Haag', it is better to describe these houses as 'Vlaardingen type' houses, a type defined as oval two-isled houses consisting of a double hexagon. So far, these houses have only been found at these two sites. At Veldhoven Habraken, a site located on the sandy uplands about a hundred km to the southeast, a hexagonal structure was found as well (Fig. 9.5). Unfortunately, the structure was found on the edge of the trench. Because the part to the east of the structure has not been excavated, it is unclear if the structure continues beyond the trench. Currently the structure is interpreted as a possible granary. The hexagonal structure has dimensions similar to those from Vlaardingen and Steynhof. Hence it is tempting to suggest that the structure possibly consists of a partial house plan of the 'Vlaardingen type'.

For the use-wear analysis, all retouched tools were selected from trench 15 and 17. In addition, all artefacts with macroscopically visible wear traces, points, and/or edges with a straight cross-section >1 cm were selected. The selection criteria were based on the criteria proposed, and applied, by Van Gijn for the assemblage of Hekelingen III (1990b, p. 104).

A selection of material from trench 11 was previously studied by Van Gijn (1984). It was decided to study part of this assemblage as well, to provide additional information on specific tool categories. The scraper assemblage from this trench was analysed to provide insight into the diversity in hide working traces. The tools with 'sickle gloss' were studied, as it is debated whether cereals were grown locally at the site: if these tools are indeed linked to cereal harvesting this would provide an additional argument in favour of local cultivation. Furthermore, the heavily rounded borers in the assemblage were examined. Recently, it has come to light that these are often linked to the drilling of ceramics (Carter, 2021; Houkes et al., 2017; Van Gijn, 2021a). Lastly, the finishing traces on axe fragments in the assemblage were analysed (Van den Dikkenberg, 2024a). In addition to finishing traces the hafting traces on these fragments were also studied. The

Trench	Axe fragments	Axes/ Chisels	Arrow-heads	Scrapers	Borers	Burins	Blades	Flakes	Cores	Total
0	12 (1)	1		18	3	-	1	112	1	135
1	13 (8)	-	2	27	5	-	8	113	1	169
2&3	32 (15)	-	3	67	4	-	17	181	-	304
4	4 (2)	-	-	16	1	-	1	30	1	53
5	-	-	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	-	-	-	
7	18 (7)	-	4	59	1	-	11	111	1	205
8	5 (1)	-	-	7	-	-	1	11	-	24
9	-	-	1	3	-	-	1	60	-	66
10	43 (7)	1	16	134	8	-	19	2365	11	2622
11	117 (4)	1	7	138	9	-	269	1221	6	1528
12	5 (2)	-	1	25	1	-	4	49	-	85
13	20 (1)	-	1	45	3	-	7	487	6	569
14	-	-	-	-	-	-	-	-	-	0
15	29 (12)	-	5	51	34	4	3	279	21	426
16	39 (5)	-	4	38	10	6	2	386	15	500
17	1 (0)	-	-	-	-	-	-	88	-	89
Total	337 (65)	3	44	628	79	10	344	5493	63	6775

Table 9.1 Typology of the flint from Vlaardingen Arij Koplaan (after Van Beek, 1990, pp. 78–208).

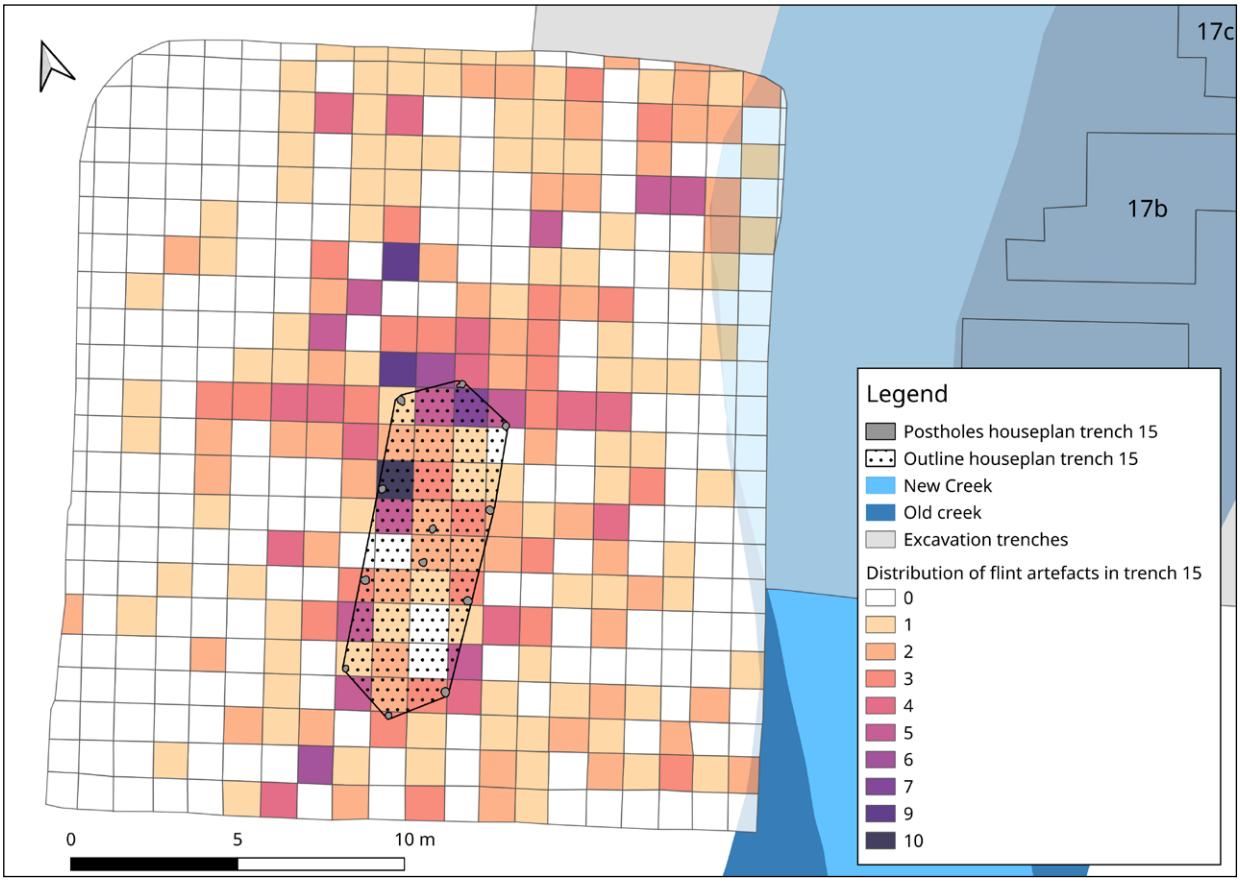


Figure 9.6 Distribution of flint artefacts in trench 15, plotted over the house plan (after Van Beek, 1990).

cutting edges of the axes and axe fragments were examined, as there is presently very little data on the use of flint axes in this period (Van den Dikkenberg, 2024a). After the analysis, it turned out that the boxes assumed to be from trench 11 also contained the tools from trench 16. Therefore, material from both trench 11 and trench 16 was analysed.

The typology of the lithic assemblage is originally presented by Van Beek (Van Beek, 1990, pp. 78–208; also see Tab. 9.1). The results presented by Van Beek appear to be based on descriptions in the original site reports. However, it became apparent that these are inaccurate. These inaccuracies are not limited to inaccurate typological attributions, also the total counts reported by Van Beek do not add up. During the present study a total of 448, instead of 426, artefacts were noted for trench 15, while for trench 17 a total of 118, instead of 89 artefacts are counted. These inaccuracies cast doubt on the data presented by Van Beek. A complete reanalysis falls outside of the scope of the present study, but it is highly recommended that basic classifications of all lithics be done in the future.

9.2.4 Spatial distribution

Trench 15 provides an opportunity to study the spatial distribution of artefacts with use-wear traces. The flint was collected in squares of 1 × 1 metre, which allows us to plot different activities on a map, to see whether we can identify specific activity zones in and around the house. The general distribution of lithic artefacts indicates that the main concentration of lithic artefacts is found directly in, and around the house, as well as in a concentration just north of the house plan. The distribution of flint gradually decreases with distance from the house (Fig. 9.6). This indicates that the house, and the zone just north of the house, are prominent activity zones.

9.3 Flint preservation

The lithic assemblages are well preserved and the state of preservation in trench 15 and trench 17 is comparable (Tab. 9.2). In most cases the use-wear analysis is not hampered by patination or (severe) burning. The fact that most of the flint in trench 17 came from the creek deposits did not affect the preservation significantly (neither positively nor negatively). It is unclear whether the preservation of the tools in trench 11 and 16 is representative of the entire artefact assemblage in these trenches, as only a selection of artefacts is included.

9.4 Flint procurement

The raw material and technological aspects have not previously been systematically studied. Van Gijn noted that

Table 9.2 Burning and patination per trench at Vlaardingen Arij Koplaan.

	Total	Burnt	Unburnt	Indet	Patinated	Unpatinated	Indet
Trench 11	269	31 (11.5%)	235	3	6 (2.2%)	254	9
Trench 15	448	128 (28.6%)	313	7	22 (4.9%)	296	130
Trench 16	86	19 (22.1%)	67	0	3 (3.5%)	79	4
Trench 17	118	29 (24.6%)	84	5	6 (5.1%)	106	6
Total	921	207 (21.7%)	699	15	37 (3.9%)	735	149

	WP11	WP 11 (%)	WP15	WP15 (%)	WP16	WP16 (%)	WP17	WP17 (%)
Cap Blanc Nez	5	2%	7	2%	0	0%	4	3%
French	4	1%	11	2%	1	1%	5	4%
Hesbaye	65	24%	102	23%	25	29%	23	19%
Meuse-egg	0	0%	4	1%	0	0%	3	3%
Moraine flint	0	0%	1	<1%	0	0%	0	0%
Obourg/Zevenwegen	0	0%	0	0%	0	0%	1	1%
Rolled pebble indet	0	0%	2	<1%	0	0%	0	0%
Southern eluvial	28	10%	8	2%	1	1%	5	4%
Southern	66	25%	51	2%	23	27%	15	13%
Spiennes/Lanaye	30	11%	50	11%	12	14%	11	9%
Terrace flint	0	0%	9	2%	0	0%	4	3%
Unknown	71	26%	203	45%	24	28%	47	40%
Total	269	100%	448	100%	86	100%	118	100%

Table 9.3 Flint raw materials, counts and percentages per trench.

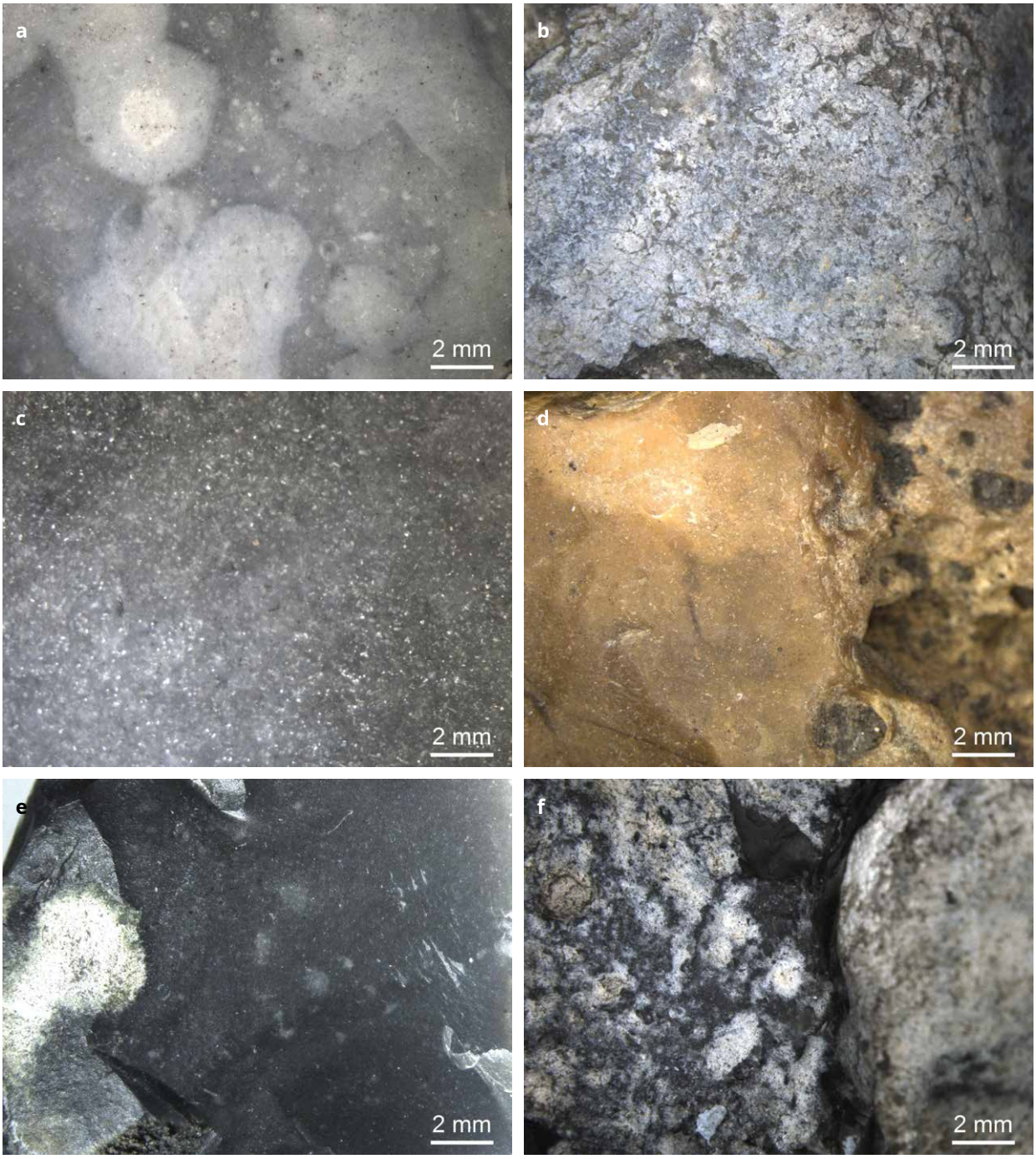


Figure 9.7 Raw material variation in Vlaardingen Arij Koplaan, trench 15, a) Hesbaye flint (453.2); b) cortex on Meuse-egg flint (606.2); c) Spiennes/Lanaye flint (489.1); d) cortex on terrace flint (575.1); e) Cap Blanc Nez flint (327.1); f) cortex on moraine flint (487.1).

most of the raw material from trench 11 consisted of fine-grained flint of good quality (1984). The origin of which must be sought in southern Belgium, probably in/near Spiennes. Few tools showed remains of cortex, which according to Van Gijn indicated that sufficient raw material was present on the site (1984, p. 7). Data on raw material procurement is presented in Table 9.3 (also see Fig. 9.7). For trench 11 and trench 16 only a selection of tools was studied. Here it is expected that these are not representative of the entire assemblage.

The assemblages are characterised by a prevalence of imported high-quality flint, mainly Hesbaye and Lanaye/Spiennes flint, with only a minor contribution from low-quality flints such as Meuse-eggs and terrace flint.

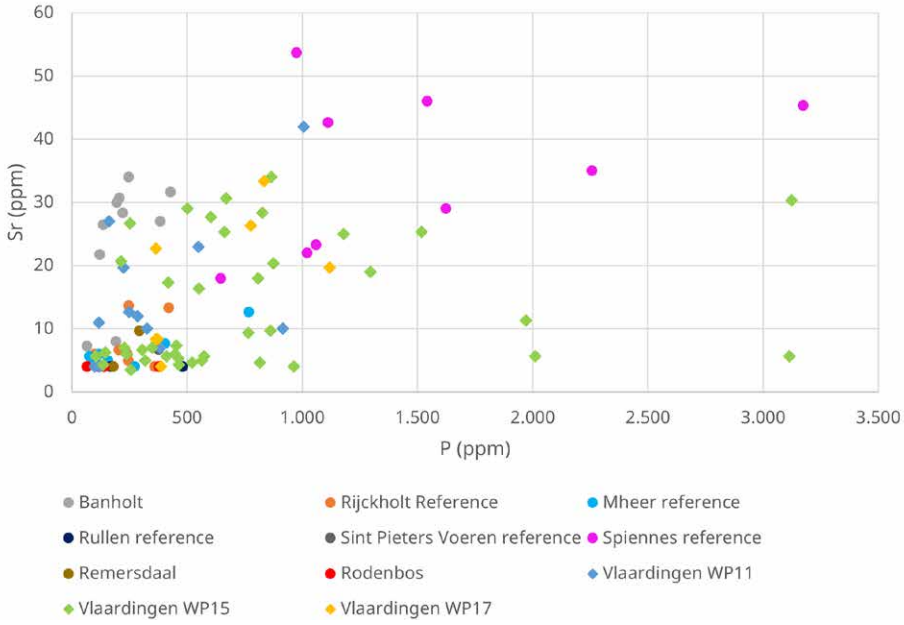


Figure 9.8 Spiennes and Lanaye flints: scatterplot of phosphorus (P) and strontium (Sr) values for reference sources (circles), and for the Spiennes/Lanaye flints from different trenches in Vlaardingen Arij Koplaan (diamonds) (after Van den Dikkenberg & Braekmans, 2025).

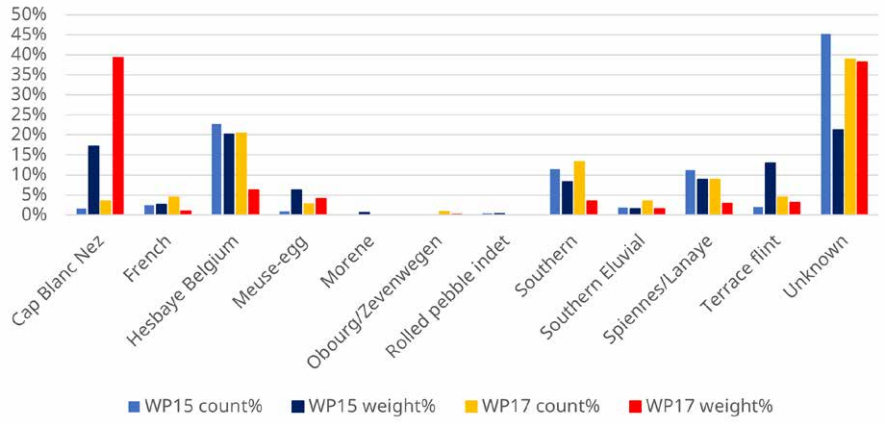


Figure 9.9 Bar graph with percentages of the different flint types for both trench 15 and 17. Percentages in blue are calculated according to the number of objects, in orange the percentages are calculated according to the total weight of the artefacts per flint type.

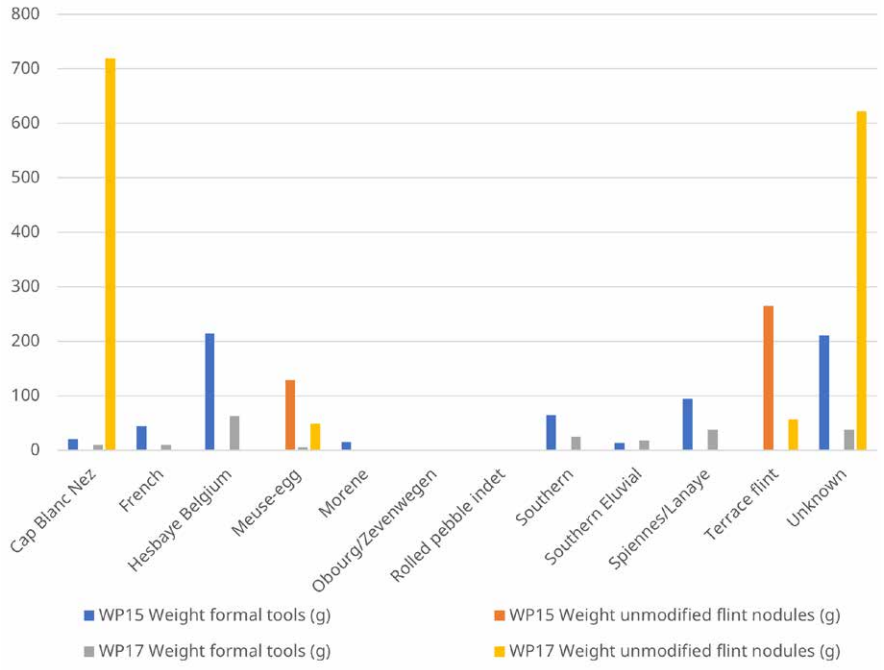


Figure 9.10 Difference in total weight (g) for different flint types between formal tools (including unmodified blades and all retouched artefacts) and unmodified flint nodules.

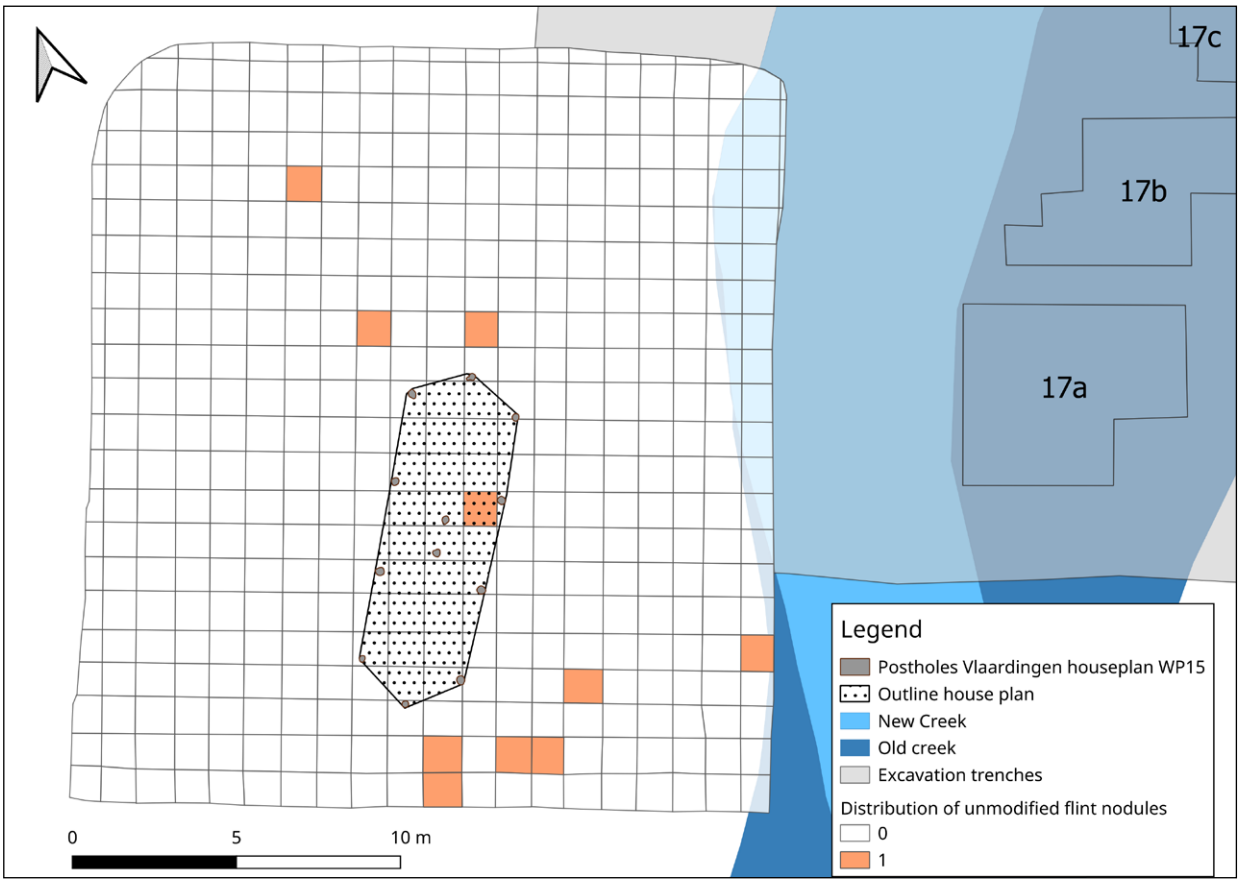


Figure 9.11 Distribution of unmodified flint nodules in trench 15 (after Van Beek, 1990).

A scatterplot of phosphorus and strontium data from reference sources and flints from Vlaardingen Arij Koplaan suggests that both Spiennes and Rijckholt/Lanaye flint are present at the site (Fig. 9.8). Most flints have low strontium and phosphorus values, consistent with the values observed in Rijckholt/Lanaye flint. Several samples, especially from trench 15, have high strontium and phosphorus values consistent with those from the reference samples of Spiennes flint. Furthermore, several samples have low phosphorus values and high strontium values (>20 ppm). These values are only found in reference samples from Banholt, potentially indicating that these come from Banholt (Van den Dikkenberg & Braekmans, 2025).

There are notable discrepancies in terms of the biographies of flint from different sources. A distinction can be made between high-quality flint (such as Spiennes/Lanaye and Hesbaye flint) and low-quality flint such as terrace flint and Meuse-eggs. High-quality flint is generally found in a fragmented state. Low-quality flints such as Meuse-eggs and terrace flint were, however, hardly worked. These flints generally occur as complete nodules. Cap Blanc Nez flint was also often found as complete nodules. The differences become clear when we compare the weights and counts for different raw materials (Fig. 9.9).

It seems that formal tools are generally produced from high-quality flint (Fig. 9.10). When both high-quality and low-quality flint were available for use, the former was mainly selected for tool production.

Because unmodified flint nodules can be seen as potential raw materials, the nodules from trench 15 were plotted in a distribution map (Fig 9.11). The aim was to see whether these nodules were stored in specific spaces in, or around, the house. Unmodified nodules were found both to the north and south of the house, as well as inside the house. Therefore, their distribution does not clearly provide indications for specific storage locations.

9.5 Flint technology

Technological characteristics of the flint from the site have not been previously systematically analysed. A distinction between flakes and blades was made by Van Beek; this is the only technological characteristic which he recorded (Van Beek, 1990). For the current analyses several technological characteristics were included. For all selected artefacts the percussion type was noted, as well as flake terminations.

Primary classification	WP11	WP15	WP16	WP17
Blade	33	7	7	15
Core	2	18	8	6
Flake	217	257	45	50
Nodule	0	11	0	9
Tablet	0	1	0	0
Waste	16	152	22	38
Unsure/other	1	2	4	0
Total	269	448	86	118

Table 9.4 Primary classifications per trench.

Blade type	WP11	WP15	WP16	WP17	Total
Blade indet	-	-	1	-	1
Blade with flake negatives	8	1	-	3	12
Blade with one blade negative	6	1	-	1	8
Blade with cortex	1	-	-	-	1
Trapezoidal blade	4	1	1	3	9
Triangular blade	12	4	5	8	29
Micro-blade	2	-	-	-	2
Total	33	7	7	15	62

Table 9.5 Blade types per trench.

Percussion type	WP11	Percentage	WP15	Percentage	WP16	Percentage	WP17	Percentage
Hard hammer	44	36.4%	86	58.5%	21	65.6%	15	40.5%
Bipolar percussion	3	2.5%	2	1.4%	0	0.0%	2	5.4%
Soft stone hammer	45	37.2%	30	20.4%	3	9.4%	7	18.9%
Organic soft hammer	0	0.0%	9	6.1%	3	9.4%	2	5.4%
Soft hammer indet	29	24.0%	20	13.6%	5	15.6%	11	29.7%
Total	121	100.0%	147	100.0%	32	100.0%	37	100.0%

Table 9.6 Percussion types with counts and percentages per trench.

Furthermore, for the axes and axe fragments the finishing traces were studied (Van den Dikkenberg, 2024a). For blades the blade type was recorded, for cores a distinction was made between flake and blade cores.

Table 9.4 lists the primary classifications of the flint artefacts per trench. For trench 11 and trench 16 only a selection of artefacts was examined (see section 9.2.3). All cores in the assemblage consist of flake cores, blade cores are absent. It is noteworthy that the assemblage contains a large number of blades, especially in trench 17. This is surprising as Van Beek did not mention any blades in the assemblage of this trench (Van Beek, 1990, p. 208).

Blades with cortex, flake negatives or single blade negatives can potentially be seen as byproducts of flake production. However, blades with trapezoidal (with three blade negatives) and triangular (with two blade negatives) cross-sections are likely deliberately produced during blade core reduction (Sain & Goodyear, 2016, p. 117). The fact that such blades are present, while blade cores are absent, suggests that blades were imported as finished products (Tab. 9.5). Occasionally, it could be observed that these blades have carefully prepared striking platforms, further distinguishing them from the locally produced flakes (see for example Fig. 9.14j).

9.5.1 Percussion types and terminations

The use of percussion types varies slightly across the different trenches (Tab. 9.6). Nevertheless, in all trenches stone percussion (mostly hard stone, but also soft stone percussion) dominates the assemblages. Five out of fourteen artefacts created with soft organic percussion consist of blades with triangular (n=3) or rectangular (n=2) cross-sections. These are presumably imported to the site in a finished state (see the previous section).

Termination	WP11	Percentage	WP15	Percentage	WP16	Percentage	WP17	Percentage
Feather	38	64.4%	53	41.7%	20	76.9%	12	50.0%
Hinge	13	22.0%	54	42.5%	6	23.1%	11	45.8%
Plunging	1	1.7%	3	2.4%	0	0.0%	0	0.0%
Snap	0	0.0%	1	0.8%	0	0.0%	0	0.0%
Step	7	11.9%	13	10.2%	0	0.0%	1	4.2%
Cortex	0	0.0%	2	1.6%	0	0.0%	0	0.0%
Total	59	100.0%	127	100.0%	26	100.0%	24	100.0%

Table 9.7 Flake terminations, counts and percentages per trench.

	Total number of flint artefacts	Number of axe fragments	Percentage of recognisable axe fragments	Estimated number of axe fragments	Estimated percentage of axe fragments
Trench 15	448	94	21.0%	229	51.1%
Trench 17	118	20	16.9%	49	41.5%

Table 9.8 Number of axe fragments, percentages of recognisable axe fragments, and based on the experimental data estimated number of axe fragments and estimated percentage of axe fragments per trench (see chapter 5; Van den Dikkenberg et al., 2024a).

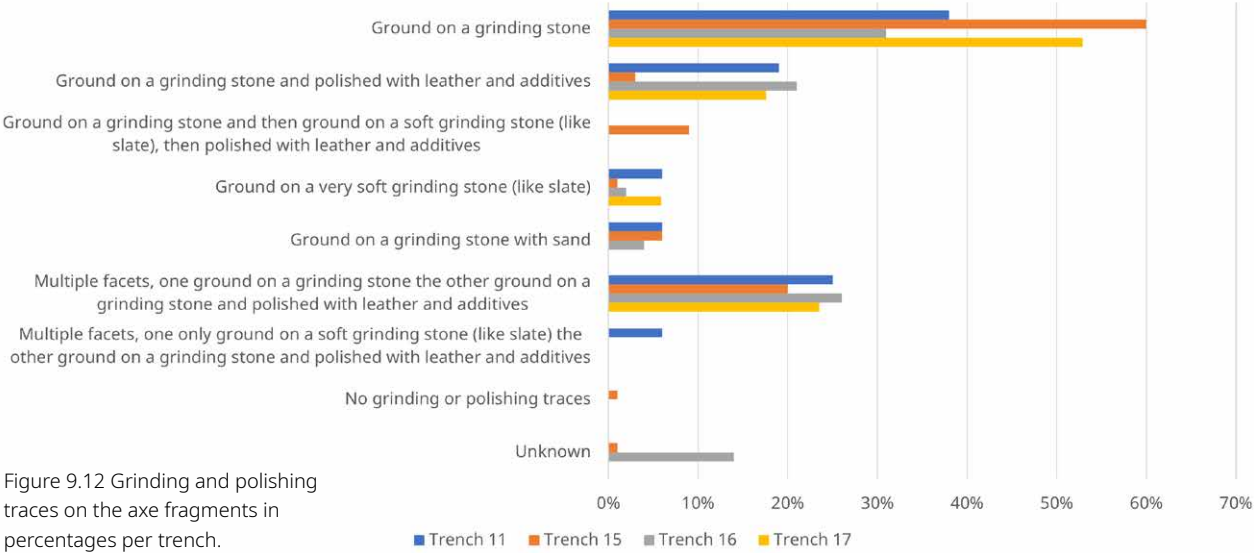


Figure 9.12 Grinding and polishing traces on the axe fragments in percentages per trench.

Local tool production thus mainly employed stone hammers, while organic soft hammers were rarely used. This pattern fits well with previous observations about technologies employed at VLC sites (Van Gijn, 2010b, p. 83).

Table 9.7 notes the flake terminations for each trench. From trench 11 and trench 16 only selected formal tools and tools with use-wear traces are analysed. This presumably explains the higher percentages of feather terminations in these assemblages. Flint from trench 15 and 17 displays a high percentage of hinges and step fractures, this indicates a fairly low degree of skill, consistent with that of non-specialised flint knappers (Shelley, 1990).

9.5.2 Axe fragments and grinding and polishing traces

Axe fragments in trench 15 (n=94) and trench 17 (n=20) are much more abundant than previously reported by Van Beek, who only reported 41 axe fragments for trench 15 and only a single axe fragment for trench 17 (Van Beek, 1990). The new data sheds new light on the importance of recycled axes at Vlaardingen Arij Koplaan. These axe fragments display a remnant of the outer ground or polished surface of the axes.

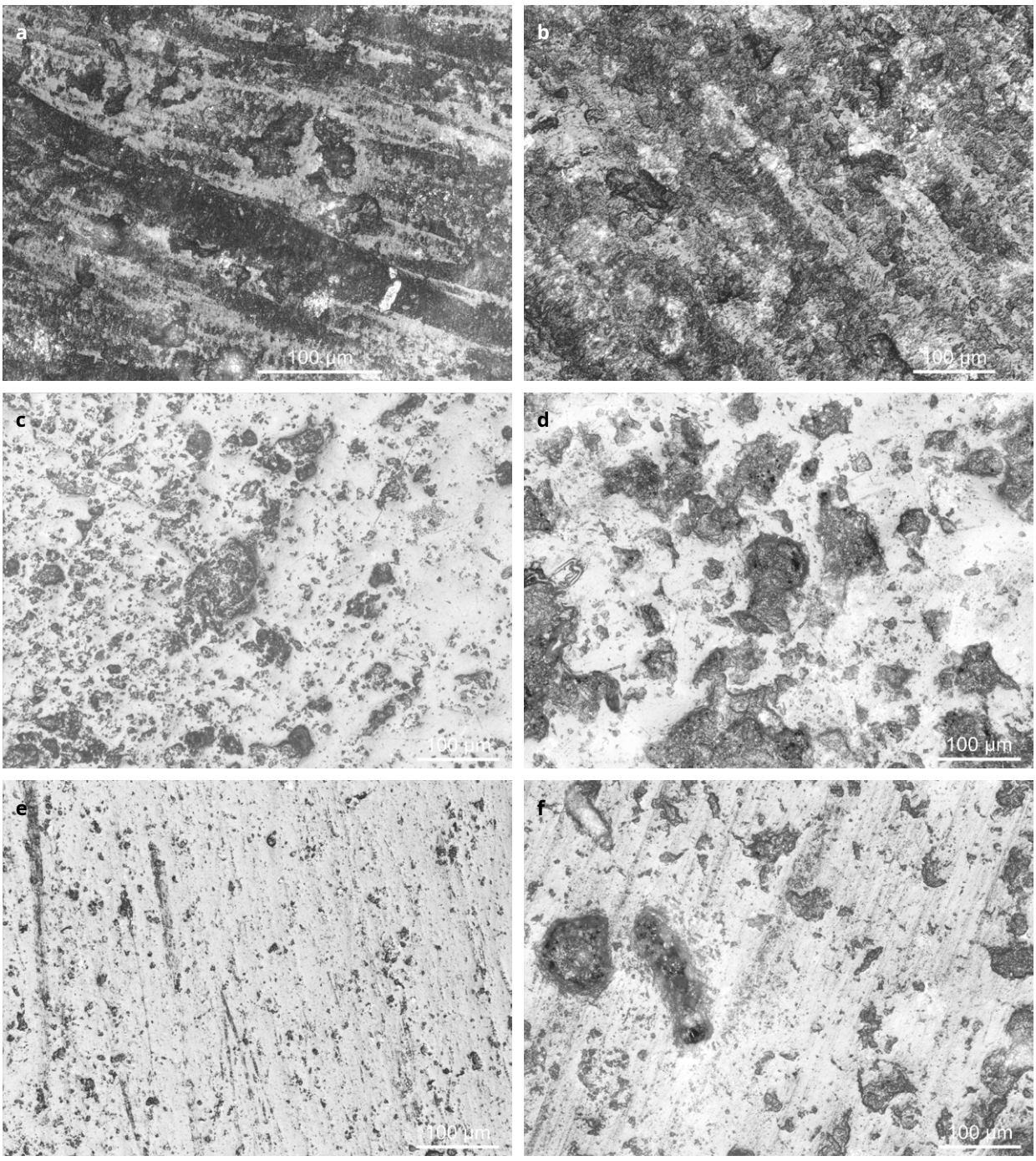


Figure 9.13 Vlaardingen Arij Koplaan: finishing traces on flint axes with comparable traces on experiments; a) Exp. 3310 grinding flint on sandstone; b) matching traces on a scraper made from a recycled axe (558) from trench 11; c) Exp. 3131 polishing with sand and leather in deeper flake negatives; d) matching traces on a flake core made from a recycled axe (641.1) from trench 15; e) Exp. 4292 polishing on slate and subsequently briefly (2 min.) polishing with sand and leather; f) matching traces on a retouched waste fragment made from a recycled axe (406.1) from trench 15 (after Van den Dikkenberg, 2024a).

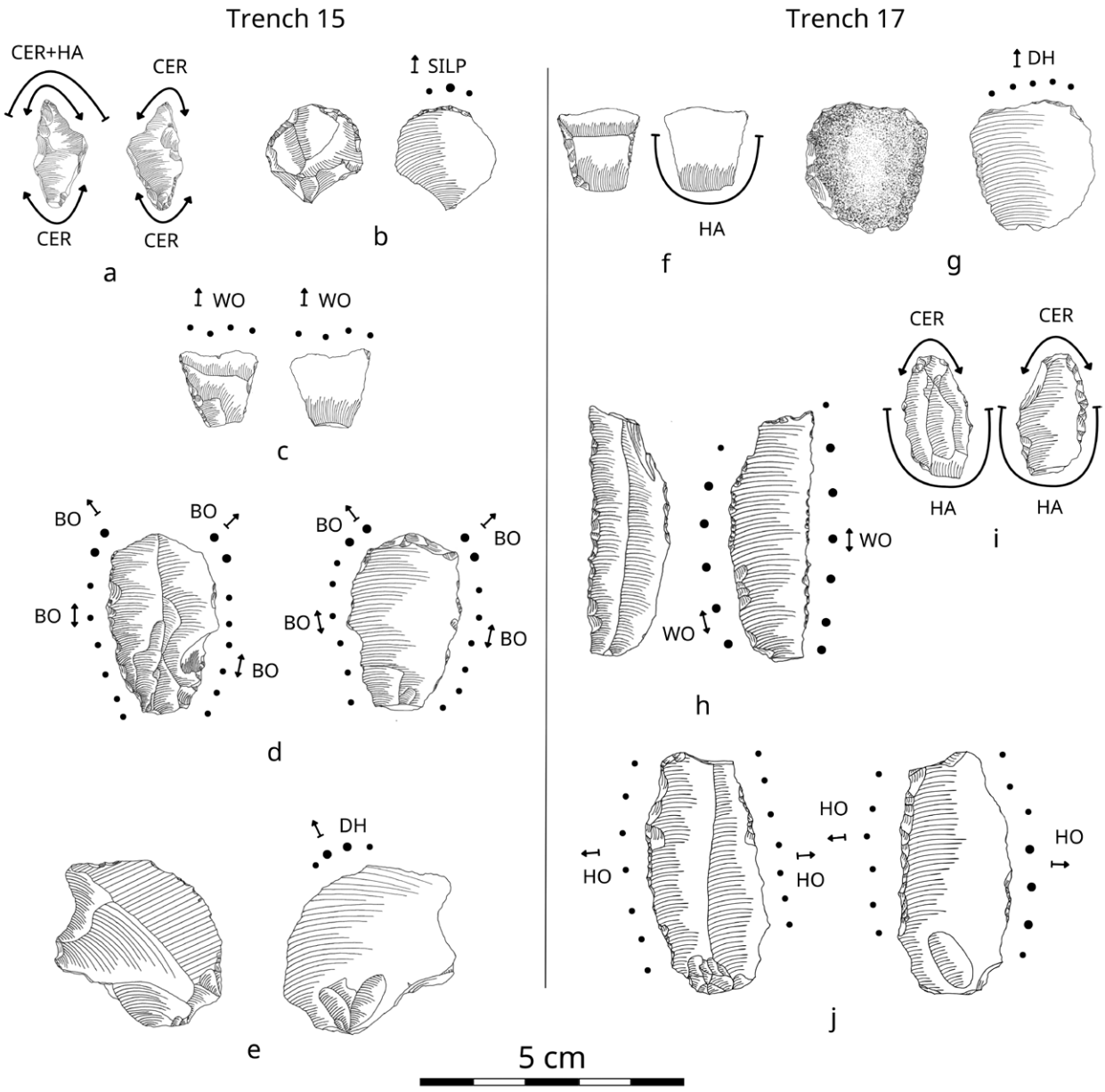


Figure 9.14 Drawings of flint artefacts from trench 15 and trench 17; a) double borer used on both sides to drill ceramics, with hafting traces on one end (322.2); b) scraper used to scrape silicious plant (303.1); c) transverse arrowhead used to scrape bark (671.2); d) retouched blade used to carve and saw bone (383.1); e) retouched flake made from a recycled flint axe, used to scrape dry hide (544.1); f) transverse arrowhead hafted in hard material with hide bindings (570c.1); g) scraper used to scrape dry hide (255.1); h) retouched blade used to saw wood (465c.1); i) borer used to drill ceramic, hafted in wood with hide bindings (119b.2); j) retouched blade used on two sides to scrape horn (531i.1).

Our experiments demonstrated that if axes are recycled through flaking only an estimated 41% of the total number of axe fragments will have such a remnant of the outer polished axe surface. The other fragments remain 'archaeologically invisible' because they are struck from the inside of the axes (see section 5.6; Van den Dikkenberg et al., 2024a). Using the data from these experiments we can now estimate how much of the flint in these trenches came from recycled flint axes. Here we assume that the axe fragments with a remnant of the outer polished or ground surface represent ca. 41% of the total number of axe fragments (see chapter 5; Van den Dikkenberg et al., 2024a). Based on these experiments it seems that ca. 51% of the flint in trench 15, and 42% of the flint in trench 17 comes from recycled axes (Tab. 9.8). These percentages are far higher than what we previously reported based on the data by Van Beek (Van Beek, 1990; Van den Dikkenberg et al., 2024a). These percentages are comparable with the percentage reported for Hekelingen III (43.7%) (see chapter 5 and 8; Van den

Dikkenberg et al., 2024a). Recycled axes were thus a major source of flint used at Vlaardingen Arij Koplaan.

The axe fragments show varied patterns in terms of finishing traces (Fig. 9.12). In trench 11 axe fragments which are polished dominate, mainly consisting of those polished with leather and additives (Fig. 9.13d). In trench 15 and trench 17 axe fragments which exclusively have grinding traces dominated the assemblage but, in both trenches, polished axe fragments are common as well. Some fragments from trench 15 display polishing traces which resemble traces from polishing with leather and additives, but which stand out because they display many fine striations. An experiment (Exp. 4292) in which flint is first polished on slate after which it is briefly polished with leather and sand displayed similar traces (Fig. 9.13e and f). It thus seems that these axes were polished in two steps: first on a soft stone, then using leather and additives (Van den Dikkenberg, 2024a).

An oddity is the axe fragment from trench 15 which displayed neither grinding nor polishing traces. This consisted of a small fragment of a bifacially flaked oval axe butt with traces from an antler haft.

9.6 Flint typology

Due to the errors in the original publication the typological analysis of the artefacts in trenches 15 and 17 was re-done (Tab. 9.9). In both trenches the formal tool assemblage is dominated by retouched flakes and scrapers (Fig. 9.14). Furthermore, strike-a-lights[26], borers, and transverse arrowheads are found. No major typological differences between the two trenches can be identified. All arrowheads consist of transverse arrowheads, while tanged arrowheads are lacking. This suggests the assemblages can be linked to the earlier phases of the VLC, rather than the late VLC (Van Hoof & Metaxas, 2009; Houkes et al., 2017). The ^{14}C date (2874–2578 cal BCE) from trench 17 however suggests that the VLC-layer dates to the Late Neolithic (Lanting & Van der Plicht, 1999/2000, pp. 69–82; Bronk Ramsey, 2009; Reimer et al., 2020). This highlights the problems frequently encountered when chronological value is attributed to VLC typologies. Similarly we see that ceramic types, such as ceramic baking plates, which are often assumed to be associated only with the earlier phases of the VLC, are also well known from later VLC contexts (Bloo, 2017; Van Gijn & Bakker, 2005).

9.7 Results of the use-wear analysis of flint from trench 11 and 16

The use-wear results will be presented per trench. First the previous studies by Van Gijn and Vernon on the material from trench 11 is discussed (Van Gijn, 1984; Vernon, 2018). Next the analyses for trench 11 and 16 are presented. Section 9.8 and 9.9 deal with the wear traces observed on material from trench 15 and 17.

26 In these cases a typological classification as strike-a-light is corroborated by the use-wear analysis (see section 9.8).

	Trench 15	Trench 17
Borer	14	4
Double borer	2	0
Flint oval axe fragment	1	0
Denticulé	0	1
Hammerstone	0	1
Scraper	40	6
Transverse arrowhead	3	1
Strike-a-light	7	0
Retouched blade	3	8
Retouched core	1	0
Retouched flake	62	19
Retouched waste	20	6
Flake core	16	6
Core rejuvenation tablet	1	0
Unmodified blade	4	7
Unmodified flake	146	21
Unmodified flint nodule	11	8
Waste	117	30
Total	448	118

Table 9.9 Typology of flint artefacts in trench 15 and 17.

9.7.1 Previous analysis of trench 11

Two selections of flint from Vlaardingen trench 11 have so far been studied. The most important is the 1984 study by Van Gijn[27] on 68 artefacts from trench 11 (Tab. 9.10). The sample consisted of randomly selected retouched tools and 13 blades. Although only a selection of the flint was analysed, the sample provided a good overview of the activities carried out on the site, in this case near the house from trench 11 (Van Gijn, 1984).

Hafting traces were also found, but from the report it is unclear which kind of tool displayed these traces. The use-wear analysis indicated that dry hide scraping was the dominant activity on the site.

A sample of flint scrapers, from the same selection as Van Gijn studied, was analysed by Vernon, primarily with the aim of identifying hafting traces (Vernon, 2018). The scrapers were used to scrape hide, which in three cases could be specified further as dry hide scraping. The hafting traces consisted in one case of residue, in two cases of unidentified semi-hard material. In one case hafting in wood and in one

27 The analyses conducted by Van Gijn were part of the study by Van Beek (Van Beek, 1990, p. 143; Van Gijn, 1984). The latter, however, dedicated only a small paragraph to the results of the use-wear analysis, focusing solely on the spatial distribution of activities. Hence, for details on the use-wear analysis, the original, but unpublished, report is often cited here (Van Gijn, 1984).

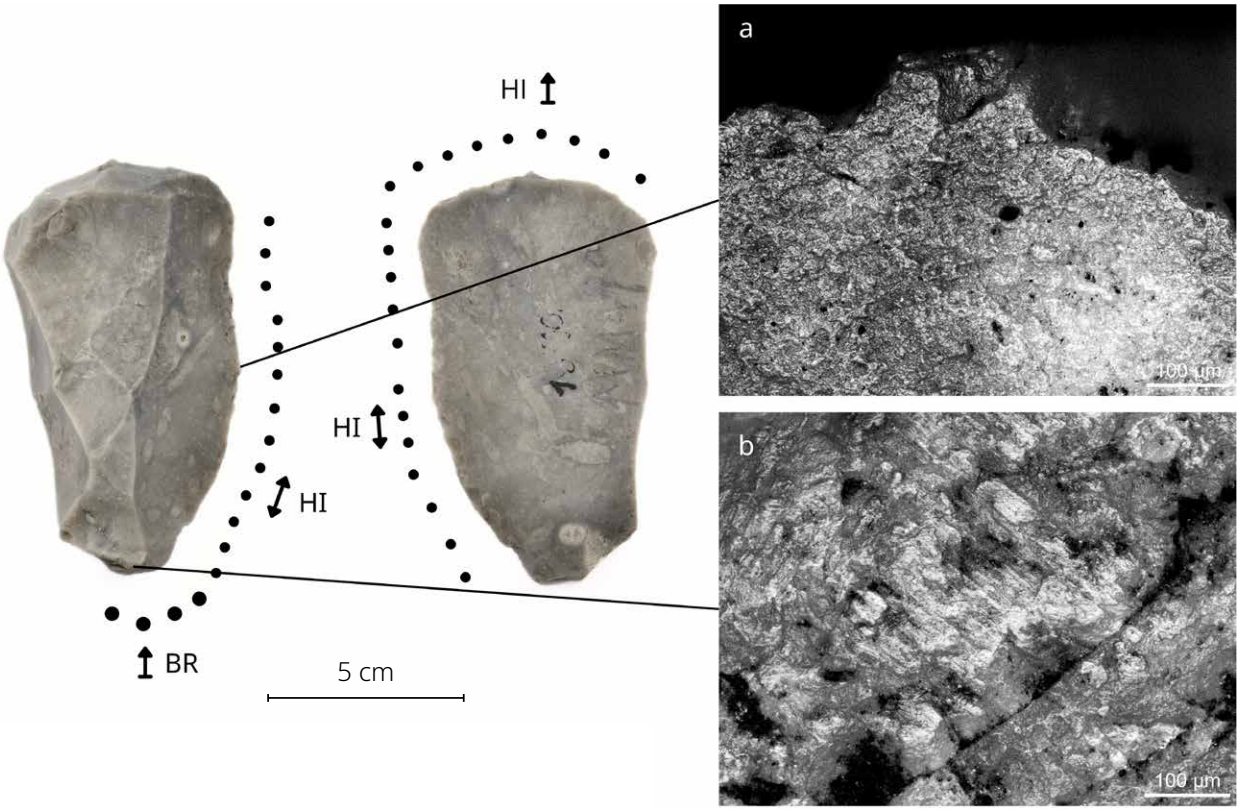


Figure 9.15 Endscraper (1540) from trench 11 with wear traces related to scraping hide, cutting hide (a), and traces from pounding pyrite (b), related to fire-making.

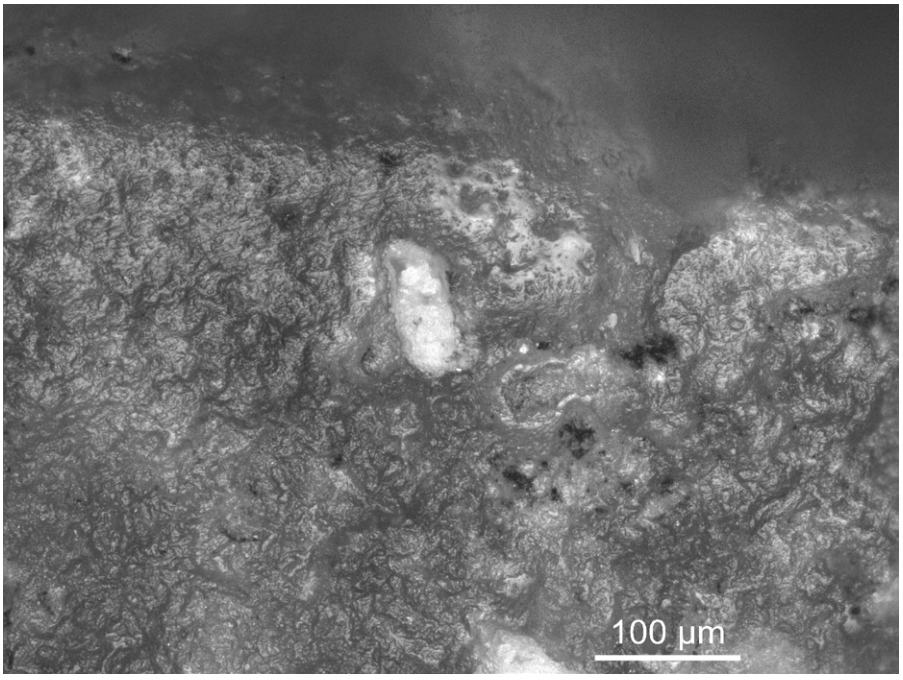


Figure 9.16 Use-wear traces from scraping hide with mineral additives on scraper 1349 from trench 11.

Use-wear results	Count	Percentage
Bone	5	7.4
Bone/antler	1	1.5
Dry hide	11	16.2
Butchering	6	8.9
Soft plant	4	5.9
Wood	3	4.4
Unknown	8	11.8
No traces	13	19.1
Burnt	8	11.8
Patinated	9	13.2

Table 9.10 Initial use-wear results from trench 11 in Vlaardingen (after Van Gijn, 1984, p. 11).

instance hafting in bone (Vernon, 2018, p. 118). The latter especially is interesting as this had not been previously observed on other VLC artefacts.

9.7.2 Flint scrapers

The selection of scrapers from trench 11 and trench 16 was reanalysed to gain more insight into the variation in hide working traces at the site. The sample consists of all scrapers from the selection made by Van Gijn for her study of trench 11 (Van Gijn, 1984). This amounts to 156 scrapers and two combination tools: one scraper/borer and one scraper/saw. Initially, it was assumed that all tools came from trench 11, but it turned out that the boxes also contained the tools from trench 16. Hence these are included in the analysis as well.

The scrapers from trench 11 were predominantly used to scrape hides in various stages (Tab. 9.11). Scrapers also frequently showed hafting traces, mostly related to hafting in hard materials. The scraper which was used to cut cereals will be discussed in more detail in section 9.7.3. Several scrapers were used for multiple tasks. An interesting example is provided by the endscraper 1540 of which the

	Cutting	Hafting	Pounding	Scraping/ transverse	Transverse?	Unsure	Total
Animal							
Antler	-	-	-	2	-	-	2
Antler?	-	-	-	-	1	-	1
Bone	-	1	-	2	-	-	3
Bone or antler	-	-	-	1	-	-	1
Dry Hide, dehairing hide	-	-	-	1	-	-	1
Dry hide	-	-	-	31	-	-	31
Fresh hide	-	-	-	4	-	-	4
Hide with mineral additives	-	-	-	2	-	-	2
Hide indet	1	-	-	22	-	1	24
Animal indet.	-	-	-	1	-	-	1
Plant							
Cereal	1	-	-	-	-	-	1
Silicious plants	4	1	-	-	-	-	5
Wood	-	4	-	-	-	-	4
Plant indet?	-	-	-	-	2	-	2
Inorganic							
Pyrite	-	-	1	-	-	-	1
Unknown material							
Hard material	-	18	-	-	-	-	18
Medium hard material indet	-	1	-	-	-	-	1
Indet	-	1	-	-	-	1	2
Total	6	26	1	66	3	2	104

Table 9.11 Crosstab with motions (x-axis) and contact materials (y-axis) for the scrapers from trench 11.

	Chopping	Hafting	Transverse	Unsure	Total
Animal					
Antler	-	-	1	-	1
Dry hide	-	-	5	-	5
Hide indet	-	-	2	-	2
Animal hard	-	1	-	-	1
Plant					
Silicious plants	-	-	-	1	1
Wood	1	1	-	-	2
Unknown material					
Unsure	-	1	-	1	2
Total	1	3	8	2	14

Table 9.12 Crosstab with motions (x-axis) and contact materials (y-axis) for the scrapers from trench 16.

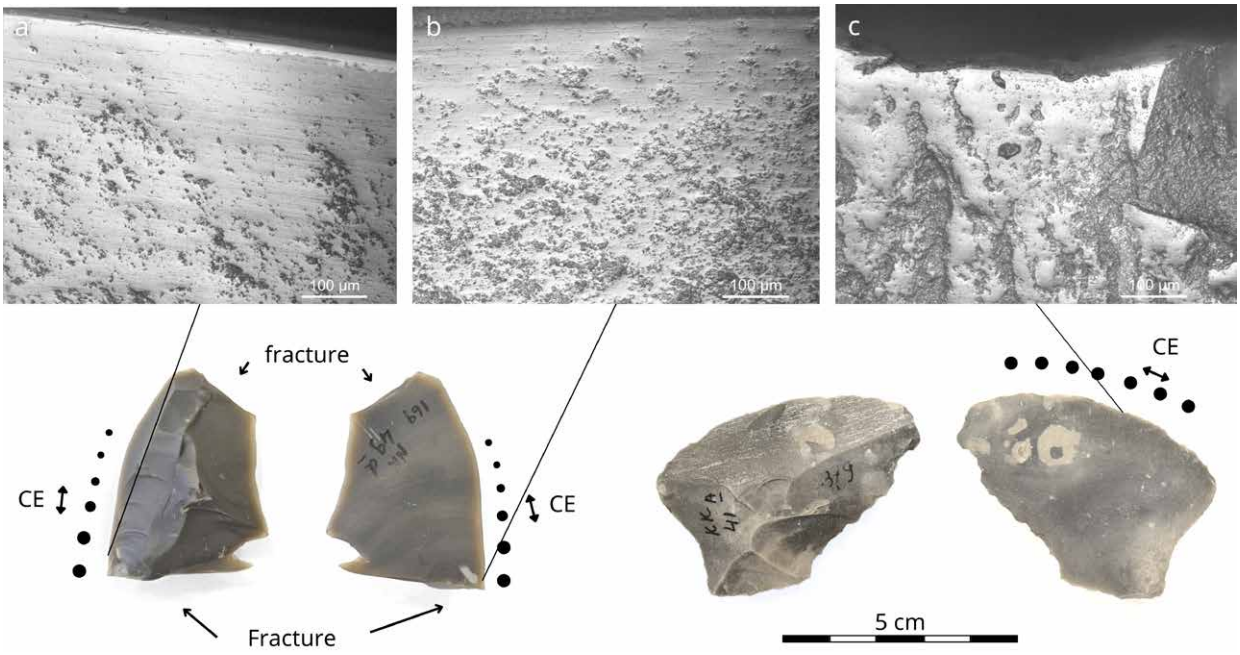


Figure 9.17 Cereal harvesting tools from Vlaardingen trench 11: unmodified flake 169 (left) and retouched axe flake 379.1 (right) with photographs of typical cereal harvesting traces (a,b), and a photograph of cereal harvesting traces being intersected by subsequent retouching (c).

butt end was used as a strike-a-light while a lateral side was used to cut hide (Fig. 9.15). The scraper edge was used for scraping hide and the ventral side of the scraper also displayed hafting traces related to hafting in an unknown kind of hard material.

Two scrapers were used to scrape hide with mineral additives (Fig. 9.16). These traces did not resemble the experiments we conducted on seal skins with the addition of sand or clay (Van den Dikkenberg et al., 2024b). The traces on those experimental tools are more well developed and they spread along the edge in a wide (macroscopically visible) band. The experiment by Van Gijn (Exp. 249) in which a hide was scraped with ochre looks somewhat similar, but again those traces are better developed than the traces on the archaeological tool (Van Gijn, 1990b, p. 29). The traces on the archaeological tool are more akin to the traces observed on an experiment conducted by Rots (2002, p. 69). In this experiment ochre was used to scrape a hide for thirty minutes. It is possible that in this case the additives were used to dye the hides with minerals, such as ochre. This seems more likely than that the additives were used to absorb the fat while scraping fatty hides. If this was done more additives would have been required, which

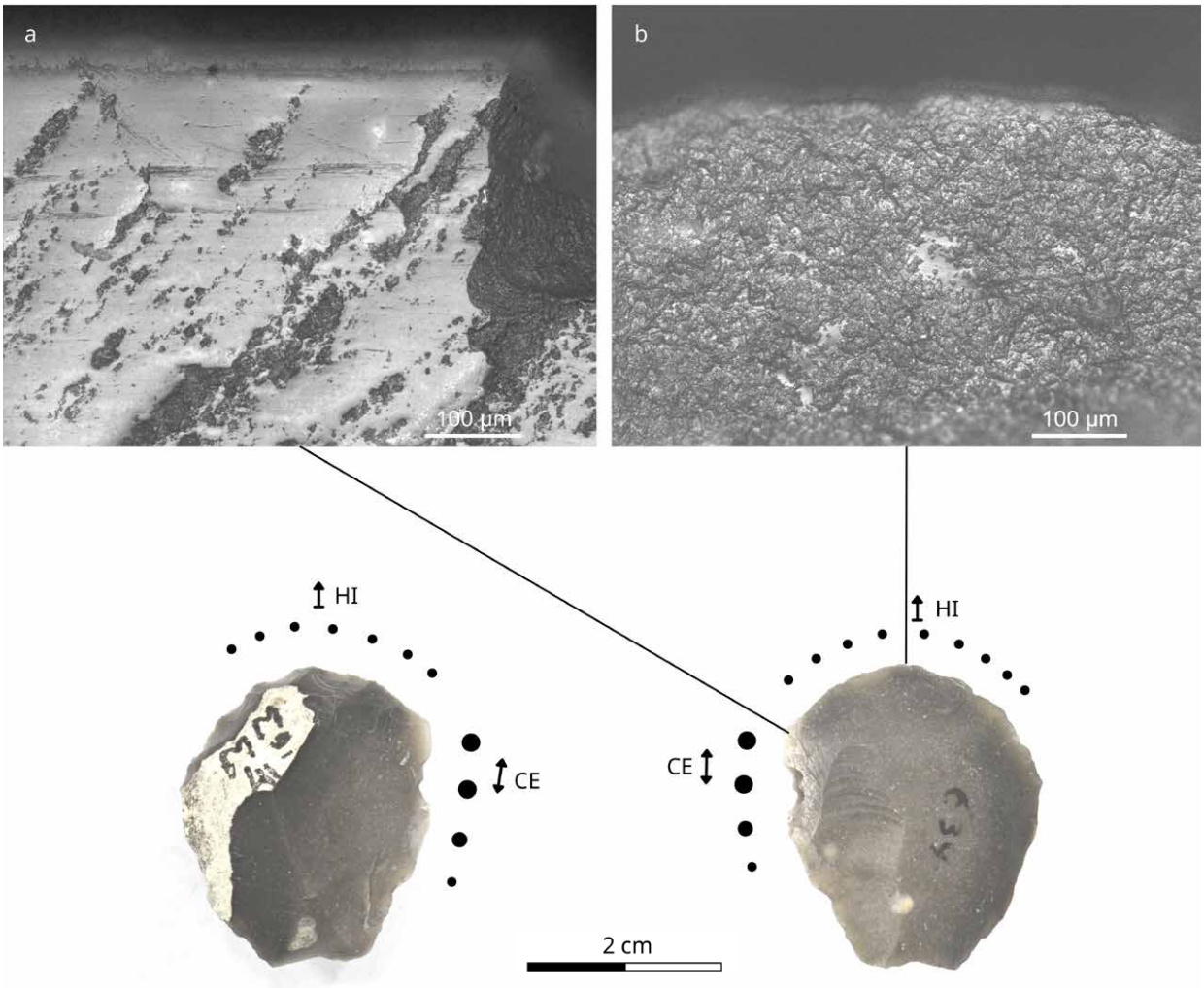


Figure 9.18 Scraper 634, sickle used for cereal harvesting, retouched after use and then reworked into a scraper which was used to scrape animal hides; with photographs polish resulting from cereal cutting (a) and polish resulting from hide scraping (b).

would create traces comparable to our sealskin scraping experiments (Van den Dikkenberg et al., 2024b).

The scrapers in trench 16 were predominantly used to scrape (dry) hide, and in one instance antler (Tab. 9.12). A flake from the cutting edge of a polished axe (126) displayed traces from chopping wood. The flake was retouched into a scraper which was used to scrape hide.

9.7.3 Traces from cereal harvesting and silicious plants working

In total eight tools were found in trench 11 and 16 with traces from contact with cereal (N=3) or silicious plant (N=5). The three cereal harvesting tools came from trench 11. This is a surprisingly high number, which nearly equals the total number of cereal harvesting tools on all other VLC sites combined, and also approaches the total number of silicious plant cutting tools (Houkes et al., 2017; Metaxas, 2010; Van Gijn, 1990b, p.; and see chapter 6 and 8). The presence of cereal harvesting tools was noted in the initial report by Van Gijn but, due to the lack of other use-wear analysis in the region at the time, the importance of the tools was not yet recognised (Van Gijn, 1984). Because of the scarcity of these tools in VLC assemblages these tools will be discussed in more detail below.

The three cereal harvesting tools appear to have been deliberately destroyed. Two of them were secondarily retouched after use (Van Gijn, 1984, p. 12). One artefact (Fig. 9.17 left) was broken in at least three pieces, of which only the middle part was found in the selected assemblage. Sickles from the VLC and the preceding Hazendonk-3 group were often burnt, retouched, and broken after use (Houkes et al., 2017; Van Gijn, 2014b; Van Gijn et al., 2006). The edges of the other tools were retouched after use (Fig. 9.17c; Fig. 9.18), similar to what was observed on the cereal harvesting tool from Den Haag Wateringse Binnentuinen (Houkes et al., 2017).

The lateral edge of the cereal harvesting tool 634 was retouched after use (Fig. 9.17 right). It is interesting that in this case the proximal end of the sickle was retouched into a scraper edge after use. The scraper end was subsequently used to scrape hide. The idea that sickles were ritually destroyed in this period is not new (Houkes et al., 2017, p. 202). What is remarkable about this case is that the destruction did not lead to deposition, or the abandonment of the tool. It could be observed that the retouch from the scraper's edge intersected the cereal harvesting traces (Fig. 9.18a). Therefore, the cereal harvesting traces must predate the function as a scraper.

It should furthermore be noted that there appear to be marked differences in the polishes on the three implements. When comparing the polishes in Figure 9.17 we observe that the polish on flake 169 (Fig. 9.17a and b) is flatter and more evenly distributed than the polish on the retouched flake 379 (Fig. 9.17c). Some attempts have recently been made to distinguish between different types of cereals through use-wear analysis, both using metallographic microscopes as well as with confocal microscopes (D'Errico, 2017; Ibáñez et al., 2014; Ibáñez et al., 2019; Pichon et al., 2023). For the presently observed differences it is unclear whether they should be attributed to differences in raw materials, or whether they perhaps represent differences in types of cereals which were harvested, or perhaps differences in harvesting techniques. Without more detailed experimental work this question cannot presently be answered. Nevertheless, the discovery of these three sickles with clear use-wear traces resulting from cereal harvesting provides an indication of local crop cultivation at the site. This challenges the notion, voiced by Out and Dörfler, that the difference between the coastal dune sites and the levee sites is one in which the former should be seen as cereal producer sites while the latter should be seen as consumer sites (Out & Dörfler, 2017, p. 61). This study indicates that cereals were likely cultivated on the levees. Cultivation at Vlaardingen Arij Koplaan should presumably be considered to be small scale cultivation considering cereal pollen is scarce, and in view of the limited contribution to the overall diet at the site, based on the residue analysis done in the *Putting Life into Late Neolithic Houses* project (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31).

9.7.4 Heavily rounded borers

Three of the heavily rounded borers from trench 11 displayed traces related to drilling holes in ceramics. The traces could be identified based on the presence of a rough and matt bright polish with many parallel striations clearly indicating the directionality of the motion. These match experimental traces from drilling holes in pottery (Carter, 2021, pp. 67–71; Van Gijn, 2021a). One borer also displayed hafting traces: isolated smooth and matt spots of polish on the dorsal ridges. These traces are indicative of the use of a hard material haft. Borer 299 was too heavily burnt for an interpretation of the contact material, but the heavy rounding nevertheless indicated that the borer was used on an abrasive contact material.

One of the heavily rounded borers (1760) turned out to be a strike-a-light, which had three used zones (Fig. 9.19). Furthermore, the distal end showed hafting traces inside the fracture. Much of the tool displayed a glossy surface. But this gloss was not present in the distal fracture where the hafting traces were found. A similar gloss was found on the strike-a-lights from Schipluiden. This has been interpreted as being the result of the strike-a-lights being in contact with pyrite powder. These traces occur because during handling and use of the tool the pyrite powder is rubbed against the surface of the tool (Van Gijn et al., 2006, p. 155).

This study indicates that we should be careful when interpreting heavily rounded tools as 'strike-a-lights' without microscopic research. This strike-a-light was classified as a heavily rounded borer. For the site of Den Haag Wateringse Binnentuinen a selection of heavily rounded tools was studied, based on the hypothesis that they were likely used as strike-a-lights. Here only one of the tools displayed strike-a-light traces, the others were used to drill different kinds of materials such as ceramics and amber (Houkes et al., 2017, pp. 186–188). Heavily rounded tools are thus not necessarily strike-a-lights (or borers). As it has been argued for Paleolithic pyrotechnologies, use-wear studies thus seem to be vital for identifying these tools (Sorensen et al., 2018, p. 2). This notion is further supported by the previously mentioned scraper 1540, which displayed characteristic strike-a-light traces on its proximal end (Fig. 9.15).

9.8 Results of the use-wear analysis of trench 15

The assemblage from trench 15 included a total of 117 artefacts with observable use-wear traces (Tab. 9.13). A number of tools displayed multiple used zones (Tab. 9.14).

The flint artefacts from trench 15 displayed a wide variety of use-wear traces (Tab. 9.15 and Fig. 9.20). The largest category relates to hide working (N=31). Bone (N=21) and antler (N=14) working are also very common. Surprisingly, the third largest group of use-wear traces relates to bark processing (N=20). Hafting traces will be discussed separately in section 9.8.5.

9.8.1 Hide working traces

Most hide working traces could not be specified beyond scraping 'hide unspecified', but occasionally they could be specified as dry hide scraping traces (Fig. 9.20a). Hide working also included cutting hide. Scrapers, and occasionally retouched flakes, often displayed signs of resharpening (N=21). The scrapers were predominantly used to scrape hide, although in one case the traces were related to the scraping of bark fibres.

Interpretation	Number of artefacts	Percentage
Use-wear traces	117	46.2%
Not interpretable	117	46.2%
No use-wear traces	19	7.5%
Total	253	100.0%

Table 9.13 Interpretability of use-wear traces at Vlaardingen Arij Koplaan trench 15.

Number of AUAs	Number of artefacts	Percentage
1	71	60.7%
2	34	29.1%
3	9	7.7%
4	2	1.7%
5	1	0.9%
Total	117	100.0%

Table 9.14 Number of AUAs of the artefacts from Vlaardingen Arij Koplaan trench 15.

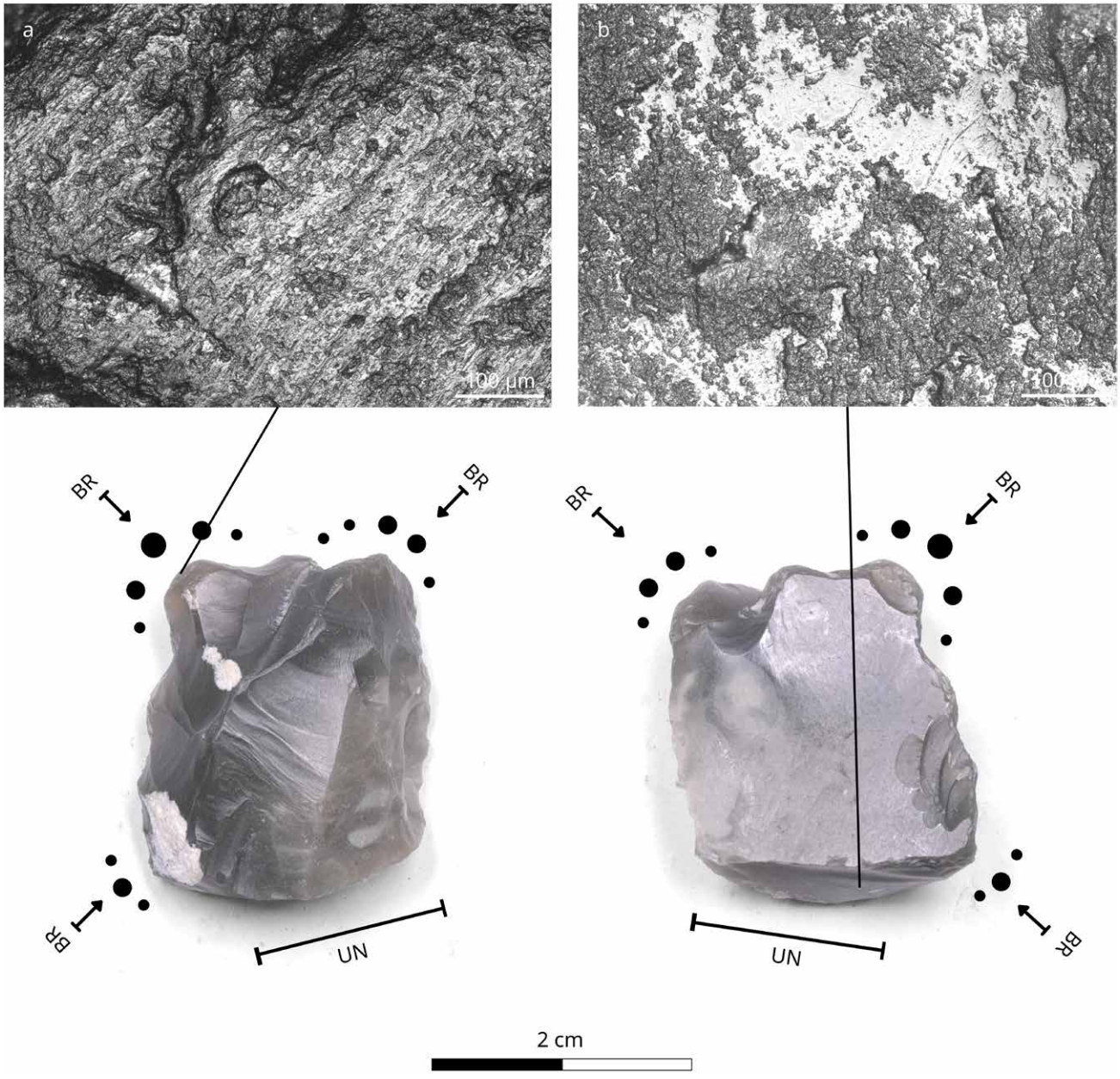


Figure 9.19 Strike-a-light (1760.1) from trench 11 with traces from fire-making using pyrite (a) and hafting traces (b).

	Boring/drilling	Chopping	Cutting	Graving	Longitudinal	Pounding	Sawing	Scraping	Splitting	Whittling	Unsure	Total
Animal												
Antler	-	-	-	1	5	-	7	1	-	-	-	14
Bone	1	-	-	8	2	-	10	-	-	-	-	21
Bone or antler	-	-	-	1	1	-	-	-	-	-	-	2
Meat and bone	-	-	-	-	-	-	-	1	-	-	-	1
Dry hide	-	-	-	-	-	-	-	8	-	-	-	8
Hide indet	-	-	3	-	-	-	-	20	-	-	-	23
Fish	-	-	3	-	-	-	-	-	-	-	-	3
Plant												
Bark	-	-	5	-	-	-	-	12	3	-	-	20
Nettle	-	-	1	-	-	-	-	1	-	-	-	2
Silicious plants	-	-	-	-	-	-	-	2	-	-	1	3
Wood	1	1	-	-	-	-	2	-	-	1	-	5
Plant indet	-	-	2	-	1	-	-	5	1	-	-	9
Inorganic												
Pottery	10	-	-	-	-	-	-	-	-	-	-	10
Pyrite	-	-	-	-	-	2	-	7	-	-	-	9
Unknown material												
Hard material	1	-	-	-	-	6	-	-	-	-	-	7
Medium hard material	1	-	-	-	-	-	-	-	-	-	-	1
Soft or medium hard material	-	-	-	-	-	-	-	1	-	-	-	1
Unsure	-	-	-	-	-	-	-	-	-	-	5	5
Total	14	1	14	10	9	8	19	58	4	1	6	144

Table 9.15 Crosstab with motions (x-axis) and contact materials (y-axis) for trench 15 excluding hafting traces.

Tools with hide working traces were mainly found close to the house (Fig. 9.21). No clearly defined activity areas related to hide working could be identified, although north of the house plan a small cluster with hide working tools potentially represents a small activity area.

9.8.2 Plant processing traces

The flint from Vlaardingen Arij Koplaan displayed a variety of different plant working traces. Unfortunately such traces are notoriously difficult to disentangle. Despite extensive experimental studies it is generally still not possible to link specific traces to specific plants species (Little & Van Gijn, 2017; Osipowicz, 2019, p. 3622). However, occasionally direct comparisons with material from the reference collection at the Material Culture Laboratory allowed for more specific identifications. The traces related to the processing of bark could not be linked to a specific species. Bark or bast refers to woody plant fibres, but some plants with woody stems could potentially fall under this category (Verbaas & Van den Dikkenberg, 2024). In two cases the plant working traces were related to the cutting and scraping nettle fibres (Fig. 9.20e). The harvesting of nettle fibres ideally takes place between mid-July and late August (Vogl & Hartl, 2003, p. 123). As such these cutting traces provide insights into the seasonality of activities at the site. The scraping traces cannot be related to a specific season because these fibres can be dried and processed later.

It is possible that some of the traces that were interpreted as being related to bark could be due to the processing of nettle fibres. However, it is equally possible that several types of bark fibres were processed. The traces related to the scraping of silicious and non-silicious plants can also be related to the processing of fibres. The use of such fibres was also attested by the finds of cord fragments (Glasbergen et al., 1961, p. 45; Van Iterson Scholten, 1977). Traces from scraping bark and silicious plant are very common in late

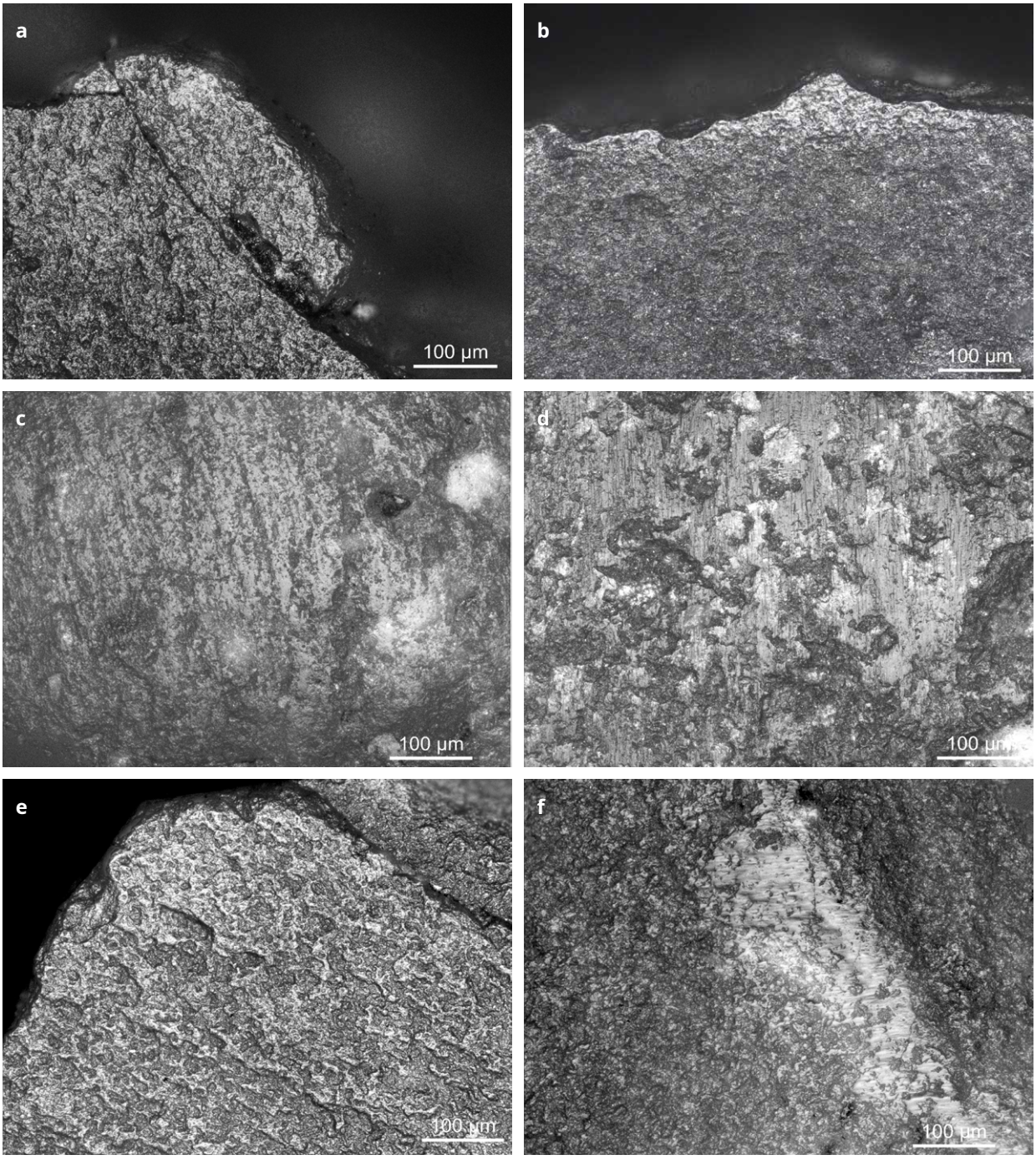


Figure 9.20 Trench 15 use-wear traces observed: a) traces from dry hide scraping with a non-detached resharpening flake (389.1); b) traces from antler sawing (667.2); c) traces from ceramic drilling (322.2); d) traces from pyrite scraping (447.1); e) traces from nettle cutting (665.1); f) traces from hafting in antler (544.2).

Mesolithic and Swifterbant contexts, but they are generally scarce at VLC sites (Devriendt, 2013a, p. 174; Little & Van Gijn, 2017; Van Gijn et al., 2001a, pp. 146–151; Van Gijn et al., 2001b; Verbaas & Van den Dikkenberg, 2024). Their extensive presence in Vlaardingen indicates that the processing of bark and other plant fibres did not cease in the VLC period.

In terms of spatial distribution plant processing traces show a remarkable pattern (Fig. 9.22). North of the house a cluster of plant processing tools could be observed. In terms of the general distribution of flint in trench 15 this northern zone does not display a stronger clustering of artefacts than the zone to the south or to the east of the house plan. It

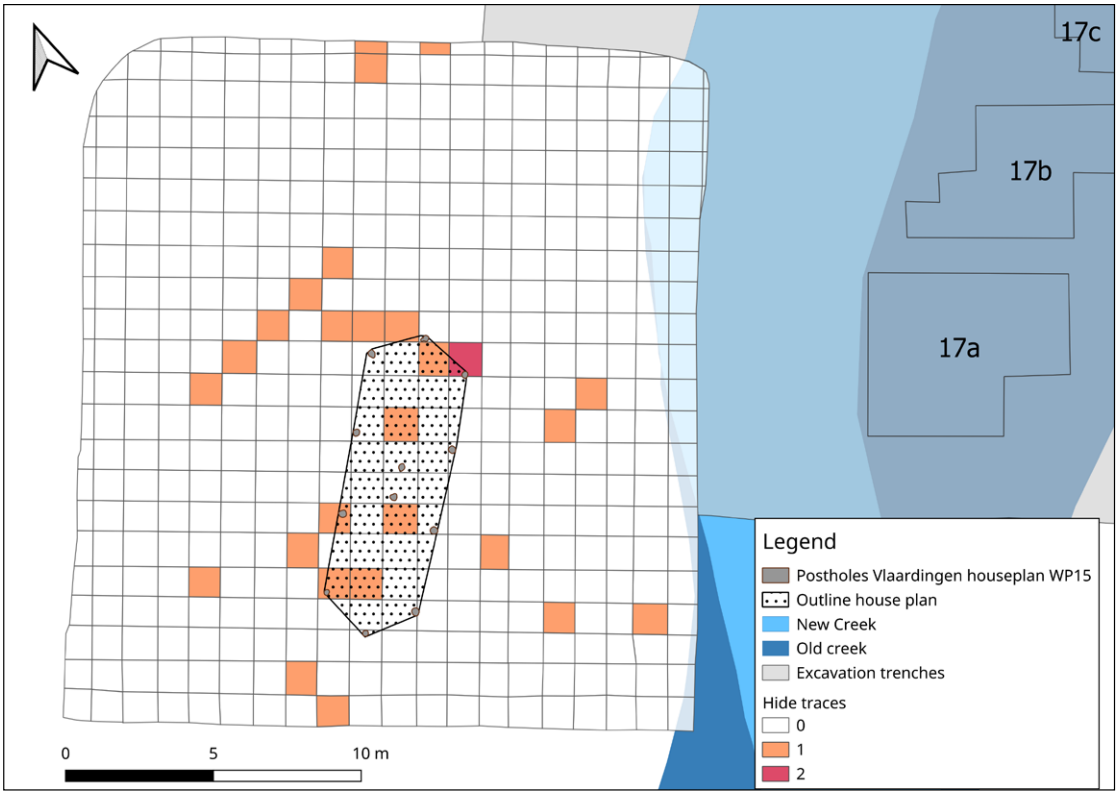


Figure 9.21 Distribution of hide working tools in trench 15 (after Van Beek, 1990).

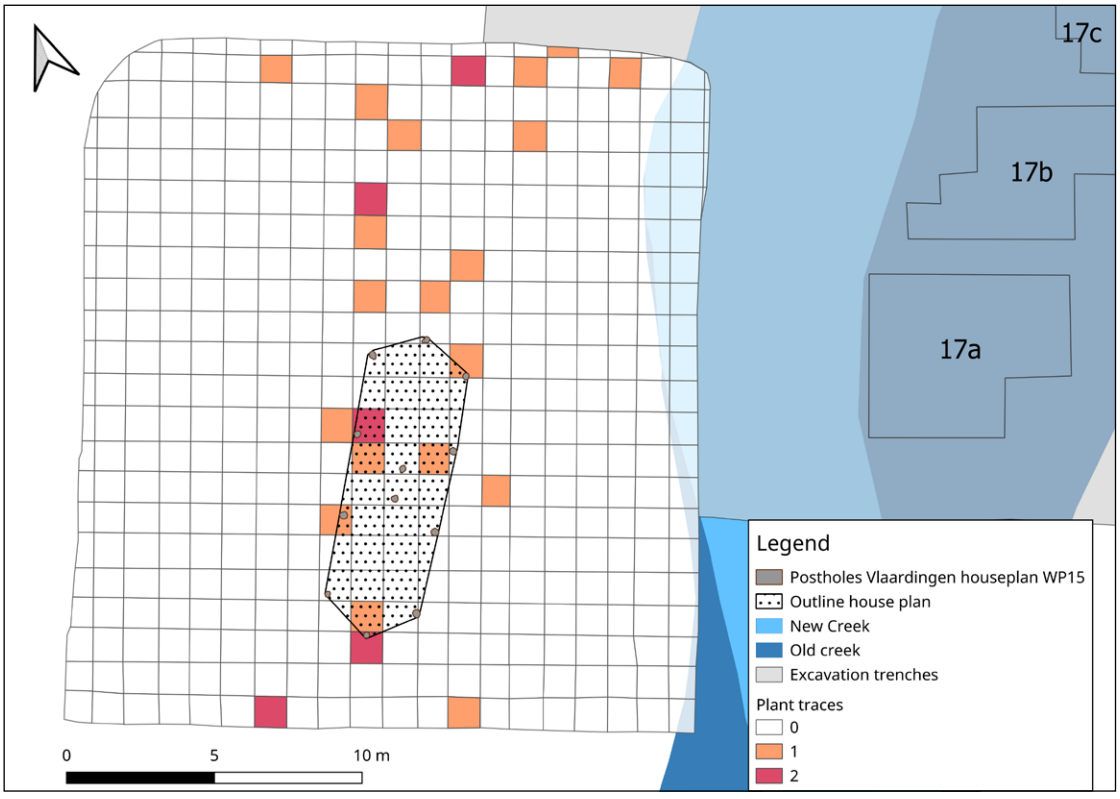


Figure 9.22 Distribution of plant working tools (excluding wood working) in trench 15 (after Van Beek, 1990).

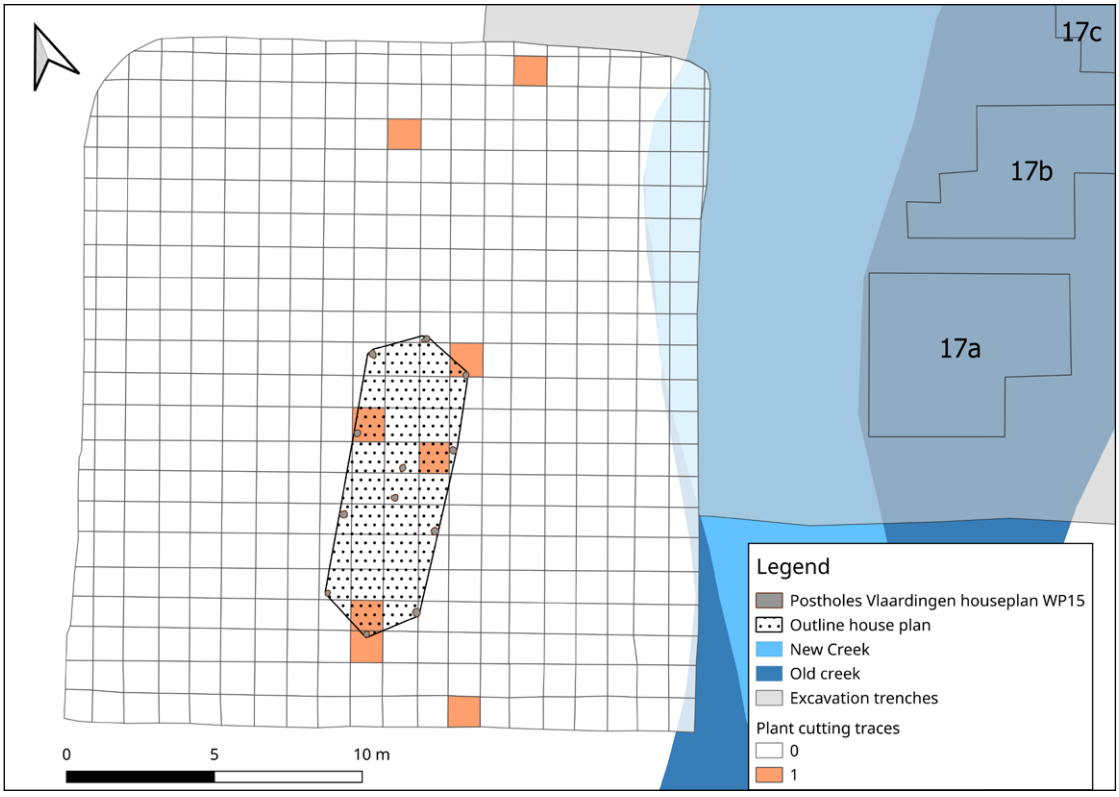


Figure 9.23 Distribution of plant cutting tools, and tools with plant traces resulting from an unidentified longitudinal motion in trench 15 (excluding wood working traces) (after Van Beek, 1990).

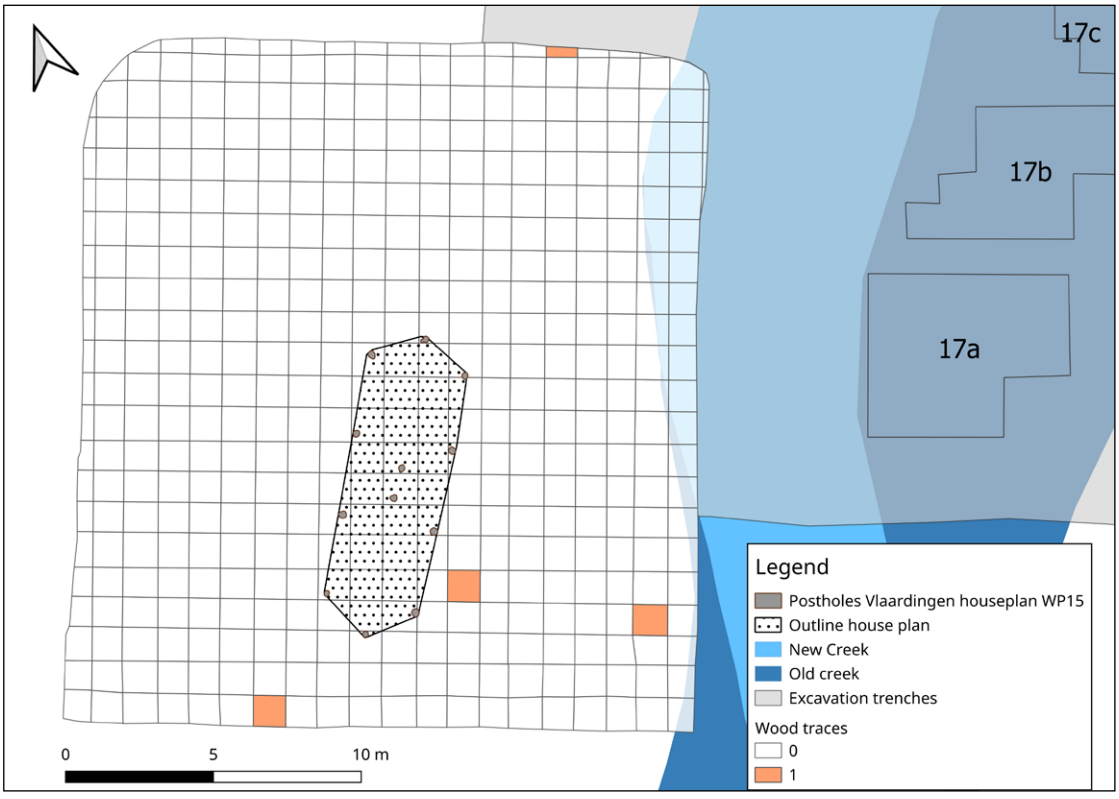


Figure 9.24 Distribution of wood working tools in trench 15 (after Van Beek, 1990).

thus seems that this northern cluster represents a specific activity zone for plant processing. Plant processing traces included those relating to the cutting of plant fibres possibly related to harvesting of fibres and traces of scraping plant fibres. The latter relates to activities to further process these fibres. To see whether the northern cluster perhaps related specifically to harvesting, rather than processing, plant cutting traces were plotted in a separate distribution map (Fig. 9.23). These traces were distributed in the same general areas as the scraping traces. In addition to this northern cluster a number of tools with plant working traces are found near, and inside, the house.

Tools with wood working traces are scarce in trench 15, they are found to the north and south-east of the house (Fig. 9.24). It is likely that this activity was frequently carried out with bone tools, such as bone chisels, and flint axes. These tools could be used for a prolonged period. Flint axes were likely reused after they broke (Van den Dikkenberg et al., 2024a). As such it seems likely that the spatial distribution of axe fragments is more indicative of knapping areas than of wood working activity areas. Several bone chisels were recovered during the excavations (Maarleveld, 1985). A number of these will be analysed by C. Kromotaroeno as part of the *Putting Life into Late Neolithic Houses* project (Kromotaroeno & Van Gijn, in prep.; Maarleveld, 1985). This will provide more insight into the question whether these are indeed related to wood working activities. Based on the distribution of flint artefacts it is not clear where wood working exactly took place.

9.8.3 Bone and antler working

Bone and antler working constitute important activities in Vlaardingen. Production waste, especially from bone working, confirmed the importance of these activities (Maarleveld, 1985). The bone working traces are highly diverse, attesting to various stages of processing. The traces included those from

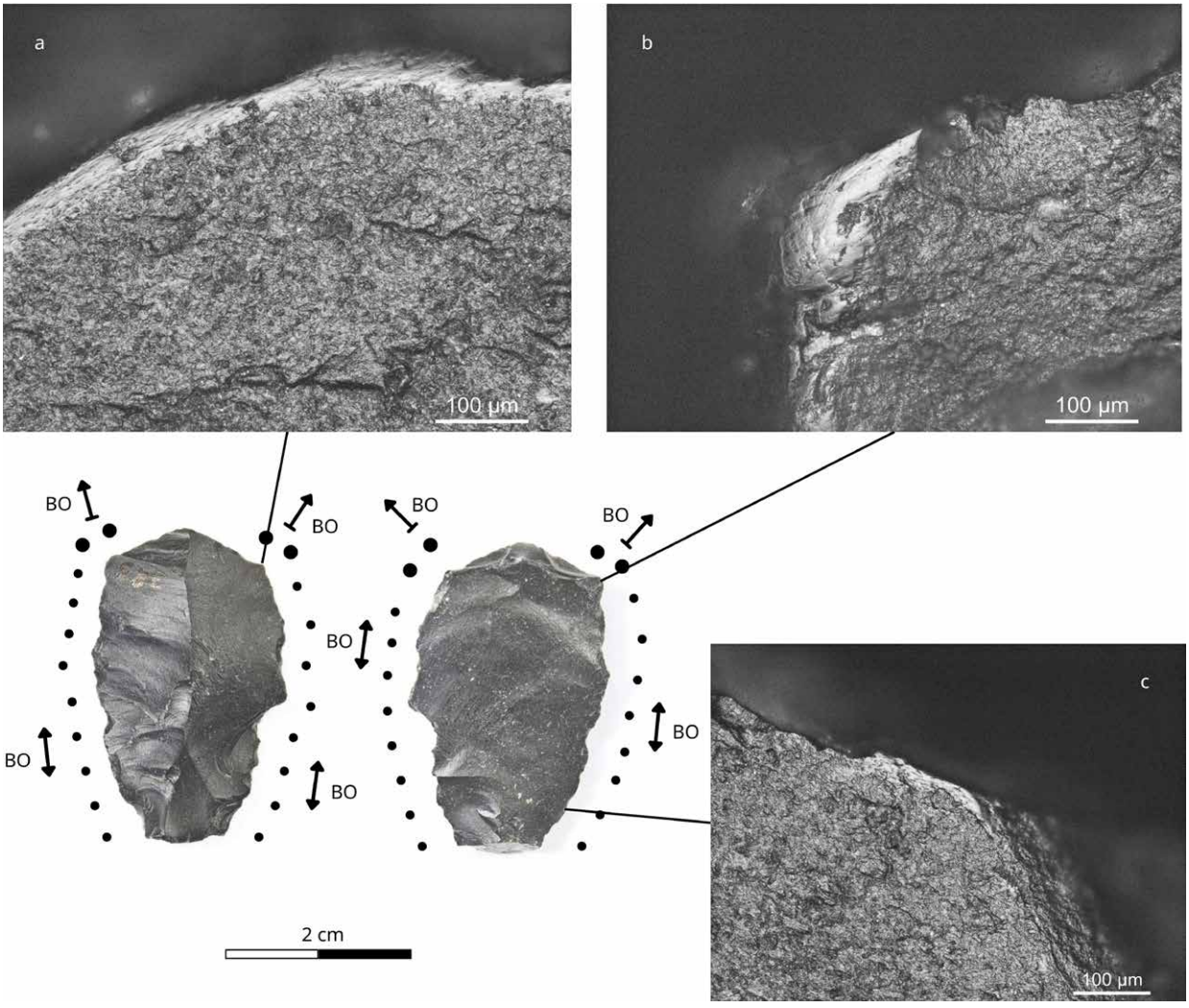


Figure 9.25 Multitool (383.1) with use-wear traces: a and b) from carving bone; c) sawing bone (after Van den Dikkenberg & Van Gijn, 2024).

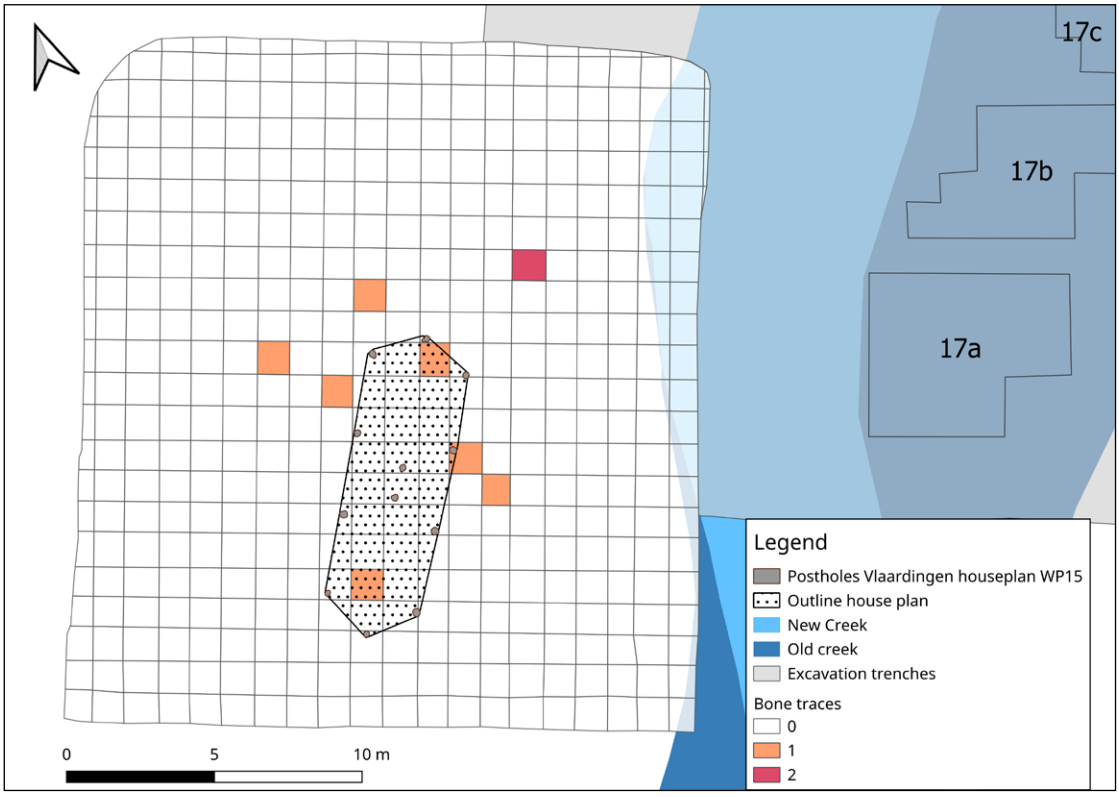


Figure 9.26 Distribution of bone working tools in trench 15 (after Van Beek, 1990).

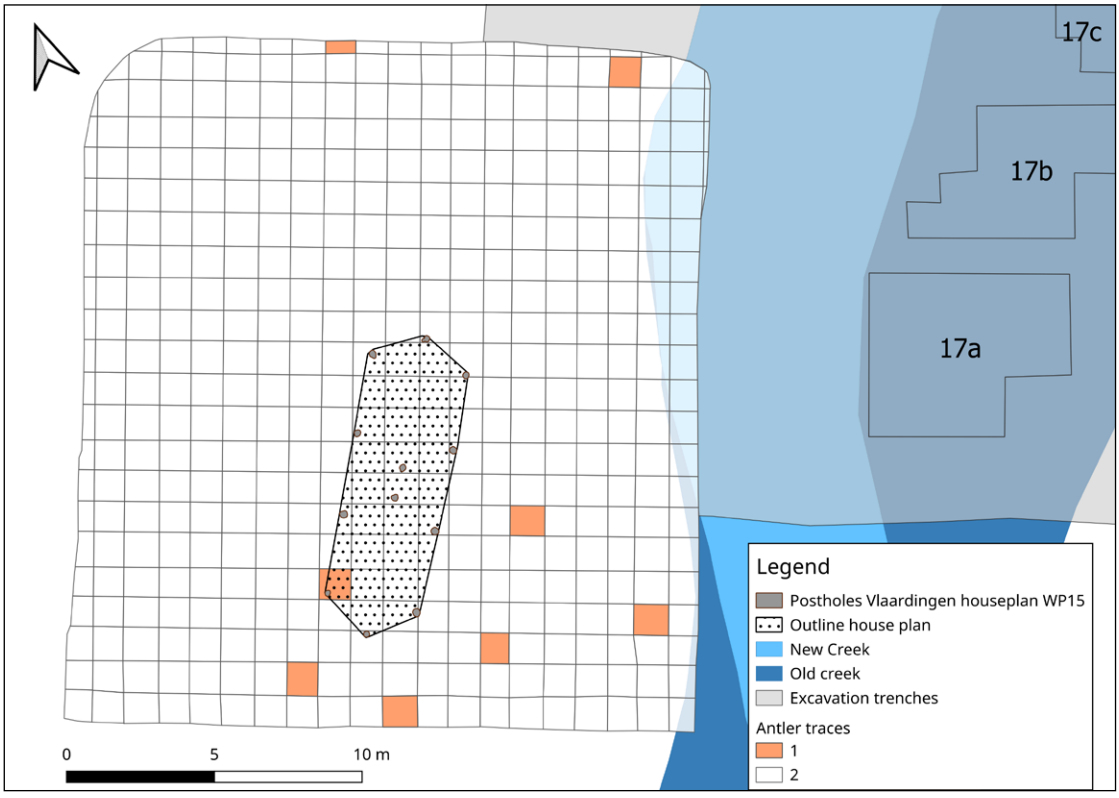


Figure 9.27 Distribution of antler working tools in trench 15 (after Van Beek, 1990).

scraping meat from bones, an initial cleaning before further processing. The use of the metapodium technique could well be attested (Van den Dikkenberg & Van Gijn, 2024). Several tools displayed traces from carving and sawing bone. The carving in these instances was done to deepen the grooves in the metapodia which would facilitate their splitting. The sawing can be related to the sawing off the distal (or at times proximal) ends of the metapodia. These traces often co-occurred on tools, indicating that a single multitool was used for both the sawing and the splitting of these bones (Fig. 9.25). A similar link between the bone production waste and use-wear traces on flint tools is made by Van Gijn for Hekelingen III (Van Gijn, 1990b; 1994b, pp. 263–264).

Interestingly, one borer also displayed traces related to the drilling of bone. Perforated bone artefacts have not been recovered in Vlaardingen, but several perforated teeth have been found. It is possible that these traces thus relate to the perforating of teeth, rather than actual bone. A similar suggestion has been proposed for the flint drills from the Mesolithic site of Starr Carr which displayed wear traces relating to the drilling of bone (Bates et al., 2022).

Bone working tools are mainly confined to the inside and the zone next to the house plan. Bone working seems to represent a domestic activity conducted inside or near the house (Fig. 9.26). Interestingly, tools with antler working traces occur mainly north and south-east of the house plan (Fig. 9.27). Possibly the southern cluster represents an activity area where antler working took place. Unlike bone working these traces are not directly associated with the house plan. This might have to do with the specific properties of the material. Soaked worked antler produces a strong smell (personal communication A.L. van Gijn, 2024), it is possible that this activity took place outside specifically because of this smell.

9.8.4 Miscellaneous activities

Traces resulting from the drilling of ceramics can be related to the repair of pots (Carter, 2021; Van Gijn, 2021a, p. 179). These activities are not spatially bound to a specific activity zone (Fig. 9.28). Tools with traces related to this activity are found inside, to the north, south and east of the house.

Fish cutting traces are found on two tools in two locations within the trench (Fig. 9.29). In one case the tool was found close to the house, the other tool near the waterside.

Two unmodified Meuse-eggs were used as hammerstones on hard materials. A specific contact material was not identified, but it seems likely that these were used for flintknapping. Three out of four Meuse-eggs found in trench 15 were unmodified and two of these displayed these characteristic battering traces. The use of Meuse-eggs as hammerstones was thus more common than the use of Meuse-eggs as flake cores. This contrasts with sites in the coastal dune areas where Meuse-eggs were mainly used for bipolar reduction (Amkreutz, 2013b, p. 343; Van Gijn, 1990b, p. 134). It seems that this difference in use is related to the availability of high-quality flint from Spiennes, Rijckholt, and Hesbaye.

9.8.5 Hafting traces and resharpening of flint

In total 22 tools with hafting traces were found, twelve of which are axe fragments (Tab. 9.16). Here the hafting traces are likely related to the use-life of these axes. The other ten AUAs with traces from hafting are found on six scrapers (four related to hafting in hard material, two to hafting in wood), two borers (hafting in wood and hafting in bone/antler), an unmodified blade (hafting in antler), and a retouched waste fragment (hafting in wood). Wood is generally the preferred material for hafting, but antler is also frequently used, notably for hafting axes (Fig. 9.20f). In these cases, it is likely that an antler sleeve was used in combination with a wooden haft. These antler sleeves have not been found on VLC sites in the western Netherlands, but one was retrieved from the VLC site of Beuningen Ewijkse Velden (Asmussen & Moree, 1987, p. 166).

In total 32 tools from trench 15 display traces of resharpening. In twelve instances these consist of axe fragments which are resharpened, or reshaped, through grinding. These axe fragments were originally polished using leather and additives. These traces were subsequently removed by grinding. The original polishing traces are only still visible in the deeper flake negatives. Similar traces are found on axe fragments from other sites as well (Van den Dikkenberg, 2024a). Eight scrapers are heavily resharpened, as evidenced by the presence of overhanging dorsal ridges (Van Gijn, 1990b, p. 135). The other resharpened tools also consist mainly of scrapers and retouched flakes. Five of these have non-detached resharpening flakes (Fig. 9.20a), in other instances it could be observed that the band of polish, and the rounding on the edge, are intersected by resharpening retouches.

9.9 Results of the use-wear analysis of trench 17

On 33 of the 69 artefacts studied traces of use could be detected (Tab. 9.17). A number of tools displayed multiple used zones (AUAs). The 33 tools displayed a

	Hafting	Hafting previous use-life, axe fragments	Total
Antler	1	3	4
Bone/antler	1	-	1
Wood	4	7	11
Hard material	4	2	6
Total	10	12	22

Table 9.16 Hafting traces in trench 15.

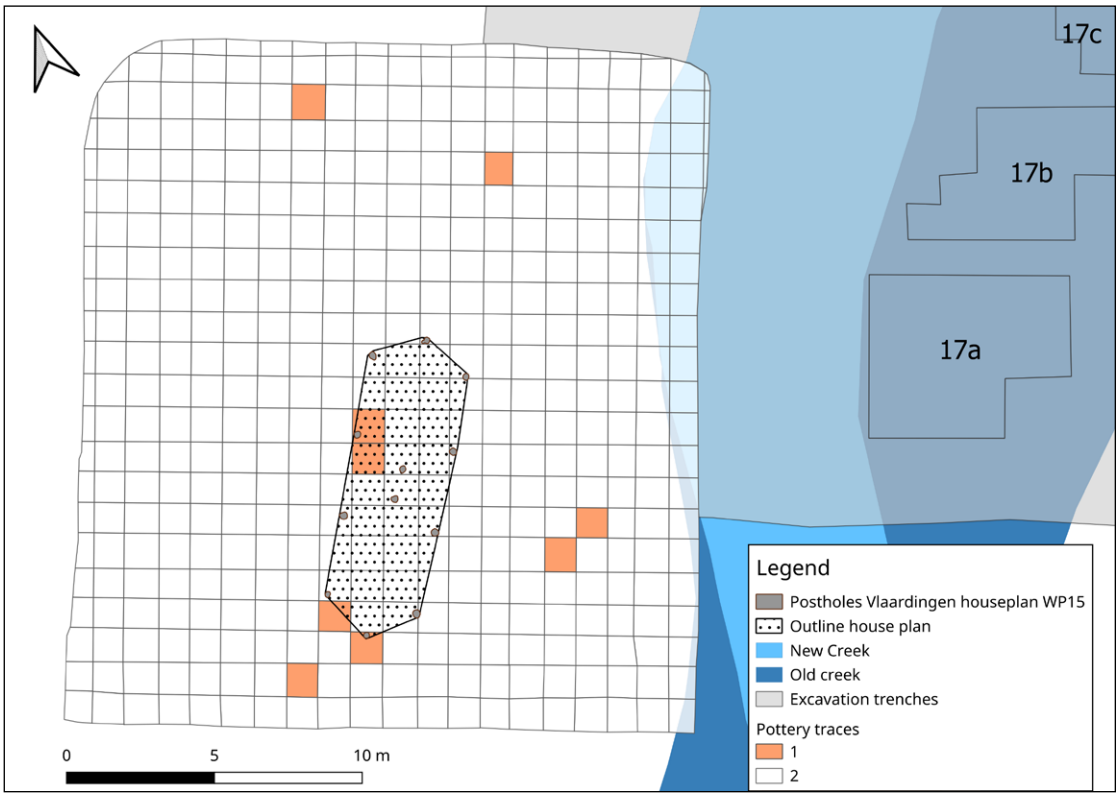


Figure 9.28 Distribution of pottery drilling tools in trench 15 (after Van Beek, 1990).

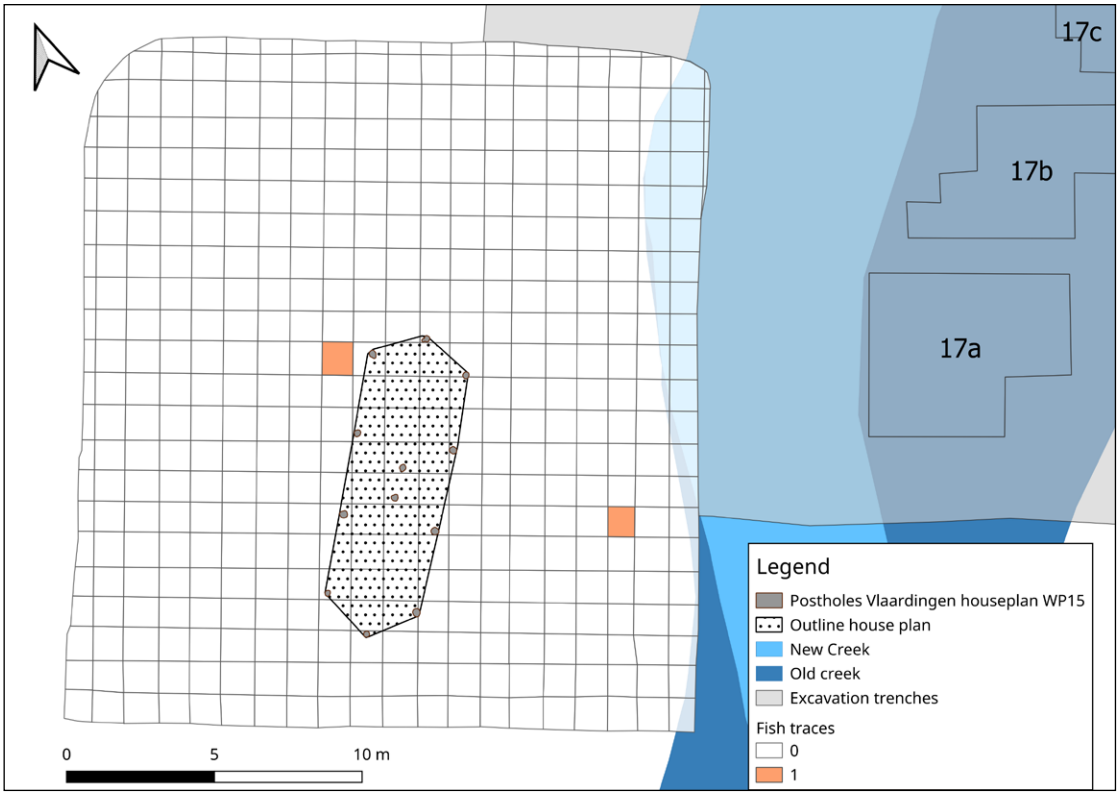


Figure 9.29 Fish cutting tools in trench 15 (after Van Beek, 1990).

Interpretation	Number of artefacts	Percentage
Use-wear traces	33	47.8%
Not interpretable	27	39.1%
No use-wear traces	9	13.0%
Total	69	100.0%

Table 9.17 Interpretability of use-wear traces at Vlaardingen Arij Koplaan trench 17.

Number of AUAs	Number of artefacts	Percentage
1	16	48.5%
2	14	42.4%
3	2	6.1%
4	1	3.0%
Total	33	100.0%

Table 9.18 Number of AUAs of the artefacts from Vlaardingen Arij Koplaan trench 17.

	Boring	Chopping	Cutting	Cutting/sawing/whittling	Diagonal	Piercing	Transverse	Wedging	Possibly used/indet	Residue	Total
Animal											
Antler	-	-	2	-	-	-	-	-	-	-	2
Bone	-	-	1	3	-	-	-	-	-	-	4
Bone or antler	1	-	-	-	-	-	-	-	-	-	1
Horn	-	-	2	-	-	-	2	-	-	-	4
Dry hide	-	-	-	-	-	-	1	-	1	-	2
Fresh hide	-	-	1	-	-	-	-	-	1	-	2
Hide indet	-	-	1	-	-	1	2	-	-	-	4
Animal indet.	-	-	-	1	-	-	-	-	-	-	1
Plant											
Bark	-	-	-	-	2	-	-	-	-	-	2
Cereal	-	-	1	-	-	-	-	-	-	-	1
Silicious plants	-	-	1	-	-	-	-	-	-	-	1
Wood	-	1	-	4	-	-	-	-	-	-	5
Inorganic											
Pottery	1	-	-	-	-	-	-	-	-	-	1
Ochre?	-	-	-	-	-	-	-	-	-	1	1
Unknown material											
Hard material	-	-	-	-	-	-	-	2	-	-	2
Medium hard material	3	-	-	-	-	-	1	-	-	-	4
Medium or hard material	-	-	1	-	-	-	-	-	2	-	3
Possibly used	-	-	-	-	-	-	-	-	7	-	7
Total	5	1	10	8	2	1	6	2	11	1	47

Table 9.19 Crosstab with motions (x-axis) and contact materials, excluding hafting traces (y-axis) for trench 17.

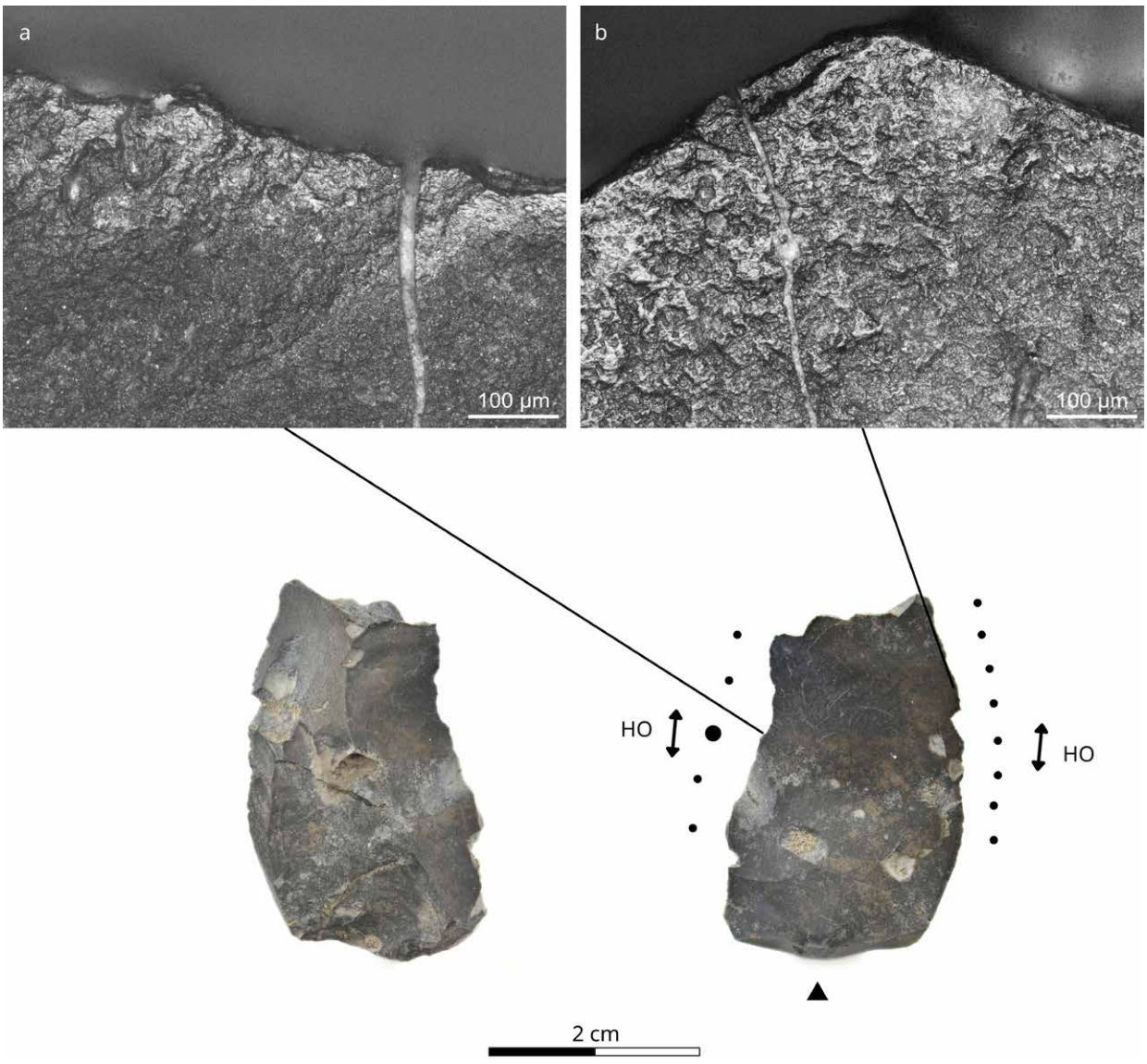


Figure 9.30 Horn cutting tool from trench 17 (522e.1), used on two sides to cut horn (a and b).

total of 54 AUAs (Tab. 9.18 and 9.19), seven of which were associated with hafting. Nine out of the 33 artefacts with use-wear traces were blades, which means that 27% of the used tools consisted of blades. Furthermore, thirteen of the AUAs were found on imported blades (with trapezoidal or triangular cross-sections). This meant that 24.5% of all AUAs were found on imported blades. This indicated that blades, despite the lack of a blade technology in this period, were important tools within the technological system at the site (Van den Dikkenberg, 2024b; Van Gijn, 2010b).

One AUA consisted of a spot of reddish residue, possibly ochre. This interpretation remains tentative because chemical analyses were not conducted. The use-wear traces are present on flakes, blades, borers, scrapers, a core, and waste fragments.

It seems that hide (N=8), wood (N=7), and bone and antler working (N=7) were prominent activities. In addition to these activities, traces from harvesting cereals, cutting silicious plants, and drilling ceramics were found. A significant discovery was presented by the evidence for horn working, found on two tools. Considering the small size of the assemblage, the variety of traces is noteworthy.

A wide range of motions was represented. Hide working included scraping fresh and dry hides, as well as the cutting and piercing of hides. Wood working was done both through chopping and cutting/sawing or whittling. In two instances traces from debarking wood were encountered.

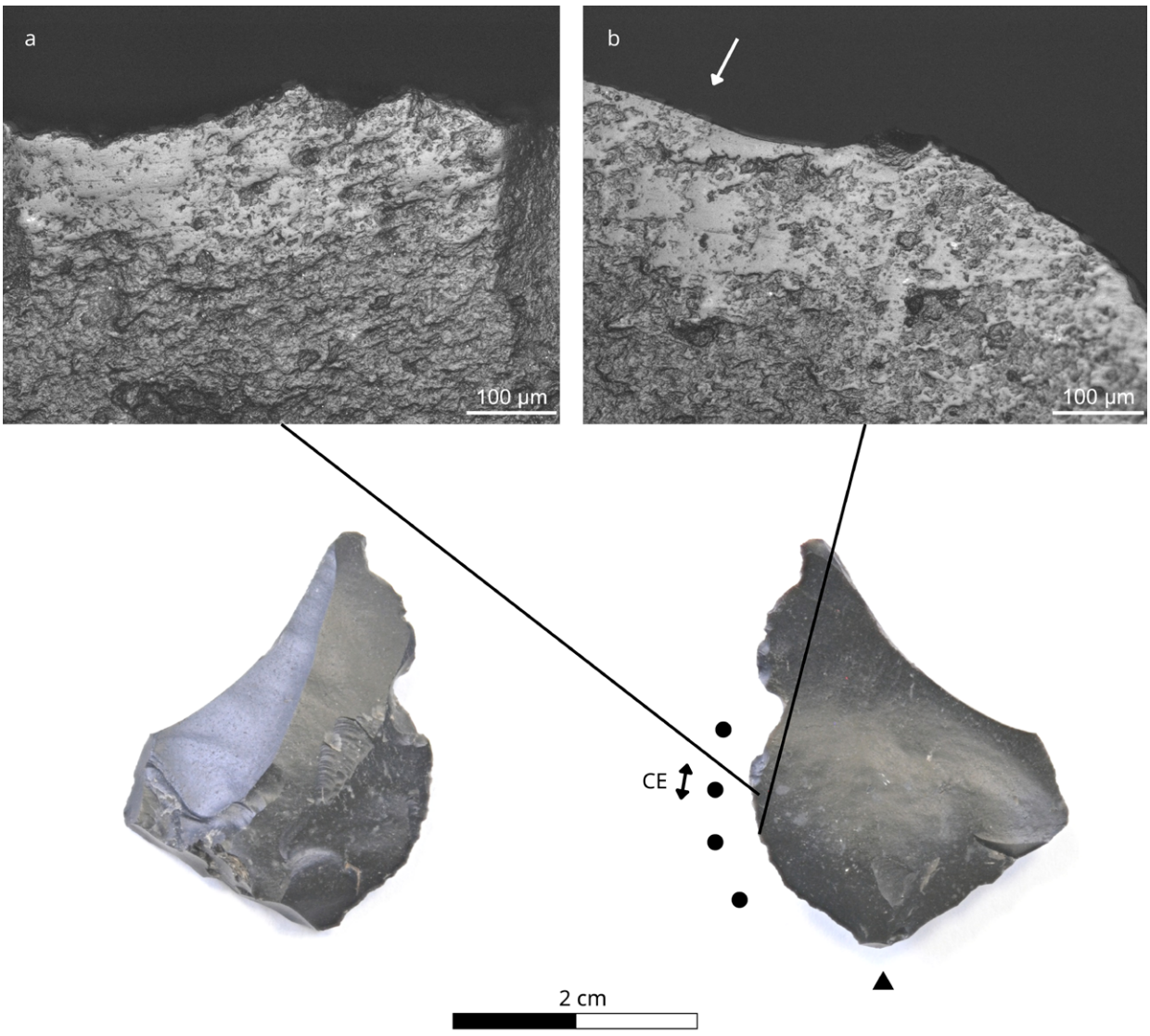


Figure 9.31 Cereal harvesting tool 24C3c of which the edge was destroyed by retouching after use. Use-wear is distributed as a band of domed smooth and matt polish with parallel striations along the edge (a), in many parts the polish is intersected by retouch, see white arrow (b).

Bone and antler working generally relates to longitudinal motions such as cutting or sawing, and in one instance a drilling motion.

Two tools displayed horn working traces, one of which, a retouched blade was used on two sides to scrape horn. The other tool was of a burnt retouched axe flake used on two sides for cutting horn. The polish on these tools could be described as smooth and greasy, which in the case of the cutting tool (522e.1) displayed a clear longitudinal directionality (Fig. 9.30a). In the well-developed parts the polish was distributed as a band along the edge, while otherwise it was more patchy. The polish matched that from the experimental tools described in chapter 5 (section 5.5).

A relatively large flake was used to cut cereals (24C3c). The edge was destroyed by retouching after the tool was used (Fig. 9.31). This confirms earlier observations that cereal harvesting tools in this region were systematically destroyed after use (Houkes et al., 2017, pp. 180–184; Van Gijn, 2010b, p. 86; 2014b; Van Gijn & Verbaas, 2008).

Four tools display hafting traces, with a total of seven AUAs. Three tools displayed hafting traces relating to multiple materials. One flint borer was hafted into a wooden haft and the sides of the borer displayed traces related to hafting in hide. This potentially indicates

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Common merganser (*Mergus merganser*)												
Red-throated/Artic loon (*Gavia stellata*/*G. arctica*)												
Brent goose (*Branta bernicla*)												
Crane (*Grus grus*)												
Pike (*Esox lucius*)												
Sowing cereals (*Cerealia*)												
Collecting shed antlers												
Wild onion (*Alium*)												
Dog rose (*Rosa canina*)												
Sturgeon (*Acipenser sturio*)												
Reaping cereals (*Cerealia*)												
Harvesting nettle fibres												
Hazelnut (*Corylus avellana*)												
Hunting red deer with fully grown antlers												

Table 9.20 Seasonality of activities and food sources at Vlaardingen, most likely season of exploitation in dark green, possible seasons of occurence/exploitation in light green (Bakels & Zeiler, 2005; Beerenhout, 2010, pp. 58–65; Hoogenstein et al., 2017, pp. 16, 32, 73–75; Out, 2009, appendix VI; Van Regteren Altena et al., 1963a, pp. 40–53; Vogl & Hartl, 2003).

that the tool was inserted in a wooden haft with hide bindings. It is also possible that the tool was wrapped in wet rawhide, which shrinks as it dries and thus secures the tool. A retouched blade and a transverse arrowhead displayed traces relating to a haft made of a hard material, also in combination with the use of hide bindings or wrappings. Lastly, one retouched flake displayed hafting traces that were related to a haft of hard material.

Evidence for resharpening was found on eight tools. Four scrapers were clearly resharpened. On two of these the use-wear traces were not interpretable. One displayed traces of dry hide scraping, the other displayed traces of hide scraping. Three of the scrapers had overhanging dorsal ridges, indicating repeated resharpening (Van Gijn, 1990b, p. 135). On the other scraper the rounding and polish along the edge were intersected by resharpening retouches. In addition to these scrapers, four axe fragments displayed evidence for resharpening. These axes were resharpened through grinding on a hard grinding stone.

9.10 Discussion

9.10.1 Seasonality at Vlaardingen Arij Koplaan

The site of Vlaardingen Arij Koplaan shows evidence of habitation during all seasons of the year (Tab. 9.20). Combining the data from the zooarchaeological and archaeobotanical studies with the use-wear analyses presented, we are able to reconstruct yearly cycles at the site. The winter presence is most strongly indicated by the avian winter guests present in the faunal assemblages (Bakels & Zeiler, 2005; Hoogenstein et al., 2017, pp. 16, 32, 73–75; Van Regteren Altena et al., 1963a, p. 40). During late winter and spring, shed antlers were collected, and pike was also caught during the mating season in late winter/early spring. Furthermore, the residue analyses indicate that wild onions were collected during this season (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31). In spring or early summer, cereals were sown and dog rose could be collected (Beerenhout, 2010, pp. 58–65; Out, 2009, Appendix VI; Van Regteren Altena et al., 1963a). During early summer, the sturgeon migration season initiated extensive sturgeon fishing, while later in the summer nettle fibres could be harvested (Beerenhout, 2010, pp. 58–65; Van Regteren Altena et al., 1963a, p. 53; Vogl & Hartl, 2003). Autumn provided hazelnuts, and between September and February red deer with fully grown antlers were hunted (Van Regteren Altena et al., 1963a, p. 47). The yearly cycle closely resembles that of Hekelingen III. It cannot be stated with certainty that the site was continuously inhabited. It is theoretically possible that these activities represent multiple temporary visits. Yet, if we assume repeated visits, it is remarkable that the site would have been appealing in all four seasons, albeit for different reasons. As such, there seemed to be no incentive to leave the site during a specific season. It is plausible that the site was permanently inhabited at some point. Other parts of the site may not have been inhabited year-round but instead visited for specific purposes.

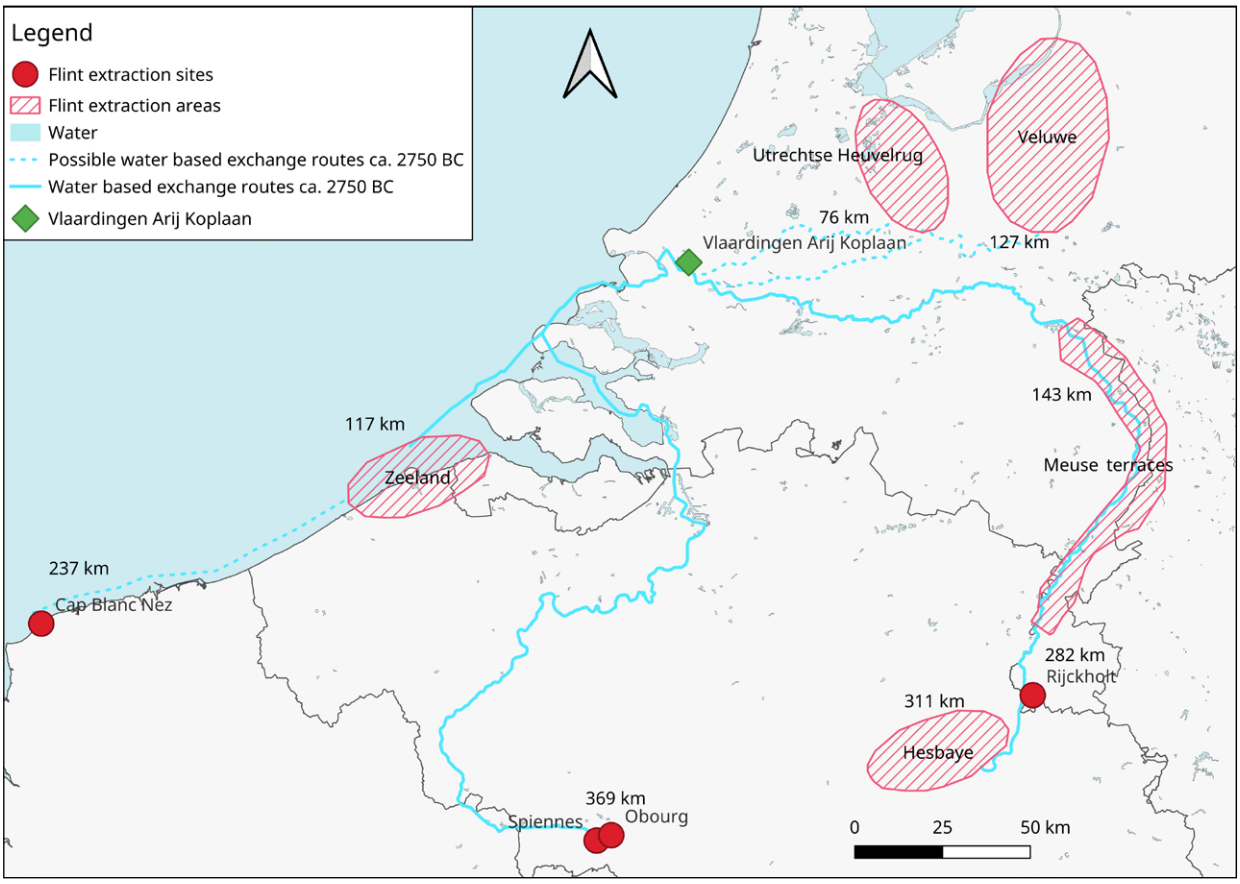


Figure 9.32 Vlaardingen Arij Koplaan and water-based routes with calculated distances between the sources and the site, reconstructed based on the palaeogeographic map of the Netherlands ca. 2750 BCE (Van Gijn et al., 2006; Vos et al., 2020).

9.10.2 Spatial distribution of domestic activities

By plotting different activities on distribution maps of trench 15, an attempt was made to gain insight into the spatial organisation of craft activities in, and around, the house. The house itself formed a strong focal point for domestic craft activities such as fibre processing, hide working and bone working. In addition to zones directly surrounding the house, activities also took place in the area to the southeast of the house. These activities included antler working, hide working and pottery drilling. Plant fibre and bone working did not take place in this area. The zone several metres to the north of the house was intensively used for plant fibre processing, hide working, and to a lesser extent for antler working and pottery drilling for ceramic repairs. In general, it seems that domestic activities are not strictly separated in specific spatial zones in and around the house. Only antler working was mostly done outside of the house. This is possibly related to the fact that antler produces a strong smell when it is worked, as argued earlier.

9.10.3 Discussion and conclusion

In terms of raw material distribution, it appears that Vlaardingen was very well connected to southern areas. The majority of the flint at the site consists of high-quality flint, mostly imported from flint mining areas in Hesbaye, Rijckholt, and Spiennes. Low-quality materials such as terrace flint and Meuse-eggs were only rarely imported to the site. They often remained unused, suggesting that the supply of high-quality flint was steady and continuous. The site is conveniently located at the intersection between different routes (Fig. 9.32). Since low-quality flint was generally not used, it might have been obtained for other purposes. The site may have functioned as a redistribution centre, where flint was imported in higher quantities than was necessary to supply the inhabitants. It is possible that flint was then redistributed to less well-connected sites in the coastal dune area. Although present at Vlaardingen, low-quality flints were generally not used. They were, however, frequently used at sites such as Leidschendam Prinsenhof (Van Gijn, 1990b, p. 134).

As on other VLC sites, the technology is dominated by a simple flake technology (Van Gijn, 2010b). Blade cores are absent and blades were imported in a finished state. Although these imported blades are rare, they were clearly important as 27% of all used tools in trench 17 consisted of imported blades. Flint axes were also imported in fairly large quantities and a large portion of the flint consisted of recycled flint axes. Both traces from grinding and polishing with leather and additives commonly occurred on these fragments.

The use-wear analysis revealed a broad spectrum of craft and subsistence activities. Trench 11 and trench 17 revealed several tools with clear traces from cereal harvesting. This further supported the notion that cereals were grown locally at the site, something that was previously suggested based on the presence of cereal pollen (Van Regteren Altena et al., 1963b, p. 54). Craft activities at the site were highly diverse, consisting of hide working, plant fibre processing (including nettle), bone, antler, horn, and wood working. The site can be seen as a prime example of a site with an extended broad spectrum economy, taking advantage of seasonally available wild resources, while simultaneously cultivating cereals and herding animals.

10

Zandwerven

The site of Zandwerven is selected for analysis mostly because it is the only site in West Frisia which has been classified as a VLC site on the basis of its ceramics. Because the site also contained CWC ceramics, it features prominently in discussions on the introduction of the CWC in the Netherlands (Beckerman, 2015; Kroon et al., 2019). Yet, these discussions are exclusively based on ceramic analyses. The lithics of the site have not been systematically analysed or inventoried.

10.1 Excavation and landscape setting

Zandwerven is located on a low dune in the salt marshes of West Frisia. It is one of the northernmost sites attributed to the VLC (Fig. 10.1). Other contemporary sites in the area are mainly attributed to the CWC (Beckerman, 2015, p. 241; Van Heeringen & Theunissen, 2001b).

The site was discovered in 1928 by J. Butter, after which the first campaign took place in 1929, led by Prof. Dr. A.E. van Giffen (Van Giffen, 1930). Two more campaigns were conducted in 1957–1958 and 1983–1985 respectively. The site represents the first Neolithic excavation in the coastal area of the Netherlands (Beckerman, 2015, p. 68). During the first campaign, four layers were identified, the upper layer did not contain finds, except for a possible hearth. The third layer was associated with CWC pottery, while the layers below contained typical VLC pottery (Van Regteren Altena, 1958, pp. 144–148).[28] During new campaigns in 1957 and 1958, ^{14}C dates were obtained, but unfortunately these were often taken from shell samples, which are unreliable due to a potential reservoir effect. Dates based on organic residues on pottery are similarly unreliable, unless residue analysis can establish the absence of marine influences (Van Heeringen & Theunissen, 2001a, p. 56; Van Regteren Altena et al., 1962a). Recent absorbed residue analysis conducted as part of the *Putting Life into Late Neolithic Houses project* indicated that fish was frequently cooked in VLC pots, further undermining the reliability of such dates (Kubiak-Martens et al., in prep.; Van Gijn et al., 2025, p. 31). Charcoal dates from layers I and IV, however, provide reliable absolute dates for the occupation (Fig. 10.2).

During the 1957 and 1958 campaigns only one layer was identified, which correlated with layer II and III found during the first campaign (Van Regteren Altena, 1958, p. 152; Van Regteren Altena et al., 1962a, p. 10). The final campaign consisted of a coring survey conducted between 1983 and 1985 (Van Iterson Scholten, 1984; 1988, p. 242).

10.2 Settlement type

Zandwerven is considered to be a permanently inhabited coastal dune site. However, it should be noted that the site is located on a low dune in the salt marshes, rather than on the main coastal barriers to the south (Amkreutz, 2013b, p. 397; Raemaekers, 2003,

28 Although the term Vlaardingen Culture was not invented until the excavations in the 1960's at Vlaardingen Arij Koplaan.

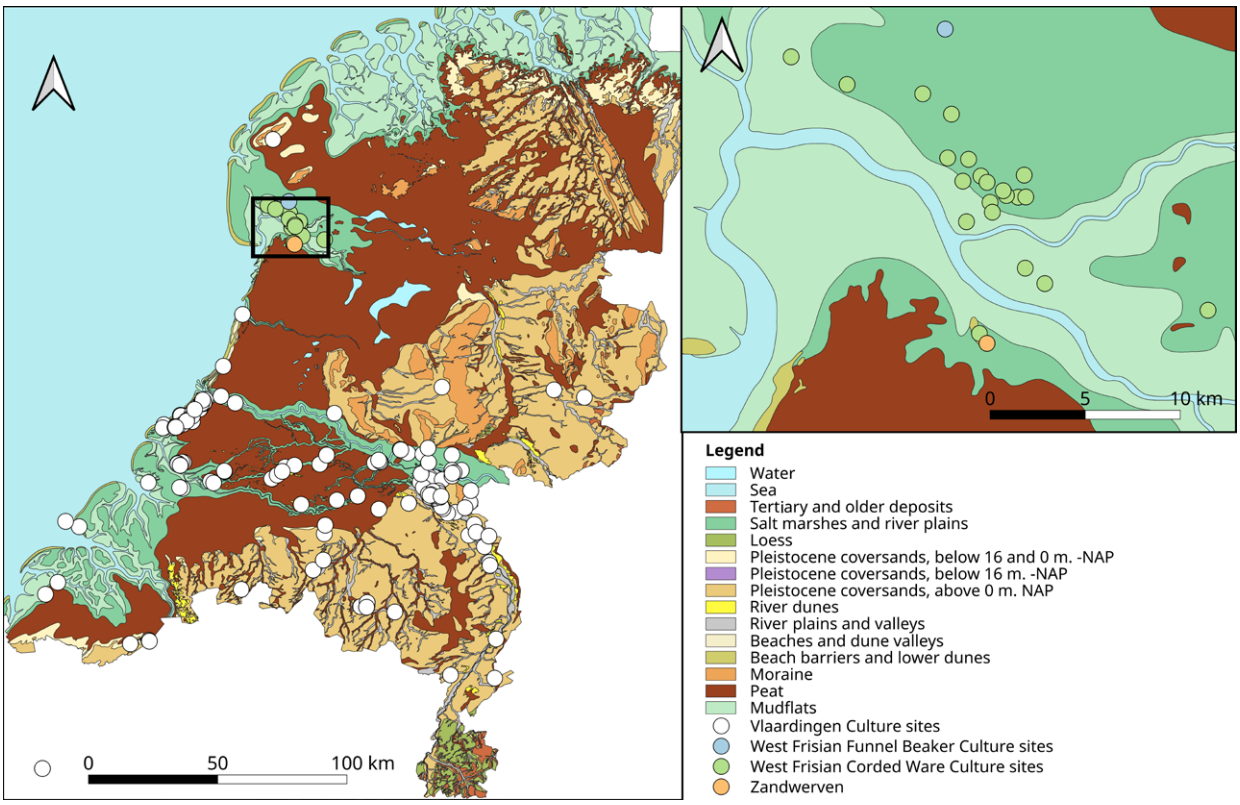


Figure 10.1 Location of Zandwerven plotted on the palaeogeographic map of the Netherlands ca. 2750 BCE. The map also includes other VLC sites and nearby CWC and FBC sites (after Van Heeringen & Theunissen, 2001b; Vos et al., 2020).

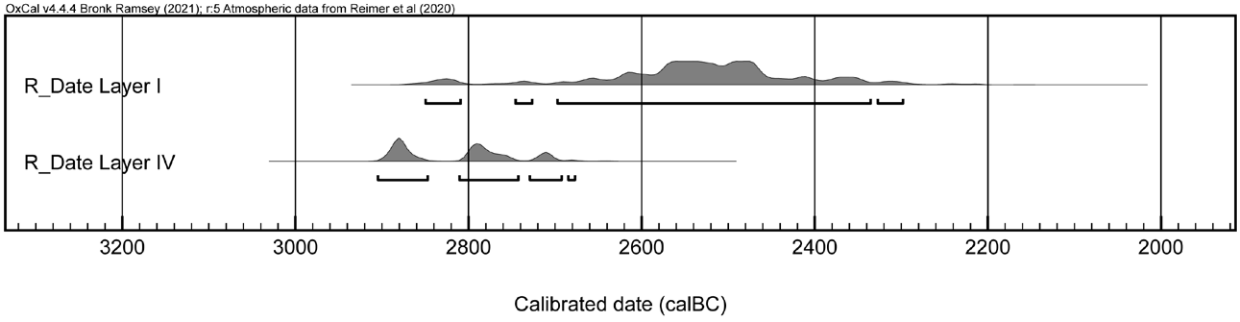


Figure 10.2 Zandwerven charcoal ^{14}C dates calibrated with the Intcal20 calibration curve (Bronk Ramsey, 2009; Reimer et al., 2020; Van Heeringen & Theunissen, 2001a, p. 56).

p. 744: also see Fig. 10.1). Based on the zooarchaeological data, it is suggested that the inhabitants heavily relied on cattle herding. Of the 48 mammal bones which could be identified to species level, 44 consist of cattle bones (Clason, 1962, p. 210). This, however, ignores the fact that these bones were found in shell middens of mussel and cockle shells. These layers furthermore contained "*numerous bones of small fish*" (Van Regteren Altena et al., 1962a, p. 10). Bird bones were generally not specified to a species level. Two remains were identified as those of a red-throated loon, other species include mallard, graylag goose and white-tailed eagle (Clason, 1967, p. 12; Van Regteren Altena et al., 1962a, p. 40). Although the importance of cattle, as opposed to hunting wild mammals, seems to stand, the importance of aquatic sources should not be underestimated. Unfortunately, due to the selective sampling, poor documentation, and the general lack of identified fish bones, it is impossible

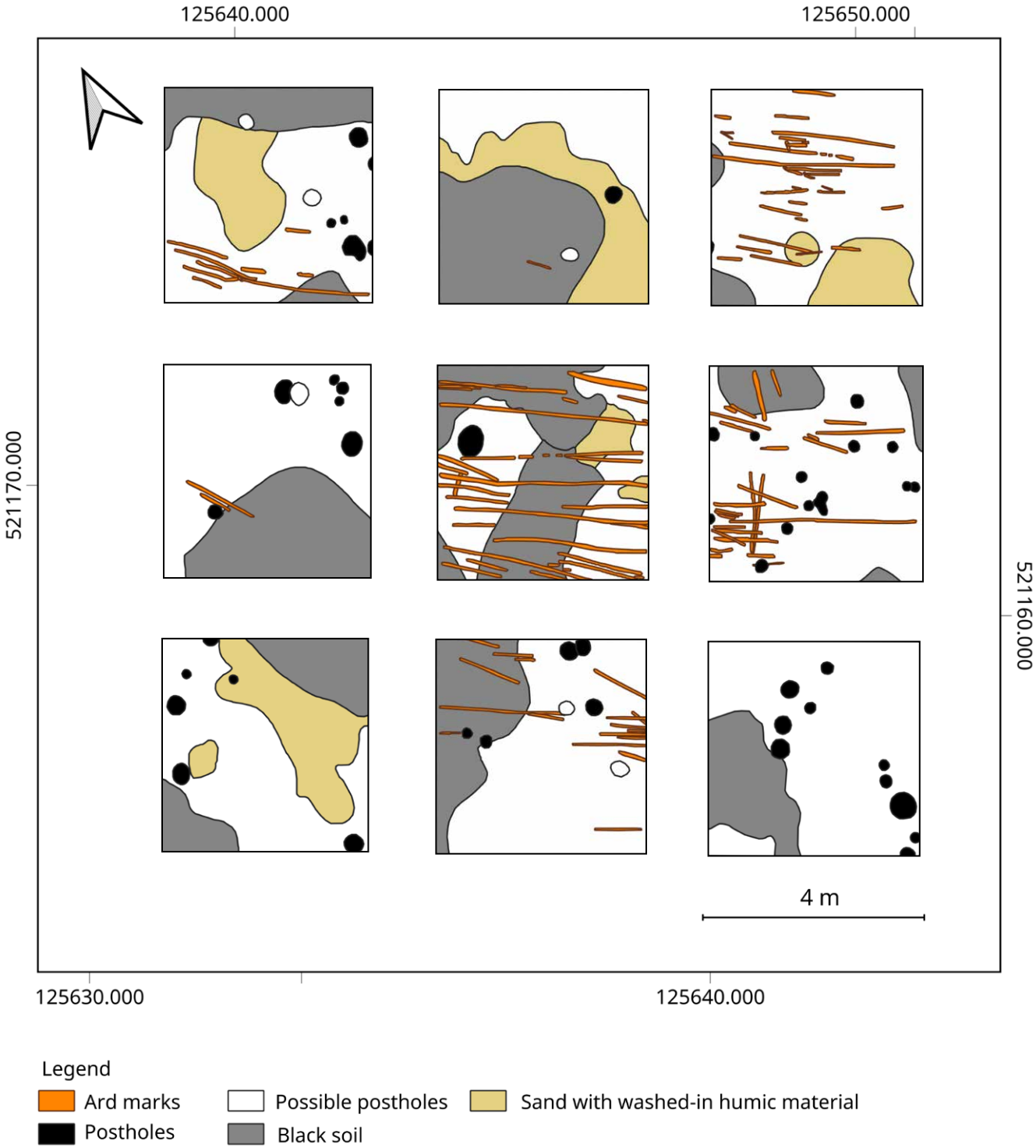


Figure 10.3 Ard marks and postholes exposed during the second campaign in the 1950s (after Van Iterson Scholten, 1988, p. 234).

Figure 10.4 Bone chisel made from the radius of a cow found at Zandwerven.

to properly assess the importance of fishing and shellfish collected at the site.

10.3 Features at the site and material selection

In terms of zooarchaeological remains, bones of cattle, sturgeon, pig, sheep/goat, and harbour porpoise were found (Clason, 1962, p. 210). Apart from the sturgeon remains, the fish bones have not yet been analysed. In addition to animal products, remains of cereals (*Hordeum vulgare var. nudum* and *Triticum diococcon*) were identified. In terms of collected wild plants, there is evidence for the collection of hazelnut (*Corylus avellana*) and dewberry (*Rubus caesius*). Ard marks at the site indicate that plants were locally cultivated (Fig. 10.3).

Pottery finds included both typical Vlaardingen pottery as well as CWC beaker pottery. The ceramics also include remains of ceramic baking plates. Part of a ceramic spoon was found as well. The ceramics are published extensively in previous studies (Beckerman, 2015; Kroon, 2016; Kroon et al., 2019).

Only one bone tool was found at the site, a chisel made from the radius of a cow (Fig. 10.4). As for lithics, the assemblage contained several scrapers and several axe fragments. The flint was reported to be of a northern origin, presumably collected at the moraine deposits on Wieringen or Texel. In terms of ground stone tools it is noteworthy that part of a battle axe and a 'polishing stone' were found (Van Iterson Scholten, 1984, p. 213; Van Regteren Altena et al., 1962a, p. 13).

English name	Species	Part	Quantity
Emmer wheat	*cf. Triticum turgidum ssp. dicoccon*	Cereal grain	2
Cereal indet	*Cerealia*	Cereal grain (fragment)	5
Hazel	*Corylus avellana*	Nutshell	30
Alder/hazel	*Alnus/Corylus*	Charcoal	1
Birch	*cf. Betula*	Charcoal	1
Indet	Indet	Charcoal	40
Total			79

Table 10.1 Botanical remains from the shell sample (identified by S. Reurings).

Taxa			NISP	%	Burnt bones	% Burnt
Osteichthyes	Anguillidae	*Anguilla anguilla*	55	30	0	0
	Cyprinidae		15	8	9	21
	Pleuronectidae		16	8	1	2
	Undetermined		64	36	20	48
Amphibia			11	6	3	7
Aves			21	12	9	21
Total			182	100	42	100

Table 10.2 Non-mammalian bone assemblage from the shell sample of Zandwerven (identifications by L. Llorente Rodriguez).

The entire assemblage was studied, as it only consisted of 115 flint artefacts. However, it is clear that the assemblage, which is available, is incomplete. Previous publications mentioned polished axe fragments, which are completely absent in the available material (Van Iterson Scholten, 1984, p. 213; Van Regteren Altena et al., 1962a, p. 13). For the use-wear analysis all retouched tools were selected. In addition, all artefacts with macroscopically visible wear traces, points, and/or edges with a straight cross-section >1 cm were selected. The selection criteria were based on the criteria proposed, and applied, by Van Gijn for the assemblage of Hekelingen III (Van Gijn, 1990b, p. 104).

10.4 Sieved shell sample

Although botanical and archaeozoological studies were conducted during the initial investigation of the site, not all remains were systematically studied. One bag with a sieved shell sample was not analysed. The bag mostly contains highly fragmented shells, mainly cockles and mussels. However, the bag also contains charcoal, burnt seeds, small fragments of flint, ceramics, and animal bones. The flint from this bag is included in the present study. The archaeobotanical remains were analysed by S. Reurings for the purpose of the present study. The non-mammalian bones from the shell sample were analysed by L. Llorente Rodriguez.

10.4.1 Botanical remains from the shell sample

The analyses of the botanical remains confirmed previous observations. Several cereal grains of emmer wheat (*Triticum diococcon*) were found (Tab. 10.1 and Fig. 10.5), as well as many fragments of hazelnut (*Corylus avellana*). These species were also noted in earlier studies (Van Zeist, 1968, p. 59). The results thus do not present new information regarding the use of edible plants.

It is assumed that firewood was collected near the site, so the analysis of charcoal fragments can provide insights into the landscape setting. Birch (*Betula sp.*), hazel (*Corylus avellana*), and alder or hazel (*Alnus/Corylus*) are identified. These finds are comparable to those from the nearby CWC sites of Mienakker, Keinsmerbrug, and Zeewijk (Brinkkemper & van den Hof, 2014; Kubiak-Martens, 2012; Van den Hof & Brinkkemper, 2013). In terms of landscape setting, birch can be seen as an indication of fairly wet conditions, influenced by fresh water. Hazel potentially grew on the drier areas in the landscape (Brinkkemper & van den Hof, 2014; Kubiak-Martens, 2012, p. 87; Van den Hof & Brinkkemper, 2013, p. 150).

10.4.2 Fish bones from the shell sample

The shell sample contains a total of 182 non-mammalian bones and bone fragments (Tab. 10.2). While the mammal bones were previously classified by Clason, the non-mammalian bones had not yet been studied systematically (Clason, 1962). The majority of the bones in the shell

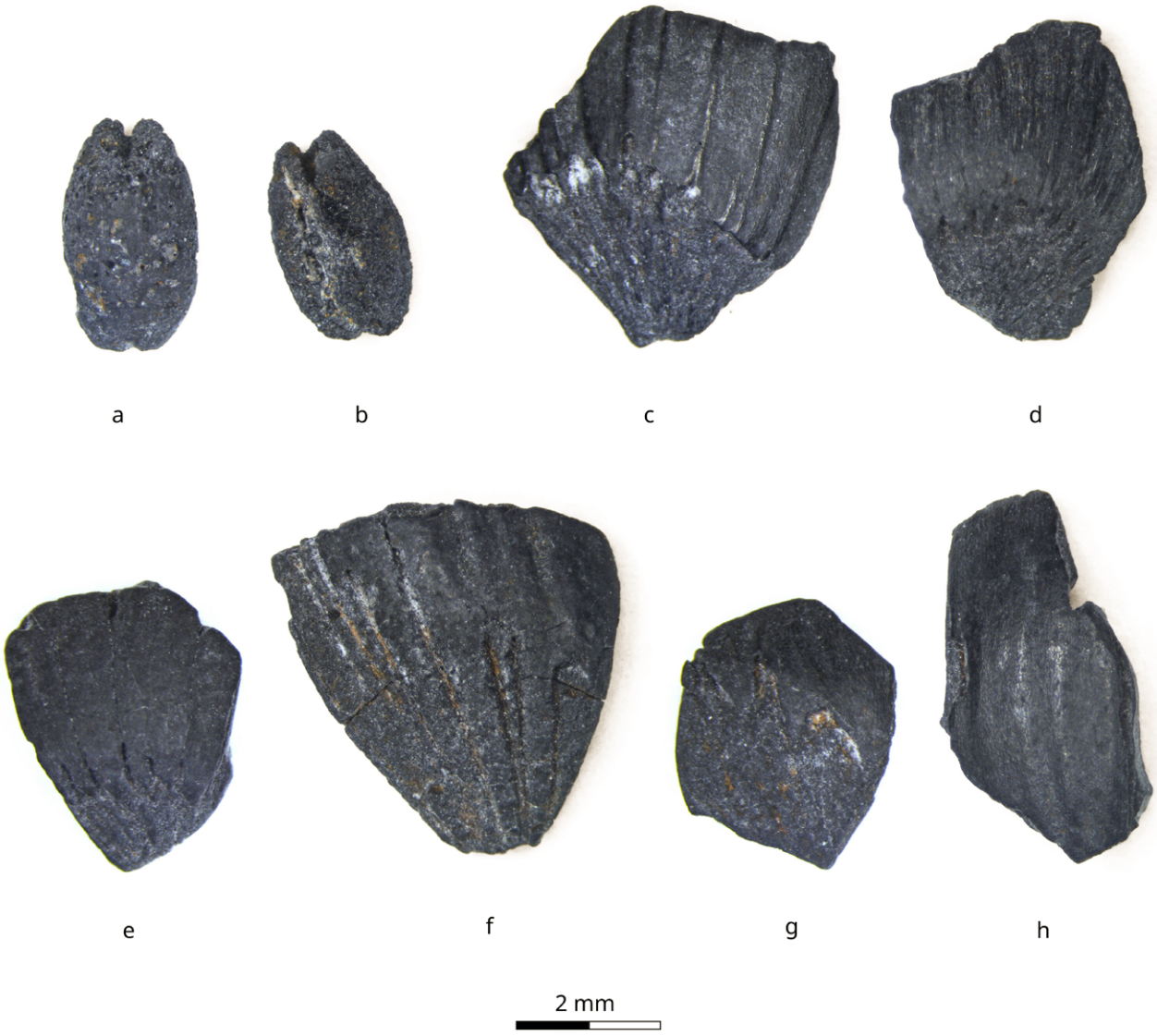


Figure 10.5 Macrobotanical remains from the shell sample of Zandwerven: a and b) charred emmer grains (cf. Triticum turgidum ssp. dicoccon); c-h) charred hazelnut shell fragments (Corylus avellana) (identified by S. Reurings).

sample consist of fish remains, a few of them can be attributed to amphibians and birds of which the species could not be specified.

Unfortunately, it could not be determined whether the taxa identified consisted of background fauna or whether they should be interpreted as being related to subsistence strategies at the site (personal communication L. Llorente Rodriguez, 2025). The fish remains were generally very small, which might indicate that they are in fact background fauna rather than consumption waste (Fig. 10.6).

10.5 Preservation

The lithic assemblage is poorly preserved. Of the total assemblage, 37 artefacts are patinated and eleven artefacts are possibly patinated. Furthermore, thirty artefacts are burnt, while four artefacts are possibly burnt (Tab. 10.3). During the use-wear analysis, it became apparent that many of the seemingly well-preserved pieces were in fact heavily affected by post-depositional processes.

10.6 Procurement

Flint procurement at Zandwerven was geared towards the exploitation of locally available sources (Tab. 10.4 and Fig. 10.7). Nearly all flint could have been collected from nearby moraine deposits of Wieringen and Texel. The only exception is two Meuse-eggs which were likely either collected (or obtained through exchange) from the deposits at the Utrechtse Heuvelrug or the Meuse

Figure 10.6 Fish vertebrae caudales from the shell sample: a) eel (Anuilla anguilla); b) plaice family (Pleuronectidae); c) carp family (Cyprinidae) (identifications by L. Llorente Rodriguez).

Table 10.3 Flint preservation at Zandwerven.

	Burnt	Unburnt	Indet	Patinated	Unpatinated	Indet
Number of artefacts	30	81	4	37	67	11
Percentages	26.1%	70.4%	3.5%	32.2%	58.3%	9.6%

Table 10.4 Lithic raw materials at Zandwerven.

Raw material	Number of artefacts	Percentage
Eluvial flint	1	1%
Meuse-eggs	2	2%
Moraine flint	21	18%
Northern bryozoan flint	19	17%
Northern flint indet	1	1%
Rolled pebble indet	8	7%
Unknown	63	55%
Total	115	100%

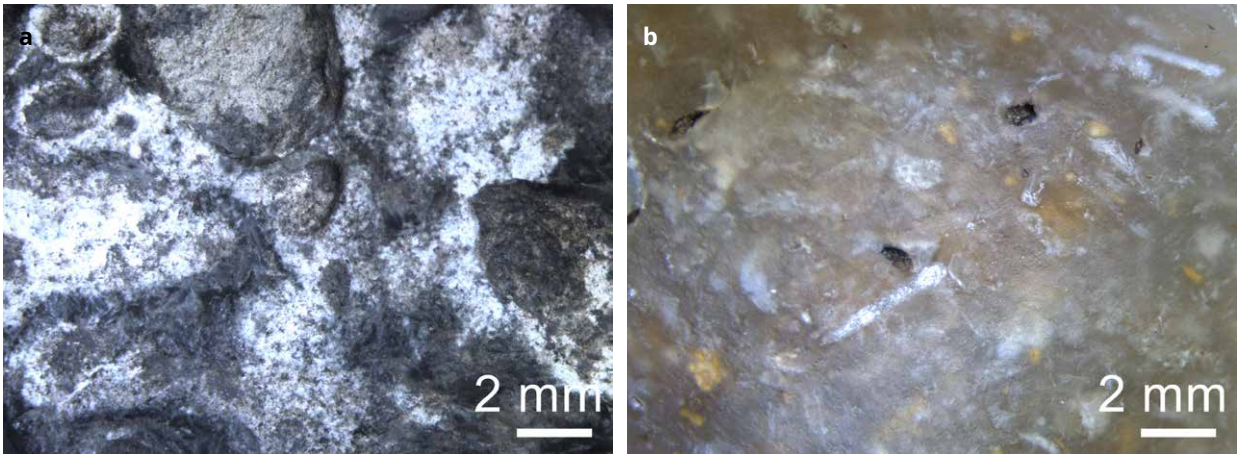


Figure 10.7 Raw materials at Zandwerven a) moraine flint cortex (66-II.3); b) northern bryozoan rich flint (16.1).

Percussion type	Number	Percentage
Hard hammer percussion	32	49%
Soft stone hammer	6	9%
Soft percussion indet	1	2%
Indet	26	40%
Total	65	100%

Table 10.5 Percussion types at Zandwerven.

Termination	Number	Percentage
Broken	1	2%
Feather	8	14%
Hinge	7	12%
Plunging	3	5%
Indet	39	67%
Total	58	100%

Table 10.6 Flake terminations at Zandwerven.

Typology	Amount
Blade unmodified	3
Borer	1
Flake core unmodified	9
Flake unmodified	29
Hammerstone	1
Potlid	3
Retouched blade	1
Retouched core	1
Retouched flake	8
Retouched waste	2
Scraper	20
Strike-a-light	1
Unmodified flint nodule	8
Waste	28
Total	115

Table 10.7 Flint typology at Zandwerven.

terraces.[29] The site contrasts sharply with the VLC sites in Zuid-Holland, where southern flint abounds (Van Gijn, 2010b, pp. 82–83; also see chapter 6–9). The raw material procurement strategies at the site fit well with those of the nearby CWC sites, such as Keinsmerbrug and Zeewijk (García-Díaz, 2012, p. 79; 2014, p. 88).

10.7 Technology

Flint was mainly worked using hard hammer percussion. Soft stone percussion was also used (Tab. 10.5). In seven instances bipolar flaking was applied, a technique frequently observed both in the CWC settlements in the area, as well as on other VLC sites (García-Díaz, 2017, p. 215; Van Gijn, 2010b, p. 83). Flint technology was geared towards flake production (N=57). Blades (N=4) are scarce and the blades in the assemblage do not appear to be

29 The two Meuse-eggs, one of which was a hammerstone were originally included in the non-flint stone bags. They were however identified by Aaron Westra and Annemieke Verbaas during the analysis of the non-flint stone, after which they were incorporated into the present study.

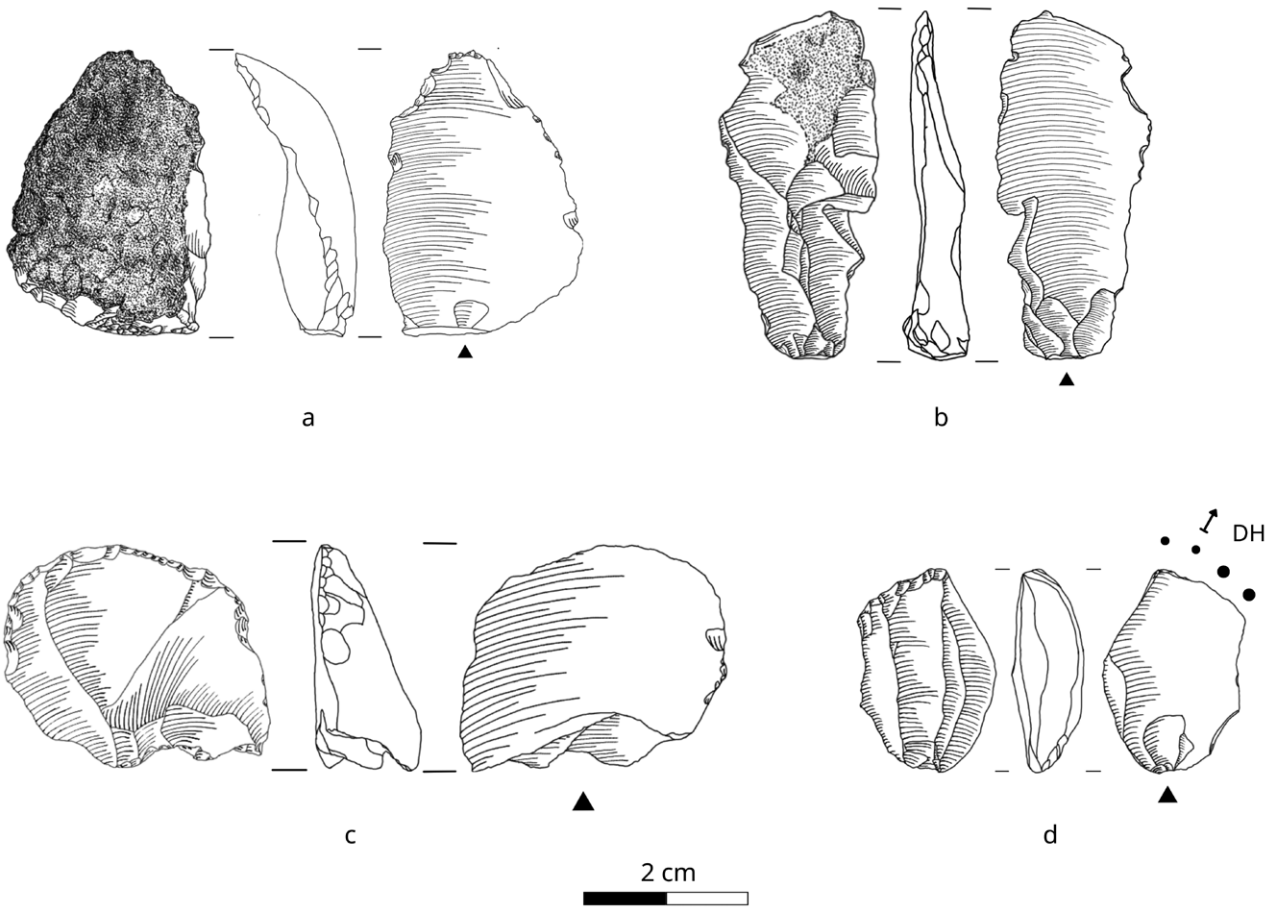


Figure 10.8 Drawings of flint artefacts from Zandwerven, a) cortical flake (6.2); b) unmodified blade (ZW46/J.1); c) scraper (66J.1); d) scraper used to scrape dry hide (FX/XI.2).

systematically produced. On the dorsal sides they have flake negatives rather than parallel ridges. These should therefore be seen as elongated flakes, rather than as actual blades (Fig. 10.8b; 10.9g). All cores (N=10) are flake cores with flake negatives, evidence for blade production is thus absent.

In terms of flake terminations hinge (N=7) and plunging (N=3) types occur more frequently than feather (N=8) terminations (Tab. 10.6). This indicates a low degree of skill, consistent with that of non-specialised knappers (Shelley, 1990).

10.8 Typology

Typologically, the site displayed limited variability; the assemblage is dominated by unmodified flakes (N=29) and waste (N=28). Formal tools mainly consist of scrapers (Tab. 10.7; Fig. 10.8c and d). Other tool types included retouched flakes, blades, a borer, and a strike-a-light fragment (Tab. 10.7; Fig. 10.9). It is notable that arrowheads were absent.[30] This supported the notion that hunting was not an important activity on the site. Ground and polished axe fragments were absent, even though these were mentioned in an earlier publication (Van Regteren Altena & Bakker, 1961, p. 35). This is unfortunate, as axe fragments from VLC sites are usually of a southern origin (Van Gijn, 2010b, p. 83). It would have been interesting to know whether the presence of axe fragments at the site indicated southern connections, or if these are northern imports, or potentially even locally produced axes. It seems that these finds were lost.

10.9 Results of the use-wear analyses

The flint assemblage is poorly preserved, which heavily affected the results of the use-wear study. Of the 59 artefacts selected for analysis, only 17 displayed interpretable use-wear traces (Tab. 10.8 and 10.9).

30 Although bone and antler tools, or even 'ad hoc' flint flakes as was the case in Hekelingen III, could have been used as projectiles as well (Van Gijn, 1990).

Interpretation	Number of artefacts
Use-wear traces	17
Not interpretable	37
No use-wear traces	5
Total	59

Table 10.8 Interpretability of use-wear traces at Zandwerven.

	Unsure	Boring	Graving	Hafting	Pounding	Scraping	Wedging	Total
Animal								
Bone	-	-	1	-	-	-	-	1
Dry hide	-	-	-	-	-	4	-	4
Hide indet	-	-	-	-	-	6	-	6
Plant								
Plant indet	1	1	-	-	-	-	-	2
Inorganic								
Pottery	1	-	-	-	-	-	-	1
Pyrite	-	-	-	-	1	-	-	1
Unknown material								
Hard material	-	1	-	1	2	-	1	5
Total	2	2	1	1	3	10	1	20

Table 10.9 Crosstab of use-wear contact materials (x) and motions (y).

In total 20 used areas were found on 17 tools. Three tools displayed two AUAs, one of which was a borer which was used to drill unknown plant material. The sides of this tool were used to work plant material in an unknown motion. The second was a hammerstone which was used on two sides[31]. The last one was a scraper used to scrape hide, hafted in an unknown type of hard material.

Because of the limited amount of AUAs, it is unclear to what extent the use-wear results provide a representative reflection of the activities conducted at the site. Furthermore, the assemblage is incomplete, which possibly created a bias. It is likely that, especially during the first campaign by Van Giffen, not all flint was systematically collected, favouring formal tool types such as scrapers and borers. It is thus unclear whether the high percentage of scrapers (17.4%) and the high percentage of hide working traces (50%) at the site reflect an actual prominence of hide working. If that would be the case, the assemblage would closely resemble that from Den Haag Steynhof.

Besides hide working, there is evidence for plant working, fire-making, bone working, and pottery making (Fig. 10.9 and 10.10). Although the motion for the pottery working tool could not be established, it seems likely that the tool was used to decorate leather hard pottery. The tool has a very rounded protrusion on the side of a retouched flake. It is possible that the tool was used to create decorations in the CWC style pottery found at the site. Fire-making traces were found on a small fragment of a strike-a-light (Fig. 10.9b and 10.10e). The hammerstone was likely used for flintknapping.

10.10 Discussion and conclusion

In terms of raw material procurement, the site is atypical for VLC sites, but it fits well with other Late Neolithic CWC sites from West Frisia such as Mienakker, Keinsmerbrug, and Zeewijk (García-Díaz, 2012; 2013; 2014; 2017). In terms of technology, typology, and use of the artefacts, the site bears much resemblance to both the local CWC sites, as well as other VLC sites. Because of the poor preservation, and the presumed biased sampling strategies, the present study provides limited indications for the function of the site. Nevertheless, the ard marks which indicate local crop cultivation, favour the interpretation that the site was permanently inhabited.

31 The hammerstone was originally included in the selection for non-flint stone tools, which are analysed by Aaron Westra and Annemieke Verbaas. The analysis for this tool was therefore originally conducted by A. Westra as part of his RMA thesis.

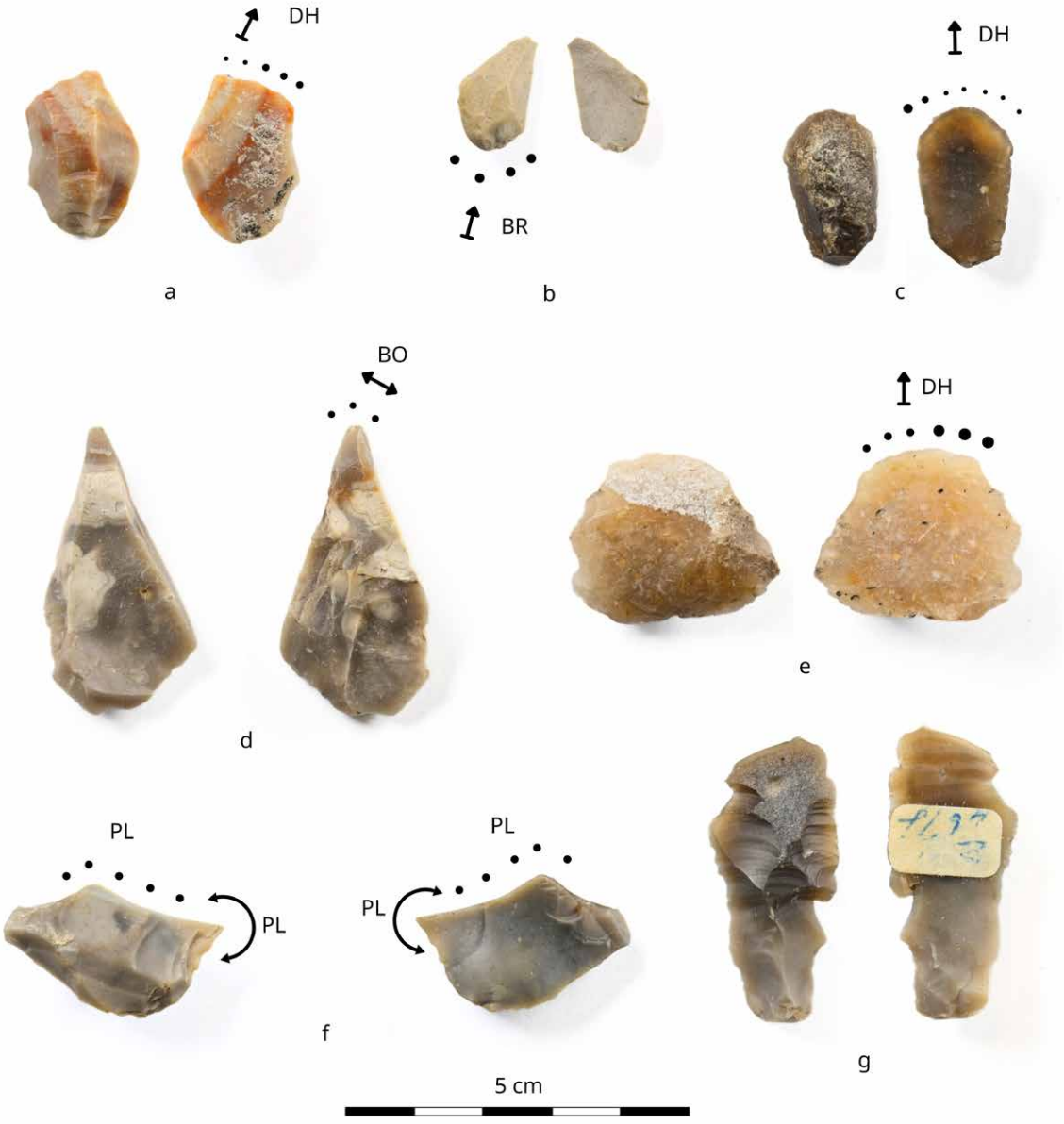


Figure 10.9 Flint tools at Zandwerven: a) scraper used to scrape dry hide (FX/XI.2); b) fragment of a strike-a-light used on pyrite (66/II.15); c) scraper used to scrape dry hide (46.1); d) retouched waste used for graving bone (79.7); e) scraper used to scrape dry hide (16.1); f) borer used for perforating plant and for working plant in an unknown motion (LV.2); g) unmodified blade, use-wear traces were not interpretable because the surface was heavily affected by PDSM (ZW46/J.1).

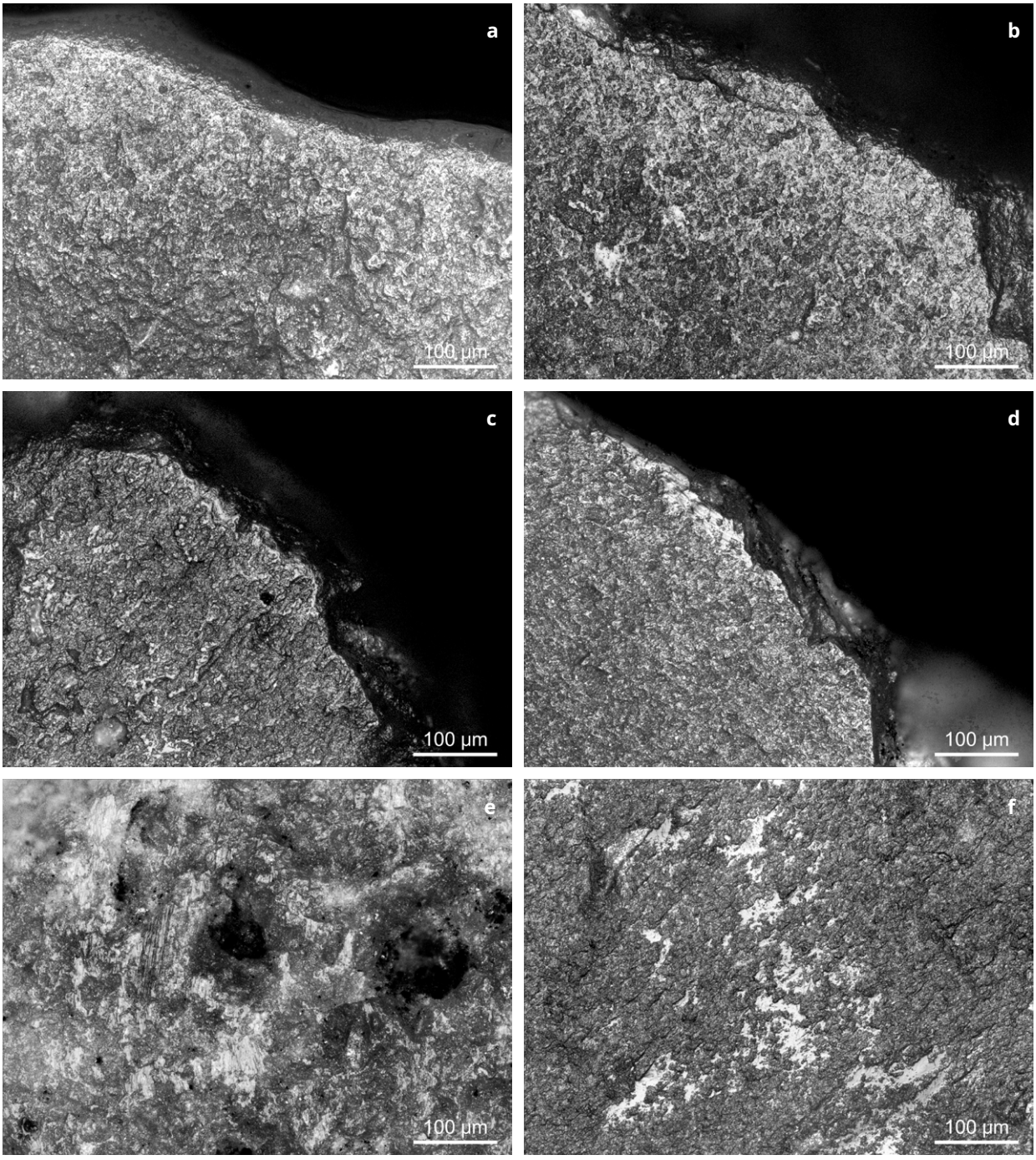


Figure 10.10 Use-wear traces on flint from Zandwerven, a and b) dry hide scraping traces (16.1 & FK-XI.2); c) plant drilling traces (L.V.2); d) bone graving traces (79.7); e) pyrite scraping traces (66-II.15); f) friction gloss, traces from hafting in an unknown hard material (79.4).

Part III. Cooking. Visualisation by Kelvin Wilson.

PART III

LIVING WITH FLINT IN THE RHINE-MEUSE DELTA

11

Networking and sourcing during the Vlaardingen Culture period

This study has resulted in a large amount of data on the origin of the flint used by Vlaardingen Culture communities in the Rhine-Meuse delta. These data make it possible to reconstruct biographies for 'artefact populations' (Hägerstrand 1974b, 272–5 in: Carlstein, 1982). Studying these artefact populations provides information about the mobility of groups, and the extent of the exchange networks of which these communities were part. This chapter focuses on how and where people obtained their raw materials. It also addresses how exotic flint, imported from far away, was appropriated and incorporated into the local technological system (Van Gijn, 2008, 2015). Because raw material acquisition is not an isolated phenomenon, I will also address how the acquisition of flint is embedded in wider taskscapes.

11.1 Diversity in sources

The raw material data for the four case studies are mapped in a network visualisation (Fig. 11.1). The map shows the overall strong southern focus of VLC raw material procurement strategies. The network demonstrates the rather isolated nature of Zandwerven, where mostly local moraine flint was used. The other three sites not only have strong southern connections, but they also clearly focus on obtaining high-quality material such as Hesbaye flint.

In addition to the four case studies, quantitative information on the use of lithic raw materials was available for 28 VLC sites. Unfortunately, a number of these consist of palimpsests with earlier and later periods. In seven instances the assemblages were small (fewer than 50 artefacts), which hampered a quantitative assessment of raw material use. Four sites had to be excluded because of inconsistencies in the data.[32] Excluding these sites, an overview is available for fourteen sites for which usable quantitative data exists (Tab. 11.1). Smaller and vaguely defined groups were added to the other/indet category.

32 For the site Voorschoten De Donk, it is unclear how much of the flint should be attributed to the Hesbaye group (Van Veen, 1989, p. 27). A similar problem can be observed for the sites Veldhoven Habraken and Rotterdam Beverwaard, where it is unclear how much of the flint belongs to the group terrace flint (Devriendt, 2013b, p. 111; Zijl et al., 2011, p. 48). One of the sites, Leidschendam Berberis, has furthermore been excluded (Veldhuis, 2020). There was significant disagreement between specialists regarding the raw material identifications in the report. According to R. Houkes, who made the drawings for the lithics from Leidschendam Berberis, several of the identifications require a second opinion. He has doubts about the dominance of northern flint at site, which would be atypical for VLC sites in the region. Furthermore, the half flint axe which was described in the publication as Lousberg flint should according to Houkes be interpreted as Hesbaye flint (personal communication R. Houkes 12-06-2025). Having seen the photographs made by R. Houkes of the axe, I agree that this is not a Lousberg axe but a classical (but patinated) Hesbaye axe.

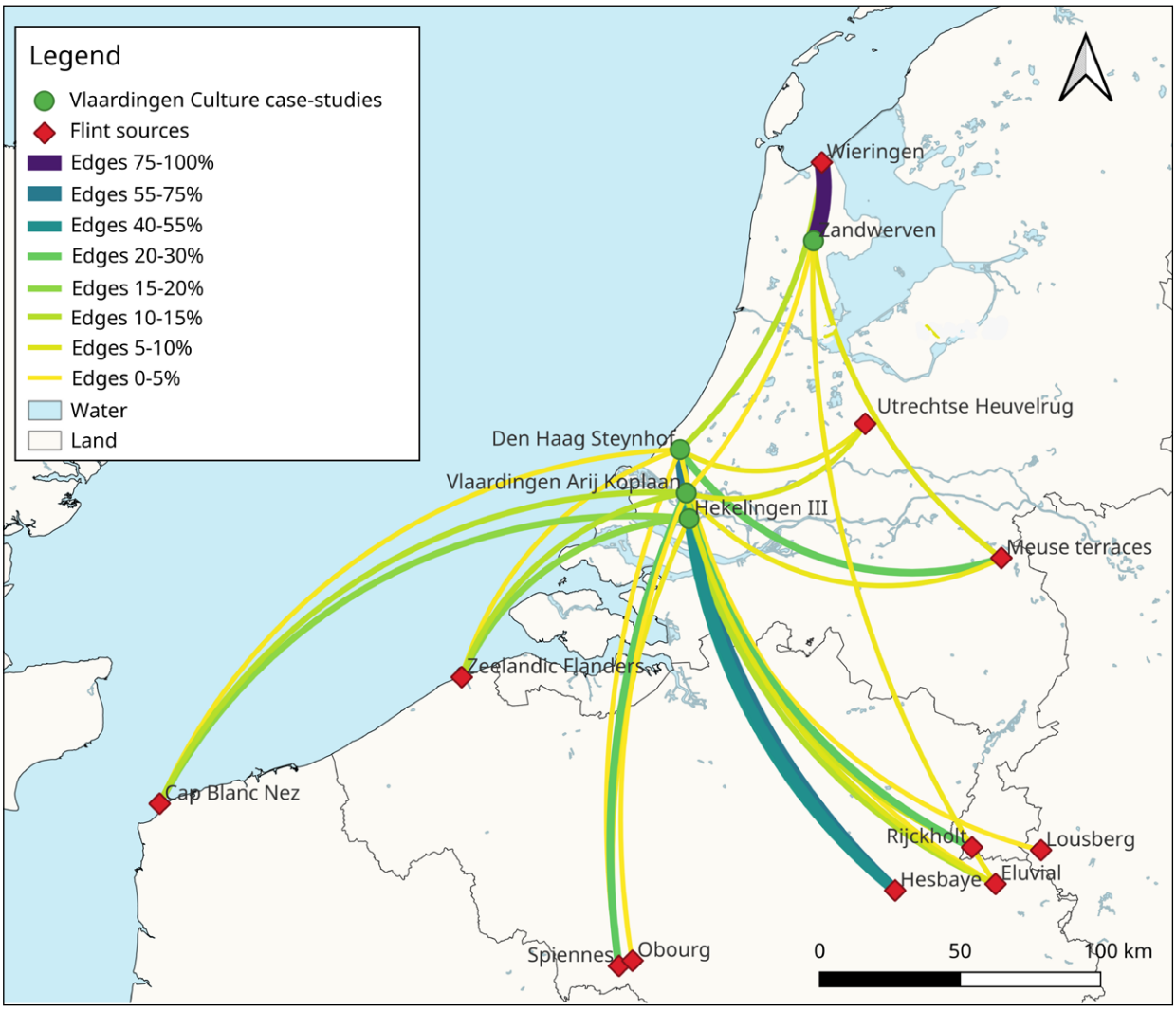


Figure 11.1 Network visualisation of the raw material distribution for the four case studies; edges are visualised in percentages. For Cap Blanc Nez flint it is unclear whether this comes from Cap Blanc Nez or Zeelandic Flanders, for both regions edges are visualised based on the percentages of Cap Blanc Nez flint. The Utrechtse Heuvelrug is plotted as source area for terrace flint, but it should be noted that this could also be collected further east. For Spiennes and Lanaye/Rijckholt a distinction was made using ED-XRF analysis, based on the phosphorus concentrations (Van den Dikkenberg & Braekmans, 2025; basemap: © EuroGeographics 2024, map made in QGIS).

Lousberg and Valkenburg flint were included individually, because their scarcity on these VLC sites is noteworthy. These types of flint are commonly found in the Limburg area (associated with the Stein group). As such, the contrast between the Vlaardingen and Stein areas is remarkable (Louwe Kooijmans, 1983; Verhart, 2010b). The differences between these groups do not necessarily result from a lack of contact between these communities. Based on the frequent presence of Rijckholt flint at VLC sites we can conclude that these groups maintained regular contacts (Van den Dikkenberg & Braekmans, 2025). Although this flint cannot easily be distinguished from Spiennes flint, the chemical analysis of the Lanaye/Spiennes material from Hekelingen III, Vlaardingen trench 15 and 17, Den Haag Steynhof, and Den Haag Wateringse Binnentuinen demonstrated that both Spiennes and Rijckholt/Lanaye flint are present on all four sites (Van den Dikkenberg & Braekmans, 2025).

From the network graph it becomes apparent that seven types of flint have a central position within the network: Hesbaye flint, Lanaye/Spiennes flint, eluvial flint, Meuse-eggs, terrace flint, Cap Blanc Nez/French flint, and northern/moraine flint (Fig. 11.2). These flint types often co-occur at VLC sites. Terrace flint is especially prominent on sites in the Nijmegen area. Meuse-eggs, by contrast, seem to be most important on coastal dune sites, confirming earlier observations on the topic (Amkreutz, 2010; 2013b; Van Gijn, 2010b). Northern flint is generally absent on

Site	Hesbaye	Lanaye/ Spiennes	Eluvial	Meuse-egg	Terrace flint	Moraine/ northern	Cap Blanc Nez/ French	Lousberg	Valkenburg	Obourg/ Zevenwegen	Other/ indet
Beuningen Ewijk Hekkeslag	18	13	0	0	0	17	0	3	0	2	12
Beuningen Ewijkse Veld	130	2	219	4	88	0	64	0	4	0	715
Den Haag Noordweg 76	1	1	2	7	0	0	0	0	0	0	59
Den Haag Rhyenhof	101	15	0	24	4	2	7	0	0	2	2899
Den Haag Steynhof	211	6	3	83	11	37	4	0	0	0	1980
Den Haag Wateringse Binnentuinen	17	5	501	27	1	0	1	0	0	1	2831
Haamstede Brabers	55	0	0	372	0	0	0	0	0	0	163
Hekelingen III	94	47	22	0	0	0	33	1	0	0	145
Hellevoetsluis Ossenhoek	20	136	26	36	24	0	8	1	0	0	2572
Leyweg Volkstuinen	2	0	0	10	0	1	0	0	0	0	53
Nijmegen Noord. Project Ngk8	0	1	0	0	36	0	0	0	0	0	10
Vlaardingen trench 15	102	50	8	4	9	1	18	0	0	0	256
Vlaardingen trench 17	23	11	5	3	4	0	4	0	0	1	67
Wijchen Oosterweg	2	4	0	3	113	1	0	0	0	0	215
Zandwerven	0	0	1	2	0	41	0	0	0	0	71

Table 11.1 Flint sources for VLC sites for which quantitative data is available (Asmussen & Moree, 1987; De Koning et al., 2010; Drenth, 2019; Van Hoof & Metaxas, 2009; Houkes, 2014; 2021b; 2023; Houkes et al., 2017; Van de Korft, 2019; Van Zoolingen, 2018; Verhart, 1992).

levee sites except for a single artefact from Vlaardingen trench 15. It is, however, the dominant type of flint found at Zandwerven.

The dominance of northern flint types is a common feature on contemporary West Frisian sites attributed to the CWC (García-Díaz, 2017; Van Iterson Scholten, 1981). In Figure 11.3 the CWC sites of Mienakker, Keinsmerbrug, and Zeewijk are included in the network graph. It can be observed that Zandwerven has more in common with these West Frisian CWC sites than with other VLC sites (García-Díaz, 2017; Peeters, 2001; and based on the original databases by García-Díaz). These sites are located to the north, and it is tempting to attribute their isolated position within the network to the geographical distance between these sites and the flint mining centres to the south. However, at Zeewijk and Mienakker southern flint is not necessarily absent. At Zeewijk Hesbaye, Rullen, and Valkenburg flint are present, though extremely scarce. At Mienakker one piece of Rijckholt flint was found. Furthermore, at both Zeewijk and Mienakker Grand-Pressigny flint was found. The difference between these CWC sites and Vlaardingen sites represents a quantitative difference in which these West Frisian sites heavily depend on locally procured northern flint, while southern VLC sites depend on a wider range of predominantly southern sources, notably on Hesbaye, Lanaye/Spiennes, Meuse-eggs, eluvial flint, terrace flint, and Cap Blanc Nez/French flint. In terms of procurement strategies, we observe two distinct communities of practice. Those of the West Frisian sites are geared towards the exploitation of locally available, low-quality, flint sources. Exotic flint is not a significant component in these assemblages. Its significance lies more in the social/ritual sphere than in the economic domain. This is especially the case with Grand-Pressigny (GP) flint. Use-wear analysis on GP-daggers revealed that these were not used for practical daily-life tasks. The main wear traces observed on complete GP-daggers relate to the daggers being taken in and out of sheaths made from plant material. They were not included in the local technological system, but they served as objects meant for display on special occasions (Van Gijn, 2010a, pp. 145–148; Wentink, 2020, pp. 98–100). It should be noted that complete GP daggers are only known from barrow contexts in the eastern Netherlands. However, broken dagger fragments occasionally ended up in settlement contexts in West Frisia (García-Díaz, 2017; Van Gijn, 2010a; Van Heeringen & Theunissen, 2001a; Wentink, 2020). In these cases, it seems likely that the daggers were reused and recycled, much in the same way as we see with flint axes at VLC settlements (Van den Dikkenberg et al., 2024a; Van Gijn, 2010a, p. 145).

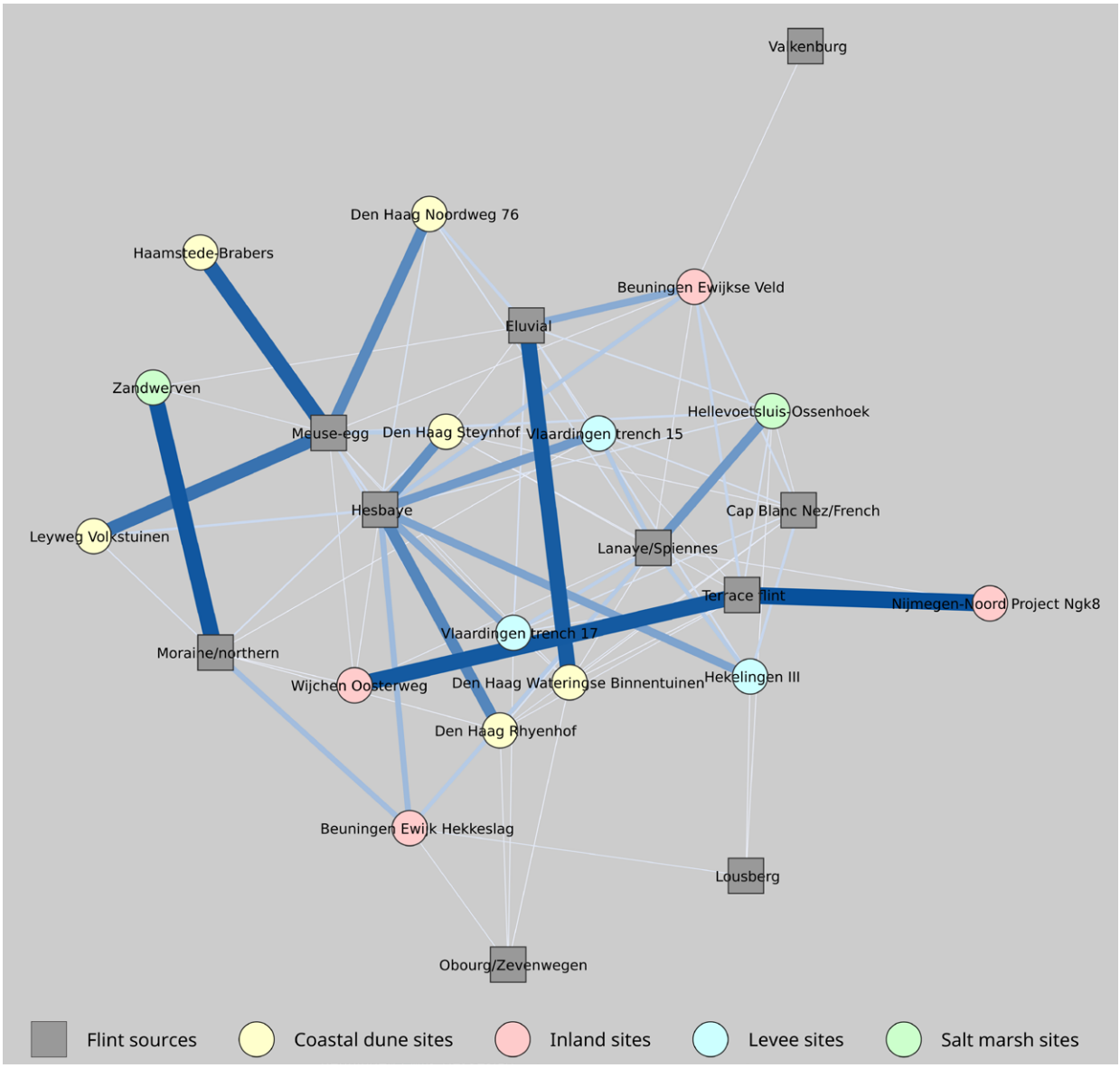


Figure 11.2 Network representation of different flint sources in percentages (squares), excluding other/indet. VLC sites are plotted by landscape zone (circles). The links are ranked by weight, visualised in stress minimisation layout (based on Tab. 11.1).

Nevertheless, compared to the recycling of flint axes in the VLC period, the recycling of GP daggers appears to be of minor significance in the technological system of these coastal CWC communities.

In addition to sites where quantitative data were available, it is worthwhile discussing several other VLC sites. It is interesting to note that at Leidschendam Prinsenhof the majority of the flint consisted of small rolled pebbles (Van Gijn, 1990b, p. 134). A similar pattern is observed at Voorschoten De Donk where the majority of flint artefacts are derived from Meuse-eggs (Van Veen, 1989, pp. 26–27). The rolled pebbles frequently found on coastal dune sites were previously assumed to be of a local origin. It was believed that such flint nodules could be collected on the beach, as they can nowadays (Houkes & Verbaas, 2014, p. 264; Houkes et al., 2017, p. 172; Van Gijn, 1990a, p. 85; 2010b, p. 82; Van Hoof & Metaxas, 2009, p. 82; Verhart, 1992, p. 80). However, recent insights by Houkes cast doubt on this supposed locally sourced 'coastal flint'. The flint that can nowadays be collected on

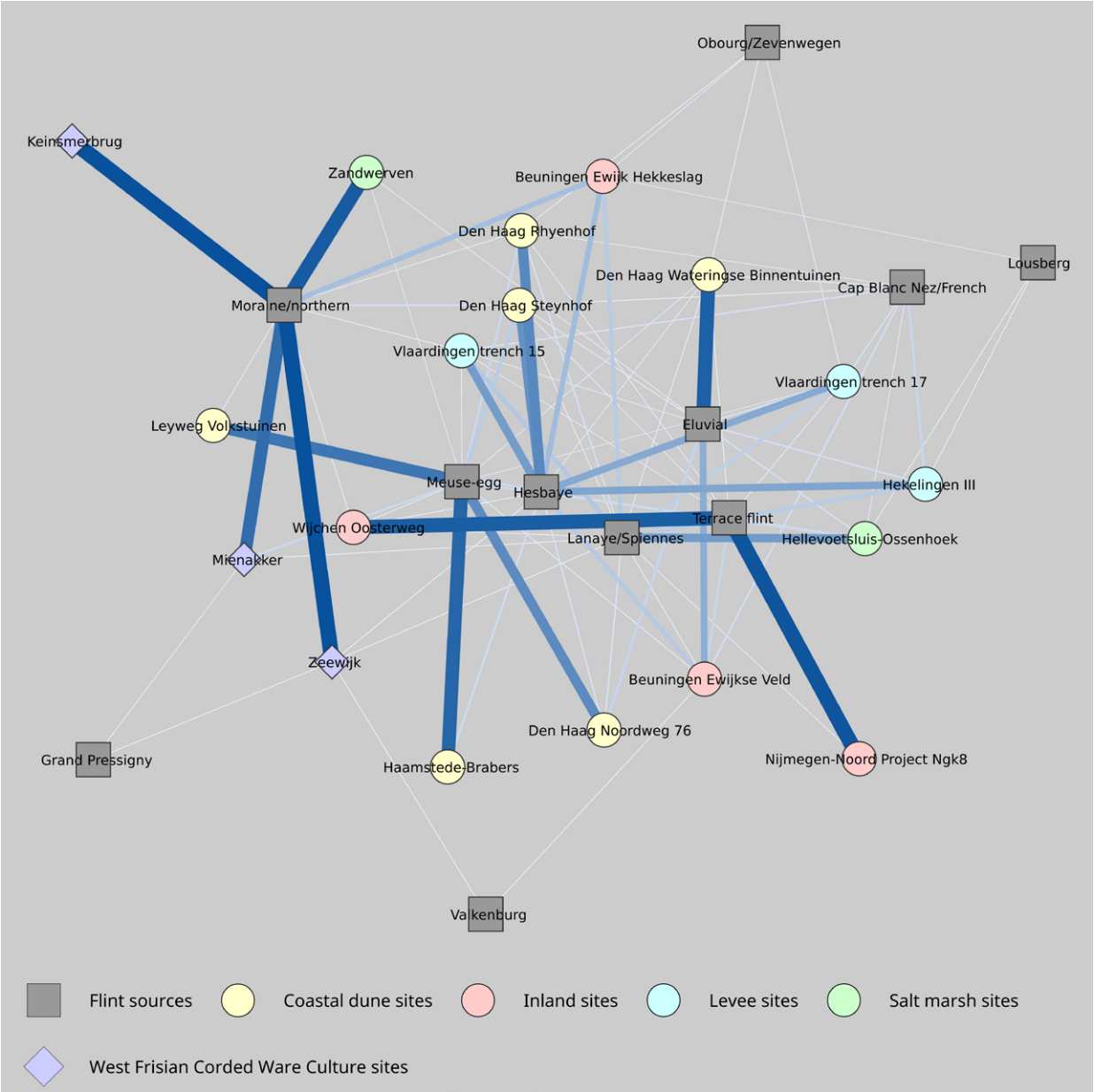


Figure 11.3 Network representation of Figure 11.2 with the addition of three CWC sites (purple diamonds). With different flint sources (squares), excluding other/indet, and VLC sites by landscape zone (circles), and CWC sites (purple diamonds), the links are ranked by weight. The network is visualised in stress minimisation layout (based on Tab. 11.1).

the beaches comes from deeper layers from the dredged seafloor. Prehistoric tidal currents would not be strong enough to erode these deeper layers and expose the flint embedded here (Houkes, 2021b, p. 147). I therefore agree with Houkes that the rolled pebbles found on these sites must have come from river deposits, and that these were not sourced locally on the beach. The only exception is Cap Blanc Nez flint which could potentially be collected along the beaches of Zeelandic Flanders (Houkes, 2021b, p. 169).

While on some of the coastal dune sites low-quality flint dominates, the recently excavated sites near The Hague, for example Den Haag Steynhof, have a major component of imported Hesbaye flint (Houkes, 2021b, 2024). This site is conveniently located on the edge of the dune, close to the Meuse. The notion that the dunes as a whole were poorly connected to the hinterland can thus be nuanced (Van Gijn, 2010b). Sites in proximity to the river were well connected while sites to the north further along the dunes mainly had access to poor quality flint.

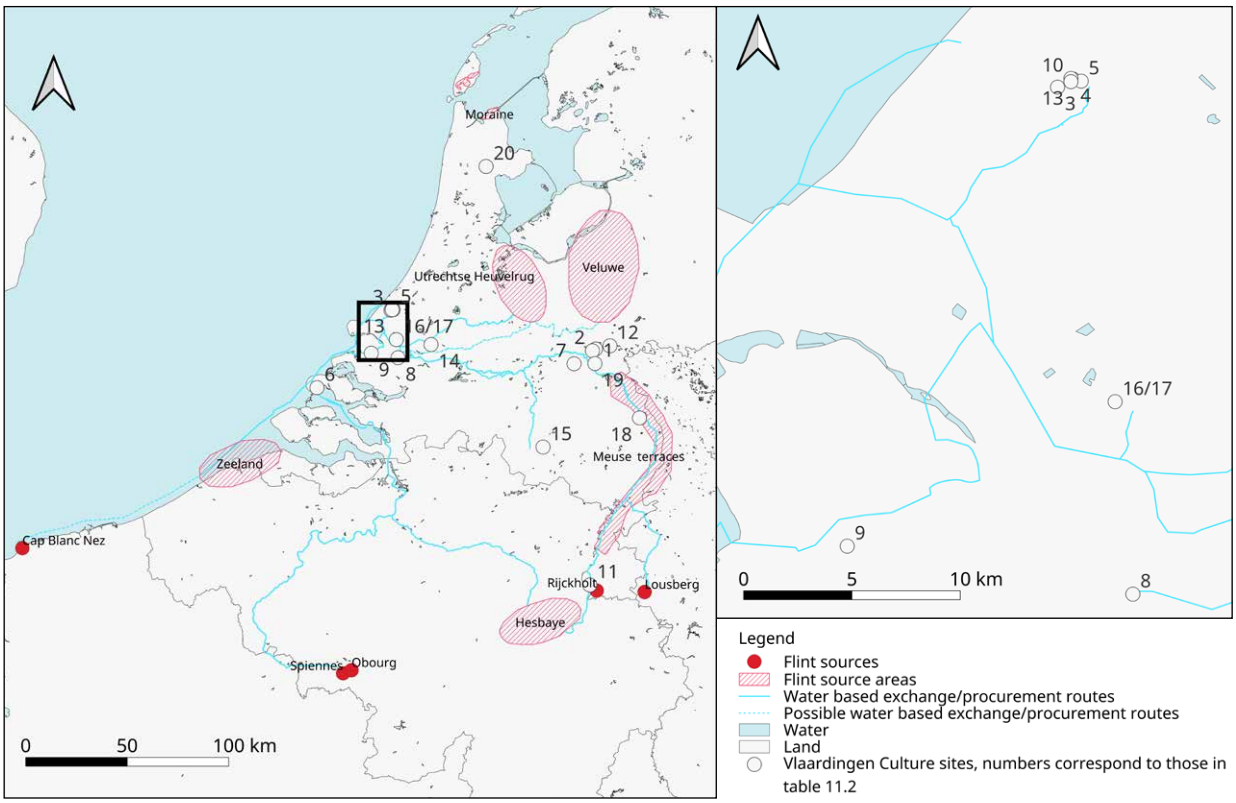


Figure 11.4 Map with VLC sites mentioned in Table 11.2 and flint sources exploited during the VLC period. Waterways are reconstructed based on the palaeogeographic map of the Netherlands ca. 2750 BCE (after Van Gijn et al., 2006; Vos et al., 2020; basemap: © EuroGeographics 2024, map made in QGIS).

This is clear from the assemblages from the levee sites where high-quality Hesbaye, Lanaye/Spiennes, and Cap Blanc Nez flint dominates. It is known that Lanaye-like flints can potentially also be found in river terraces (Van Gijn, 2010a, p. 122). Nevertheless, the general lack of cortex and the high percentages of axe fragments clearly indicates that most of the Lanaye/Spiennes flint came from the mining areas and surrounding eluvial deposits (also see section 11.3.1).

If flint is locally available, this local flint generally dominates the assemblages. This is for example the case at the West Frisian sites (where moraine flint is locally available). If raw materials are not available flint has to be imported from further away. At sites which had direct access to major waterways, mostly the levee sites, high-quality flint was imported. When sites were located further away from these major waterways, for example at most of the coastal dune sites, we see that lower-quality flints are predominantly used. It thus seems that the affordances of the landscape, both in terms of flint availability of resources, as well as in terms of access to water-based exchange routes, play a key role in determining the procurement strategies employed at VLC sites.

11.2 Down-the-line exchange or direct procurement

As demonstrated above, VLC sites procured flint from a wide range of sources. Flint can be obtained directly from these sources through exchange, either at these source areas, or at sites on the route between the VLC sites and the flint sources (Fig. 11.4). Lastly, flint could be obtained through down-the-line exchange, as has previously been proposed (Amkreutz, 2013b, p. 220). To assess which of these scenarios is the most likely, we need to delve into the data. Below, the hypothesis that flint reached these VLC communities through a system of down-the-line exchange will first be tested.

In a down-the-line exchange network, direct contact between people in the delta and those in the inland is not required. Rather, it is expected that exotic flint is handed down from procurement sites to other nearby sites, thus gradually spreading out further from the source. Following this model, we expect that producer sites (in this case, the flint mining areas of Belgium and Dutch Limburg) produced an excess amount of flint. This flint would then be transported to nearby sites. Those sites would use a portion of this flint while handing the remainder of the flint they obtained to other nearby sites (which are then one step

Nr.	Site	Flint total	Hesbaye	% Hesbaye	Distance to Hesbaye (km)	Remark
1	Beuningen Ewijk Hekkeslag	65	18	27.69%	184	Includes 6 km land transport
2	Beuningen Ewijkse Veld	1227	130	10.59%	182	Includes 4.4 km land transport
3	Den Haag Rhyenhof	3054	101	3.31%	275	
4	Den Haag Steynhof	2335	211	9.04%	275	
5	Den Haag Wateringse Binnentuinen	3384	17	0.50%	275	
6	Haamstede-Brabers	590	55	9.32%	205	
7	Haren Groenstraat	2615	0	0%	196	
8	Hekelingen III	342	94	27.49%	269	
9	Hellevoetsluis Ossenhoek	2823	20	0.71%	247	
10	Leyweg Volkstuinen	66	2	3.03%	275	
11	Maastricht Hoogenweerth*	?	0	0%	32	
12	Nijmegen-Noord. Project Ngk8	47	0	0%	184	Includes 11 km land travel to the river Meuse
13	Noordweg 76	70	1	1.43%	275	
14	Rotterdam Beverwaard Tramremise	634	18	2.84%	297	
15	Veldhoven Habraken	694	32	4.61%	73	Inland connection, riverine route would be 262 km
16	Vlaardingen trench 15	448	102	22.77%	275	
17	Vlaardingen trench 17	118	23	19.49%	275	
18	Well Hoogwatergeul	217	11	5%	140	
19	Wijchen Oosterweg	338	2	0.59%	183	
20	Zandwerven	113	0	0%	382	

Table 11.2 Hesbaye flint percentages and distances between the source and the sites (Asmussen & Moree, 1987; Brounen et al., 1990; Devriendt, 2013b; Drenth, 2019; Houkes, 2021b; 2023; Houkes & Drenth, 2017; Houkes et al., 2017; Knippenberg, 2013; Siemons & Bulten, 2014; 't Hart et al., 2019; Ter Wal & Tebbens, 2012; Van Hoof & Metaxas, 2009; Van Zoolingen, 2018; Verhart, 1992; Vos et al., 2020; Zijl et al., 2011). * Total amount of flint is not mentioned, but the publication mentions that all the flint is from Rijckholt.

further removed from the procurement site). This down-the-line exchange model has previously been demonstrated in archaeological contexts (De Grooth, 2015; Ibáñez et al., 2016b; Renfrew, 2011, pp. 465–470). De Grooth (2015) has proposed this model for the exchange of Rijckholt flint during the Early Neolithic in the Rhine-Meuse delta. It is expected that this mode of exchange continued during the Middle and Late Neolithic (Amkreutz, 2013b, p. 343). Due to the overlapping characteristics of Rijckholt and Spiennes flint it is difficult to test the model for these flint sources (De Grooth, 2011). Using ED-XRF we were able to distinguish between these sources, but unfortunately this analysis has only been conducted on assemblages of four sites (Van den Dikkenberg & Braekmans, 2025). Therefore, suitable data for testing this model using Spiennes or Rijckholt/Lanaye flint was not available. Using the distribution of Hesbaye flint we can, however, put this model to the test. In Tab. 11.2 the VLC sites for which quantitative data on flint sources is available are listed, together with Stein sites for which this information was available. Based on the palaeogeographic map of the Netherlands around ca. 2750 BCE the water-based distances between these sites and the Hesbaye area are reconstructed (Tab. 11.2).

For some sites water-based routes seem unlikely. This is for example the case with the site Veldhoven Habraken, which is located 263 km from Hesbaye, if water-based routes would be used. However, by land the site is only located 73 km from this source. For other sources it is assumed that part of the route was land-based. This is for example the case with sites in the Nijmegen area. These sites are connected to the river Rhine, but not to the Meuse. If exclusively water-based routes would be used a major detour towards the west needs to be made. It seems more likely that people would cross the river Rhine, walk south towards the Meuse from where water-based routes to the south would be available. It should be noted that it is uncertain whether paddling up these major rivers is possible with a dugout, as we lack data on the past flow

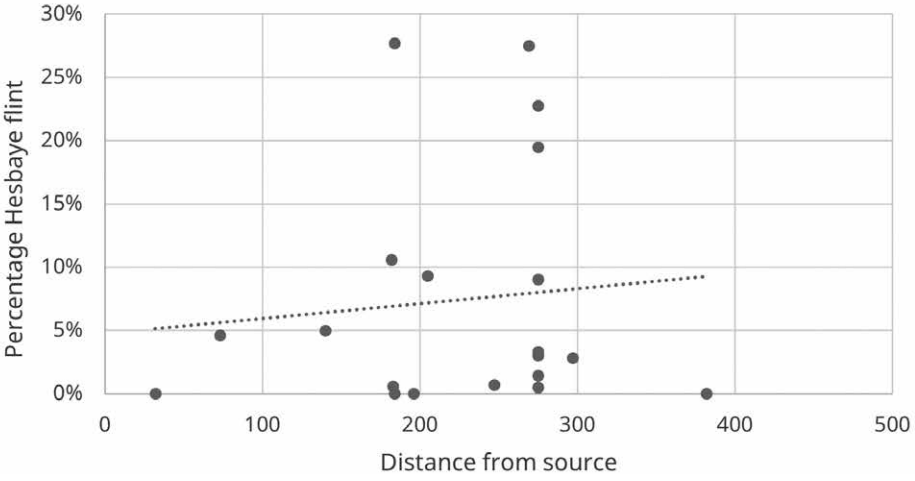


Figure 11.5 Percentages of Hesbaye flint for different VLC and Stein sites with distances between the source and site (in km).

velocity of the Meuse, and because we do not know how far inland the influence of the tides extended. However, if the upwards currents are too strong it is possible that the final stretch of the journey is done walking, possibly towing the dugout while walking along the riverbanks. For sites where a significant portion (more than 2 km) of land-based travel is required this is listed in the remarks in Tab. 11.2.

The distances and percentages in Tab. 11.2 are plotted in a scatterplot in Fig. 11.5. The data are ranked and a Spearman's Rank Correlation (ρ) test is conducted, showing a slight positive correlation between the distance to the source and the percentage of Hesbaye flint ($\rho = 0.03664$). This correlation was, however, not significant (p-value = 0.8781). It is thus clear that a strong correlation, in which availability decreases significantly with distance, cannot be established. Hesbaye flint is actually more common at VLC sites in the western Netherlands (200–300 km from the source) than on sites closer inland. For the Stein sites near Hesbaye we observe that they often have a major component of mined Rijckholt flint (Brounen et al., 1990). Other sites in the Nijmegen area, but also on the cover-sand area of Brabant, as demonstrated by the site Veldhoven Habraken, often heavily rely on locally sourced terrace flint (Asmussen & Moree, 1987; Devriendt, 2013b; Houkes & Drenth, 2017). On sites in the western parts of the Rhine-Meuse delta flint is not locally available. Hence, local procurement was not an option. The high percentages of Hesbaye flint at sites like Hekelingen III and Vlaardingen Arij Koplaan suggest that these communities had direct access to flint from this source. Rather than depending on a down-the-line exchange system, these people likely had direct contact with people in Hesbaye, and presumably with communities from flint mining areas in Limburg and other parts of Belgium.

Not all sources of mined flint were frequented equally in this system. While direct contacts with communities in Hesbaye, Rijckholt, and Spiennes were likely to have been frequent, the flint mines in Valkenburg and Lousberg were largely avoided. These flint types are common on Stein sites, further highlighting the unlikely existence of a down-the-line system (Louwe Kooijmans, 1983; Verhart, 2010b). If flint is handed down from Stein sites near the source areas in Limburg and Belgium we would expect that flint from these sources reached the Vlaardingen sites in similar ratios. But instead we observe that there are clear preferences in terms of which flint types were selectively imported.

If we envision people directly obtaining these flints from the south we can propose the following hypothetical route. Following the river Meuse people would almost pass by the Utrechtse Heuvelrug and Veluwe area where terrace flint could be obtained. Further down river one would have access to Meuse-eggs which can be collected along the Meuse terraces. Upstream one would pass by the Rijckholt flint mines and finally one would reach the Hesbaye area. In order to reach Valkenburg or Lousberg one would have to deviate from this hypothetical route, following one of the tributaries of the Meuse to the east (Fig. 11.6). Following the route to Hesbaye one would be able to obtain most of the commonly used flint sources. If Hesbaye is the intended destination for these journeys it makes sense to avoid Lousberg and Valkenburg. In addition to the Meuse route we can envision a similar route towards the west. This route follows the river Scheldt, eventually reaching Spiennes and Obourg. Along the route it is possible that Cap Blanc Nez flint was collected in Zeelandic Flanders, along the coast. It is also possible that Cap Blanc Nez flint was obtained directly from the cliffs in northern France. It should also be noted that the route towards Zeelandic Flanders still requires a significant detour, as the Scheldt route, during the Neolithic, would not directly pass by Zeelandic Flanders (Fig. 11.6).

Considering that a down-the-line exchange system does not fit the data we are left with several alternative possibilities. It is possible that VLC communities met with people from the south half-way along these routes.

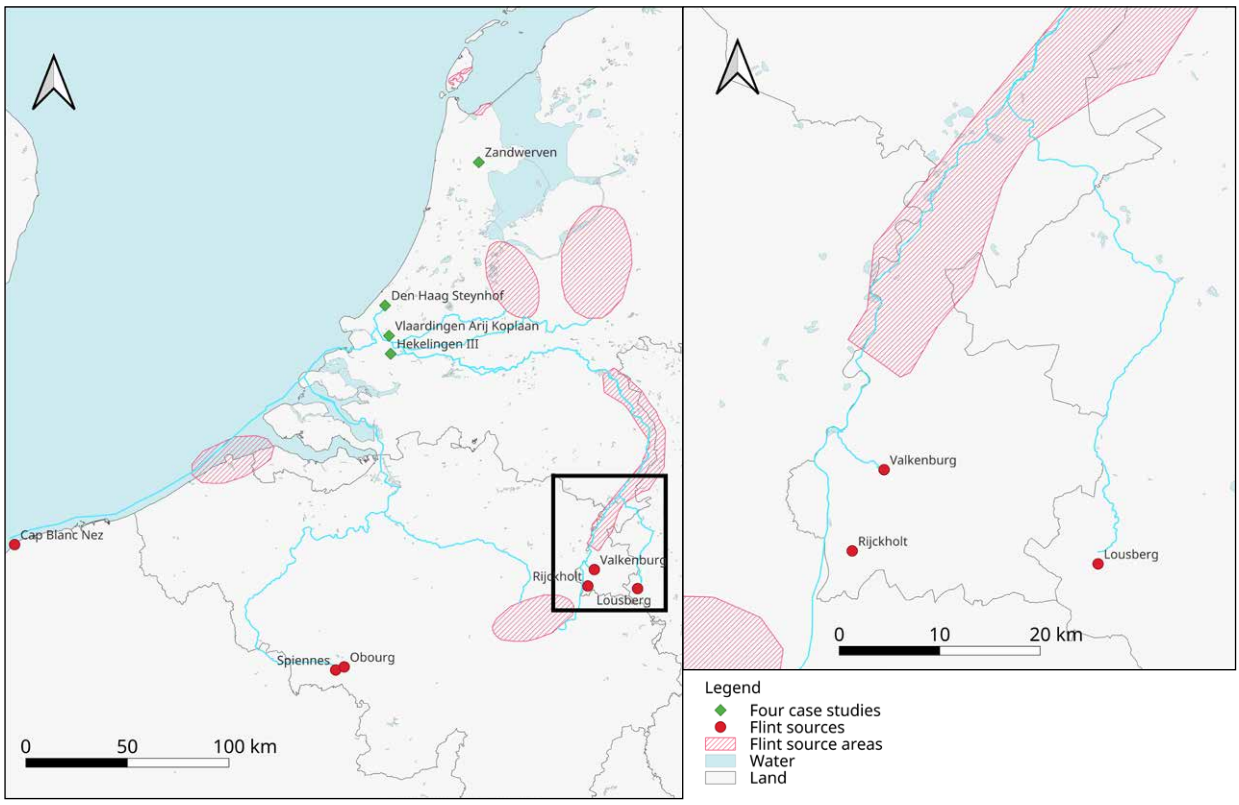


Figure 11.6 Map with waterways, including the Limburg area with routes to Valkenburg, Lousberg, Rijckholt, and Hesbaye. Waterways are reconstructed based on the palaeogeographic map of the Netherlands ca. 2750 BCE (after Van Gijn et al., 2006; Vos et al., 2020; basemap: © EuroGeographics 2024, map made in QGIS).

This would mean that sites in the Nijmegen area could potentially function as intermediate stations. Yet, considering that flint at these sites mainly consists of locally-obtained terrace flint, and considering that imported flint is scarce here, this seems unlikely. The most plausible scenario seems to be one which involves direct contact between communities in the wetlands and those in the south. This could consist of southern communities travelling to VLC communities, or alternatively it could be VLC communities travelling to these sources. For the first we can envision southern communities bringing their own flint. This scenario seems less likely because all VLC sites present a characteristically diverse mix of southern flint sources (Rijckholt, Spiennes, Cap Blanc Nez, Hesbaye etc.). If these assemblages would reflect southern communities moving to the coast we would expect a more homogenous pattern in which raw material spectra at these sites are similar to those of the upland communities (Amkreutz, 2013b, pp. 402–403). Also the varied mix of flint sources for individual clusters at Hekelingen III argues against such an interpretation (see chapter 8).

A down-the-line exchange system does not explain the abundance of exotic flint on the levee sites. However, it might explain the spread of exotic flint from the levees to sites further north along the coastal dune area. Houkes noted that axe fragments were especially abundant in the southern parts of the coastal dune area while they were scarcer further north (Houkes, 2024). He suggested that a down-the-line exchange system might have been in place through which these axe fragments were handed down from sites in the southern margins of the coastal dune area to sites further north. He also suggested that this system did not only involve complete axes, but also broken and fragmented axes. This notion is supported by refitting analyses on coastal dune sites. Often axe fragments could not be refitted and on many sites it seemed that the axe fragments originated from multiple axes (Houkes, 2024).

In Figure 11.7 sites along the coastal dunes are plotted, showing the relationship between the percentage of axe fragments on these sites and their distance from the Meuse. The graph also includes the sites of Hekelingen III and Vlaardingen Arij Koplaan, as it was noted earlier that it is expected that these sites might have been focal points from where exotic flint was redistributed. It holds true that Hekelingen and Vlaardingen seem to have remarkably good access to exotic flint, but this also pertains to the

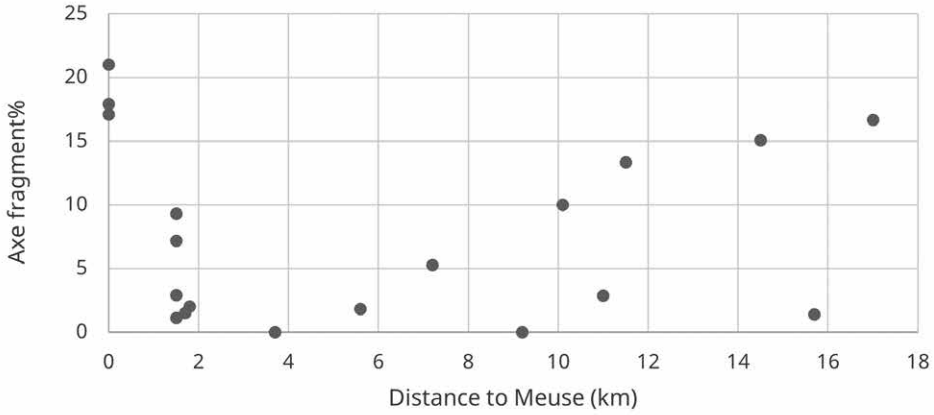


Figure 11.7 Scatterplot with axe percentages and distance from the river Meuse and its tributaries, for sites in the coastal dune area and for Hekelingen III and Vlaardingen trench 15 and 17 (the latter three are set at a distance of 0 km) (Drenth & De Kruyk, 2019; Glasbergen et al., 1967a; Hirschel, 2009; Houkes, 2014; 2021b; 2023; Houkes & Dorenbos, 2004; Houkes & Verbaas, 2014; Houkes et al., 2017; Leijnse, 2004; Machiels, 2022; Molthof, 2018; Van Veen, 1989; Van Zoolingen, 2018; Verhart, 1983).

sites of Den Haag Wateringse Binnentuinen and Steynhof (Houkes, 2021b; Houkes et al., 2017). However, the overall distribution pattern of axe fragments does not directly reflect a down-the-line exchange system. Several other sites to the north, such as Voorschoten-Boschgeest, also contain high percentages of axe fragments (Glasbergen et al., 1967a). What is however significant is that these sites are located close to the river Rhine, rather than the Meuse. They are thus also well connected, albeit via a different route. The scatterplot in Figure 11.7 suggests a more or less u-shaped distribution, with sites on both ends of the graph being well connected. Those sites are also the ones located close to major rivers, on the left of the graph are sites located near the Meuse, those on the right are close to the Rhine.

It thus seems plausible that axes along the dunes were exchanged through a down-the-line exchange system, as suggested by Houkes (Houkes, 2024, p. 81). However, for the overall distribution of flint at VLC sites this seems unlikely. The distance between sources and sites is not necessarily a decisive factor for the distribution of flint. Direct access to local sources or major waterways are however key factors. The levee sites seem to be well connected in this respect. This might in part be due to their function as potential seasonal gathering places, presumably coinciding with the sturgeon fishing season in the late spring or early summer (Prummel, 1987, p. 237). In Neolithic Britain, it has similarly been observed that gathering places also functioned as focal points for the exchange of axes (Bradley & Edmonds, 1993, p. 164). The fact that Hesbaye flint reached these communities both as axes (finished products) and as nodules (raw materials) suggests that it is also possible that multiple distribution systems were in place.

11.3 Collecting flint nodules or importing finished products

Flint can be imported to a site as nodules, pre-worked nodules, or as finished products, such as flint axes. Nodules could have been picked up by VLC people. But objects such as flint axes were clearly made by other communities. Acquiring these objects thus also involves social networks (Van den Dikkenberg, 2024b). It is therefore not only important to know where flint comes from, but also in what state flint reached these VLC settlements. This can be analysed by studying the amount of cortex on objects, and by analysing axe fragments on different sites, which can be recognised based on the presence of polished or ground facets on flint objects.

11.3.1 Collecting flint nodules

As flint is not locally available in the western Netherlands it had to be obtained through either direct procurement or exchange. It seems likely that certain types of flint were obtained through direct procurement. Especially in the case of Zandwerven most of the flint was obtained from local moraine deposits of Wieringen and Texel. Procurement strategies at this site resemble those observed on nearby contemporary CWC sites (García-Díaz, 2017, p. 270). While true 'local' deposits are absent in the south of Holland we can propose that the import of terrace flint and Meuse-eggs followed a similar pattern. An interesting aspect is the state in which these materials reach the VLC sites. At Hekelingen III Meuse-eggs and terrace flint were absent. At Vlaardingen these sources were virtually absent, when they were present they were mostly found in a complete (unused) state. This seemed to be related to the availability of high-quality flint at the site (see chapter 9). At Steynhof Meuse-eggs occured more abundantly, and here they were clearly intended for use, as several artefacts made from

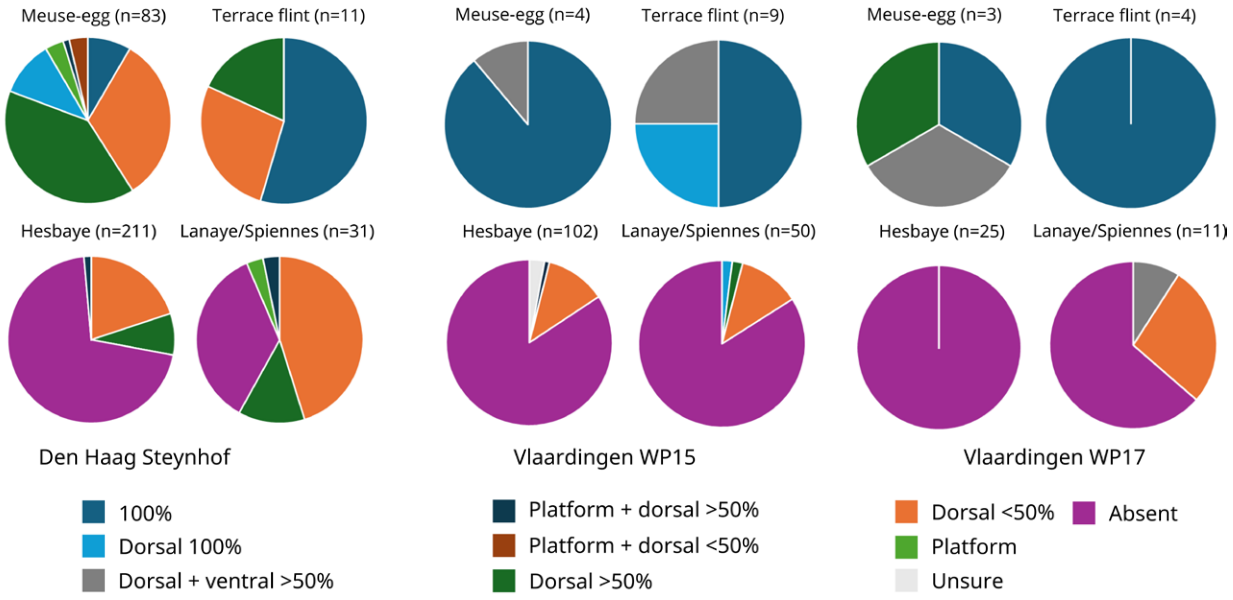


Figure 11.8 Cortex extent for Meuse-eggs, terrace flint, Hesbaye flint, and Lanaye/Spiennes flint at Den Haag Steynhof and Vlaardingen trench 15 and 17 (Houkes, 2021b).

Meuse-eggs also displayed use-wear traces. If we compare the extent of cortex on Meuse-eggs and terrace flint with Hesbaye and Lanaye/Spiennes flint at Steynhof we observe important differences between these sources (Fig. 11.8). It should be noted here that the category 'absent' can be largely ignored because Meuse-eggs and terrace flint can only be recognised based on the characteristics of the cortex. Hence, for these types of flint this category invariably created a bias. In general the differences between raw materials will create a degree of bias. Small nodules (such as Meuse-eggs) will generally produce a higher degree of cortical flakes than high quality raw materials (larger nodules). Despite these differences, overall, if complete nodules are imported we expect cortical flakes to be present even when dealing with larger nodules. Focusing on the remaining categories we observe that cortical flakes are virtually absent in Hesbaye and Lanaye/Spiennes flint. The majority of Meuse-eggs and terrace flint have more than 50% cortex on the dorsal side. The patterns clearly indicate different states in which these raw materials reached the site. Meuse-eggs and terrace flint were clearly brought to the site in the form of nodules. This contrasts sharply with the Hesbaye and Lanaye/Spiennes flint, from which a large portion must have reached the site in an advanced state of decortication. A similar pattern can be observed for Hesbaye flint in Vlaardingen trench 15 and 17. Cortex here is either absent or when it is present it covers less than 50% of the dorsal surface, or it is found only on the platform. True cortical flakes are completely absent (Fig. 11.8). Similarly, only two of the Lanaye/Spiennes flakes at the Vlaardingen have more than 50% cortex while most have no cortex, or less than 50% (Fig. 11.8).

The moraine flint at Zandwerven shows a pattern like that observed in the Meuse-eggs and terrace flint of Steynhof. Here most of the flint has more than 50% cortex, indicating that the flint was imported as unworked nodules. Overall, we can conclude that low-quality flint (Meuse-eggs, moraine flint, and terrace flint) was imported as complete nodules. High-quality flint was frequently imported in a largely decorticated state. It is possible that these were imported from other communities (who pre-worked these nodules). Alternatively, it is also possible that these differences result from the different affordances of the raw materials. High-quality flint nodules are larger, hence removing (part of) the cortex prior to transport might be more efficient considering the distance they need to travel. For smaller nodules (such as Meuse-eggs) the cortex is usually not removed before the flint is used, and considering their small size they are easier to transport in an unworked state. Cap Blanc Nez flint is scarce at Steynhof, but it is more frequent at Vlaardingen and Hekelingen III. At Vlaardingen we see that this type of flint is also imported as complete nodules. One complete nodule was found in trench 17. In addition, several flints had more than 50% cortex (n=4), indicating that decortication of these nodules took place at the site.

11.3.2 Importing flint axes

An important component in the lithic assemblages is formed by imported axes, or possibly imported axe fragments, as suggested by Houkes (2024). Based on our recycling experiments we can calculate an estimated amount of axe fragments for different flint sources, as only ca. 41%

Site	Number of artefacts	Axe fragments	Estimated number of axe fragments	Estimated percentage axe fragments
Den Haag Steynhof	211	62	151	71.6%
Hekelingen III	94	24	58	61.7%
Vlaardingen trench 15	102	36	88	86.3%
Vlaardingen trench 17	23	7	17	73.9%

Table 11.3 Hesbaye flint at different sites, number of artefacts, number of axe fragments and estimated percentage of axe fragments for Hesbaye flint (Houkes, 2021b).

of the axe fragments will still have a remnant of the outer surface of the axe (Van den Dikkenberg et al., 2024a; also see chapter 5). Using this experimental data, an estimate has been made to assess how much Hesbaye flint consists of (recycled) flint axes. On all sites we observe that Hesbaye flint was mainly, but never exclusively, imported in the form of finished axes (Tab. 11.3). The presence of cortex on some of the Hesbaye flint indicates that this type of flint was also, to a lesser extent, imported in the form of (presumably pre-worked) nodules.

Based on the ED-XRF analysis it is also possible to distinguish between Spiennes and Rijckholt/Lanaye type flints (Van den Dikkenberg & Braekmans, 2025). Based on these analyses we can estimate the importance of Rijckholt/Lanaye flint on Vlaardingen trench 15. The other sites had only a limited number of artefacts that could securely be attributed to either of these groups.[33] Unlike Hesbaye flint, Rijckholt/Lanaye flint was not mainly imported in the form of complete axes. Only two out of the 16 flint objects attributed to the Rijckholt/Lanaye group consisted of axe fragments. Based on the recycling experiments we can estimate that ca. 30% of the Rijckholt/Lanaye flints here consisted of axe fragments (Van den Dikkenberg & Braekmans, 2025; Van den Dikkenberg et al., 2024a). At trench 15, four flakes showed eluvial cortex, indicating that eluvial Lanaye deposits were also exploited at this time. In these cases it was not possible to attribute them to a specific source, but numerous deposits can be found in the Limburg area (Brounen & Peeters, 2000/2001; De Grooth, 2011; Vermeersch et al., 2005). A few fragments in this assemblage display high strontium values (>20 ppm), but low phosphorus values (<500 ppm). These values are comparable to those of the reference samples from the eluvial deposits in Banholt (Van den Dikkenberg & Braekmans, 2025). This suggests that some of the eluvial flints in the assemblage were possibly obtained from Banholt.

Occasionally blades were also imported (Van den Dikkenberg, 2024b). Blades with clear trapezoidal and triangular cross-sections were produced in a *chaîne opératoire* which involved blade core reduction (Sain & Goodyear, 2016). Yet, the absence of blade cores at these sites indicates that these blades were not produced, but were imported in a finished state (Van den Dikkenberg, 2024b).

We can thus conclude that different flint types reached these sites in different forms. Low-quality flint, Meuse-eggs, terrace flint, and moraine flint, was imported as complete nodules. High-quality flint, such as Hesbaye flint and Lanaye/Spiennes flint, was often imported in the form of complete (or broken) axes, as complete blades, or as pre-worked nodules.

11.4 Appropriation of exotic flint

The flint procurement networks which were in place during the VLC period were gradually shaped since the Late Mesolithic (Van Gijn, 2008; 2015). 'Local' flint types such as Meuse-eggs and terrace flint are well known from earlier Swifterbant and Hazendonk-3 group sites (Devriendt, 2013a; Houkes, 2008b; Van Gijn et al., 2006). The inter-regional exchange networks in which Rijckholt and Hesbaye flint circulated also predated the emergence of the VLC. In this section we explore how imported flint was appropriated by VLC people. This is linked to the different phases of appropriation as defined by Hahn (also see chapter 3 section 3.3): 1) material appropriation, 2) objectification, 3) incorporation, and lastly 4) transformation (2004). The long-term perspective below was provided by previous studies by Van Gijn (2008; 2015).

The term 'exotic flint' is not well defined; it broadly refers to flint which is imported over long distances of several hundreds of kilometres from a site. In the context of the Neolithic in the Rhine-Meuse-Scheldt delta, the term is used to refer to flint from sources such as Rijckholt, Spiennes, Hesbaye, Lousberg, and Grand-Pressigny (Amkreutz, 2013b, p. 343; Amkreutz & Verhart, 2024; Van Gijn, 2008, 2009a, 2015). Occasionally, Cap Blanc Nez flint is also cited as an example of exotic flint (Amkreutz, 2013b, p. 343). If this flint is obtained from the chalk cliffs in France, this seems to be a valid position. Unfortunately, it could not be ascertained whether the Cap Blanc Nez flint at VLC sites was derived directly from these cliffs or originated from the beaches in Zeelandic Flanders, in which case the distance between source and site would be similar to that of regional flints such as Meuse-eggs or terrace flint. Therefore, the question as to which of these groups Cap Blanc Nez flint should be attributed remains open for debate.

Rijckholt flint was imported to the Rhine-Meuse delta from the Late Mesolithic onwards. This is evidenced by

33 Hekelingen III is not included here because the ED-XRF analyses were only done on the sample selected for micro-wear analysis which presumably creates a bias. It can be noted that here 7 out of 14 fragments consisted of axe fragments, none of the others have cortex indicating that the flint in the sample mostly consisted of axe fragments.

a large pre-core from Hardinxveld-Polderweg phase 1 (5500–5300 BCE), and two macrolithic blades from Hardinxveld-De Bruin phase 3 (4700–4450 BCE). The large pre-core was imported, but it was never utilised. Similarly, the large macrolithic blades did not display convincing use-wear traces (Van Gijn, 2015, p. 57). Although these networks were thus already established during the Late Mesolithic, there is no indication that they served a utilitarian purpose. Exotic flint was not incorporated within the existing technological system. Objects changed ownership, and following the steps defined by Hahn, in a material sense they were appropriated. However, there is no indication that these objects were objectified, incorporated, or transformed (Hahn, 2004).

The nature of the exchange networks changed during the Middle Neolithic with the emergence of the Michelsberg Culture. We observe that contacts intensified, as both Hesbaye and Rijckholt flint now feature more prominently in the lithic assemblages in the wetlands. Imports include large macrolithic tools of a typical Michelsberg signature. The macrolithic tools from Brandwijk (4600–4200 BCE), such as endscrapers and blades, displayed use-wear traces typically associated with upland communities (Van Gijn, 2008; Van Gijn & Wentink, 2013, pp. 125–126). Use-wear traces such as 'polish 10', a type of hide/plant-like polish derived from a so far unknown kind of activity, are characteristic of upland communities, but they are otherwise absent in the wetlands (Van Gijn, 2010a, p. 106). These tools did not display traces of resharpening. It appears that these implements were imported in a used state from these upland communities (Van Gijn & Wentink, 2013, p. 126). They were kept, but not repurposed, despite their seemingly functional superiority. Thus, despite the presence of use-wear traces these objects were not objectified, incorporated or transformed (Hahn, 2004).

At the Hazendonk-3 group sites of Schipluiden and Ypenburg it was observed that macrolithic tools, made from Hesbaye and Rijckholt flint, were only utilised for a specific/limited set of tasks, notably ornament production, cereal harvesting, and fire-making (Van Gijn, 2015, p. 59). Here we observe that these objects were, for the first time, appropriated and incorporated into the local technological system, but their use remained limited to these specific 'special' tasks'. They were considered as distinctly different objects, different from other locally produced tools. Even though the morphology of the tools would allow for a wide range of uses, they were clearly specifically selected only for these tasks. Borers, for example, could also have been used on bone or antler, yet the imported borers were specifically selected for ornament production. These objects went through several of the stages defined by Hahn. They changed ownership, and hence they went through the first stage of material appropriation. They were also correctly identified and presumably named (Hahn, 2004, p. 220). Borers were used for drilling, they were thus functionally recognised as borers. They were therefore also 'correctly used' and in this sense incorporated in the local technological system (Hahn, 2004; Van Gijn, 2015). Nevertheless, they were not truly transformed as defined by Hahn (Hahn, 2004). They maintained their distinct position as 'foreign' objects. They were never granted the functional plurality assigned to similar objects, made from locally sourced materials.

Following this long-term perspective on the use of exotic raw materials, it will be interesting to see how imported flint is used at VLC settlements. In the network graph in Figure 11.9 we observe that these earlier distinctions, in which exotic flint is only employed for a limited number of tasks, vanished during the VLC period. Exotic Hesbaye and Lanaye/Spiennes flint is employed for the same range of tasks as non-exotic flint types. An activity such as fire-making (contact with pyrite in Fig. 11.9) is conducted both with exotic Lanaye/Spiennes flint, as well as with non-exotic flint such as Meuse-eggs. The central position of Hesbaye and Lanaye/Spiennes flint in the network indicates that these non-local materials had become integral to the technological system. In the graph it becomes apparent that exotic flint is employed for a wider range of activities than non-exotic flints. This is partially due to the fact that at two (Hekelingen III and Vlaardingen Arij Koplaan) of the four sites exotic flint is more common than non-exotic flint. Furthermore, the predominantly locally collected flint from Zandwerven was poorly preserved, thereby limiting the observed spectrum of wear traces. Overall, we observe a preference for the use of exotic high-quality flint. At sites where both exotic flint and non-exotic flint were available the exotic flint was mainly used, while much of the non-exotic flint remains unused. At Vlaardingen Arij Koplaan, for example, the non-exotic flint (Meuse-eggs and terrace flints) is predominantly present in an unmodified and unused state. It is unclear why these flints were brought to these sites. Possibly they represented 'pieces of places', picked up on journeys to the south. It is also possible that flint was accumulated on these well-connected levee sites to be partially passed on to sites in the coastal dune area, where flint was likely distributed along the dunes through a down-the-line exchange system. Perhaps the inhabitants of the levees kept much of the high-quality material for their own use while also importing low-quality flint to pass on.

It can be observed in Vlaardingen trench 17 that when imported blades were present these were used in a much higher frequency than flakes (see chapter 9). The tasks for which they were used were not special kinds of activities. Unlike in earlier periods these imported blades were used for the same range of functions as unmodified and retouched flakes (Fig. 11.10). Imported blades were struck from a blade core, rather than produced as byproducts of flake production. Specifically blades with trapezoidal

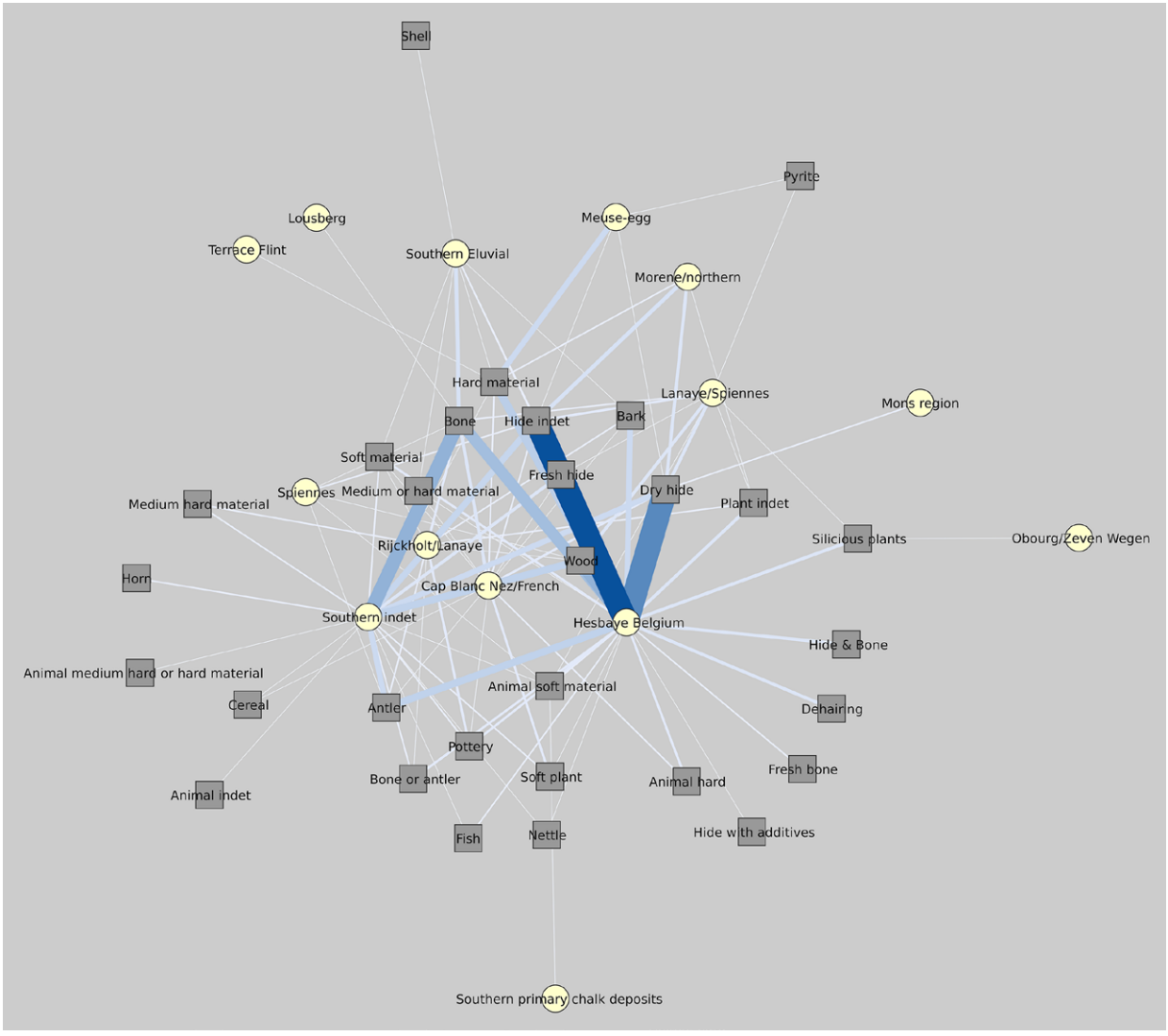


Figure 11.9 Network representation of different flint sources (yellow) and contact materials (grey), excluding hafting traces and unsure/indet, visualised in stress minimisation layout. Links are scaled according to their weight. The network is based on the data from Den Haag Steynhof, Vlaardingen Arij Koplaan trench 15 and 17, Hekelingen III, and Zandwerven (chapter 4–7). The distinction between Spiennes and Rijckholt/Lanaye flint is made based on ED-XRF analysis (Van den Dikkenberg & Braekmans, 2025).

and triangular cross-sections are indicative of blade-core reduction (Sain & Goodyear, 2016, p. 117). Considering the lack of blade-cores on the VLC sites under study, we can assume that these blades were therefore imported in a finished state (Van den Dikkenberg, 2024b).

The only task for which imported flint objects were exclusively used is wood chopping. This does not seem to signify a deliberate choice. Rather, it reflects the fact that axes were no longer produced locally in the western Netherlands (Van den Dikkenberg, 2024b). The observation that some axes were also used to scrape hides highlights that this does not represent an ideological choice, in which imported objects are singled out for specific tasks (considering hide scraping is also done with non-exotic flint). Rather, imported axes were the only tools with functional edges suitable for wood chopping.

We can conclude that a radical shift in attitude towards imported flint took place during the VLC period. Imported exotic flint was now fully incorporated into the local technological system. Exotic flint was favoured when available, due to its superior quality, but it was not treated in a special manner. The abundance of objects made from exotic flint on some sites, especially at Hekelingen III and Vlaardingen Arij Koplaan, highlights the fact that they were no longer seen as 'special exotic objects'. We observe that these objects shifted from

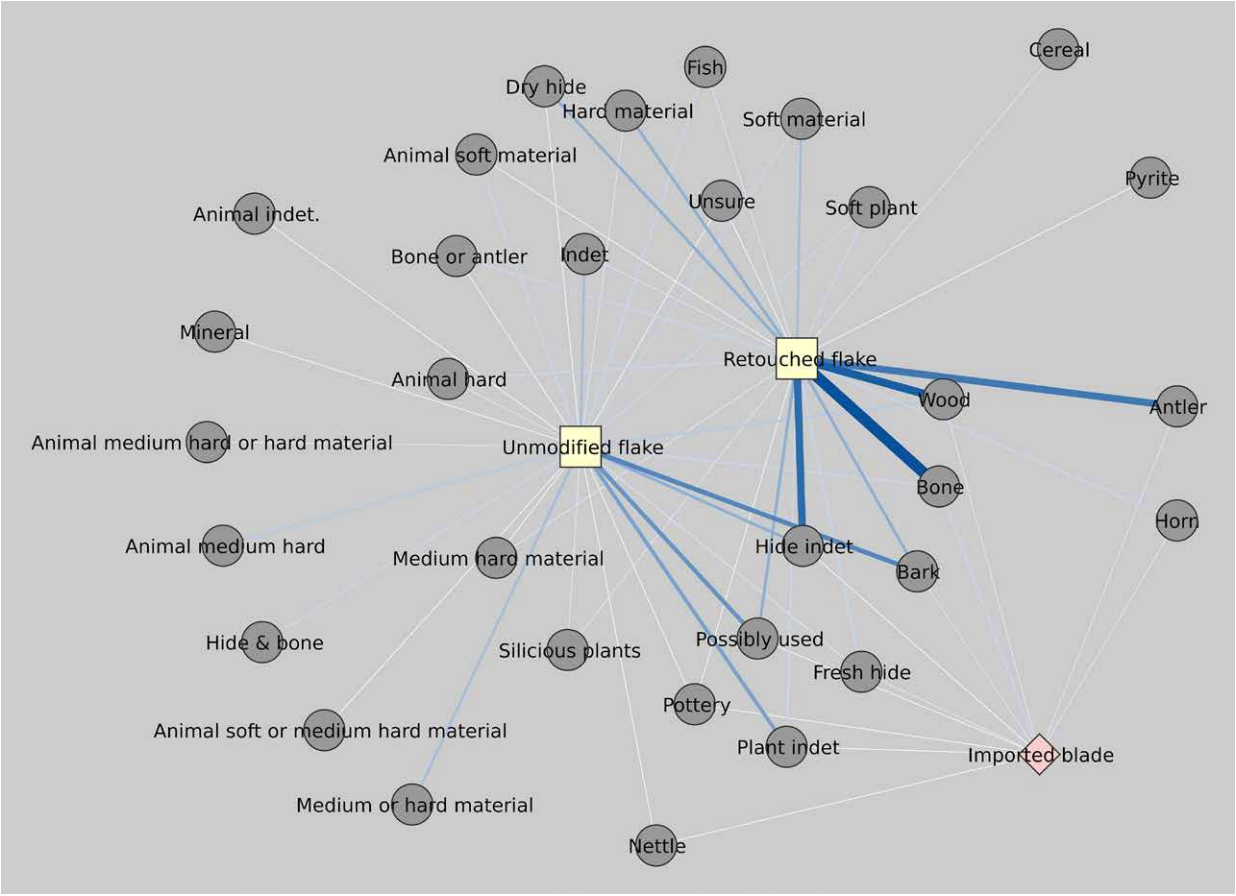


Figure 11.10 Network representation of unmodified and retouched flakes (yellow squares), imported retouched and unretouched blades (red diamond), and contact materials, excluding hafting traces (grey circles), links are scaled according to their weight. Visualised in stress minimisation layout. Based on the data from Den Haag Steynhof, Vlaardingen Arij Koplaan trench 11, 15, 16 and 17, Hekelingen III, and Zandwerven (chapter 4–7).

tokens of long-distance connections to utilitarian objects which appear to be conceptually indistinguishable from their local counterparts. They were transformed into objects which could be used, reused and recycled much like non-foreign objects, as such they went through the transformation stage as defined by Hahn (2004). We observe that two millennia of regular sustained contact gradually transformed the notions surrounding these 'exotic' types of flint.

It is also noteworthy that local axe producing technology disappears in favour of the import of exotic axes. This emphasises the steadily increasing importance of these networks. These axes consistently display wear traces, and those from chopping wood were not encountered on other types of artefacts. If people intended to use flint for this purpose, they were completely dependent on skilled knappers from distant communities. Although bone and antler tools might have been used as alternatives it is significant that flint axes were never locally produced. Whereas the material culture of the Linear Bandkeramik is markedly different from that of Late Mesolithic and Swifterbant sites in the wetlands, the material culture remains of the Vlaardingen and Stein group are notoriously similar (Louwe Kooijmans, 1983; Verhart, 2010b). These long-distance networks brought these communities closer together in a cultural sense. They began adopting similar pottery styles, as well as, to a lesser degree, lithic technologies.

11.4.1 Neolithisation, the consolidation of networks, and appropriation

Van Gijn linked the increasing adaptation of exotic flint to an increased incorporation of a new farming identity. Flint in this respect served to negotiate the emergence of a new identity which coincided with the adaptation of new subsistence strategies (Van Gijn, 2008, p. 200). The steps in the process of appropriation of Neolithic flint indeed mirror those of the Neolithisation process. The exact timeline for the Neolithisation process in the Rhine-Meuse-Scheldt delta is heavily debated (Amkreutz, 2013b;

Dusseldorp & Amkreutz, 2020; Louwe Kooijmans, 1993; Raemaekers, 2003; Raemaekers et al., 2021). However, it is unmistakable that the two processes, the appropriation of exotic flint and the adaptation of farming, largely coincide temporally and spatially (Van Gijn, 2008, 2015). In his study on the Neolithisation process in the Rhine-Meuse-Scheldt delta Amkreutz proposes an adapted version, building on Actor-Network-Theory, of the consolidation model by Zvelebil and Rowley-Conwy (Amkreutz, 2013b; Zvelebil & Rowley-Conwy, 1984). The proposed model of attunement consists of three phases: acquaintance; attunement; and integration (Amkreutz, 2013b, pp. 449–450). During the first phase of acquaintance people come in contact with new Neolithic elements (e.g. crop cultivation). This phase creates an awareness of these newly introduced traits, while it has only a limited impact on existing structures. The second phase of attunement involved the temporary acceptance of these new features. This phase involves the (temporary) acceptance of new actors and its subsequent positioning within established relations. The final phase is the integration phase in which the new elements are transformed and in which they acquire an accepted position within the network (Amkreutz, 2013b). In its nature the first step closely resembles the first of the four steps by Hahn. The second step resembles the second and third step as defined by Hahn, in the sense that here objects, or new subsistence strategies are used but are still regarded as 'new'. The final step resembles the fourth step in Hahn's typology, in which new elements are to a lesser degree regarded as something new.

The Neolithisation process is thus mirrored in the appropriation of exotic flint (Fig. 11.11). It shows that the transitions taking place in societies during the Neolithisation process did not only involve the adaptation of agriculture. The process is deeply rooted in social conventions and networks. The increased familiarity with farming strategies coincides with an increased familiarity, and increased contact, with upland communities.

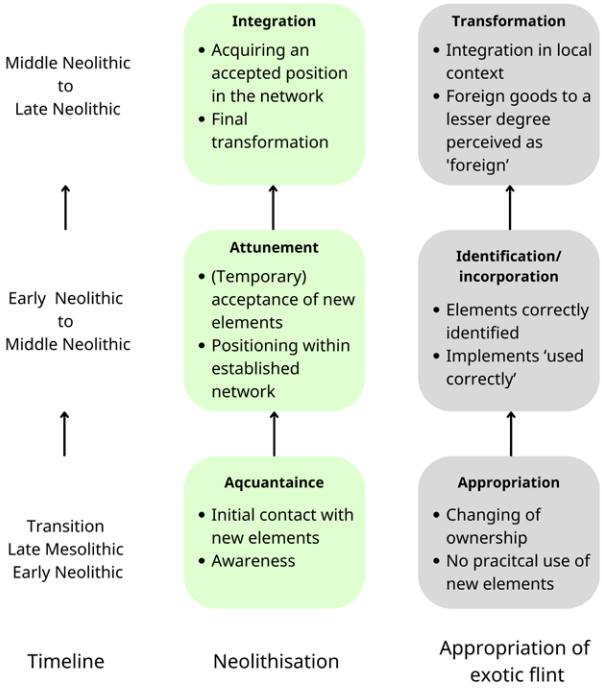


Figure 11.11 Visual representation of how the Neolithisation model by Amkreutz corresponds with the appropriation of flint, following the phases defined by Hahn (Amkreutz, 2013b; Hahn, 2004; Van Gijn, 2008; 2015).

11.4.2 Appropriation of exotics after the Vlaardingen Culture period

The Vlaardingen period can rightfully be seen as a period during which interconnectivity between different regions peaked, resulting in an increased normalisation of exchanged flint. Long-distance exchange continued during the latter part of the Late Neolithic, but here we again observe that long-distance import is interwoven with specific cosmological notions. Only during the Bronze Age do we again observe that exotic materials replace local technologies (Van Gijn, 2010c, p. 49; Vandkilde, 2016). This is not to say that the CWC and later BB societies were not well connected. DNA analysis revealed that these groups were highly mobile, and stable isotope analyses revealed that people often travelled great distances during their lifetime (Douglas Price et al., 1994; Haak et al., 2015; Olalde et al., 2018; Ortega et al., 2021; Papac et al., 2021). Wentink convincingly argued that these societies modelled their burial ritual to represent the deceased as travellers (Wentink, 2020). To construct widely recognised fronts similar objects were used in a standardised fashion. This afforded a common mode of communication across vast distances. He further notes that the exchange of objects was an integral part of this. These objects in turn served as a memento of these travels (Wentink, 2020, pp. 245–246). Grand-Pressigny daggers were exchanged over vast distances. Through these networks they also ended up with CWC societies in the modern-day Netherlands. But when these objects were exchanged their meaning and function changed. In France where they were originally produced, and in Switzerland, these objects are generally used as cereal harvesting tools (Plisson et al., 2002). In the Netherlands however these objects were reappropriated and reinterpreted. Their edges do not seem to have been used, but instead the daggers were repeatedly taken in an out of a sheath made from plant fibres (Van Gijn, 2010a, pp. 146–148). Despite their seemingly superior cutting edges they were thus not incorporated into the local technological system (Van Gijn, 2010a). Rather, they served as tokens of long-distance networks and display became their primary function. They were thus not

appropriated as defined by Hahn, and their originally intended use was not 'correctly identified', or at least they were not used according to their originally intended function (Hahn, 2004).

A modern parallel can be found in the import of Chinese porcelain in western Europe since the 16th century. Throughout the 17th and 18th centuries decorative porcelain was imported in large quantities for display purposes. These exotics served as 'pieces of places' much like Rijckholt flint in the Early Neolithic Rhine-Meuse delta or Grand-Pressigny daggers in Dutch CWC societies (Van Gijn, 2010a, 2015). Nowadays Chinese porcelain is still imported in vast quantities. However, due to globalisation and increased connectivity we no longer regard these imports as exotic 'pieces of places'. They have fully taken on the role which was previously fulfilled by locally produced earthenware. We have incorporated these objects in our local technological system, they are transformed, and as noted by Hahn, this transformation results in a different perception (Hahn, 2004). These objects are now only to a limited extent regarded as foreign. While we are aware of their origin we do not see them as 'Chinese cups', they are simply cups.

Considering the limited geographical scope of the VLC exchange networks we cannot consider this a phase of globalisation. However, it is interesting to note that the consolidation of these networks in many ways conforms to the trends which Jennings defined as characteristic traits for globalisation. The first of these is '*time-space compression*', an acceleration of economic, social and political processes, which shrinks one's experience of space and time. An obvious example of this phenomenon is the emergence of the internet (Jennings, 2017, p. 14). We can observe a similar trend here, as Rijckholt flint was for a long time considered to be 'exotic' (Van Gijn, 2015). The lands from which it came were clearly perceived as far away and conceptually as 'different'. The extensive similarities between the VLC and Stein group can furthermore be seen in the light of '*homogenisation*', another defining trend for globalisation (Jennings, 2017, p. 15; Louwe Kooijmans, 1983). A third associated trend is '*vulnerability*', Jennings notes that complex connectivity results in interdependence (Jennings, 2017, p. 17). Because of this dependence disruptions can have far-reaching consequences. It is noteworthy that the introduction of the BB in the region coincides with the disappearance of flint mines. At the Bell Beaker/Barbed Wire settlement of Molenaarsgraaf we observe that people exclusively use low-quality locally collected flint (Louwe Kooijmans, 1974, p. 234). Rijckholt/Spiennes and Hesbaye flint, which abounds at VLC sites, disappeared from the wetlands. Arguably we indeed observe vulnerability in this respect as these networks[34], which were shaped over a period of two millennia, were suddenly and irreversibly disrupted around 2500 BCE. The mining centres are a pan European phenomenon, with flint mines being known from Poland to the United Kingdom (Lech, 1997). There seems to be virtually no evidence for interactions between these mining centres, and no mined Polish or British flint is known from the present study area. We thus do not see the emergence of pan European exchange networks. The networks are more localised (compared to the later Bronze Age networks), in terms of their geographical breadth, but in nature they mirror later Bronze Age networks, which are described as an early form of globalisation (Vandkilde, 2016).

11.5 Taskscapes

This study focuses on flint and this inevitably creates a research bias, also reflecting a clear preservation bias. In this section I will therefore briefly touch upon the links between the flint procurement strategies and the way in which this activity is embedded within wider taskscapes. These taskscapes involve practical tasks, but they are also strongly rooted in social conventions and social networks (Ingold, 1993).

Based on the imported flint objects and the raw materials of which these products are made we can identify two distinct groups. Several raw materials appear to be imported exclusively as complete nodules. This mainly pertains to low-quality flints such as Meuse-eggs, terrace flint and moraine flint, as well as to Cap Blanc Nez flint. The second group is characterised by a wider range of imported products including pre-worked nodules, flint axes, and imported flint blades. This group is represented by Hesbaye flint and Spiennes/Lanaye flint. It has been suggested that this group mainly pertains to Spiennes flint, while Rijckholt flint is supposed to be scarce at VLC sites (Louwe Kooijmans, 1983, p. 60). The ED-XRF analysis however demonstrates that both Lanaye and Spiennes flints occurred frequently, and systematically, on these sites (Van den Dikkenberg & Braekmans, 2025). Lastly, we can identify a subgroup of the latter. This group is characterised by the same range of products. However, quantitatively this group is characterised by its scarcity. This subgroup consists of Lousberg, Valkenburg, and Obourg/Zevenwegen flint. Less than a dozen artefacts per source have been found for these groups, suggesting their import is incidental rather than systematic. The import of these flint groups was embedded in taskscapes which also involve other activities (Fig. 11.12).

34 Although the abandonment of these networks during the BB phase can also be explained from a social perspective, considering the abandonment as a choice rather than as vulnerability.

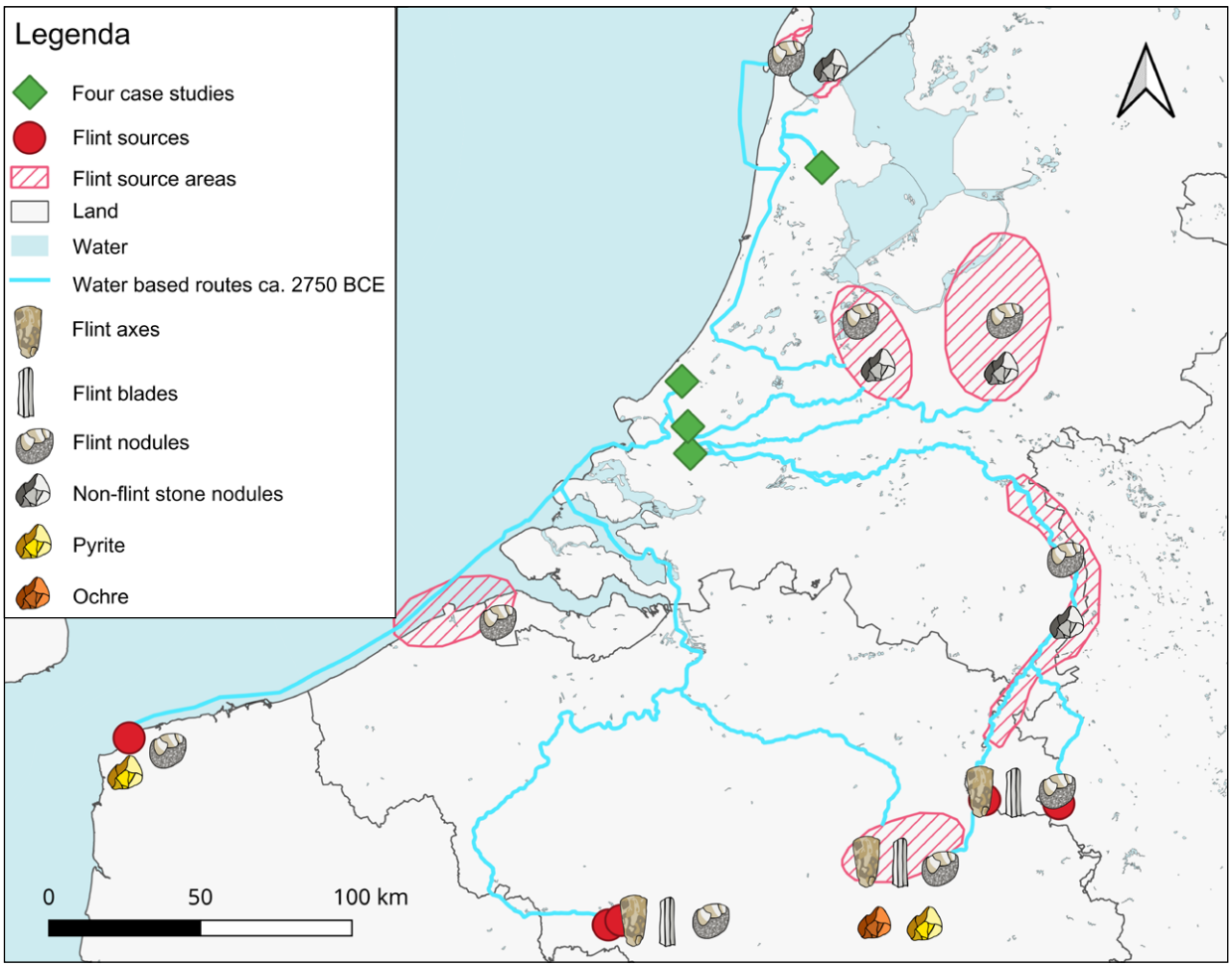


Figure 11.12 Map with flint sources, the four VLC sites under study, water-based exchange routes and procurement activities involved in the taskscapes across the landscape (after Van Gijn et al., 2006; Vos et al., 2020; basemap: © EuroGeographics 2024, map made in QGIS).

11.5.1 Regional sources, flint and stone

The group of materials imported from local/regional sources is imported from three distinct areas. The procurement of flint from these regions is embedded in taskscapes involving other procurement activities as will be discussed below. Meuse-eggs and terrace flint were imported from the areas of the Utrechtse Heuvelrug, the Veluwe area, and the Meuse-terraces. These areas also provided other types of stone such as sandstone, quartz, and granite (Houkes, 2021a, p. 121). These stones were used as hammerstones, grinding stones, and querns. Furthermore, granite and quartz were important tempering agents (Beckerman & Raemaekers, 2009; Bloo, 2017, 2021; De Bruin, 2024; Stet, 2021; Van Regteren Altena et al., 1962b). In line with previous suggestions by Van Iterson Scholten, I would argue that the procurement of these stones and flint was embedded within the same taskscape. (Van Iterson Scholten, 1981). A similar case can be made for the moraine flint which was presumably collected from moraine deposits in the north of Holland in Wieringen or Texel. Here a similar range of non-flint stones can be found (García-Díaz, 2017, p. 209). Again, we observe here that these procurement activities are combined in a single taskscape. For Cap Blanc Nez flint it is presently difficult to pinpoint the location from which this flint was extracted. The flint originates from the chalk cliffs in northern France, but sea currents could have transported this flint northwards towards the beaches of Zeelandic Flanders. These are vastly different areas, with distinct potentials. If flint was procured directly from the cliffs at Cap Blanc Nez the procurement of flint could have been combined with the procurement of pyrite nodules which can be collected in the same area (Strijbos, 1997). Pyrite nodules are hardly ever found at VLC sites. They are only known from Hellevoetsluis Ossenhoek (Van Gijn & Verbaas, 2009). The presence of strike-a-lights with pyrite pounding or scraping traces, however, demonstrates that pyrite must have been part

Figure 11.13 Nodule of Lousberg flint found at Voorschoten Boschgeest with stereomicroscope photo of the flint and cortex.

of the fire-making toolkits at many VLC sites (Houkes & Verbaas, 2014; Houkes et al., 2017; Metaxas, 2009; 2010; also see chapter 6, 9–10).

Because Zeelandic Flanders is closer to the VLC settlements this is often mentioned as the most likely source of Cap Blanc Nez flint (Van Hoof & Metaxas, 2009, p. 82). However, the idea that proximity was a decisive factor in procurement strategies is not necessarily supported by the study of raw materials. As Hesbaye flint and Spiennes/Lanaye flint were also imported from far away, the cliffs at Cap Blanc Nez would well fit within the geographic ranges from which flint could be imported. Recent experiments have furthermore demonstrated that simple dugouts could well have been used for long-distance seafaring journeys (Kaifu et al., 2025). At present the question of the exact origin of this flint cannot be solved, but if Cap Blanc Nez flint was procured directly from the cliffs in northern France it seems likely that its procurement was embedded in a taskscape which also involved the procurement of pyrite.

11.5.2 Axes and social networks

The collection of Hesbaye, and Spiennes/Lanaye flint involved a different taskscape. As argued in section 11.2 I consider it most likely that these flints were obtained through direct exchange, as the distribution of flint sources does not correspond with what we would expect in a down-the-line exchange model. If these flints are indeed directly procured the taskscape involving their procurement could potentially also include the procurement of other materials. Hesbaye is for example located close to the Ardennes region from which pyrite and ochre, which is occasionally found on VLC sites, could be imported (Houkes & Verbaas, 2017; Joosten et al., 2012). This taskscape is strongly rooted in social networks as it also incorporates the import of finished products. It is clear that the import of flint axes and blades was an important component of these networks. These objects must have been obtained through exchange because local skills and knowledge to produce these artefacts was lacking in the western Netherlands (Van den Dikkenberg, 2024b). These networks are thus not only characterised

by a dependency related to raw materials, but people also relied on skills from other groups. This taskscape therefore not only involved the exchange of objects. It also entailed social interactions with people from other communities. Gifts are reciprocal and as such, we expect that exchange also involved the export of products (Mauss, 1954). This likely pertains to organic objects, especially for Den Haag Steynhof it seems plausible that hide products were exchanged for flint (see section 12.2.2). It is also possible that bone, antler, meat, fish, or plant products were part of these exchange networks (Louwe Kooijmans, 1987).

11.5.3 Exotics and detours

The collection of Valkenburg and Lousberg flint that only occasionally made its way to the VLC sites involved a different taskscape. The scarcity of these flint sources suggests that these sources were presumably not regularly frequented. It seems more likely that these flint types were procured through down-the-line exchange. For example, in the area from which Rijckholt/Lanaye flint was imported Lousberg and Valkenburg flint also circulated (Louwe Kooijmans, 1983; Verhart, 2010b). It is likely that the scarce examples of Valkenburg and Lousberg flint were obtained occasionally through the same network which involved the import of Rijckholt/Lanaye flint. The mines in Lousberg and Valkenburg are reached through different side branches of the Meuse river and it seems unlikely that those routes were regularly visited. Presumably the social contacts related to their exchange were more important than their practical functions. In this sense these scarce objects might be regarded as 'pieces of places' rather than being an integral part of the local technological system. An interesting example of this is further provided by a yet unpublished nodule of Lousberg flint found at Voorschoten Boschgeest (Fig. 11.13). It is the only nodule of Lousberg flint in the western Netherlands (Valk & Hirschel, 2010; Van Hoof & Metaxas, 2009; Verhart, 1983). The object consists mostly of cortex and, had it been worked, it would only have provided a minimal amount of flint. It seems unlikely that this nodule was imported over a distance of more than 300 km because of its use potential. Rather, it seems likely that it was imported as a token of long-distance contacts, quite similar to what was observed regarding the unworked Rijckholt precore found at the Late Mesolithic site of Hardinxveld Polderweg (Van Gijn, 2015; Van Gijn et al., 2001a).

11.6 Looking ahead

We can conclude that flint during the VLC period was obtained from a wide range of far-flung sources. While some exotics might have been obtained through down-the-line exchange it seems that the most common materials such as Hesbaye flint were likely obtained through direct exchange. Non-local flint became more prominent than in previous periods which led to an increased normalisation and appropriation of exotic flint. These diverse procurement strategies are embedded in wider taskscapes which also involve other materials such as non-flint stone, pyrite and ochre. It also entails the long-term maintenance of social networks which facilitated the exchange of goods. From a biographical perspective the above is merely the start of the life journey of objects. Flint is sourced and turned into objects, which in turn are meant to be used. The following chapter will therefore continue the biographical itinerary by addressing the production and use of flint objects.

12

The technological system

12.1 Lithic technologies

It is often noted that VLC lithic technology can be characterised as ad hoc technology (Amkreutz et al., 2016, p. 174; Van Gijn, 2010b, p. 83). This is supported by the present study. In addition to formal tools, a wide variety of ad hoc tools was found. As observed previously by Van Gijn, unmodified flakes were often used in a wide variety of tasks (Van Gijn, 1990b). Ad hoc technologies are often described as being wasteful with respect to raw material (Amkreutz, 2013b, p. 182; Andrefsky, 1994). This does not appear to be the case with the VLC ad hoc use of flint. It can be observed that a high percentage of artefacts in these assemblages bear use-wear traces (Tab. 12.1). At Den Haag Steynhof and Vlaardingen about one in four artefacts has use-wear traces. A technology directed at for example the production of bifaces would produce far greater numbers of waste artefacts (unused artefacts) per functional tool (Newcomer, 1971, p. 92). The focus on functional edges is deemed characteristic of the VLC lithic industry (Van Gijn, 2010a, p. 135). This in turn provides an efficient means to produce a maximum number of workable edges while producing only a limited amount of waste. The efficiency of this ad hoc technology thus lies in its flexibility. This study highlights that we should be hesitant with equating ad hoc technologies with wasteful technologies (Andrefsky, 1994). This suggests that knapping debitage cannot be regarded as 'waste' without conducting use-wear analyses. This was also recently shown by Stemp et al. in their study of assemblages from two Maya sites in Mexico and Belize, where they found that debitage had been extensively utilised (Stemp et al., 2021).

This frugal use of flint is further highlighted by the extensive evidence for recycling (Van den Dikkenberg et al., 2024a). The importance of recycling is best demonstrated by the reuse of flint axes, but other artefact types were also reused and recycled. An interesting example is provided by a sickle fragment which was turned into a scraper used for hide working (Fig. 12.1d).

In terms of recycled flint axes, it is interesting to note that the importance of recycled flint axes varies greatly among VLC sites. Based on our experiments we can assume that the number of axe fragments with a remnant of the outer ground or polished surface of axes represents only ca. 41% of the total number of axe fragments on a site (Van den Dikkenberg et al., 2024a; also see chapter 5). Based on this figure, estimates have been provided for different VLC sites

Site	Total number of artefacts in selected zone	Number of artefacts with use-wear traces	Percentage of artefacts with use-wear traces
Den Haag Steynhof	1253	317	25.3%
Hekelingen III	1011	143	14.1%
Vlaardingen Arij Koplaan trench 15	448	117	26.1%
Vlaardingen Arij Koplaan trench 17	118	33	28.0%
Zandwerven	113	17	15.0%

Table 12.1 Number of artefacts per site and number and percentage of artefacts with use-wear traces (Van Gijn, 1990b).

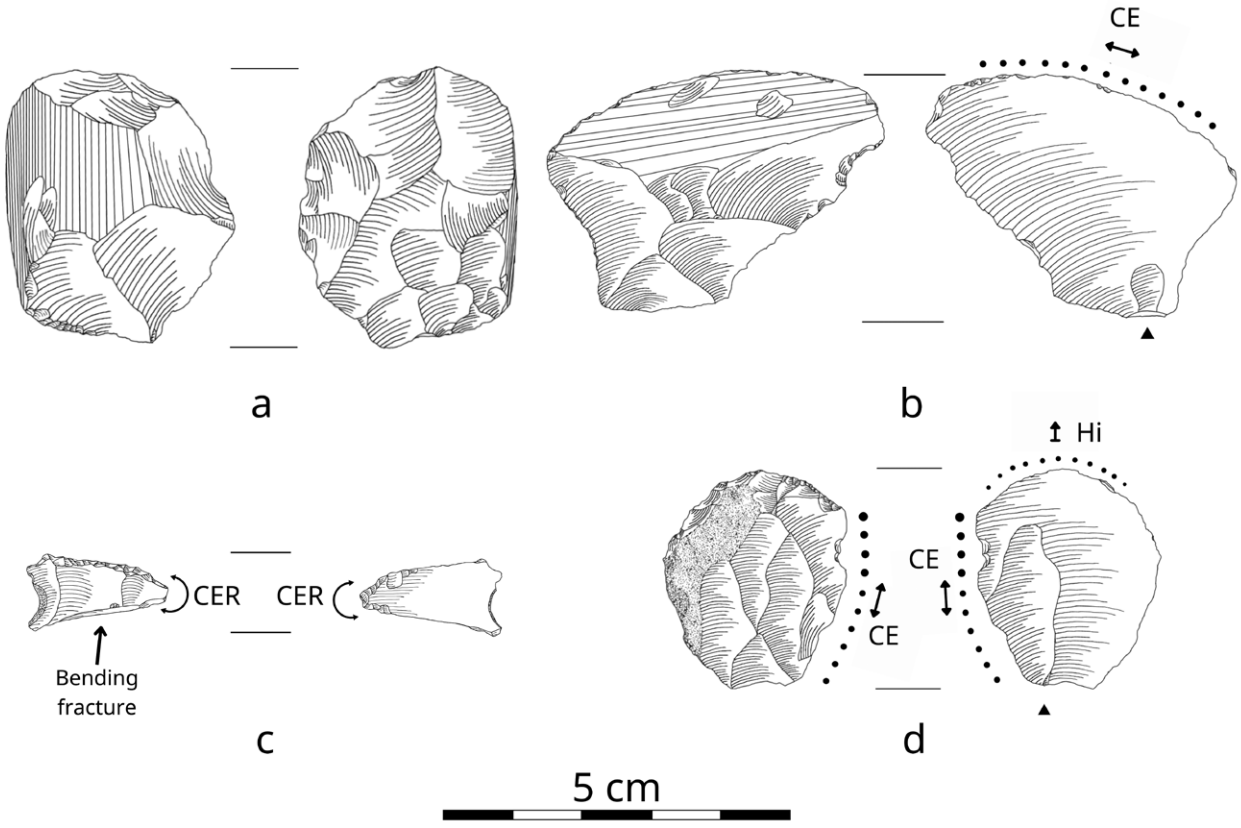


Figure 12.1 Recycling of flint at Vlaardingen Arij Koplaan, a) flake core 1017 from trench 16 made from a recycled flint axe, b) sickle 379 used for cereal cutting from trench 11 made from a flake struck from a flint axe, c) flint borer 252 from trench 11 made from a broken scraper, d) flint scraper 634 from trench 11 made from a recycled flint sickle.

(for which data was available) for assemblages with >20 flint artefacts, and which did not consist of mixed assemblages (see appendix 8).[35] If we group these sites by environmental settings we see that axe fragments are especially common on the levee sites (Fig. 12.2). Here they are far more common than on sites in the eastern river area (the area near Nijmegen) and Brabant. Those areas are located in between the levees and the areas from which these axes are obtained. This makes it furthermore unlikely that axes were imported to the levees via a down-the-line exchange system (see chapter 11). The uneven distribution raises questions about how recycled axes ended up in these assemblages. If communities would recycle their own axes when they break we would expect that axes occur in similar quantities on all VLC sites. Houkes suggested that broken axes might also have been imported to VLC sites (Houkes, 2024). This indeed might explain the great variation in importance of recycled flint axes.

An interesting question posed by Van Gijn is whether the recycling of flint axes is mainly driven by opportunism, or whether perhaps axes are specifically selected for reuse because of their exotic origin and aesthetic qualities (Van Gijn, 2010a, p. 139). To test whether axe fragments are more frequently selected for use than other flints percentages have been calculated for the assemblages of Den Haag Steynhof, Hekelingen III, and Vlaardingen Arij Koplaan (Tab. 12.2). At these sites axe fragments are more commonly used than non-axe fragments. However, an unpaired t-test shows that the differences are not significant ($\rho = 0.0872$). This seems to suggest that the recycling of axes was likely opportunistic, rather than axes being selected specifically because of their exotic origin and aesthetic qualities.

12.1.1 Percussion types

It is often noted that the predominant use of hard hammer percussion is characteristic of VLC sites (Amkreutz et al., 2016, p. 174; Van Gijn & Bakker, 2005, p. 295). This can be nuanced based on the data presently available. For thirteen sites quantitative data is available on percussion types. At seven soft hammer percussion dominates (Tab. 12.3).[36] For the assemblages of Rotterdam Beverwaard Tramremise,

35 Zandwerven was excluded from the overview because, although the original publication reported axe fragments, these were absent in the analysed material. It is therefore unclear to what extent the recycling of axes played a role at this site (Van Regteren Altena & Bakker, 1961, p. 35).

36 Data from Haamstede Brabers is not included here, although Verhart reported percussion types he does not mention bipolar percussion. But one of the scrapers in Figure 6 appears to have a bipolar impact mark suggestion that bipolar percussion was applied at this site (Verhart, 1992, 78-80).

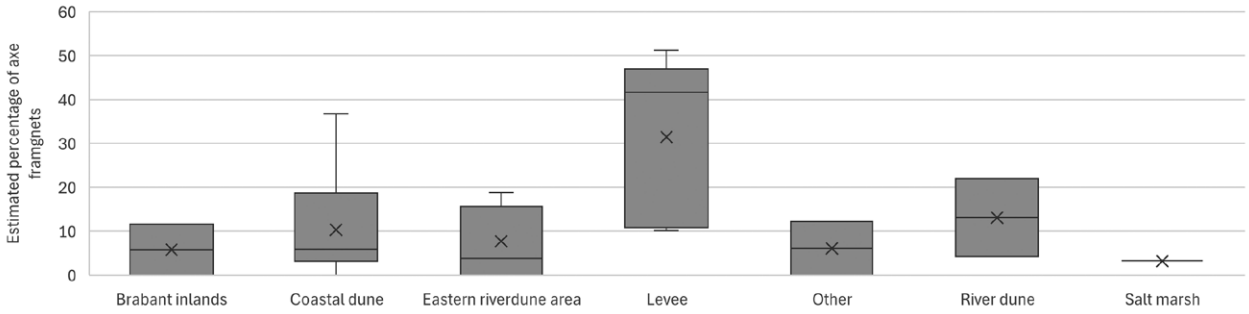


Figure 12.2 Estimated importance of recycled flint axes for VLC sites in different environmental zones (Van den Dikkenberg et al., 2024a; see appendix 8).

	Total number of axe fragments	Axe fragments with use-wear traces	Total number of non-axe flint artefacts	Non-axe flint artefacts with wear- traces	% Axe fragments with use-wear traces	% Non-axe flint with use-wear traces
Den Haag Steynhof	81	40	393	277	49.4%	41.3%
Hekelingen III	73	35	269	111	47.9%	41.3%
Vlaardingen trench 15	62	28	192	89	45.2%	46.4%
Vlaardingen trench 17	13	8	57	25	61.5%	43.9%

Table 12.2 Axe fragments and use-wear traces for Den Haag Steynhof, Hekelingen III, and Vlaardingen Arij Koplaan.

Voorschoten-De Donk, Beuningen Ewijk Hekkeslag, Nijmegen Griftdijk/Stationsstraat Noord vindplaats 1 and Den Haag Rhyenhof quantitative data is absent, but for these sites it is noted that hard hammer percussion dominates (Houkes, 2014, p. 107; Mendelts, 2018, p. 336; Van de Korft, 2019, p. 74; Van Veen, 1989, pp. 27–28; Zijl et al., 2011, p. 50).

The use of hard hammer percussion thus indeed dominates most VLC assemblages, but soft percussion is generally present as well. It is unclear to what extent the dominance of soft hammer percussion on some sites, as opposed to the dominance of hard hammer percussion at others, should be explained as varying interpretations. For the assemblages of Vlaardingen Arij Koplaan and Zandwerven I included the use of soft stone percussion as a specific category. Soft stone percussion can be recognised based on the presence of a lip in combination with a fairly pronounced, and occasionally a double, bulb of percussion (Moos et al., 2024; Pélegrin, 2000; Pélegrin & Inizan, 2013). It thus resembles both features from soft organic percussion (lip) as well as those from hard stone percussion (a pronounced bulb of percussion). Because this category is absent in interpretations of other assemblages it is unclear to what degree these ended up either with the category of hard hammer percussion (because of the pronounced bulb of percussion) or those with soft hammer percussion (because of the lip). For Zandwerven and Vlaardingen it could be observed that soft percussion is mostly represented by the use of soft stone hammers. Overall, organic soft hammer percussion appears to be scarce. Stone hammers, both soft and hard stone, seemed to be the preferred type of hammer during the VLC period. This fits well with the observed ad hoc flaking technology, since organic hammers are more commonly used in technologies such as biface production (Schindler & Koch, 2012, p. 100).

The use of bipolar percussion is mostly related to the use of low-quality raw materials such as rolled pebbles (Van Gijn, 2010a, p. 136; 2010b, p. 83). As such the use of bipolar percussion varies greatly per site. At Hekelingen I, II, III and IV this technique is absent, as is low-quality flint (Verhart, 1983). At Zandwerven by contrast the technique is very common, here all flint consists of low-quality material (Tab. 12.3). This technique was necessary when small rolled pebbles were used (Van Gijn, 2010a, p. 136; 2010b, p. 83). It thus seems that the application of bipolar percussion is raw material dependent, being linked to the use of low-quality flint. The presence of this technique at the dune sites and in the Nijmegen area is likewise mostly due to the affordances of the raw materials. Knapping technologies were thus in part predetermined by the raw material availability. A similar observation was previously made about flint used on CWC settlements in Noord-Holland (García-Díaz, 2017, p. 215). As such this seems to represent a wider phenomenon during the Late Neolithic.

The occasional presence of antler pressure flakers indicates that pressure flaking was also applied (Van den Broeke, 1983, pp. 174, 190). This likely relates to the production of objects with surface retouch, notably

Site	Hard hammer	Soft hammer	Bipolar	% Bipolar
Den Haag Noordweg 76	12	0	1	7.7%
Den Haag Steynhof	830	123	83	8.0%
Den Haag Wateringse Binnentuinen	390	15	8	1.9%
Hekelingen I	15	138	0	0%
Hekelingen II	1	6	0	0%
Hekelingen III	241	419	0	0%
Hekelingen IV	4	10	0	0%
Leidschendam Berberis	8	477	10	2.0%
Vlaardingen Arij Koplaan trench 15	86	59	2	1.4%
Vlaardingen Arij Koplaan trench 17	15	20	2	5.4%
Wijchen Bijsterhuizen	63	93	7	4.5%
Wijchen Oostflank	725	52	41	5.0%
Zandwerven	25	7	7	21.9%

Table 12.3 Percussion types per site and percentage of bipolar flakes per site (Houkes, 2021b; Houkes & Drenth, 2017; Houkes et al., 2017; Veldhuis, 2017, 2020; Verhart, 1983).

tanged arrowheads. Lastly, at the excavation of Wijchen Bijsterhuizen it was noted that indirect percussion was also used (Veldhuis, 2017, p. 179). This technique has not been analysed in this study, or in other published studies. As such it remains unclear whether the use of indirect percussion at Wijchen Bijsterhuizen is exceptional, or whether it represents a common, but understudied, technique.

12.1.2 Flint hammerstones

An interesting observation can be made about the use of flint hammerstones in the VLC. Such hammerstones are well known from Linear Bandkeramik sites, but they appear to be scarce in other periods (De Grooth, 2005; Houkes et al., 2017, p. 176; Van Gijn, 1990b, pp. 66–69). Only a few examples are known from Swifterbant (n=18), Hanzendonk-3 (n=5), or FBC (n=3) assemblages (Tab. 12.4). The use of flint hammerstones is not known from CWC settlements in Noord-Holland (García-Díaz, 2012, 2013, 2014; Van Heeringen & Theunissen, 2001b). The few hammerstones found in CWC graves in the Netherlands are all made from non-flint stone (Wentink, 2020, p. 134). In VLC assemblages flint hammerstones are not exceptional, with 51 known examples they are a regular occurrence (Tab. 12.4). Their use fits well with the observed ad hoc nature of the VLC technological system. This use is often secondary, as 47% of the flint hammerstones consist of recycled flake cores (n=24), which in turn are often made from recycled flint axes (n=7). It is interesting that flint hammerstones are absent on CWC sites in Noord-Holland. This suggests that these communities had different notions about the appropriate raw materials for hammerstones, signalling they made different technological choices (Lemonnier, 1986). Vlaardingen communities used both flint and non-flint hammerstones while CWC communities exclusively used non-flint stones as hammerstones (García-Díaz, 2017). Later BB and Bronze Age sites only contain seven flint hammerstones (Van Gijn & Niekus, 2001). It is significant that the number of flint hammerstones found at VLC sites (n=51) exceeds the combined number of known flint hammerstones from Swifterbant, Hazendonk-3 group, FBC, CWC, BB, and Bronze Age sites (n=32).

It is remarkable that the flint hammerstones from VLC sites occasionally outnumber the hammerstones made from other stone types.[37] This is especially the case with VLC sites in Noord-Brabant and the Nijmegen area (Tab. 12.5). This contrasts sharply with Swifterbant sites where a clear preference for the use of sandstone and quartzite hammerstones is apparent (Devriendt, 2013a, p. 112; Knippenberg & Verbaas, 2023). A similar preference for sandstone and quartzite hammerstones can be observed on the Hazendonk-3 group sites of Schipluiden and Wateringen-4 (Raemaekers et al., 1997; Van Gijn & Houkes, 2006). At Ypenburg the stone types show a greater variation (Houkes, 2008a). For the Vlaardingen flint hammerstones no clear preference for either high or low-quality flint could be observed. Occasionally they consist of high-quality flint, often in the form of recycled flint axe flake cores. Nevertheless, low-quality flint such as Meuse-eggs were also employed.

Overall we can conclude that the frequent use of flint hammerstones, with the exception of their use during the

37 Flint and non-flint hammerstones are discussed together here, functional analysis on either of these categories has however not been systematically conducted. It has been suggested that flint hammerstones from the LBK might have been used for pecking grinding stones, if flint and non-flint hammerstones indeed have differing functions they might represent two different tool types (personal communication L.W.S.W. Amkreutz and A.L. van Gijn, 2025).

	Unworked nodule	Flake core	Axe flake core	Other/ indet/ unspecified	Total
Beuningen Ewijkse Veld	4	19	1	-	24
Den Haag Noordweg 76	-	-	1	-	1
Den Haag Steynhof	1	-	-	-	1
Den Haag Wateringse Binnentuinen	-	2	1	1	4
Den Haag Wateringse Veld areaal west	-	-	-	1	1
Hekelingen III	-	-	2	-	2
Vlaardingen trench 17	1	-	-	-	1
Wijchen Oostflank	4	3	-	2	9
Oerle Zandoerlseweg	-	-	-	1	1
Leidschendam-Voorburg Duivenvoordecorridor	-	-	1	-	1
Veldhoven Habraken	4	-	1	-	5
Zandwerven	1	-	-	-	1
Total	15	24	7	5	51

Table 12.4 Flint hammerstones from VLC sites (Asmussen & Moree, 1987; Devriendt, 2013b; Houkes, 2014; 2021b; 2023; Houkes & Drenth, 2017; Houkes et al., 2017; Molthof, 2018; Van Hilst, 2018).

	Flint hammerstone	Other stone	Total	Percentage flint hammer-stones
Vlaardingen Culture				
Beuningen Ewijkse Veld	24	4	28	85.7%
Den Haag Noordweg 76	1	2	3	33.3%
Den Haag Steynhof	1	18	19	5.3%
Den Haag Wateringse Binnentuinen	4	10	14	28.6%
Den Haag Wateringse Veld areaal west	1	1	2	50%
Hekelingen III	2	7	9	22.2%
Vlaardingen trench 17	1	2	3	33.3%
Wijchen Oostflank	9	13	22	40.9%
Oerle Zandoerlseweg	1	0	1	100%
Leidschendam-Voorburg Duivenvoordecorridor	1	1	2	50%
Veldhoven Habraken	5	1	6	83.3%
Zandwerven	1	11	12	8.3%
Bell Beaker/Bronze Age				
Meteren de Bogen	1	50	51	2%
Eigenblok	3	9	12	25%
Boog C-Noord	1	19	20	5%
Lienden	2	14	16	12.5%

Table 12.5 Flint hammerstones and other stone hammerstones from VLC, BB/Bronze Age, FBC, Hazendonk-3 group, and Swifterbant Culture sites (Asmussen & Moree, 1987; Devriendt, 2013a, 2013b; Houkes, 2014; 2021b; 2023; Houkes & Drenth, 2017; Houkes et al., 2017; Houkes, 2008a; 2008b; Knippenberg et al., 2011a; Knippenberg & Verbaas, 2023; Knippenberg et al., 2011b; Molthof, 2018; Niekus & Huisman, 2001; Niekus et al., 2002a; 2002b; Niekus et al., 2001; Raemaekers et al., 1997; Van Beek, 1990; Van der Kroft, 2023; Van Gijn et al., 2002; Van Gijssel et al., 2002; Van Hilst, 2018; Verbaas et al., 2011a; Verbaas et al., 2011b; personal communication A. Westra 2025 for Zandwerven and Vlaardingen trench 17 non-flint hammerstones).

	Flint hammerstone	Other stone	Total	Percentage flint hammer-stones
Funnel Beaker Culture				
Hanzenlijn-Oude Land	1	3	4	25%
Hattemerbroek-Bedrijventerrein Zuid, location 1	1	108	109	0.9%
Hattemerbroek-Bedrijventerrein Zuid, location 12	1	1	2	50%
Hazendonk-3 group				
Wateringen-4	1	13	14	7.1%
Ypenburg	3	28	31	9.7%
Swifterbant Culture				
Tiel Medel	16	350	366	4.6%
Swifterbant S3	2	12	14	14.3%

Table 12.5 continued.

Site	Hinge	Step	Feather	Plunging	Other/ indet	Total	Hinge/Step/ Plunging%
Den Haag Noordweg 76	1	0	7	0	11	19	
	5.3%	0%	36.8%	0%	57.9%		5.3%
Den Haag Steynhof	43	21	284	13	237	598	
	7.2%	3.6%	48.2%	2.2%	39.6%		12.9%
Den Haag Wateringse Binnentuinen	77	0	181	4	257	519	
	14.8%	0%	34.9%	0.8%	49.5%		15.6%
Hekelingen I	50	8	44	0	9	111	
	45.0%	7.2%	39.6%	0%	8.1%		52.3%
Hekelingen II	3	0	4	0	0	7	
	42.9%	0%	57.1%	0%	0%		42.9%
Hekelingen III	309	18	161	2	41	531	
	58.2%	3.4%	30.3%	0.4%	7.7%		62.0%
Hekelingen IV	6	0	4	0	0	10	
	60.0%	0%	40.0%	0%	0%		60%
Vlaardingen trench 15	54	13	53	3	128	251	
	21.5%	5.2%	21.1%	1.2%	51%		27.9%
Vlaardingen trench 17	11	1	12	0	39	63	
	17.5%	1.6%	19%	0%	61.9%		19.0%
Zandwerven	7	0	8	3	40	58	
	12.1%	0%	13.8%	5.2%	69.0%		17.2%

Table 12.6 Flake terminations number and percentages per site (Houkes, 2021b; 2023; Houkes & Drenth, 2017; Verhart, 1983).

Linear Bandkeramik period, is a typical VLC phenomenon (De Grooth, 2005; Houkes et al., 2017, p. 176; Van Gijn, 1990b, pp. 66–69). Their use fits well with the previously observed preference for the use of hard hammer percussion. Although flint hammerstones are a recurring feature, they are not present on all VLC sites. They are for example absent at Leidschendam Berberis and the Hazendonk (Bienenfeld, 1986; Veldhuis, 2020).

12.1.3 Skills, the emergence of flint mines

On all sites high percentages of hinge, plunging, and step terminations attest to a low degree of skill (Tab. 12.6; Fig. 12.3). The percentages are consistent with what would be expected of non-specialised knappers (Shelley, 1990). It is remarkable that flint from the levee sites displays higher percentages of hinge, step, and plunging terminations. Mostly these consist of hinge fractures.

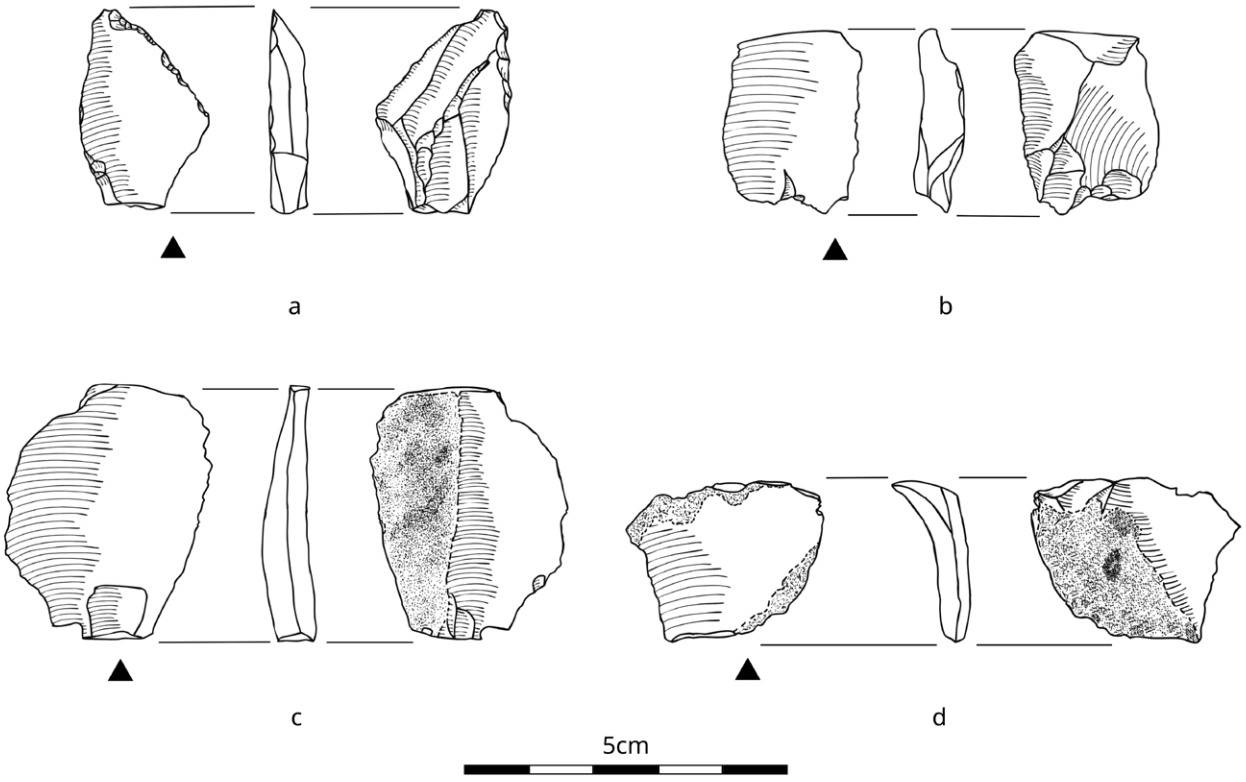


Figure 12.3 Flake termination on lithics from Vlaardingen Arij Koplaan: a) feather (trench 15, 301.1); b) hinge (trench 17, 511b); c) step (trench 17, 453f); d) plunging (trench 15, 261.1).

In the coastal dune area feather terminations are consistently more common than hinge fractures. Hinge fractures commonly occur when insufficient force is applied during knapping (Whittaker, 2009, p. 109). In the coastal dune area raw materials generally consist of small nodules (Van Gijn, 2010b). It is possible that due to the small size of these nodules hinges are less common, as less force is required for a successful strike. It is interesting in this respect that plunging terminations seem to be more common on the dunes than on the levees. Plunging terminations result from excessive force being applied (Whittaker, 2009, pp. 227–229). This in turn logically occurs more easily with small nodules than with large nodules. It seems plausible that the occurrence of knapping mistakes is partially predetermined by the available raw materials.

The percentages of hinge fractures on VLC assemblages seem to be higher than those reported for earlier Swifterbant material, where hinge percentages range from 6–11% (Devriendt, 2013a, p. 180). This might indicate a decrease in knapping skills over time for wetland sites. This decrease would then coincide with the gradual disappearance of blade technologies and the reorientation towards ad hoc flaking technologies (Amkreutz et al., 2016; Peeters & Devriendt, 2016).

Technologically a few tool categories stand out. The presence of oval flint axes indicates a high degree of skill which is otherwise absent at these sites. None of the flint assemblages present evidence for flint axe production, and axe preforms are completely absent in the western Netherlands (Van den Dikkenberg, 2024b). This indicates that these axes were imported in a finished state (Bakker, 2006). A similar observation can be made for some of the blades found at these sites. None of the assemblages under study contain blade cores. Yet, several blades with regular trapezoidal or triangular cross-sections seem to have been made using systematic blade core reduction strategies (Sain & Goodyear, 2016). This presence of blades combined with an absence of blade producing technologies indicates that blades were also imported in a finished state (Van den Dikkenberg, 2024b).

We observe that in areas outside of the wetlands, where high-quality flint is abundant, flint mines emerged. This coincided with the Neolithisation process and subsequent emerging sedentism. These centres retain blade technologies throughout the Michelsberg and Stein group phases (De Grooth, 1991; De Warrimont & Amkreutz, 2015; Schreurs, 2016). They furthermore emerged as specialised production sites for flint axes (De Grooth,

1991; Felder, 1975; Schyle, 2006). These technologies required specialised skills which were acquired through a combination of training and practice (Castañeda, 2021; Van Gijn, 2010a, p. 164). Archaeologically, it is documented that novices need abundant raw materials in order to properly learn complex knapping technologies (Brooke Milne, 2012; Ferguson, 2008; Finlay, 2008; Pigeot, 1990). In mobile hunter-gatherer groups this often entails extensive practice sessions when areas with abundant raw materials were frequented (Brooke Milne, 2012). We can suppose that Mesolithic and Palaeolithic communities frequented flint sources on their yearly cycles. It is interesting that evidence for practice knapping was found at the Late Palaeolithic site of Oldeholtwolde in the Northern Netherlands. The site contained a mix of both locally sourced raw materials as well as imported flint (Johansen & Stapert, 2004, p. 114). Based on the refitting analysis three individual knappers were identified at the site. One of these was an unskilled knapper who 'ruined' several cores in the process (Johansen & Stapert, 2004, pp. 217–218). Similarly, Pigeot documented that at the Magdalenian site of Etiolles, products made by novice knappers were not incorporated into the technological system. Only the more skilfully produced artefacts were used for tool production, making novice knapping highly wasteful in terms of raw material (Pigeot, 1990). This kind of wasteful practicing is not observed at VLC sites. Here it seems that true waste is rarely produced, and a large portion of the flint at these sites ends up being used (based on the use-wear analysis).

During the Neolithic we observe that communities settle down in territories with varying degrees of raw material availability (Van Iterson Scholten, 1981). Communities in the western Netherlands inhabit territories where lithic raw materials are completely absent (Houkes, 2021b, p. 147; Van Iterson Scholten, 1981). In Dutch Limburg and much of Belgium communities live near sources with an abundance of high-quality flint. After the Early Neolithic flint mines emerge here to supply communities in a wider area with high-quality flint. Simultaneously in these communities part-time knapping specialists emerge (De Grooth, 1991, p. 177). These are responsible for knapping axe rough-outs and potentially for knapping high-quality flint blades. In contrast, raw materials are not abundant on sites in the Western Netherlands. It is telling that a site like Den Haag Steynhof, with multiple house plans contains only ca. 5 kilograms of flint (Houkes, 2021b). This is insufficient to allow novices to acquire a high degree of knapping skills. Rather than acquiring the complex skills needed for axe and blade production people adopted ad hoc technologies, which were supplemented with the import of complex tool types such as axes and high-quality blades. We thus see that sedentism (though perhaps only partially present in the wetlands), raw material availability, skills, and inter-regional exchange networks are closely intertwined.

12.1.4 Axe finishing traces

The study of grinding and polishing traces on flint axes presented interesting insights. Surprisingly, major differences could be observed in the finishing traces in different landscape zones. The axes in the coastal dune area are generally only ground on a grinding stone, without being subsequently polished. The axes on the levee sites often display extensive polishing traces, mostly done with leather and additives (Van den Dikkenberg, 2024a). In terms of raw materials it can be observed that both types of finishing traces occurred on Hesbaye flint and Spiennes/Lanaye flint. Originally the latter group could not be subdivided (Van den Dikkenberg, 2024a). The ED-XRF analysis however demonstrated that Lanaye and Spiennes flint can be distinguished based on their chemical signatures (Van den Dikkenberg & Braekmans, 2025). In Figure 12.4 the production traces observed on Spiennes/Lanaye flint axe fragments are plotted together with reference samples of Spiennes and Rijckholt/Lanaye flints. The latter category includes Rijckholt flint as well as flint from six eluvial Lanaye sources. As the latter are all found in the same area in southern Limburg, and because they have a similar chemical signature, they are grouped together for clarity.

It can be observed that axes which are only ground occur both in the chemical ranges for Spiennes flint (with p values of more than 1000 ppm) and in the ranges of Rijckholt/Lanaye flint (with p values below 500 ppm). The same applies to axe fragments which were polished with leather and additives. It can thus be concluded that the observed differences in finishing traces are not related to the raw materials employed to make the axes. Hesbaye, Rijckholt/Lanaye, and Spiennes axes all display similar, diverse, production traces. The surprising differences between the dune sites and levee sites remain difficult to explain. It is possible that the finishing stages, the polishing with leather and additives, took place at VLC sites, rather than near the flint mines. Different preferences could in that sense explain the differences between these sites. It is also possible that flint mines produce both polished and unpolished axes and that inhabitants of the levees preferred polished axes while inhabitants of the coastal dune area mainly imported unpolished (but ground) axes. Another possibility is that axes are generally imported after being polished, but that the axes on the coastal dune sites were more heavily resharpened or reworked, erasing the polishing traces. Lastly, it is possible that axes on the levees were repolished after resharpening or reshaping, while this was not the case in the coastal dune area (Van den Dikkenberg, 2024a).

A future study on production traces on axes near the flint mines could shed light on the question whether polishing with leather and sand took place near the mines, or whether this was an additional production step which took place at

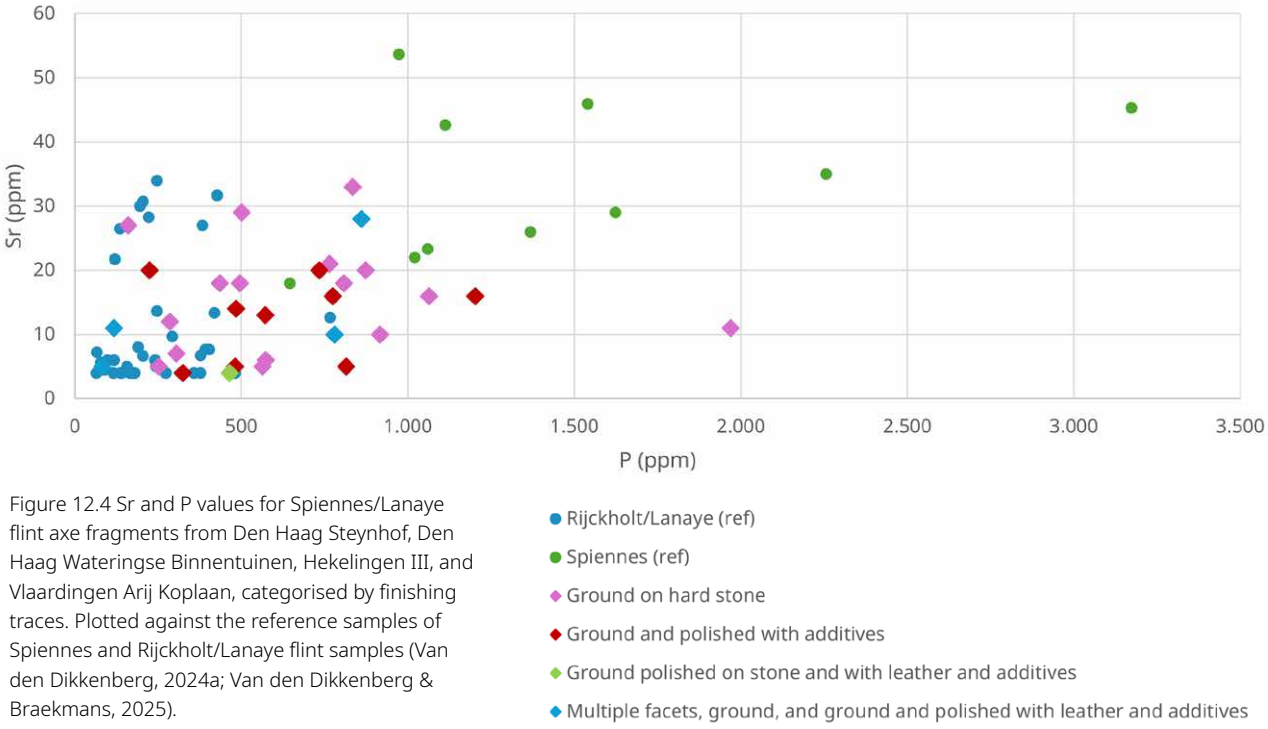


Figure 12.4 Sr and P values for Spiennes/Lanaye flint axe fragments from Den Haag Steynhof, Den Haag Wateringse Binnentuinen, Hekelingen III, and Vlaardingen Arij Koplaan, categorised by finishing traces. Plotted against the reference samples of Spiennes and Rijckholt/Lanaye flint samples (Van den Dikkenberg, 2024a; Van den Dikkenberg & Braekmans, 2025).

VLC settlements. The question also remains why additional polishing after grinding was conducted. It seems unlikely that polishing was done to enhance the performance of the axes, as in those cases we would expect that polishing would be limited to the functional edge of the axe. It could be observed, both archaeologically and experimentally, that unpolished axes display a matt appearance combined with a whitish sheen (Fig. 12.5a). This white sheen obscures visibility of the internal structure of the flint (features such as inclusion size, colour etc.). Polishing by contrast brings these patterns to the foreground (like what one can see when looking at polished gemstones).

According to Bakker 'patchy flint' (flint with large inclusions) is likely tougher and less prone to breakage.[38] He observed that this flint was specifically selected for the production of Buren axes, according to him because these patches would have been "*trademarks for excellent quality*"(Bakker, 2006, p. 263). Following this line of reasoning we can observe that such trademarks were partially obscured by grinding, but that they could be brought to the foreground through polishing (Fig. 12.5b). In this regard it might be fruitful to consider the dominance of polished axes on the levees, and the dominance of ground axes in the coastal dune area, as reflecting an emphasis on high-quality flint on the levees. This fits well with the other observations made regarding the raw material procurement strategies at those sites (see chapter 6–11). The inhabitants of the levee sites were clearly concerned with obtaining high-quality materials while this was less of a concern for inhabitants of the coastal dune area. Lastly, it can be noted that in addition to being possible markers of excellence inclusions of flint are also indicative of the origin of flint (De Grooth, 2011). It is very likely that people in the past similarly were able to recognise sources based on such qualities. If that would be the case it is possible that polishing made it easier for people to recognise the source from which these axes were derived (Bradley, 2000, p. 120). This notion was proposed by Bradley for axes from Britain, but, as Fontijn suggests, it is also worth considering the polishing of Neolithic axes from the Netherlands from a similar perspective (2002, p. 77). Based on the association between extensive polishing and an emphasis on exotic raw materials this hypothesis now seems to be a plausible explanation for the extensive polishing of flint axes during this period.

38 It should be noted that this has not been tested and thus remains hypothetical.

12.2 Domestic life in the wetlands

The functional differentiation of VLC sites is in part based on use-wear analyses (Raemaekers, 2003; Van Gijn, 1990a; 1990b). Therefore, the revision of key VLC sites in this study provides valuable new data to test notions about inter-site variation during the VLC period. Raemaekers suggested that a smaller spectrum of activities took place on levee sites than on sites in the coastal dune area. He further linked this discrepancy to different occupation durations in these environmental zones (Raemaekers, 2003). Figure 12.6 presents a network representation of activities taking place on the four main sites analysed in this study.

Figure 12.5 Hesbaye flint axe fragments, a) ground axe fragment from Den Haag Steynhof (STY17o.000710STN.6), with clear white sheen which partially obscures the visibility of the internal structure; b) axe fragment from Vlaardingen Arij Koplaan trench 15 (671.3) which was polished with leather and additives, which enhances the visibility of inclusions.

In the network we observe that the qualitative similarities between Steynhof and the levee sites greatly outweigh the differences (Fig. 12.6). The unique contact materials exclusively demonstrated for Steynhof consist mostly of broad unspecified contact materials such as 'animal soft or medium hard material'. The 'hide and bone' category is most likely related to butchering and, as such, is also present in Vlaardingen where the traces were less hide-like and more meat-like, warranting a qualification as contact with 'meat and bone'. It seems therefore that these traces are related to the same kind of activity. Only the mineral polish found at Steynhof is not found on the other sites. Mineral-like polish is present on the levee sites, but here it is clearly related to fire-making (contact with pyrite) or ceramic repairs (pottery drilling). The objects at Steynhof with an unknown kind of mineral polish are not used in either of these activities and they thus represent an unknown activity which is only represented at Steynhof and not on the levee sites. Although there are few activities only taking place at Steynhof there are a number of activities which appear to be restricted to the levee sites: antler working, silicious plant processing, and cereal harvesting are only found at Hekelingen III and Vlaardingen.

Use-wear analysis has so far been conducted on nineteen VLC sites. Often the analyses were focused only on specific tool types (Houkes & Verbaas, 2014; Houkes et al., 2017). Due to varying degrees of preservation some sites only contain small numbers of tools with interpretable wear traces. In term of sites with broad selections with a minimum of 15 interpretable tools, only a selection of eight sites is available: Den Haag Steynhof, the Hazendonk VL1b, Hekelingen III, Hellevoetsluis Ossenhoek, Leidschendam Prinsenhof, Veldhoven Habraken, Vlaardingen Arij Koplaan, and Zandwerven (Bienenfeld, 1986; Carter, 2021; Metaxas, 2010; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024; Van Gijn, 1990b; 2021a; Van Gijn & Siebelink, 2013; Van Hoof & Metaxas, 2009). These sites are plotted in the network graph in Figure 12.7. It is clear that the sites do not plot according to their environmental setting. It seems that there are no major qualitative differences between the sites in the coastal dune area and the levee sites. Furthermore, the presence of cereal harvesting traces at Leidschendam Prinsenhof demonstrates that cereal harvesting is not limited to either the levee sites or the dune sites (Van Gijn, 1990b). Silicious plant processing traces are found on the levees, but also at Hellevoetsluis Ossenhoek, in the salt marshes (Metaxas, 2010). Antler working seems to be the only activity which appears to be restricted to the levees. Although it should be noted that the category bone/antler on other sites potentially also holds traces related to antler working.

Overall it seems that the activities taking place in the coastal dune area also take place on the levees and vice-versa. Contrary to what was previously suggested by Raemaekers, it thus seems that we do not observe that a smaller spectrum of activities took place on the levee sites than in the coastal dune area (Raemaekers, 2003, p. 744). Nevertheless, quantitatively notable differences can be observed between different sites. It is clear that at Steynhof there is a remarkably strong focus on hide working. Potentially the same applies to Zandwerven, but due to the poor preservation of the material this is uncertain. Plant fibre processing and bone working are much more prominent at the levee sites than in the coastal dune area. For bone working this is related to a difference in bone working techniques. In Vlaardingen and Hekelingen the metapodium technique was frequently applied (Van den

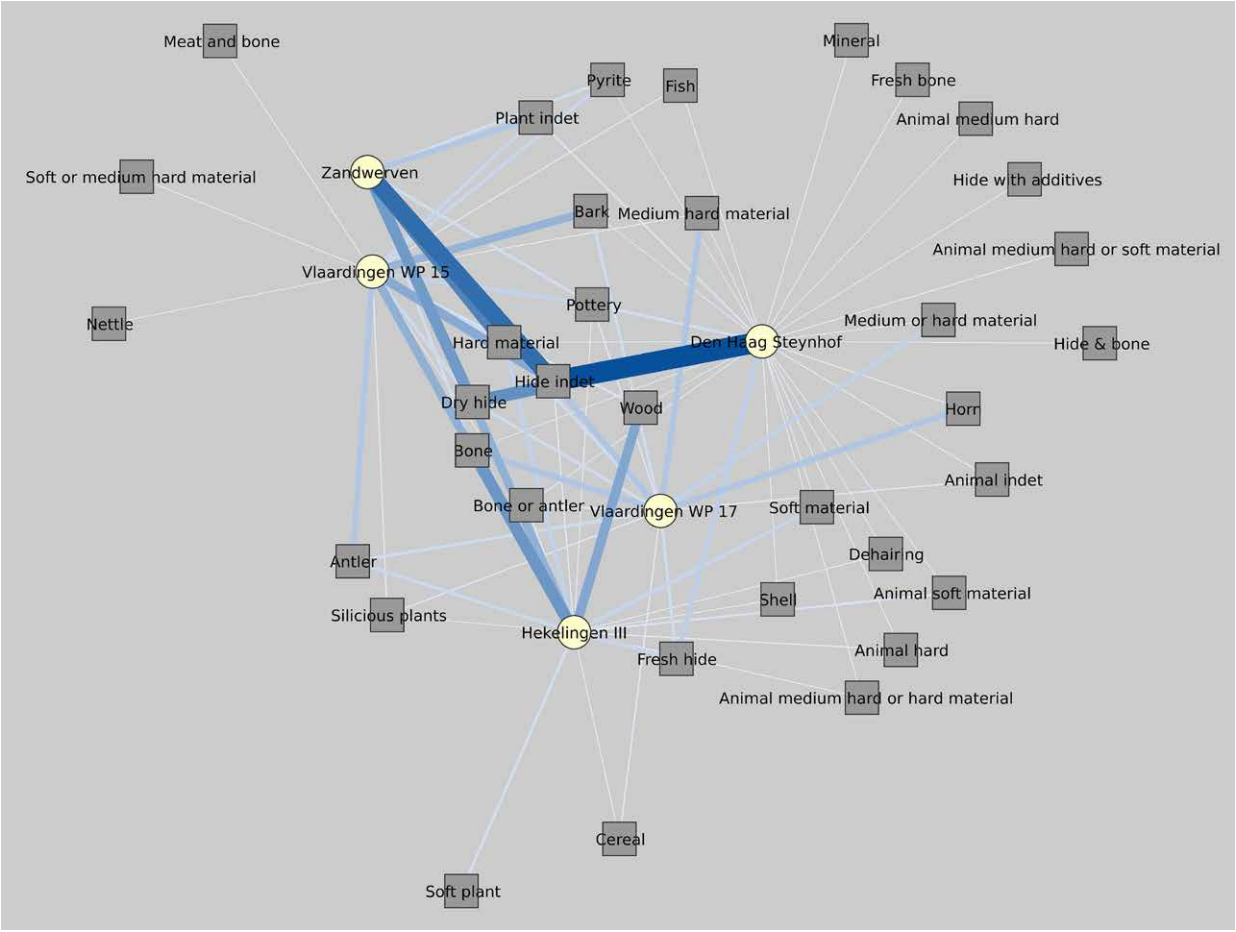


Figure 12.6 Network representation of contact materials in percentages (squares) for the four VLC sites under study (yellow circles), excluding hafting traces and unknown/unsure traces, the links are ranked by weight, the network is visualised in stress minimisation layout.

Dikkenberg & Van Gijn, 2024; Van Gijn, 1990b; Van Gijn, 1994b). In terms of use-wear traces the flint displayed extensive traces from cutting or sawing bone, as well as from carving or graving bone. These motions can be linked to the metapodium technique, as the toolkit used for this technique consists of flint tools for cutting/sawing and carving bone, as well as non-flint grinding stones. Tools used for bone cutting and carving appear to be largely absent in Steynhof (Van den Dikkenberg & Van Gijn, 2024). At Leidschendam bone or antler was carved, but there were no indications for the cutting or sawing of bone, indicating that the toolkit used in the metapodium technique is absent at this site as well (Van Gijn, 1990b, p. 139). This suggests that the use of the metapodium technique is largely restricted to levee sites (Van den Dikkenberg & Van Gijn, 2024). For this technique deer bone is specifically selected, and it is noteworthy that there appears to be a correlation between the use of this technique and the presence of deer at VLC sites (Van den Dikkenberg & Van Gijn, 2024). It is likely that bone tools produced at these levee sites were also exchanged with inhabitants from the coastal dune area, who do not seem to make these tools. For the CWC site of Mienakker García-Díaz similarly argued that some of the bone tools there might have been imported. Here, two bone tools made from red deer bone were found, while the faunal assemblage did not contain any other deer bones. This indicated that the bone tools were probably imported to the site in a finished state (García-Díaz, 2017).

A final note should be made about the newly discovered horn working traces found on two tools from Den Haag Steynhof and Vlaardingen Arij Koplaan. These tools were used for both sawing/cutting and scraping horn. The cutting traces could relate to the removal of the horns whereas the scraping motions demonstrate that the horns were also further processed and worked into objects. As no horn objects are preserved we can only speculate as to what was made from these horns. The most simple objects are containers (drinking horns). In this case the horn is sawn or cut from the base after which the inside is scraped clean. Such horns can hold liquid making them suitable to be used

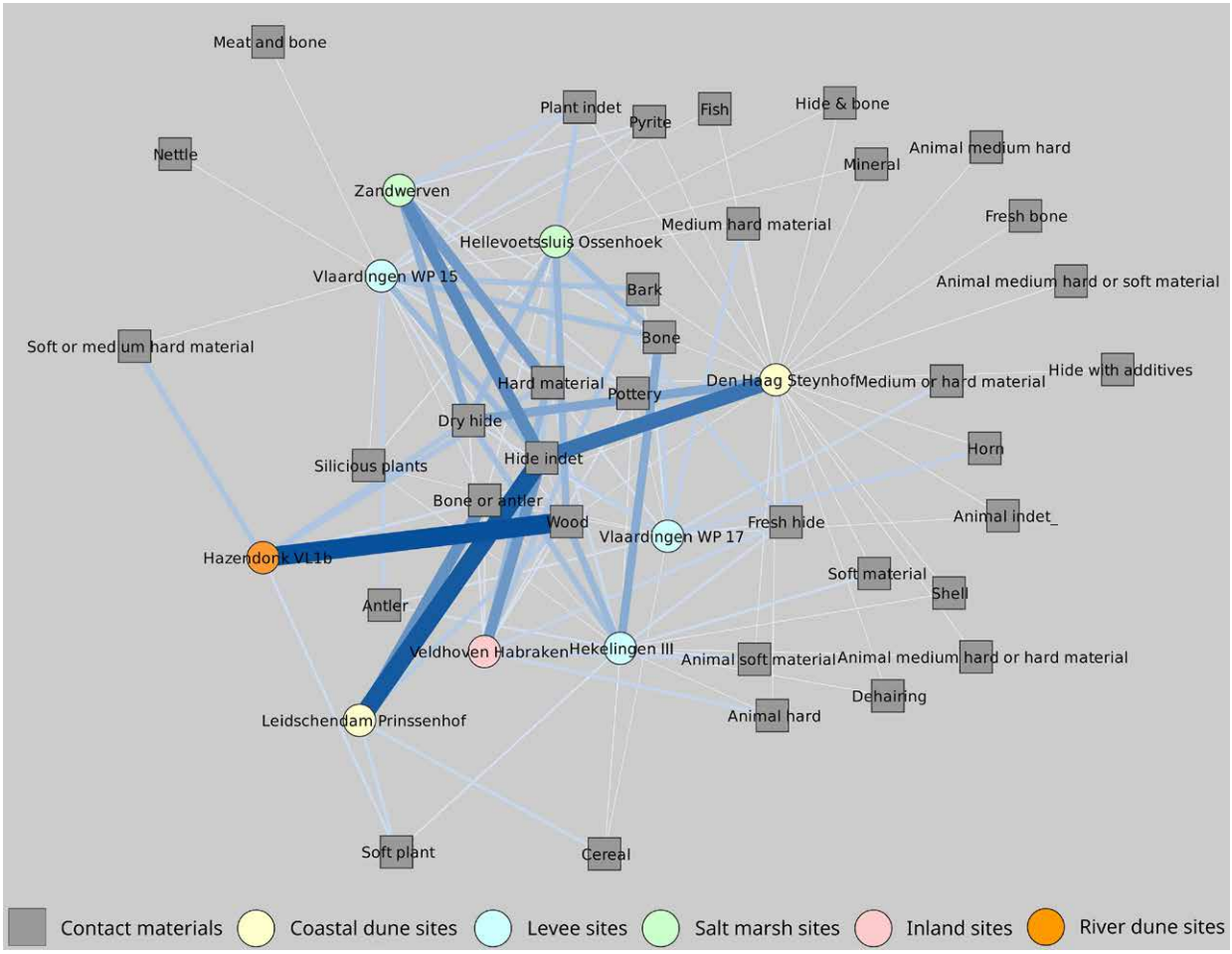


Figure 12.7 Network representation of contact materials in percentages (squares) for VLC sites, based on this study and literature, links are ranked by weight, the network is visualised in stress minimisation layout (Bienenfeld, 1986; Carter, 2021; Metaxas, 2010; Petrogiannaki, 2022; Petrogiannaki & Van Gijn, 2024; Van Gijn, 1990b; 2021a; Van Gijn & Siebelink, 2013; Van Hoof & Metaxas, 2009).

as drinking horns. It is also possible that horns were further processed into more elaborate objects (such as spoons or combs), as we know from later periods (Rijkelijkhuizen, 2013; Rijkelijkhuizen et al., 2024). At present this remains unclear, but it is hoped that further discoveries shed more light onto the horn working *chaîne opératoire*.

12.2.1 Diversity on the levees

Both Vlaardingen Arij Koplaan and Hekelingen III are characterised by a similar diversity of craft and subsistence activities. For Vlaardingen the clear evidence for cereal cultivation, the presence of wintering birds, and the permanent nature of the house plans, similar to those from Den Haag Steynhof, indicates the site was probably occupied year round (Clason, 1967, pp. 141, 168). For Hekelingen this remains uncertain, the nature of the round huts might argue for temporary occupation (Verhart, 1990). The presence of winter birds seems to suggest a presence in winter, while sturgeon catching was done during the summer (Prummel, 1987). The presence in different seasons does not automatically contradict the notion of temporary occupation. It is possible that people frequented this place at different moments in the year (Amkreutz, 2013b, pp. 399–400). Different seasons clearly provided different opportunities, which were extensively exploited. The diversity in subsistence strategies is reflected in the diversity of activities taking place at the sites. Some activities like using the metapodium technique and antler working are exclusively found on the levees. In both cases this seems to be related to the subsistence strategies, as both require deer. In the case of the metapodium technique it seems that this is culturally determined (Van den Dikkenberg & Van Gijn, 2024).

In debates about Vlaardingen site function the similarities between the levees and dunes are often overlooked. It is true that wild animals dominate the faunal spectra at the levee sites, but the fact that cattle and other domesticates are systematically present on the

levees is largely ignored. Levee sites are often described as extraction camps, or even hunting camps, which produce an excess of meat which can then be taken to permanent settlements (Raemaekers, 2003; Van Gijn, 1990a). But if these wild animals would provide a surplus of meat, it seems odd that people would butcher their cattle at these sites as well. I would therefore argue against the notion that levee sites are temporary sites, exploited by inhabitants of the coastal dune area. As observed by others the lithic raw materials used by the inhabitants of these sites are vastly different from those used by the inhabitants of the dune sites (Amkreutz, 2013b, p. 343; Louwe Kooijmans, 1987; Van Gijn, 1990b, 2010b). The differences in production traces on axe fragments highlight that it seems plausible that axes on the levee sites and dunes were procured through different networks (Van den Dikkenberg, 2024a). The differences between these sites are thus not only related to subsistence strategies, but they are also related to the involvement in social exchange networks. As such it seems more fruitful to consider the levee sites as an independent group, which operates more or less independently from the sites in the coastal dune area (Amkreutz, 2013b, p. 320). Based on the nature of the house plans and the evidence for local crop cultivation I would argue that Vlaardingen is a permanently inhabited site. The nature of Hekelingen III is ambiguous, but if we consider this to be a temporary site it is worth noting that its inhabitants seem to have more in common with people from Vlaardingen than with inhabitants of the dune area. Perhaps the inhabitants of the levees thus occupied both permanent as well as temporary sites. Similarly, it can be noted that several temporarily occupied sites were recently discovered in the coastal dune area (Bulten & Stokkel, 2017; Van Zoolingen & Rieffe, 2023). It thus seems that this zone is also characterised by a mix of permanent and temporary occupation. Although it should be noted that these sites appear to mainly be pioneering settlements, rather than special extraction camps as was suggested for Hekelingen III (Bulten & Stokkel, 2017; Raemaekers, 2003; Van Gijn, 1990a).

12.2.2 Coastal dunes and part-time specialisation at the site of Den Haag Steynhof

The most remarkable result of the use-wear analysis at Den Haag Steynhof is the overwhelming evidence for hide-processing. Rather than a diversity of activities there seems to be a strong focus on a specific kind of craft activity. This raises the question whether we should interpret this focus as evidence for craft specialisation.

Perlès defines craft specialisation as "*production that is conceived and carried out in response to needs above and beyond those of the production group itself (whether it is home- or village-based) and therefore designed to be exchanged at least in part for other products*" (Perlès, 1992, p. 134). By comparing the assemblage of Steynhof with those from other Neolithic sites I will attempt to assess whether the assemblage fits the definition by Pèrles. Regarding activities other than hide working it can be noted that most activities which took place on the levee sites also took place at Den Haag Steynhof. Notable exceptions however are the use of the metapodium technique, antler working, and cereal harvesting for which no evidence was found at Den Haag Steynhof. Cereal harvesting traces are, however, known from other sites in the coastal dune area, notably Leidschendam Prinsenhof and Den Haag Wateringse Binnentuinen (Houkes et al., 2017; Van Gijn, 1990b). It should also be noted that cereal harvesting traces in the wetlands are generally scarce, possibly suggesting that other tools were also used for this purpose, as has previously been suggested for Michelsberg Culture sites as well (Bakels & Van Gijn, 2014; Häg, 2023; 2024).

In order to assess whether the extensive evidence for hide working at Den Haag Steynhof reflects evidence for craft specialisation the percentages of hide working traces and scraper percentages were listed both for the artefact populations from Den Haag Steynhof and other Neolithic sites in the wetlands (Tab. 12.7 and Fig. 12.8). Scraper percentages were calculated against the total lithic assemblage, rather than only the retouched tools, since both this and earlier studies of Vlaardingen assemblages show that unretouched material formed a major part of VLC toolkits (Van Gijn, 1990b; 2010b; Van Gijn & Siebelink, 2013). Therefore, it seems that focusing on the retouched assemblage would not reflect the percentage of tools, but a percentage of an artificially constructed sub-selection of VLC tools.

Regarding the evidence for hide working at Steynhof, it can be noted that ca. 66% of all use-wear traces, excluding hafting traces, consist of hide working traces. This is the highest percentage recorded for any Neolithic wetland site in the Netherlands (Tab. 12.7). The high percentage of scrapers at the site correlates with a strong focus on hide working (Fig. 12.8).

Only Zandwerven comes close to the assemblage of Steynhof in terms of both its percentage of hide working traces and the percentage of scrapers at the site. However, preservation at Zandwerven was poor which potentially created a bias towards well recognisable use-wear traces (Van den Dries & Van Gijn, 1997). Furthermore, it is clear that the flint assemblage which was studied is incomplete, as earlier publication mentioned flint axe fragments which are completely absent in the currently available material (Van Iterson Scholten, 1988; Van Regteren Altena & Bakker, 1961; Van Regteren Altena et al., 1962a). It remains unclear to what extent the percentage of scrapers in the studied assemblage is representative, therefore this section will focus on the assemblage at Steynhof.

Through time, hide working became more important for Neolithic communities (Fig. 12.9). Swifterbant and Hazendonk-3 group sites never have hide working

Period	Site	Date	Scraper %	Hide working %
Swifterbant Culture	S2	4250-4000 BCE	2%	25%
Swifterbant Culture	S4	4350-3700 BCE	1.3%	30%
Swifterbant Culture	S51	4600-3900/3800 BCE	6%	19.2%
Hazendonk-3 group	Schipluiden	3630-3380 BCE	1.4%	9.6%
Hazendonk-3 group	Ypenburg	3860-3435 BCE	0.5%	10%
Hazendonk-3 group	Wateringen 4	3625-3400 BCE	2.5%	15.1%
Vlaardingen Culture	Leidschendam Prinsenhof	3200-3000 BCE	2.5%	35.5%
Vlaardingen Culture	Den Haag Steynhof	3100-2340 BCE	19.3%	65.8%
Vlaardingen Culture	The Hazendonk VL1b	3100-2900 BCE	2.7%	5.6%
Vlaardingen Culture	Hellevoetsluis Ossenhoek	3000-2800 BCE	10.7%	27.2%
Vlaardingen Culture	Hekelingen III	3011-2208 BCE	7.2%	25.6%
Vlaardingen Culture	Vlaardingen Arij Koplaan trench 15	3200-2000 BCE	8.9%	21.5%
Vlaardingen Culture	Vlaardingen Arij Koplaan trench 17	3200-2000 BCE	5.1%	17.4%
Vlaardingen Culture	Veldhoven Habraken	2900-2500 BCE	1.2%	31%
Vlaardingen Culture/Corded Ware Culture	Zandwerven	2900-2500 BCE	17.4%	52.6%
Corded Ware Culture	Mienakker	2850-2346 BCE	1.1%	35.1%
Corded Ware Culture	Keinsmerburg	2900-2300 BCE	0.2%	16%
Corded Ware Culture	Zeewijk	2900-2100 BCE	1.2%	47.6%

Table 12.7 Hide working percentage (the percentage of total use-wear traces relating to hide working, excluding hafting traces) and scraper percentages (the percentage of scrapers as part of the total flint assemblage) for Neolithic wetland sites in the Netherlands, ranging from the Swifterbant Culture to the CWC (Bienenfeld, 1985; Bienenfeld, 1986; Carter, 2021; Devriendt, 2013a; García-Díaz, 2017; Van Hoof & Metaxas, 2009; Houkes, 2021b; Houkes, 2008b; Metaxas, 2010; Petrogiannaki & Van Gijn, 2024; Raemaekers et al., 1997; Siebelink et al., 2013; Van Beek, 1990; Van Gijn, 1990b; Van Gijn et al., 2006; Van Gijn & Verbaas, 2008; Verhart, 1983).

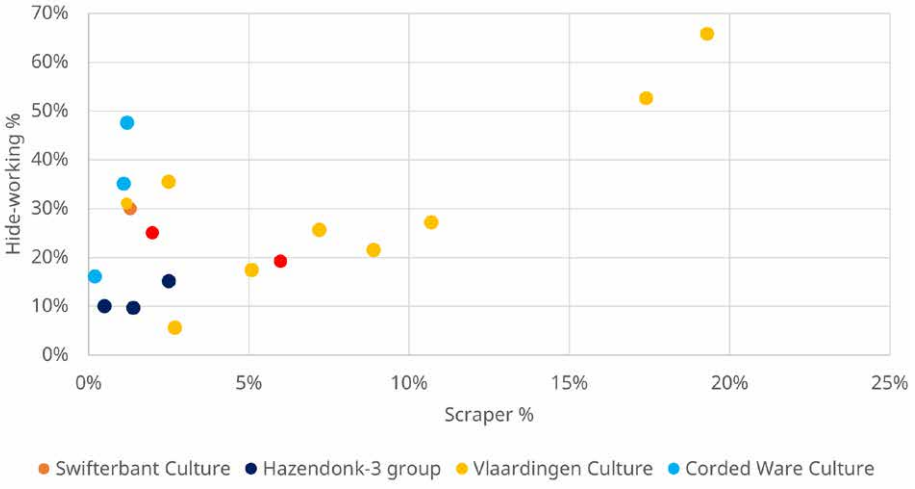


Figure 12.8 Hide working percentages for Neolithic wetland assemblages and scraper percentages, calculated as a percentage of the entire artefact assemblage (based on Tab. 12.7).

percentages of more than 30%, while this is not uncommon for Vlaardingen or CWC sites. The dominance of hide working at Steynhof, combined with the high percentage of scrapers suggests that more hide products were produced here than there were consumed. Following the definition provided by Pèrles we conclude that the production of hide products at Den Haag Steynhof reflects craft specialisation (Perlès, 1992). The presence of other subsistence and craft activities at the site demonstrate that we are not dealing with full-time, but part-time specialisation. An unprecedented amount of time was devoted to hide working while other subsistence and craft activities such as herding and plant working also took place. It seems likely that the assemblage of Den Haag Wateringse Binnentuinen also reflects such overproduction of hide products, as here it also seems that much time was devoted to this activity (Bulten & Stokkel, 2017; Houkes et al., 2017; Mullaart, 2016). It has been suggested that these hide products were exchanged for flint axes and other imported flint tools, which are present at Den Haag Steynhof (Houkes, 2021b). Based on the faunal assemblage it seems likely that the hide working activities focused on the processing of cow hides (Van Dijk, 2021). The hide working processes at the site are highly diverse, involving the cleaning, scraping of dry hides, and dehairing (Petrogiannaki & Van Gijn, 2024). The assemblage also presented evidence for the cutting of hides. The dehairing of hides indicates that hide was processed into a kind of leather. The cutting furthermore suggests that hide was also turned into finished products, possibly clothing or bags. It seems that the entire toolkit, at least in terms of lithics, necessary to process hides is present at the site. It thus seems plausible that hides were not exchanged as raw materials, but as finished products, similar to what we see with the import of flint axes (Bakker, 2006; Van den Dikkenberg, 2024b; Van Gijn, 2010b). It should be noted that the butchering of cows would similarly result in the wide availability of meat. This also suggests that in addition to hide, dried or smoked meat might also have been exported (Kooistra et al., 2024, p. 87).

According to Pèrles production in craft specialisation often depends on know-how which is not (or no longer) shared by users at large (Perlès, 1992, p. 135). This is clearly the case with the production of flint axes at flint mining centres in Limburg and Belgium. The skills to make such axes are unevenly distributed, being absent in the western Netherlands and being limited to the area close to the flint mines (Van den Dikkenberg, 2024b). To what extent we are dealing with hide working skills which are not shared by users at large is impossible to establish at the moment. The hide products produced at Steynhof are not preserved. Furthermore, use-wear analysis has not been conducted at Stein group settlements in the southern Limburg area (Schreurs, 2005). On most Stein group sites few flint artefacts have been recovered. The larger assemblages often consist of palimpsests with earlier finds. This means that it is presently impossible to assess whether the high percentages of scrapers on several VLC sites present a unique VLC phenomenon, or whether similar sites existed in the Limburg area (Verhart, 2010b).

Specialised hide working sites are also known from the Early Neolithic Bandkeramik in the Netherlands and Belgium (Sliva & Keeley, 1994; Van Gijn & Mazzucco, 2013). Studies on Middle Neolithic Michelsberg Culture sites have revealed that extensive hide-processing took place here (Schreurs, 1992, pp. 142–144). It remains unclear whether this production of hide products continued during the Stein phase. We cannot automatically assume a continuation of existing dynamics. In the case of the production of flint axes in the western Netherlands we observe that this only disappears after the Hazendonk-3 phase (Van den Dikkenberg, 2024b, p. 137; Van Gijn et al., 2006). Whether the disappearance of axe and blade production in the western Netherlands is mirrored in a disappearance or decrease of hide working technologies in the southern Netherlands and Flanders remains a mystery.

Regardless, Den Haag Steynhof clearly fits the definition of a site where craft specialisation took place (Perlès, 1992), and it presents the earliest unequivocal evidence of craft specialisation in the Rhine-Meuse delta. Moreover, Steynhof presents the only case where a clear focus on one specific activity allows us to hypothesise about the importance of organic perishable objects in Neolithic exchange networks. However, considering the abundance of imported flint at other VLC sites (especially at Hekelingen III and Vlaardingen Arij Koplaan) we can assume that other organic materials equally played a role in these exchange networks. It is plausible that antler and bone tools, which were produced on the levee sites, formed part of these exchange networks as well (Van den Dikkenberg & Van Gijn, 2024). Furthermore, we can imagine that sturgeon, and perhaps fur, could also be exchanged, as was proposed by Louwe Kooijmans for the assemblage of Hekelingen III (1987, p. 249).

Craft specialisation is known from a wide range of Neolithic contexts in Eurasia (Lemorini et al., 2020; Perlès, 1992; Sliva & Keeley, 1994; Thuesen et al., 2023; Van Gijn & Mazzucco, 2013). However, evidence invariably comes from conglomerated settlements with multiple contemporary houses. Also, the Linear Bandkeramik in our region fits this pattern of conglomerated settlements with multiple contemporary households, often with more than a hundred inhabitants (De Grooth & Van de Velde, 2005). Ethnographically, Clark and Parry found a correlation between the rise of craft specialisation and rising social complexity (Clark & Parry, 1990).

The evidence presented here suggests that craft specialisation can also emerge in small scale (egalitarian) settlements with three to four houses inhabited by no more than ca. 25 people (Bulten & Stokkel, 2017, p. 304; Kooistra et al., 2024, p. 32; Van Zoolingen, 2021b, p. 80). Hide working was clearly conducted close to, and also inside, the house (see chapter 6). The presence of other subsistence and craft activities at the site demonstrates that we are not dealing with full-time but rather part-time specialisation. The high percentage of bending fractures indicates that the skills required for hide working were learned in the zone in and around the house (see section 6.6.3). This suggest that this craft was likely organised at a household level, presumably being taught by older generations to younger members of the household.

It is recognised that the emergence of craft specialisation is situation specific (Baysal, 2013). Reasons cited for the emergence of craft specialisation are agricultural overproduction or demand for special or scarce products (Baysal, 2013; Thuesen et al., 2023). In this specific case we observe a ripple effect. We observe that during the Middle Neolithic flint mines emerged in Limburg and Belgium. People near these mining centres specialised in the production of objects like blades and flint axes (De Grooth, 1991, p. 177). Early on these objects are exported to the Rhine-Meuse delta where they initially maintained a special position within the technological system (Van Gijn, 2008, 2015). During the VLC phase we see that people begin to rely on these imports (Van den Dikkenberg, 2024b). In the area of The Hague this led to part-time specialisation focused on hide working in order to provide surplus production which could be exchanged for lithic artefacts. During the VLC period the low dunes were surrounded by fertile salt marshes which formed ideal grazing grounds for cattle (Kooistra et al., 2024). This focus on cattle herding and hide working is thus partially indebted to the affordances of the landscape surrounding the dunes.

12.2.3 The life-cycles of flint axes

Flint axes, especially those found in a fragmented state, are ubiquitous at VLC sites (Houkes, 2024; Van den Dikkenberg et al., 2024a; Van Gijn, 2010b; Van Gijn & Bakker, 2005). Because they are produced in flint mining areas in Belgium and Limburg they provide a unique category of objects, whose presence is intrinsically linked with the presence of flint mines in those areas. The spread of such ground or polished axes is often assumed to be associated with the Neolithisation process (Barkai & Yerkes, 2008; Sørensen & Karg, 2014). Although earlier Mesolithic examples are known their widespread use can be considered to be a typical feature of the Neolithic (Grünberg et al., 2016; Little et al., 2016; Sørensen & Karg, 2014). Their emergence is often linked to deforestation (Sørensen & Karg, 2014). Nevertheless, the use of axes for wood chopping is not new, and an ongoing study on Mesolithic flint core axes from Doggerland[39] suggests that these were also heavily used for wood working (personal communication R. Houkes, 2024). Furthermore, the present study casts doubt on the one-on-one relationship between flint axes and wood working as several VLC axes were used for hide working in addition to their use for wood working activities. Axes were thus employed for a wider range of tasks than was previously assumed. A direct association with deforestation is furthermore problematic as Hekelingen III, the site with both the highest percentage of axe fragments, as well as the highest number of complete flint axes, presented no evidence for extensive land clearances during the VLC period (Out & Dörfler, 2017; Van den Dikkenberg et al., 2024a; Verhart, 1983). Although wood working activities cannot be equated directly with deforestation it should be noted that other types of wood working activities such as the construction of tools, dugouts, and shelters would also have been done by Mesolithic communities.

In the Rhine-Meuse-Scheldt delta the emergence of polished axes coincides with the Neolithisation process. Like the appropriation of exotic flint their adaptation thus fits with the wider package of changes taking place in this period. I would however be hesitant to link their introduction to an increased need for wood working tools. Some experimental work has been conducted to test the efficacy of Neolithic axes as opposed to Mesolithic counterparts (Roland & Oliveira, 2020). Experiments with bone and antler tools furthermore indicated that these also provide viable alternatives to stone axes (Pomstra et al., 2015). Differences in functionality thus do not account for the excessive difference in time investment which is required for the production of ground and polished axes (Madsen, 1984)[40]. As argued in section 12.1.3 the Neolithisation process resulted in the emergence of unequal access to flint sources, and by extension with the emergence of flint mines. Axes are the largest flint objects in Dutch Mesolithic and Neolithic societies. More than any other artefact category they thus require a significant raw material investment. A striking feature of the axes and axe fragments which were analysed for the present study is that they display extensive evidence for both hafting and reshaping or resharpening (Van den Dikkenberg, 2024a). These features are indicative of a long, and especially prolonged use-life. In their study on FBC axe grave goods

39 A study currently being conducted as part of the NWO *Resurfacing Doggerland. Environment, humans and material culture in a postglacial drowning landscape* project headed by J.H.M. Peeters.

40 Flaking of bifacially worked axes can easily be done in about 20 minutes (personal observations from knapping sessions with D. Pomstra). The subsequent grinding of Neolithic axes however takes many hours (Madsen, 1984).

Wentink and Van Gijn also found extensive evidence for the resharpening of these axes. An interesting hypothesis they coined is that these axes were potentially systematically resharpened after each episode of use, in line with modern carpentry practices (Van Gijn, 2010a; Wentink, 2008, p. 109). For the VLC axes we can conclude that this was not the case. We quite often observe wear traces from different activities (hide scraping and wood working) co-occurring on the cutting edges. This suggests that after one of these activities the edges were not resharpened before using the axe for the other activity. Hence, although resharpening frequently occurs it was likely not done systematically after each use episode, but rather after the edge became noticeably blunt.

Mesolithic tranchet axes are also frequently resharpened (Rankine & Scot, 1949). Nevertheless, when these are resharpened a significant amount of material is removed in the flaking process. When Neolithic ground axes are resharpened they can be resharpened through grinding, rather than through flaking. This minimises the amount of material which needs to be removed in the process. Mesolithic axes can only be resharpened a few times before the edge reduction renders them useless. Neolithic axes, unless they break during use, can be resharpened much more frequently, at least until the cutting edge angle becomes too steep. Their functional superiority thus does not lie in their superior cutting edges, but rather in the superior mode through which they can be rejuvenated and maintained. Neolithic axes thus remained functional much longer, setting them apart from other lithics which consisted of comparatively expedient tools.

I would argue that, like the emergence of flint mines, the emergence of ground or polished flint axes is tied to the unequal access to lithic resources which emerged during the Neolithic. Due to their longevity they provided a solution to the problem of lithic scarcity.

12.3 A complex network of specialised communities

From the discussions presented above it has become increasingly clear that there are major differences among sites within the Rhine-Meuse-Scheldt delta. The differences in terms of hunting and fishing across landscape zones during the VLC period have in this respect frequently been discussed (Brinkkemper et al., 2011; Dusseldorp & Amkreutz, 2020; Raemaekers, 2003). However, I would argue that the observed variation cannot merely be explained by the environmental setting of VLC sites. Rather, I think that the variation reflects a system in which communities increasingly specialised in certain activities, as was already argued for the coastal dune site of Den Haag Steynhof. Even when certain activities are conducted by several communities we often observe variation in terms of how these activities took place.

An example of this variation is the evidence for cereal cultivation. Based on the presence of sickles and cereal pollen, cereals were locally cultivated at Vlaardingen Arij Koplaan (Groenman-van Waateringe & Jansma, 1969; Louwe Kooijmans, 1987). Nevertheless, ard marks are not present here, nor at any of the levee sites. Ard marks are only present on the dunes and salt marshes (Lanzing & Siemons, 2014; Van Hoof, 2009b; Van Regteren Altena, 1958). Perhaps this unequal distribution of ard marks across environmental zones reflects different modes of cultivation. Carlstein notes that ploughing is only necessary when cultivation becomes more prominent (Carlstein, 1982, p. 195). Perhaps the less intensive cultivation at the Vlaardingen Arij Koplaan, which is compensated by other modes of subsistence relying partially on wild resources, is reflected in the fact that they did not use the ard. Perhaps cultivation on the levees is more similar to the Swifterbant mode of cultivation, which is characterised by hand-tool tillage rather than ploughing (Huisman & Raemaekers, 2014). The notion that different agricultural modes can coexists is well supported by ethnographic studies (Carlstein, 1982, pp. 195–210). Considering the scarcity of ard marks on VLC sites, this notion, however, remains hypothetical.

VLC variation not only extends to cultivation practices, but there is also ample evidence for variation in terms of subsistence and craft activities (Raemaekers, 2003; Van Gijn, 1990a). From a use-wear perspective it is noteworthy that this variation observed among VLC sites appears to be a new phenomenon. If we compare the ratios between bone/antler working traces, hide working traces, and plant working traces of Neolithic sites in the delta we observe that VLC sites show a much greater variation in ratios than preceding Hazendonk-3 group or Swifterbant sites (Fig. 12.9). Overall, we observe a general trend in which plant working becomes less important over time. Previously Little and Van Gijn already highlighted the disappearance of specific silicious plant polishes by the time of the Hazendonk-3 phase (Little & Van Gijn, 2017). Based on the data presented here we can now conclude that the evidence for plant processing in general became scarcer towards the end of the Neolithic.

Interestingly, within the group of VLC sites we observe a split between sites with a very strong focus on hide processing and sites in which bone and antler working are prominent activities. The latter group consists mostly of levee sites, but to these the river dune site of the Hazendonk and the coastal dune site of Leidschendam Prinsenhof can be added. The other group consists of the sites Den Haag Steynhof, Veldhoven Habraken, and likely Zandwerven[41].

41 This group likely also includes Den Haag Wateringse Binnentuinen, but considering the use-wear analysis at the site was nearly exclusively focussed on scrapers it is difficult to assess the relative importance of hide working at the site.

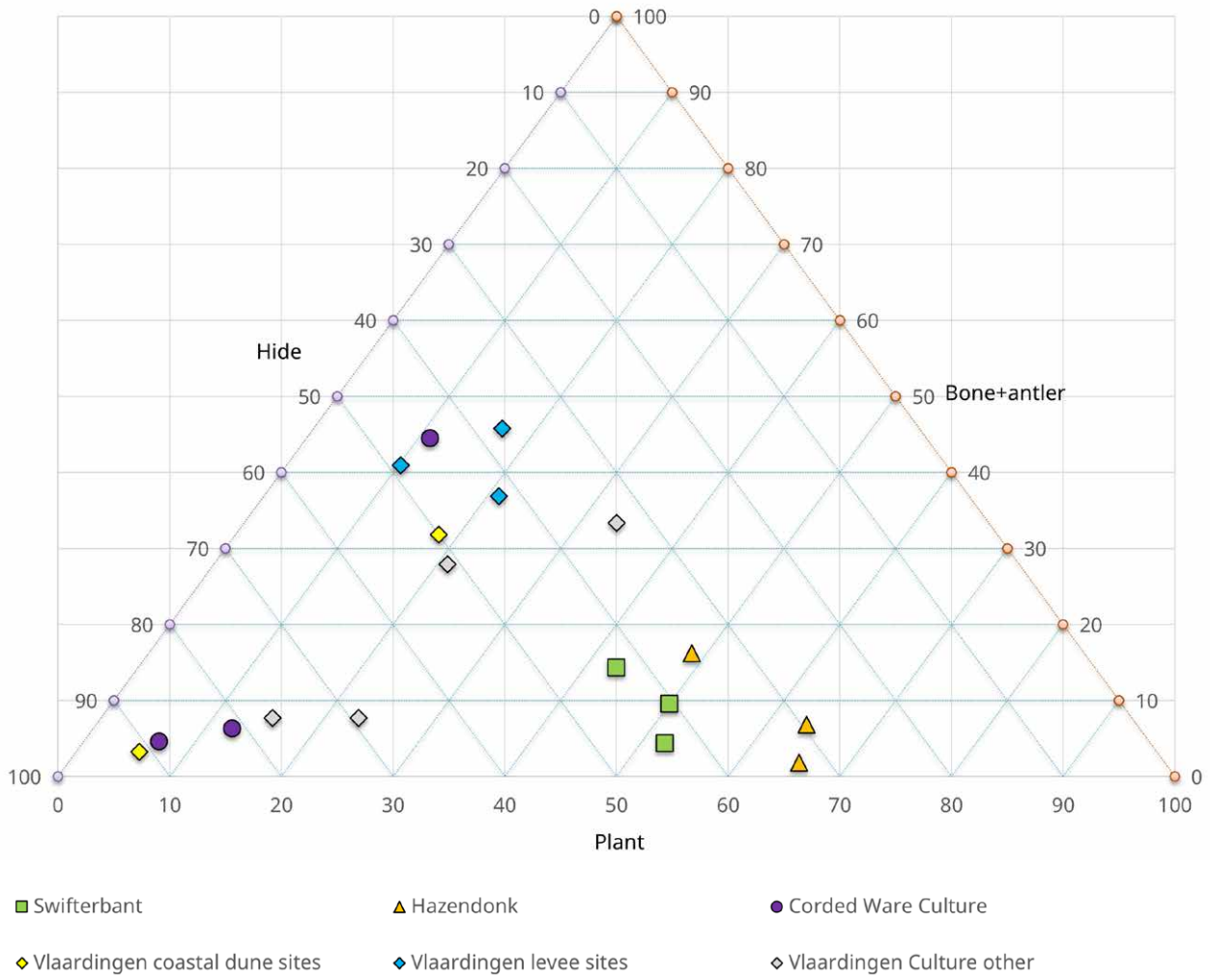


Figure 12.9 Triangular plot visualising ratios between traces from working hide, bone and antler, and plant (excluding wood) on Swifterbant sites: Swifterbant S2, S4, and S51; Hazendonk-3 group sites: Schipluiden, Ypenburg, and Wateringen-4; VLC levee sites; Hekelingen III, Vlaardingen Arij Koplaan trench 15, and Vlaardingen Arij Koplaan trench 17; VLC coastal dune sites: Den Haag Steynhof, and Leidschendam Prinsenhof; and other VLC sites: the Hazendonk VL1a; Hellevoetsluis Ossenhoek, Veldhoven Habraken, and Zandwerven (Bienenfeld, 1986; Carter, 2021; Devriendt, 2013a; Metaxas, 2009; 2010; Petrogiannaki, 2022; Raemaekers et al., 1997; Van Gijn, 1990b; 2021a; Van Gijn & Siebelink, 2013; Van Gijn et al., 2006; Van Gijn & Verbaas, 2008).

The twofold division is also observed in the West Frisian CWC sites where bone working is only a prominent activity in Keinsmerbrug while the sites of Mienakker and Zeewijk appear to focus more heavily on hide processing (García-Díaz, 2017). Zooarchaeology evidence suggests that bone and antler processing at VLC and CWC sites in the region is only prominent on sites where deer hunting was an important activity (Van den Dikkenberg & Van Gijn, 2024). Keinsmerbrug however seems to be an exception to this rule; although game was hunted here, deer appears to be absent (Zeiler & Brinkhuizen, 2012). It is noteworthy that some of the levee sites, Vlaardingen trench 15 (n=38) and Hekelingen III (n=37), have presented more evidence for bone and antler working than the Swifterbant (n=9) and Hazendonk-3 group (n=10) sites in Figure 12.9 combined (Devriendt, 2013a; Raemaekers et al., 1997; Van Gijn, 1990b; Van Gijn et al., 2006; Van Gijn & Verbaas, 2008). This may indicate an overproduction of bone and antler tools at the levee sites which could be exchanged with communities in the coastal dune area and communities in the uplands.

A major caveat in discussions regarding the variation observed at VLC sites is the issue of varying preservation of organic remains at these sites (Dusseldorp & Amkreutz, 2020; Raemaekers, 2003). The use-wear perspective presented in this study overcomes these biases, and it strongly suggests that the variations observed are not the result of preservation biases. Raemaekers furthermore notes that the known Swifterbant sites are located on the levees, while VLC sites are known from both the

levees and the coastal dunes (Raemaekers, 2003). In this context it is worth noting that the Hazendonk-3 group sites of Schipluiden and Ypenburg[42] are both located in the coastal dune area. In Figure 12.9 it can be observed that if the Swifterbant and Hazendonk-3 group sites are taken together, they are fairly similar from a use-wear perspective. The observed variation between VLC sites in terms of activities carried out thus indeed represents a discontinuity with the preceding Swifterbant and Hazendonk-3 group sites. I agree therefore with Dusseldorp and Amkreutz that the inter-site variation, and importance of wild resources, during the VLC period cannot be explained as a Mesolithic leftover or a transitional system between foraging and farming (Dusseldorp & Amkreutz, 2020). It represents a unique system with a high degree of variation in terms of craft and subsistence strategies. The unequal distribution of craft activities across sites suggests that sites not only specialised in terms of specific subsistence strategies, but also in terms of craft activities, which are often intertwined with the former. Although such inter-site specialisation is not known from the preceding Hazendonk-3 group phase, it is worth noting that at Ypenburg the use-wear analysis demonstrated that there appeared to be varying foci in terms of craft activities among the different houses. It was suggested by Van Gijn and Verbaas that this indicated a certain degree of labour division between different households (Van Gijn & Verbaas, 2008). Here communities of practice were thus mainly organised on a household level, within a household certain activities were carried out and the produce of these activities could be shared with other households within the settlement. Louwe Kooijmans suggested that variations in the role of hunting at Hazendonk-3 group sites reflected different community choices. This indicates that the differentiation evident on VLC sites has its roots in earlier Hazendonk-3 phase developments (Louwe Kooijmans, 2009). During the VLC phase these communities of practice were increasingly organised on a (micro-)regional scale. Communities in the coastal dune area, and especially in the region of The Hague, specialised in herding and hide working. Hunting and fishing, and associated craft activities such as bone and antler working, were largely carried out by communities on the levees. Upland communities in Limburg and Belgium specialised in flint mining and the production of flint axes. It seems plausible that the specialisation observed during the VLC phase was rooted in these household-level divisions which were present during the Hazendonk-3 group phase. This increasingly complex system of connected communities was facilitated by the increasing consolidation of long-distance exchange networks which had been gradually shaped since the Late Mesolithic.

42 Both of which were not yet discovered when Raemaekers published his article (2003).

13

Communities of practice during the Vlaardingen Culture period

The concept of communities of practice can be applied at different scales; one can look at individual households, at interactions between households within a community, or between residential groups (Heitz, 2023; Knappett, 2011). At a macroscale we can also apply the concept to look at the VLC as a group. What defines this group? Is there a recognisable 'regime of competence' shared by VLC communities? As technology is central to the concept of communities of practice, we will look at the VLC technological system to address this question.

13.1 The Vlaardingen Culture, life in the wetlands

Originally, the VLC was predominantly defined from ceramic and lithic perspectives. The ceramics were defined as quartz-tempered, flat-based, truncated pear-shaped or cylindrical pots with everted rims. The vessels often have perforations under the rim, occasionally with knobs, but are otherwise without decorations. In addition, spoons, collared flasks, and ornamented discs formed part of the VLC ceramic repertoire (Van Regteren Altena et al., 1962b, p. 101). Early on, it was recognised that similar ceramics were known from the area of the Stein group in Limburg (Louwe Kooijmans, 1983). From a lithics perspective, the VLC was defined based on the presence of large flint axes of the Western European type, flint chisels, transverse arrowheads, leaf-shaped arrowheads, scrapers, and borers made of southern flint (Van Regteren Altena et al., 1962b, p. 101). Two of these six supposed characteristic lithic objects were not produced by VLC people, because chisels and axes were imported as finished objects (Bakker, 2006; Van den Dikkenberg, 2024b). It is telling that these flint axes were originally often classified as 'Vlaardingen type' axes (Bakker, 2006). Our notion of what defines the VLC has thus been heavily influenced by the presence of these imports. These strong southern connections indeed seem to be a defining trait, albeit one that is unevenly distributed across VLC sites. These connections were diverse in nature, including a wide variety of southern sources like Rijckholt, Spiennes, and Hesbaye (Van den Dikkenberg & Braekmans, 2025). This study has shown that the maintenance of these networks was an integral part of the technological system. Especially in the case of flint axes, imported products fully replaced local production (Van den Dikkenberg, 2024b).

The VLC technological system thus consists of two independent but interacting aspects. The first is the exchange networks through which objects were acquired and which required advanced knapping skills. This pertains to axes, chisels, and to a lesser extent blades (Van den Dikkenberg, 2024b). The diversity in these southern sources is remarkable. In terms of archaeological regional cultures they also imply a wide range of connections. The flint mines of Valkenburg, Rijckholt, and Lousberg were exploited by people of the Stein group (Louwe Kooijmans, 1983; Verhart, 2010b). Those in Spiennes and Obourg, by contrast, were exploited by people of the Seine-Oise-Marne Culture (Verheyleweghen, 1966). Cap Blanc Nez on the other hand is located in the area of the Deûle-Escaut group. These connections thus also span a wide range of regional groups. It is interesting that

flint products from these sources usually co-occur on the same VLC site. Even when sources are not located along the same routes, they appear to be part of the same network. This is evidenced by the fact that in all assemblages which were subjected to chemical analyses both Rijckholt/Lanaye and Spiennes flint were present (Van den Dikkenberg & Braekmans, 2025). This is interesting because the products from these flint mining areas cannot be distinguished visually (De Grooth, 2011). The need to maintain both networks thus seems to stem mostly from social rather than practical needs: being included in this VLC exchange network implied maintaining this wide range of contacts.

The second component of the VLC technological system consists of locally produced objects. Here it is clear that a systematic system of apprenticeship is lacking. Complex knapping skills were not acquired, people focused on ad hoc technologies. The ad hoc nature of the technological system is well illustrated by the frequent use of flint hammerstones, and especially by the frequent reuse of flake cores as hammerstones. There is a clear focus on functional edges, rather than on specific tool types (Van Gijn, 2010b). At Steynhof, for example, it seems that often unretouched points were employed as borers (see chapter 6). An extreme example of ad hoc use was noted by Van Gijn in the assemblage of Hekelingen III where a retouched flake from a polished axe was hafted and used as a projectile point (Van Gijn, 1990b, p. 115). Thus even arrowheads, which were usually well crafted, could be made with ad hoc technologies (Van Gijn, 2010a, p. 154). Another characteristic of the VLC is the intensive focus on the recycling of objects. This is best documented in the case of the recycling of flint axes (Van den Dikkenberg et al., 2024a), but other objects like flake cores, scrapers, and sickles were also recycled.

The above-described co-existence of a local flake technology with a strong component of imported objects was also demonstrated for the Hazendonk-3 phase. At Schipluiden and Ypenburg imported objects with a clear Michelsberg signature were common (Houkes, 2008b; Van Gijn et al., 2006). But contrary to the tools imported at VLC settlements, these tools were only employed for a limited range of activities (Van Gijn, 2015). The coexistence of these systems thus predates the VLC, but the nature of this coexistence, the notion that there is no functional differentiation between exotic and 'local' raw materials, is typical for the VLC (see section 11.4).

Moving beyond the material culture perspective, it is furthermore worthwhile to note that Vlaardingen sites are invariably located close to the water (Van den Dikkenberg & Brandsen, 2025, see Fig. 4). Access to water was an essential requirement for establishing a Vlaardingen settlement. Even the sites further inland in Brabant and Nijmegen are still located close to rivers. Wetlands formed an integral part of the subsistence strategies of the VLC. They were essential for activities such as fishing and fowling (Beerenhout, 2010; Clason, 1967; Prummel, 1987). Interestingly, crop cultivation also appears to be tied to the wetland environment. The scarce evidence for local crop cultivation at VLC settlements systematically comes from either the lower dunes or the higher parts of the salt marshes (Kooistra et al., 2024, p. 83). The evidence presented here, especially for Vlaardingen Arij Koplaan, suggests that cereals were also cultivated locally on the levees, albeit likely on a small scale. True 'high and dry' zones of the landscape such as the cover-sand area in Brabant or the higher parts of the coastal dune area are devoid of evidence for local crop cultivation, possibly because of the poor soils here. Although it should be noted that such evidence is difficult to recover, and that much might have been destroyed by later agricultural activities. Nevertheless, the general scarcity of Neolithic finds in this area supports the idea that these zones were not extensively used for cultivation. It seems that manuring was not yet practiced in the region during this time (Bakels, 1997). The earliest evidence for manuring comes from Bronze Age, and possibly BB, contexts. This coincides with a shift in habitation in the region. Suddenly, the higher and drier cover-sand area of Brabant was inhabited as well (Jansen, 2021, p. 52). It seems plausible that manuring played a role in opening these new landscape zones for cultivation. The choice to practice agriculture on these border zones between dry land and wetlands during the VLC period, such as on the levees at Vlaardingen Arij Koplaan, might be related to the natural fertilisation of these environments through occasional flooding. Flooding should thus perhaps not be seen merely as a hazard, but also as part of the agricultural practices in the wetlands. In addition to being essential for subsistence activities, the wetlands, notably the major rivers, functioned as highways. These rivers facilitated the connections between VLC communities and southern communities.

13.2 Social boundaries and interactions with the Funnel Beaker Culture

Although the networks of the VLC people were wide and far-reaching, they were clearly directed at specific communities. It is noteworthy that from a lithics perspective there are no indications for contacts with the contemporary FBC. Like the southern neighbours of the VLC the FBC people also produced flint axes. In the FBC large flint axes were imported from Scandinavia, but did not serve a practical purpose. Rather these were meant for display, presumably during ritual ceremonies (Wentink, 2006). In addition to these oversized axes FBC communities also produced smaller flint axes. These were locally produced from northern flint, also had a rectangular cross-section and were often found in megalithic graves. Use-wear analysis of these smaller axes indicated that they were often heavily used prior to being deposited (Wentink, 2008). Geographically, these FBC

communities are located much closer to the VLC settlements under study than the communities in Hesbaye, Limburg or the flint mines in Spiennes. The fact that flint axes were systematically imported from the latter groups, but never from FBC communities signifies a deliberate choice. This seemingly sharp border, from a material perspective, between the FBC and VLC has also been noted by Verhart (2010a, p. 191). This could be a matter of taste, a preference for completely ground or polished oval flint axes, as opposed to the rectangular partially ground axes of the FBC. It could also reflect social boundaries, suggesting that interactions between the FBC and VLC people were of a different nature than those between VLC people and southern communities. In this respect, it is surprising that although lithics were seemingly not exchanged between VLC and FBC communities there seems to be contact between ceramists of the two communities. Recent analyses by Kroon indicated that FBC and VLC ceramics become increasingly similar over time. According to Kroon this indicates that these communities exchanged knowledge (Kroon, 2024, p. 210). Interactions in the ceramic spheres are further demonstrated by the occasional imports/or imitations of FBC ceramics found at VLC sites (Bloo, 2021, pp. 89–90; Drenth, 2010, pp. 123–124; Louwe Kooijmans, 1976, p. 286; Van Hoof, 2009a, pp. 78–80). It is possible that objects like collared flasks and ceramic discs should also be seen in the light of interactions between these groups, although it should be noted that these objects are also known from other communities than the FBC (Amkreutz, 2025; Van Regteren Altena et al., 1962c; Verhart & Amkreutz, 2017, p. 63). The border between the VLC and FBC culture is thus selectively permeable from a material perspective. Exchange and knowledge sharing seems to be limited to the realm of ceramics, while the groups appear to be isolated from a lithics perspective.

It is interesting that ethnographically these crafts (flint knapping and ceramic production) tend to be gendered crafts. Pottery production is predominantly documented as a female activity (Mukhtar Ahmed, 2016; Vincentelli, 1989). A recent study by White et al. analysing human DNA found in tar residues on repaired pots and hafted tools from Alpine Europe sheds light on potential gender divisions during the Neolithic. The authors suggest, tentatively (because of the small sample size in the study), that the repair of pots was predominantly conducted by females (White et al., 2025). Stone tool production, especially of objects such as axes, tends to be a male activity (Pétrequin & Pétrequin, 2000, p. 81; Van Gijn, 2010a, p. 158). The aforementioned study on tar highlighted that the tar found as part of hafting arrangements for stone tools exclusively contained male DNA. This suggested that such activities might be conducted predominantly by males (White et al., 2025). Also the exchange of stone axes in New Guinea seems to be predominantly organised by men (Pétrequin & Pétrequin, 2000, p. 81). It is therefore tempting to suggest that the observed differences in networks, which run along material lines, might reflect gendered divisions in craft production and exchange. In this sense we can suggest that ceramic exchange, as well as the exchange of knowledge surrounding pottery production, is related to women. The import of flint axes, and in general the maintenance of a wide variety of southern networks, might then be a male activity. It has recently been extensively demonstrated through ancient DNA and isotopic analyses that gendered differences in mobility existed during the Neolithic (Bickle & Hofmann, 2022; Knipper et al., 2017). Female mobility in this context is often linked to patrilocality, but it should be noted that the social bonds through which marriages were arranged were likely maintained outside of the marriage ceremonies themselves. It would therefore make sense that if female potters moved between FBC and VLC communities, they continued to exchange knowledge and skills. However, patrilocality has not been demonstrated for the Dutch Neolithic wetlands. Irrespective of the possible role of patrilocality, it is tempting to suggest that female potters in these communities functioned as mediators of knowledge (Streiffert Eikeland, 2025).

It should be noted that the above remains speculative. Several recent gender studies have cast doubt on the notion of strict gender divisions in past societies (Kantner et al., 2019; Van Gijn & Verbaas, 2022). An interesting case in this respect is provided by a recent study of Puebloan pottery. These ceramics were still produced in modern times, and modern ethnographic studies suggested that ceramics were predominantly produced by women. However, a palaeodermatoglyphic study demonstrated that during the 10th and 11th centuries AD there was no strict gendered labour division in ceramic production. This highlighted the possibility that gender roles, often observed in ethnographic studies, might have been heavily impacted by later colonial encounters, with western societies where such strict gender roles exist (Kantner et al., 2019). Similarly, the recent reanalysis of the LBK cemetery at Elsloo Koolweg demonstrated that gender roles in the Neolithic were more fluid than hitherto assumed. It was for example shown that several of the female graves contained stone adzes, tools which are traditionally assumed to be related to men (Van Gijn & Verbaas, 2022). Although we thus cannot presently assume gendered labour divisions for the VLC, they should be considered as a serious possible explanation. It is hoped that future studies, for example through palaeodermatoglyphic analyses, can shed light on this hypothesis.

13.3 Openness and interactions with the Corded Ware Culture

As a defining trait of the VLC I would point out the openness, combined with resilience, of the VLC communities. This openness as a defining trait for VLC communities was previously also highlighted by Verhart (1992, p. 94). The

VLC people extensively borrowed traits from neighbouring groups. To some extent this is due to exchange, as for example of imported flint axes. But this notion also pertains to borrowed stylistic traits. With the emergence of the CWC we observe typical CWC influences. We see the inclusion of CWC ceramics as well as the presence of stone battle axes and tanged arrowheads (Glasbergen et al., 1961; Glasbergen et al., 1967a; Van Gijn & Bakker, 2005). The group was thus open to changes brought about by migrating CWC communities (Haak et al., 2015). While they were open to change, they also clearly maintain independent traits, including their own pottery styles, unique dynamic lifeways, and distinct, southern oriented, lithic procurement networks. Furthermore, we see that many settlements chronologically span both the Middle Neolithic (3400–2900 BCE) and the Late Neolithic (2900–2500 BCE) phases (Louwe Kooijmans, 1987; Stokkel, 2017a; 't Hart et al., 2019; Van Hoof, 2009b). In this respect the recent ancient DNA analyses of supposed CWC individuals in the Rhine-Meuse delta is significant (Olalde et al., 2025). Genetically, these individuals are only marginally affiliated with CWC individuals elsewhere. Their DNA is mainly similar to that of older individuals in the Rhine-Meuse delta. These VLC communities thus not only persisted from a material culture perspective, maintaining their technological traditions, but also as genetic entities (Olalde et al., 2025). Previous material analyses of CWC material from the delta highlighted the high degree of similarities between the VLC and CWC (Beckerman, 2015; García-Díaz, 2017; Kroon et al., 2019). In the paper by Olalde et al. these sites are now classified as Vlaardingen/CWC settlements (2025). Perhaps it is indeed more fruitful to see these settlements as exponents of the VLC. They can be seen as highly receptive communities that quickly incorporated many of the CWC traits, including ceramic styles, flint types, and battle axes. Like southern VLC communities these northern VLC/CWC communities are highly adapted to the local wetland environment.

Despite the noteworthy similarities between the VLC and CWC it is important to point out that the characteristic burial ritual of the CWC was not incorporated by the VLC, or by the VLC/CWC communities in Noord-Holland (Olalde et al., 2025; Plomp, 2013). The fact that these burial traditions are not incorporated by these local communities is significant. There is a strong local agency in terms of choices to adapt, or not adapt, to this newly introduced phenomenon. In the case of the burial ritual, we should not underestimate the agency of the landscape. CWC communities established elaborate barrow landscapes across Europe, also in the Eastern Netherlands. These barrows were meant to last for generations, perhaps for eternity, as lasting memorials (Bourgeois, 2013). As such they inherently depend on a worldview in which the landscape is conceptualised as a permanent factor. These barrow landscapes can be seen as 'persistent places', places being repeatedly visited and used over a long period of time (Schlanger, 1992). They are persistent both in a physical sense, the notion that the landscape remains stable over time, as well as in a cultural sense, being repeatedly visited and used to construct barrows over a long period of time.

While in the eastern Netherlands the landscape remained remarkably stable since the last ice age, the landscape in the western Netherlands is highly dynamic and subject to constant change (Vos et al., 2020). For example we observe that often VLC settlements were abandoned due to growing peatlands, which eventually resulted in the loss of grazing grounds and suitable grounds for habitation (Kooistra et al., 2024). Similarly, during the occupation at Vlaardingen Arij Koplaan the course of the river significantly changed between the VLC and BB phases (Van Regteren Altena et al., 1962a, pp. 22–23). Thus, the fluidity of the delta landscape stands in contrast to burial traditions that underscored the persistence of places. It should be noted that the above does not mean that persistent places were not used and created in the delta (Amkreutz, 2013a). Rather, I would argue that these places are of a different nature, involving a much more flexible perception of the landscape.

This tension is briefly overcome during the Middle Bronze Age, when a significant number of barrows was constructed in West Frisia (Roessingh & Van Zijverden, 2011). Yet, during the urnfield period (1100–500 BCE) we again observe that urnfields are practically only constructed in the environmentally stable landscapes of the eastern and southern Netherlands, not in the dynamic landscapes of the western Netherlands (Louwen, 2021, p. 24). Also during the Middle Iron Age (500–250 BCE) the burial ritual in the western Netherlands remains elusive, while monument construction continues in the southern and eastern Netherlands (Roymans et al., 2024, pp. 481–487). It thus seems that in the long run the mismatch between the dynamic landscapes of the western Netherlands and burial traditions which emphasised permanence, proved irreconcilable. Returning to the VLC we thus observe an openness to change, but only if these changes are reconcilable with an already established worldview. In studies on the adaptation of innovations this is often highlighted as a prerequisite for the adaptation of innovations; they need to be compatible with cultural values and previously adopted ideas (Rogers, 1962/1983, p. 224). Indeed, it thus seems that the openness of VLC communities depends on the compatibility of new ideas with existing ideas and values.

13.4 Pluriform Vlaardingen Culture sites

In addition to shared traits, VLC sites are also characterised by their diversity. This diversity is often explained from the perspective of differing landscape settings (Amkreutz, 2013b; Dusseldorp & Amkreutz, 2020; Raemaekers, 2003;

Van Gijn, 1990b). This in turn is linked to the occupation duration at these sites (Raemaekers, 2003). I would however argue against the latter. This is not to say that landscape as a factor should be neglected, but it should not be automatically equated with the occupation duration at a site (Amkreutz, 2013b).

It seems that at least parts of the site Vlaardingen Arij Koplaan were permanently inhabited, based on the evidence for cereal cultivation and the permanent nature of the house plans. Furthermore, recent excavations in the coastal dune area clearly demonstrated the presence of temporary sites in this zone (Bulten & Stokkel, 2017; Van Zoolingen & Rieffe, 2023). Lastly, differences in terms of subsistence strategies seem to be differences of degree rather than kind. Hunting, fishing, and collecting also took place in the coastal dune area (Kooistra et al., 2021; Van Dijk, 2021), whereas domesticated animals were also kept at Vlaardingen Arij Koplaan and Hekelingen III (Clason, 1967; Prummel, 1987). Differences in subsistence strategies do not seem to be exclusively forced by the environmental settings. Deer can for example also be found in the coastal dune area (Van Dijk, 2021). Here, it rather seems to be a choice to focus specifically on cattle herding at these sites (Van Dijk, 2021; Van Dijk et al., 2017). This also ties into choices relating to craft activities. At Den Haag Steynhof we see a clear focus on hide working, while bone working and antler working are more prominent on the levee sites (Van den Dikkenberg & Van Gijn, 2024). This pluriform nature of VLC sites is furthermore reflected in diverging raw material procurement strategies in which at the levee sites more attention was devoted to obtaining high-quality flint.

In many respects Zandwerven seems to be an outlier within the VLC. It has however much in common with contemporary CWC settlements in West Frisia. This is for example highlighted by the focus on locally-obtained moraine flint (García-Díaz, 2017). It is interesting that shellfish collecting was an important subsistence strategy at the site (Van Regteren Altena et al., 1962a). This is likewise observed on other CWC sites in West Frisia, but shellfish was only sparsely collected at VLC sites (Kleijne et al., 2013). In terms of practices these people clearly fit in better with their CWC contemporaries than with VLC people to the south. As noted before these supposed CWC sites can perhaps better be rebranded as a subgroup of VLC settlements. In addition to shared traits this cluster is defined by its receptiveness to CWC influences, an emphasis on shellfish exploitation, and from a lithics perspective a focus on the exploitation of local moraine flint. In part these traits appear to be shaped by the affordances of the landscape. Especially, the local availability of moraine flint seems to be a key factor in determining the locally oriented lithic procurement strategies at these sites.

As noted by Furholt, specialisation generally leads to heterogeneity (Furholt, 2017). For VLC communities in the western Netherlands we can observe three distinct, specialised, communities of practice with shared raw material procurement strategies, subsistence strategies, and craft practices: 1) coastal dune sites, 2) levee sites, 3) West Frisian salt marsh sites, including the CWC sites there. Inland sites are presently poorly understood, but it seems that sites in the Brabant area also form a distinct group. These sites are characterised by large house plans, and a raw material procurement strategy focused on locally collected terrace flint. Zooarchaeological data is lacking, but cereal cultivation was important in terms of subsistence strategies. The size of the house plans suggests that livestock was kept indoors. This highlights that these communities maintained different practices relating to husbandry and presumably this reflects different attitudes towards domesticated animals (Devriendt, 2013b; Hissel, 2012; Van Hilst, 2018; Van Kampen, 2013). Lastly, it should be mentioned that the cluster in the Nijmegen area is equally poorly understood. In terms of raw material procurement strategies the use of terrace flint at many of these sites seems to suggest the group shares characteristics with the Noord-Brabant group (Drenth, 2019; Houkes & Drenth, 2017, p. 162; Louwe Kooijmans, 1980).

The open character of the VLC, as discussed in section 13.3, is strongly tied to the variation among these sites. VLC communities were receptive to new ideas and existing practices were subject to change. While the ritual/cultural sphere of the VLC largely eludes us (partly due to the scarcity of VLC burials) the present study does shed some new light on at least one of these aspects. Sickles from the preceding Hazendonk-3 group appear to have been systematically destroyed. They were broken, burnt, and their edges were retouched (Van Gijn, 2014b; Van Gijn & Verbaas, 2008). Occasionally, these tools were also subsequently rubbed with ochre (Van Gijn, 2014b). The flint sickle from Den Haag Wateringse Binnentuinen clearly shows that these practices continued during the VLC period. The sickle was burnt, broken and retouched prior to being deposited (Houkes et al., 2017). Yet, the sickles found at Vlaardingen Arij Koplaan indicate that these practices were only partially continued. One of the sickles was broken into three parts, the edge however was not retouched. The edges of the other two sickles were retouched. One of these sickles was subsequently turned into a scraper (see section 9.7.3). It thus seems that, although sickles were systematically destroyed during the VLC period, the way in which this destruction was carried out was open to variation. Retouching, burning, and breaking became optional steps.

Rather than considering the variation among VLC sites as being the result of differing occupation durations, I would suggest that it is most fruitful to consider the variation as reflecting the presence of different communities of practice, which are in part shaped by the affordances of the landscapes they inhabited. These communities structured

their lives in different ways, relying on different 'regimes of competences' (Wenger, 2010). The use of the metapodium technique for example had been noted as a typical feature for VLC communities (Van Gijn, 2010b). We now however see that this technique is specifically related to the inhabitants of the levee sites while communities in the dune area rely more on ad hoc bone working technologies (Van den Dikkenberg & Van Gijn, 2024). Furthermore, we see that maintaining long-distance exchange networks was especially important for inhabitants of the levees, and to a lesser degree for the inhabitants of the dune area. In contrast, such networks were of little economical importance for communities in West Frisia, who chose to rely on easily obtainable nearby resources of moraine flint. Considering the variation from this perspective allows us to study these sites from a non-hierarchical perspective. I agree with Amkreutz that we should be wary of considering levee sites as subordinate satellite sites of the inhabitants of either Noord-Brabant or the coastal dune area (Amkreutz, 2013b, p. 399). I think it is more fruitful if we consider them as a community in their own right. The variation among these sites fits well with the model proposed by Furholt who emphasises the pluriform nature of Neolithic social groups (Furholt, 2020). Certain practices are shared among these groups, but on other scales or, social worlds, these communities vary. In his model he visualises this with different social worlds for burial rituals, settlement patterns, and pottery production (Furholt, 2020). Zooming in on settlement patterns we can observe similar variations and pluriform communities of practice within the VLC. Here variation also extends to habitation zones, technology (e.g. the use of the metapodium technique), subsistence strategies and other spheres.

As noted in the previous chapter, we can conclude that this variation appears, at least in part, to be the result of increased specialisation. The different communities are tied together through several traits as mentioned in section 13.1, but due to the open character of VLC societies we observe considerable leeway and room for variation and adaptability. It seems that this open character was key to the persistence of these communities through times of intensive changes taking place across Europe during the Middle to Late Neolithic transition.

14

Synthesis

In this synthesis I will return to the central question posed at the beginning of this book: *how does variability in lithic biographies inform us about life in the Rhine-Meuse-Scheldt delta during the Vlaardingen Culture period?* This synthesis will provide answers to this question, as well as the sub-questions formulated in the introduction. An important part of answering this question is provided by the experiments; the lessons learned from these will be addressed in 14.1. The study on lithic procurement aimed to answer the following sub-questions posed in the introduction: *How and where did people obtain flint during this period? And how did people incorporate exotic imported flint in the local technological system?* The answers to these questions will be addressed in 14.2. Questions regarding the technological choices and the variation of VLC settlements across the landscape will be addressed in 14.3. These aspects also contribute to a wider understanding of what constitutes the VLC as an archaeological culture, and to our understanding of how the VLC relates to other contemporary groups; this will be addressed in 14.4. Finally, a methodological reflection is provided in 14.5. This work is grounded in the four decades of use-wear research conducted at the Leiden Laboratory for Material Culture Studies (formerly called the Laboratory for Artefact Studies). This provided me with access to one of the largest reference collections for use-wear studies in Europe, and furthermore to what is likely to be the most extensive dataset on use-wear analysis in the world. Therefore, the final subsection reflects on the future of use-wear and the position of the Netherlands in this field.

14.1 Lessons from the experiments

The use-wear analysis conducted on the VLC flint led to several questions that could only be explored by additional experiments. A first observation that needed detailed experimentation was the variability in axe biographies between the different VLC sites. While inhabitants of both the coastal dune area and the levee sites imported flint axes from the same flint mining areas in Belgium and Limburg, the axes on these sites were finished in a very different way. The imported axes on the coastal dune sites were generally only ground, while those on the levees were often polished with leather and additives, after having been ground. This shows that even if flint came from the same source, the biographies of these objects could differ significantly, showing hitherto unknown complexities in the exchange networks during this period. The study on archaeological axes and axe fragments revealed that the use of leather and additives for polishing in the western Netherlands dates back to the Middle Neolithic B (3400–2900 BCE). This is remarkable because in the eastern Netherlands the polishing of axes with leather and additives was not introduced until the CWC phase (ca. 2900 BCE), as was demonstrated by Van Gijn and Wentink (Van Gijn, 2010a; Wentink, 2020).

Several experiments were conducted to better understand the range of use-wear traces observed on VLC flint artefacts. The most significant results were obtained by the horn working experiments. The oldest unambiguous worked horn artefacts in the Netherlands date to the Iron Age (ca. 800 BCE) (Rijkelijkhuizen et al., 2024, pp. 39–42). The present experiments revealed that we can recognise horn working traces on flint implements,

something that has not been noted in the literature on use-wear studies before. These traces matched some of the 'unknown traces' on flint artefacts from Vlaardingen Arij Koplaan and Den Haag Steynhof. They provided the earliest evidence in the region for the use of horn in craft activities, thereby pushing back the earliest evidence for the use of worked horn for artefact production in the area by two thousand years.

Finally, the third set of experiments dealt with the ubiquitous polished axe fragments found in VLC settlement sites. The use of broken polished axes to produce flakes is a frequently observed feature at VLC sites, but our recycling experiments demonstrated that the contribution of this practice was much more important than had hitherto been assumed. The experiments showed that, if axes are recycled through flaking, most of the axe fragments resulting from this process will remain 'archaeologically invisible' (only ca. 41% of the axe fragments in the experiment display a remnant of the ground or polished outer surface). The flakes from continued reduction of the axes will generally not display a ground or polished outer surface, making it impossible to identify them as axe fragments in archaeological assemblages. These observations could now be used to provide a more realistic assessment of the importance of recycled flint axes at VLC sites. Furthermore, they provided insights into the state in which flint was imported to VLC sites. For Hesbaye flint, it could now be demonstrated that this type of flint was predominantly imported in the form of flint axes, rather than as nodules.

14.2 Sourcing flint

14.2.1 Procurement strategies and networks

An important question this study seeks to answer is where and how flint was obtained during the VLC period. It can be concluded that the diversity in flint types encountered at VLC sites is remarkable. Flint from seven sources was used, mainly: Lanaye/Spiennes, Hesbaye, eluvial flint, Cap Blanc Nez, terrace flint, Meuse-eggs, and moraine flint. Lanaye and Spiennes flints cannot generally be distinguished based on optical variations (De Grooth, 2011). Nevertheless, using ED-XRF analysis we were able to distinguish between Spiennes and Lanaye flint (Van den Dikkenberg & Braekmans, 2025). The ED-XRF analysis on archaeological samples demonstrated that Lanaye and Spiennes flint were not mutually exclusive. Despite these mines being located far apart, flint from both areas was systematically imported to VLC settlements. Clearly, people maintained regular contacts with a broad range of neighbouring communities. For high-quality flints such as Lanaye, Spiennes and Hesbaye flint we observe that flint is often imported in the form of complete objects, notably flint axes. In addition to these high-quality flints, we observe that regionally and locally available sources such as moraine flint, terrace flint, and Meuse-eggs were also frequently exploited. Choices in procurement strategies were highly dependent on the affordances of the landscape. We observed that on sites where terrace flint or moraine flint were locally available these flint types dominated the assemblages. If flint was not locally available, as is the case with most VLC sites especially in the delta area, the raw materials tend to vary depending on the access to waterways. The levee sites are conveniently located along major waterways which connect them with areas where high-quality flints such as Hesbaye, Spiennes, and Lanaye flint could be obtained. These sites thus relied heavily on the regular import of high-quality flints. Sites along the coastal dune area, which were not directly connected to these waterways generally relied on low-quality flints such as Meuse-eggs, although they typically also had a component of imported flint. We observed that sites along the route between Hesbaye and the levee sites did not have as much Hesbaye flint as the levee sites. If a down-the-line system had been present we would have observed a gradual decrease in availability of this flint as distance from the source increased. This was not the case as argued in section 11.2. For high-quality flint it thus seems likely that flint was imported through direct exchange, rather than via a down-the-line exchange network.

Although the present study focused on flint, it could be observed that flint procurement was part of wider taskscapes (see chapter 11.5). These involved complex social networks, as well as the procurement of other materials such as non-flint stone, ochre, and pyrite. The role of organics in these taskscapes is still poorly understood, but undoubtedly these also played a role.

14.2.2 Appropriation and unprecedented connectivity

While the connections with far-flung communities discussed above were shaped over the course of two millennia since the late Mesolithic, they fundamentally changed during the VLC period. At some VLC sites imported high-quality flint was more common than other flint types, something not seen before. The consolidation of these networks is further highlighted by the fact that certain local technologies disappear in favour of the import of ready-made objects. This particularly pertains to the import of flint axes and flint blades (Van den Dikkenberg, 2024b). Use-wear analyses on exotic flint from late Mesolithic, Swifterbant, and Hazendonk-3 group sites revealed that exotic flint was given a special role in the technological system, setting these objects apart from objects made from locally or regionally sourced flint (Van Gijn, 2008, 2015). Although the Rijckholt/Lanaye imports from Hazendonk-3 group sites displayed use-wear traces, their use was clearly reserved for a restricted number of activities. During the VLC phase this functional differentiation, in which exotic flint was

reserved for a specific set of special activities, disappears. Imported flint is now employed for the same range of activities as local or regional flint. The regular imports thus led to a normalisation in which exotic objects were to a lesser extent viewed as foreign, as they were now fully incorporated in the local technological system.

14.3 Living with flint in the Rhine-Meuse delta

14.3.1 Ad hoc technologies and skills

The gradual disappearance of blade technologies in favour of ad hoc flaking technologies was initiated during the Swifterbant phase (Peeters & Devriendt, 2016, p. 151). However, this development peaked during the VLC period. Local blade and axe production largely disappeared, along with local knapping skills. It is telling that the number of knapping mistakes (hinges, step fractures, plunging terminations) on VLC flint flakes is comparable to what is experimentally observed with inexperienced knappers (Shelley, 1990). We do not only observe a gradual disappearance of specific technologies, but also a gradual decrease in knapping skills. This change, which is observed on a wider scale in Neolithic societies, can be tied to the emergence of flint mining centres, where these advanced technologies were maintained (De Grooth, 1991; De Warrimont & Amkreutz, 2015; Devriendt, 2013a; Peeters & Devriendt, 2016; Schreurs, 2016).

During the Neolithic communities became increasingly sedentary. We see that some of these communities, like VLC communities in the Rhine-Meuse delta, settled in areas largely devoid of flint. Others, like those in the Limburg area, settled in areas where high-quality flint is abundant. While Mesolithic and Palaeolithic communities incorporated areas with abundant raw materials in their yearly cycles, we observe that access to flint becomes unequally distributed during the Neolithic. Communities with access to high-quality flint increasingly specialised in the exploitation of these sources, which culminated in the creation of underground flint mines. This flint is worked locally into high-quality products such as flint axes and blades which are then exported to areas where flint is not available (in this case the Rhine-Meuse delta). The production of such artefacts would require skills which can only be acquired through extensive practice, something which in turn requires access to abundant raw materials. Because the latter is lacking, people in the Rhine-Meuse delta invested less time in the acquisition of knapping skills, whereas earlier communities in the delta produced their own axes and blades. Instead VLC communities increasingly relied on ad hoc technologies, clearly making different technological choices than upland communities (Lemonnier, 1986). For several specialised artefact types such as flint axes they chose to rely on distant communities near flint mines, who had both the raw materials and skills to produce these artefacts. The discussed picture is based on a locally observed dynamic, but it is possible that similar mechanisms played a role in the emergence of flint mines elsewhere in Europe.

14.3.2 Living on the levees

The place of the levee sites within the VLC settlement system has become increasingly complex due to the present study. It was hitherto assumed that levee sites were temporarily occupied settlements, while coastal dune sites were considered to be permanently inhabited (Raemaekers, 2003). The use-wear analyses for Vlaardingen Arij Koplaan presented several cereal harvesting implements. Furthermore, the comparison between the house plan at Vlaardingen Arij Koplaan trench 15 and the one from the coastal dune site Den Haag Steynhof revealed that they are similar both in terms of type and dimensions. This calls into question whether Vlaardingen Arij Koplaan can be seen as a temporary settlement. A revision of previous data, combined with the newly gathered evidence, suggests that habitation at the site can be demonstrated for every season. Therefore, I would argue that the site was likely permanently inhabited, like many of the sites in the coastal dune area. This also means that the levee sites, as a group, cannot merely be satellite settlements, which are only seasonally exploited by inhabitants from the coastal dunes or by communities further inland. A more plausible explanation for the variation in VLC sites is that there are several subgroups. These represent subgroups of people who, to some extent, specialised in the exploitation of different landscape zones. On the levees fishing and hunting were highly important subsistence strategies. Furthermore, we see that this is also tied to differentiation in craft activities as antler working and the metapodium technique seem to be largely restricted to the levee sites (Van den Dikkenberg & Van Gijn, 2024). The status of Hekelingen III in this respect remains ambiguous. The cereal harvesting implement potentially suggests local cereal cultivation, but the lack of permanent structures still argues against permanent occupation.

14.3.3 Invisible craft specialists

The use-wear analysis of the assemblage at Den Haag Steynhof convincingly demonstrates that the inhabitants were part-time hide working specialists. This provided the first evidence for craft specialisation in the Rhine-Meuse delta. The overproduction of hide products at the site was likely aimed at export. They were presumably exchanged for objects such as flint axes. In addition to processed hides, it is also possible that other products such as meat were exchanged, although this cannot be established with any certainty. At the site the entire hide working *chaîne opératoire* could be demonstrated. This might indicate that

hide was not exported as a raw material, but rather in the form of finished products, similar to what we observe with the import of ready-made flint axes.

This discovery is also significant from a methodological point of view. Demonstrating craft specialisation when neither the finished products nor the waste products are preserved is challenging. This study shows that use-wear analysis can successfully be employed to identify craft specialisation in the archaeological record through detailed comparative studies of tool use. It highlights that use-wear analysis is an essential tool for revealing those hidden aspects of past technologies. The material worlds of the past were mostly made up of things which did not preserve. It is not only our job as archaeologists to study the remains which have stood the test of time, but also to understand these invisible aspects of life in the past. Despite major advances in the field these invisible parts of prehistoric technology remain heavily understudied. A lot of work remains to be done to uncover the meaning of those materials which have not survived, but which were surely indispensable to life in the past (Hurcombe, 2008, p. 85).

14.3.4 A network of specialised sites

The evidence for craft specialisation cited above has broader implications for our understanding of the dynamics of VLC settlements. Variation across environmental zones cannot be explained solely from the perspective of differing habitation durations. Local craft specialisation is certainly a factor which needs to be accounted for when studying the variation among VLC sites. In addition to hide working it was also noted that bone and antler working activities are unequally distributed across sites (Van den Dikkenberg & Van Gijn, 2024). While zooarchaeological studies in the past were hampered by preservation biases, the present study strongly suggests that the variation points to part-time specialisation, where different communities focused on different craft and subsistence strategies (Amkreutz, 2013b). This rise in complexity and specialisation are strongly connected to the consolidation of exchange networks in this period, as these facilitated the exchange of goods between these communities.

14.4 A lithic perspective on the Vlaardingen Culture

The present study sheds light on what defines the VLC. Neolithic cultures are generally differentiated based on ceramic typologies, but it seems more fruitful to look for shared practices among communities. For the VLC a defining trait is the strong connection with several southern communities. These bonds were gradually shaped since the Late Mesolithic, but they clearly reach new heights during the VLC period. As noted earlier, we observe that these contacts were normalised, and that for the production of blades and axes the local production of these objects was replaced with ready-made imports. The maintenance of these networks seemed to rely on water-based exchange routes. Sites along the levees, with direct access to major waterways, were especially well connected. While these connections were far-reaching, we also observe that they were not chosen at random. Especially regarding exchange with the FBC communities in the eastern Netherlands, deliberate choices were made in terms of what was exchanged. It seems that FBC and VLC communities exchanged ceramics, and also knowledge regarding ceramic production (Kroon, 2024). However, from a lithics perspective there are no direct indications for exchange, either of products or knowledge, between these communities. Clearly social boundaries in this period were highly complex and they are expressed differently in different material categories. What is furthermore striking about the VLC is the general openness of the group. When CWC communities emerged in the eastern Netherlands people quickly, partially, adopted several new traits, including tanged arrowheads, CWC ceramics, and battle axes (Glasbergen et al., 1961; Glasbergen et al., 1967a; Houkes et al., 2017; Van Regteren Altena & Bakker, 1961; Van Regteren Altena et al., 1962c). The adaptation of new traits did, however, not lead to a dissolution of the VLC phenomenon. Rather, these new traits were incorporated into the existing VLC repertoire.

Finally, a frequently mentioned trait is the diversity among VLC settlements. I would instead argue that sub-groups of the VLC appear to specialise in certain areas. The levee sites focus on the exploitation of wild resources, in bone and antler working, and they also excel at maintaining long-distance networks. At Den Haag Steynhof we see part-time specialisation focused on hide working. In general, the sites in the coastal dune area appear to focus more heavily on domestic animals and crop cultivation. As a new subgroup we can point to the West Frisian sites, which have recently been dubbed as 'Vlaardingen-CWC' sites (Olalde et al., 2025). Indeed I would favour seeing these sites as a subgroup of VLC sites. From a subsistence perspective, these sites are quite diverse, and what makes them unique, as opposed to other VLC sites, is their extensive shellfish exploitation. From a lithics perspective these sites hardly share in the strong southern connections which characterise other VLC sites. They tend to focus on locally sourced moraine flint. Furthermore, they are highly receptive to new CWC influences. This variation in sites can most fruitfully be considered from a perspective of openness. This adaptability made the VLC communities ideally suited for life in the dynamic wetlands (Amkreutz, 2013b).

14.5 Methodological reflections

The present study utilises the concept of object biographies to reconstruct biographies for artefact populations, which in turn can be seen as analogous to the past populations who

made and used these artefacts. This approach successfully bridges the gap between individual and generalised biographies. It allows us to use patterns observed on the level of artefact populations at different sites as an analogy to reconstruct patterns in human behaviour.

The approach taken in this study presupposes that the data produced by different specialists are comparable. While this cannot be fully guaranteed, I do believe that we should consider this to be generally true. Archaeology will always be an interpretative science, at some point during fieldwork someone will have to decide which black discolorations in the ground are postholes, which ones are pits, and which ones are not actually archaeological features. Similarly, lithic specialists have to decide where to draw the line between hard and soft hammer percussion, and when flint shows enough characteristics to be assigned to a specific source. In use-wear studies, it can be difficult to draw the line between fresh and dry hide polishes, and polishes which are not assigned to a specific group, but for which the broader designation 'hide indet.' is used. Aside from minor details, I would argue that different micro-wear specialists arrive at similar interpretations. Moreover, if we aim to compare dynamics on the level of artefact populations these minor differences in interpretation can be overcome if we look at wider patterns. This applies broadly to all of the above examples. It would be difficult to define prehistoric house-types based on the exact number of postholes present in a house plan. For such conclusions the differences in interpretation, past variability, and preservation create too much variation. However, the overall layout of house plans can be compared, regardless of the archaeologist who interprets the individual postholes. Similarly, minor details in interpretations among lithic and use-wear specialists may vary. Regardless, I believe that overall meaningful patterns can be recognised when comparing the works of different specialists.

14.5.1 Reaping the fruits of Malta archaeology

The vast majority of archaeological data in the Netherlands is produced by contract archaeology during development-led campaigns. If academics dismiss these data because of the likely minor differences in interpretations among specialists, we are quite likely missing the bigger picture. Utilising this data, along with the data I gathered, provided me with access to data on raw materials from VLC sites for over sixteen thousand artefacts. I could access technological data for over two thousand artefacts, and for the use-wear analyses I had access to data on over fifteen hundred artefacts. It would not have been feasible to gather this amount of data during the span of a PhD trajectory. This research builds on the approach taken by Van Gijn in her '*Flint in Focus*' book (Van Gijn, 2010a). Therefore, this study is heavily indebted to fellow archaeologists in archaeological companies who have gathered valuable data which can now be utilised to study these broader patterns in procurement, craft, and subsistence strategies of the VLC. I believe that this approach has significant potential for future studies on the prehistory of the Netherlands. Especially, for use-wear analyses the strong roots in development-led archaeology have, since 1992, positioned the Netherlands as the country with one of the highest densities of use-wear studies in the world. This uniquely allows us to track developments in tool use, and by extension craft and subsistence strategies, across time and space.

Nevertheless, although this approach was fruitful, the dataset is still fairly small compared to the total number of available VLC sites. In many aspects the present study depends on high-resolution detailed analyses (microscopic analysis of production and use-wear traces, ED-XRF analysis on Lanaye/Spiennes flint etc.) which have not been conducted for the vast majority of VLC sites. Considering the great variability observed at VLC sites it is still up for debate to what extent the patterns observed here hold true for the VLC at large, or for environmental zones within the VLC settlement systems. For example, the observed differences in terms of microscopic production traces on flint axes of the levees (mainly polished with leather and sand) and the coastal dune area (mainly being ground, but not polished) are based on samples from four VLC sites. Without further analysis it is still difficult to assess whether we can extrapolate such results to entire environmental settings. Obviously, in archaeology we will always have fragmentary and incomplete datasets. The best way to cope with this is to still seek out such patterns as much as possible, while acknowledging that our interpretations are subject to constant change due to new data being gathered and excavated.

14.5.2 The future of use-wear analysis

Borrowing the title for this section from the final section in Annelou van Gijn's PhD thesis (Van Gijn, 1990b, p. 147) I thought it would be prudent to reflect on the future of a field which has grown dear to me in these past years. I think there are currently several new pathways which are being explored. The first one is the use of confocal microscopy and the use of quantitative data. These studies excellently demonstrate that the variation we observe in use-wear traces is not a subjective observation, but that it is grounded in quantifiable factual data. Nevertheless, as a method it is time consuming and requires substantial experimental datasets for proper analyses. Unfortunately, these studies often lack fine-grained categories of wear traces which hampers our interpretations. For example, none of the confocal microscopic studies up-to-date included specific experiments with fish skins or horn (Evans & Donahue, 2008; Ibáñez et al., 2019; Ibáñez & Mazzucco, 2021). As such, the breadth of these programs is limited, which in turn

limits archaeological interpretations. Therefore, I think the main added value of these studies is to disentangle specific questions, as has been demonstrated with studies on specific harvesting and cereal processing techniques (Ibáñez-Estévez et al., 2021; Ibáñez et al., 2016a; Ibáñez et al., 2014; Mazzucco et al., 2024). Another development which is increasingly important is the application of artificial intelligence (AI) and machine learning. While these applications have been around since the 1990s they recently saw a boom in interest (Eleftheriadou et al., 2025; Van den Dries, 1998). This is largely due to increased computer capacities, which significantly improved the potential of these methods. So far, results have still been limited, but AI applications potentially have the possibility to speed-up analyses. However, a main issue is that AI generally fails to be able to acknowledge when it does not recognise things (Li et al., 2024). An AI model trained on bone, antler, and hide working traces would likely group horn working traces in one of those three categories. I think it will be very difficult to train an AI model which can critically recognise unknown traces which have been formed through processes which are not part of the training data. If this problem can be overcome, we can envision a methodology in which large quantities of tools are processed with AI after which a group with unclassified traces are studied in detail through traditional microscopic methods, using new experiments. Another potential avenue for AI applications, in line with the previously mentioned successes of confocal microscopy, is to focus on more detailed research questions. One example would be addressing how to differentiate use-wear traces that are otherwise difficult to disentangle. For tools with complex biographies imagination and renewed experimentation will however remain indispensable.

While the above two current pathways provide methodological innovations I think, at large, they fail to provide a deeper understanding of the human past. Often use-wear analyses have focused on site level analyses. Like all specialisms this is inherently how one starts. However, the most interesting stories to be gained are those derived from inter-site comparisons on tool use, such as studes in which we can seek out regional variations and chronological developments in tool use. Lists of contact materials such as hide, bone, antler, cereal, etc. are not interesting on their own. However, placed in a wider context, and especially when related to other aspects of the biographies of those tools (such as raw materials), they provide valuable insights into the human past. One can compare this notion to zooarchaeology, having a single site with a list of species for a site tells us very little about life in a certain period. But having gathered significant datasets for multiple periods has allowed us to trace long-term developments in human-animal relationships. Building such datasets for object biographies has made Netherlands, and specifically the Laboratory for Material Culture Studies in Leiden, a frontrunner in synthesising such datasets. We are uniquely positioned to extract big stories from microscopic traces, whether they concern long-term trends in the use of exotic flint, disappearing technologies at the onset of the Neolithic, craft specialisation, regional variations in tool use, or the treatment of tools in ritual contexts (Little & Van Gijn, 2017; Van den Dikkenberg & Van Gijn, 2024; Van Gijn, 2008; 2010a; 2013; 2014b; 2015; Van Gijn & Mazzucco, 2013; Van Gijn & Wentink, 2013; Wentink, 2008; 2020). I believe that creating these kinds of synthesising narratives based on artefact populations, rather than individual biographies will prove to be the main contribution of use-wear analysis in the future.

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Appendix 8: Axe fragments by environmental setting (csv.)

Nederlandstalige samenvatting

Leven met vuursteen: objectbiografieën en het dagelijks leven in de Rijn-Maasdelta ten tijde van de Vlaardingencultuur (3400-2500 v.Chr.)

Inleiding

Het leven in de Nederlandse delta bood in het verleden zowel kansen als uitdagingen voor de inwoners van de Rijn-Maasdelta. De Neolithische Vlaardingencultuur (3400–2500 v.Chr.) gemeenschappen waren uitstekend aangepast aan het leven in deze dynamische omgeving. In dit boek wordt het dagelijks leven in de delta tijdens het Neolithicum onderzocht aan de hand van een uitgebreide studie van de biografieën van vuurstenen objecten. Het pluriforme karakter van Vlaardingencultuur (VLC)-vindplaatsen is al lange tijd onderkend, maar er bestaat discussie over hoe deze variatie moet worden geïnterpreteerd. Een verklaring is dat de variatie samenhangt met verschillen in bewoningsduur: de kustduin-nederzettingen zouden permanente nederzettingen zijn geweest, terwijl de oeverwallen slechts tijdelijk werden bewoond. Omdat de argumentatie voor deze verklaring deels gebaseerd is op gebruikssporenonderzoek zullen deze opvattingen opnieuw worden geëvalueerd op basis van de hier gepresenteerde nieuwe data.

Het vuursteen van vier prominente VLC-nederzettingen is geanalyseerd om inzicht te krijgen in de verwerving, productie, het gebruik en hergebruik van vuurstenen artefacten. In plaats van te focussen op individuele objectbiografieën ligt de nadruk in dit boek op artefactpopulaties, die worden opgevat in analogie met menselijke populaties, de gemeenschappen die de artefacten maakten en gebruikten. Het onderzoek maakt gebruik van het perspectief van *communities of practice* om de wisselwerking tussen gemeenschappen en technologie te begrijpen. Daarnaast wordt het concept *taskscapes* gebruikt om te laten zien hoe de verwerving van vuursteen is ingebed in andere activiteiten. Het gebruikssporenonderzoek wordt ook verbonden aan de herkomstanalyse om inzicht te krijgen in hoe exotisch vuursteen door VLC-gemeenschappen werd toegeëigend.

Methodologie en experimenten

Methodologisch is de herkomststudie grotendeels gebaseerd op een visuele inspectie van grondstoffen, door gebruik te maken van de lithotheek van de Universiteit Leiden. Optisch gezien kan vuursteen uit Spiennes en Rijckholt/Lanaye echter meestal niet van elkaar worden onderscheiden. Daarom is ED-XRF-analyse toegepast op referentiemateriaal en archeologische artefacten uit deze groepen. In het gebruikssporenonderzoek werd de uitgebreide referentiecollectie van het *Laboratory for Material Culture Studies* in Leiden gebruikt. Nieuwe onderzoeksvragen en de vondst van gebruikssporen zonder experimentele tegenhanger maakte het noodzakelijk om nieuwe experimenten uit te voeren. Dit leidde tot nieuwe experimenten met vissenhuiden, hoorn en het schrapen van huid met minerale toevoegingen. De technologische experimenten werden

uitgevoerd om de afwerking van vuurstenen bijlen beter te begrijpen. Een laatste reeks experimenten richtte zich op gerecycleerde vuurstenen bijlen, om inzicht te krijgen in het belang van recycling in deze periode.

Vuursteen op nederzettingen van de Vlaardingencultuur

De analyses leverden nieuwe inzichten op in de verwerving, productie en het gebruik van vuurstenen artefacten. Zo kon worden vastgesteld dat de oeverwal-nederzettingen van Hekelingen III en Vlaardingen Arij Koplaan nauwe banden onderhielden met andere gemeenschappen, waardoor ze toegang hadden tot hoge kwaliteit vuursteen. Op de Westfriese vindplaats Zandwerven gebruikte men vooral lokaal gewonnen morenevuursteen. Vuursteen van de kustduin-nederzetting Den Haag Steynhof bestond uit zowel hoogwaardig vuursteen uit België en Limburg, alsook lokaal/regionaal verkregen vuursteen zoals Maas-eitjes en terrasvuursteen. Qua technologie werd een eenvoudige ad-hoc-afslagtechniek toegepast. Vuursteenklingen en bijlen werden vaak als kant-en-klare producten geïmporteerd. De hoge percentages hinges, steps en kernvoeten aan de distale einden wijzen op een laag niveau van vuursteenbewerking, dit is in overeenstemming met wat verwacht kan worden van niet-gespecialiseerde bewerkers. Hoewel bijlen kant-en-klaar werden geïmporteerd, kon worden vastgesteld dat bijlen van de oeverwal- en kustduin-nederzettingen niet op dezelfde manier waren afgewerkt. De bijlen van de oeverwal-nederzettingen werden meestal uitgebreid gepolijst met leer en additieven, terwijl die van de kustduin-nederzettingen alleen geslepen waren, zonder verdere polijsting. Het lijkt erop dat het polijsten de karaktersitieken van het vuursteen benadrukte waardoor zowel wij als mensen in het verleden de herkomst van het materiaal konden herkennen. We kunnen daarom stellen dat dit uitgebreide polijsten van vuurstenen bijlen op de oeverwallen goed past bij het accent wat deze gemeenschappen legden op het verwerven van hoogwaardige exotische grondstoffen.

Uitwisselingsnetwerken

Op basis van de verspreiding van Haspengouw-vuursteen op VLC-vindplaatsen kon worden aangetoond dat het onwaarschijnlijk is dat dit vuursteen via een *down-the-line*-ruilsysteem werd verkregen. Eerder lijkt het erop dat mensen direct contact hadden met gemeenschappen in het zuiden. Dit zuidelijke geïmporteerde vuursteen werd niet alleen kwantitatief belangrijker in de VLC-tijd, het werd nu ook voor een veel breder scala aan activiteiten gebruikt dan in eerdere perioden. Exotisch vuursteen werd nu gebruikt voor hetzelfde repertoire van activiteiten als lokaal of regionaal verzameld vuursteen. Dit toont aan dat exotisch vuursteen volledig was geïntegreerd in het lokale technologische systeem. Tot slot kan worden opgemerkt dat de verwerving van vuursteen was ingebed in *taskscapes,* die ook de verwerving van andere materialen omvatten, zoals dat van andere steensoorten, oker en pyriet.

Technologisch systeem

De vuursteentechnologie in de VLC-periode was gericht op de productie van functionele werkranden en niet zozeer op de productie van specifieke werktuigtypen. Het ontstaan van dit ad-hoc-technologische systeem valt samen met de opkomst van vuursteenmijnen in Zuid-Nederland en België. Tijdens het Paleolithicum en Mesolithicum trokken gemeenschappen rond door het landschap. In hun jaarlijkse trektochten bezochten deze jager-verzamelaars waarschijnlijk ook gebieden met voldoende toegang tot lithische grondstoffen. Etnografisch is goed gedocumenteerd dat dergelijke gebieden dienen als oefenterrein voor beginnende steenbewerkers. Met de opkomst van het Neolithicum begonnen mensen zich in specifieke delen van het landschap te vestigen. Sommige gemeenschappen, bijvoorbeeld in Zuid-Limburg, konden lokaal hoogwaardig vuursteen verkrijgen. Hiermee hadden ze dus ook toegang tot oefenterreinen waar men kon leren vuursteen bewerken. Andere gemeenschappen, onder andere in de Rijn-Maas-delta, hadden geen directe toegang tot lokaal vuursteen. Deze ongelijke verdeling van toegang tot grondstoffen leidde tot de opkomst van uitwisselingsnetwerken, wat resulteerde in de opkomst van gemeenschappen die zich specialiseerden in de verwerving van vuursteen en de productie van specifieke vuurstenen artefacten zoals bijlen en klingen. Dit kan in verband worden gebracht met de opkomst van vuursteenmijncentra in Limburg en België. Tegelijkertijd zien we dat gemeenschappen in de Rijn-Maas-delta steeds meer vertrouwden op ad-hoc-technologieën. Deze technologieën vereiste een minimale investering in grondstoffen, vooral omdat weinig training nodig was om te voorzien in de technologische behoeften. Voor complexere objecten, zoals vuurstenen bijlen, werden mensen volledig afhankelijk van import. In plaats van tijd te investeren in het verwerven van de vaardigheden om deze objecten zelf te maken, koos men ervoor om bijlen kant-en-klaar te importeren. We kunnen dus constateren dat het neolithisatieproces, het ontstaan van vuursteenmijncentra en het ontstaan van ad-hoc-technologieën in de delta nauw met elkaar verweven waren.

In Den Haag Steynhof lijkt de intensieve focus op huidbewerking verband te houden met deeltijdspecialisatie. De overproductie van huidproducten was waarschijnlijk bestemd voor uitwisseling. Het is aannemelijk dat deze huidproducten werden geruild tegen vuurstenen bijlen en andere geïmporteerde vuurstenen objecten. Bij de oeverwal-nederzettingen kan worden opgemerkt dat er een opmerkelijke diversiteit aan activiteiten plaatsvond. Botbewerking was erg belangrijk voor deze gemeenschappen, wat suggereert dat ook benen artefacten

mogelijk werden uitgeruild. Daarnaast kon op basis van het gebruikssporenonderzoek worden aangetoond dat graan lokaal werd verbouwd in Vlaardingen Arij Koplaan. Op basis van deze analyses en een herwaardering van de aard van de huisplattegrond uit werkput 15, wordt nu gesteld dat (in ieder geval een deel van) deze nederzetting waarschijnlijk permanent werd bewoond in het Neolithicum.

Een bijzondere ontdekking was de vondst van drie werktuigen die waren gebruikt voor hoornbewerking. De gebruikssporen op deze werktuigen konden nu worden herkend dankzij de nieuw uitgevoerde experimenten. Hoornobjecten zijn niet bekend uit het Nederlandse Neolithicum. Deze werktuigen vormen daarmee het oudste bewijs voor het gebruik van hoorn in ambachtelijke activiteiten in Nederland.

Het beeld dat naar voren kwam tijdens dit onderzoek is dat de VLC bestond uit diverse lokale gemeenschappen met unieke accenten, zowel in de bestaanseconomie als ook op het vlak van ambachtelijke activiteiten. Bewoners van de oeverwallen richtten zich vooral op de jacht en visvangst, terwijl ze ook uitgebreide handelsnetwerken onderhielden. De bewoners van de kustduinen richtten zich meer op het houden van vee, en in het geval van Den Haag Steynhof specialiseerden zij zich in huidbewerking. Zandwerven moet worden gezien als onderdeel van het cluster van Vlaardingen–Enkelgrafcultuur-nederzettingen in West-Friesland. Deze gemeenschappen richtten zich op de exploitatie van lokale morenes voor het verwerven van vuursteen. De bestaanseconomie op deze nederzettingen was divers. In tegenstelling tot zuidelijke VLC-nederzettingen, verzamelde men hier ook vaak schelpdieren. Bovendien waren deze vindplaatsen duidelijk veel ontvankelijker voor Enkelgrafcultuur (EGK)-invloeden dan de zuidelijke VLC-gemeenschappen.

De Vlaardingencultuur vanuit een lithisch perspectief

De diversiteit van deze VLC-gemeenschappen laat zien dat het gaat om open gemeenschappen. Deze openheid en diversiteit waren belangrijk voor de veerkracht van de VLC. Hoewel de vuursteenverwervingsstrategieën van de VLC-gemeenschappen zeer divers zijn, is een algemene zuidelijke oriëntatie kenmerkend. Wat betreft contacten met andere groepen zien we dat de VLC-gemeenschappen een uitgebreid netwerk onderhielden. Deze contacten manifesteerden zich echter verschillend in verschillende materiaalgroepen. Voor contacten met de Trechterbekercultuur (TRB) kan bijvoorbeeld worden opgemerkt dat er vanuit een lithisch perspectief vrijwel geen bewijs is voor banden met deze groep. Dit contrasteert met recente studies waaruit bleek dat Trechterbekergemeenschappen en VLC-gemeenschappen veelvuldig aardwerktechnologieën onderling deelde. De discrepanties bieden stof tot nadenken, omdat het erop wijst dat verschillende groepen (bijvoorbeeld gendergroepen) binnen Neolithische samenlevingen verschillende contacten onderhielden. Hoewel vanuit een lithisch perspectief contacten met TRB-gemeenschappen beperkt waren, blijkt dat de contacten met zuidelijke gemeenschappen erg belangrijk waren voor VLC-gemeenschappen. Contacten met latere EGK-gemeenschappen waren ook intensiever. De VLC wordt dus gekarakteriseerd door een open houding tegenover andere groepen. Naast deze openheid zien we ook dat Vlaardingen-gemeenschappen veerkrachtig waren. In de tijd dat de introductie van het EGK-fenomeen leidde tot het verdwijnen van lokale groepen en tradities in grote delen van Europa wist de VLC-gemeenschap haar unieke levenswijze te behouden.

English summary

Living with Flint: Lithic biographies and daily life in the Rhine–Meuse Delta during the Vlaardingen Culture period (3400–2500 BCE)

Introduction

Life in the Dutch wetlands has always provided opportunities and challenges for the inhabitants of the delta. The Neolithic Vlaardingen Culture (3400–2500 BCE) can be seen as the epitome of adaptability to this dynamic environment. In this book, life in the wetlands during the Neolithic is explored through a detailed study of lithic object biographies. The pluriform nature of these Vlaardingen Culture (VLC) sites has long been recognised, but it is debated as to how this variation should be interpreted. One explanation is that the variation relates to varying occupation durations. In this view, the coastal dune sites are permanent settlements, while the levee sites are temporary settlements. Because the argumentation for this is partly based on use-wear analysis, these notions will also be re-evaluated based on the newly presented data.

The flint from four key VLC sites is analysed to provide insight into the procurement, production, use, and recycling of flint artefacts. Rather than focusing on individual biographies the focus here lies in the study of artefact populations, which can be seen as analogous for the human populations who produced and used these artefacts. The study incorporates the perspective of communities of practice to understand the interplay between communities and technology. The notion of taskscapes is used to address how flint procurement is embedded in other practices. The use-wear analyses are furthermore tied to the provenance studies in order to understand how exotic flint is appropriated by VLC communities.

Methodology and experiments

Methodologically, the sourcing study mostly relies on visual identifications of raw materials, making use of the lithotheque at Leiden University. However, optically Spiennes and Rijckholt/Lanaye flint cannot generally be distinguished. Therefore, ED-XRF analysis was employed to analyse reference samples, and archaeological artefacts from these groups. For the use-wear analysis, the extensive reference collection in the Laboratory for Material Culture Studies was used. Nevertheless, new research questions and the finding of traces without an experimental match made it necessary to conduct new experiments to understand previously unclassified traces. This led to new experiments with fish skins, horn, and hide scraping using additives. Technological experiments were carried out to understand the finishing traces observed on flint axes. A final set of experiments dealt with recycled flint axes, aiming to provide insight into the importance of recycling during this period.

Flint on Vlaardingen Culture settlements

The analyses provided interesting new insights into the procurement, production and use of flint artefacts. It could be observed that the levee sites of Hekelingen III and Vlaardingen Arij Koplaan were well connected to other communities, providing access to high-quality flint. At the West Frisian site of Zandwerven locally-obtained moraine flint dominated the assemblage. Flint from the coastal dune site of Den Haag Steynhof consisted of a mix of high-quality mined flint and more regionally obtained low-quality flints such as Meuse-eggs and terrace flint. In terms of technology, a simple ad hoc flaking was employed. Blades and axes were usually imported as finished products. The high percentages of hinge, step, and plunging terminations indicate a low degree of knapping skills, consistent with what we could expect from non-specialised knappers. Although axes were apparently imported in a finished state, it could be observed that axes from the levee sites and the coastal dune sites were not finished in the same manner. The former were usually extensively polished with leather and additives while the latter were only ground. It seems that polishing highlighted those features in the flint which allow us, and people in the past, to recognise the origin of the material. We can therefore suggest that this extensive polishing of flint axes found on the levee sites fits well with the focus of these communities on the acquisition of high-quality raw materials from distant sources.

Lithic exchange networks

Based on the distribution of Hesbaye flint at VLC sites, it seems unlikely that this flint was obtained through a down-the-line exchange system. Rather, it seems likely that people had direct contact with communities in the south. This southern imported flint not only became more prominent in a quantitative sense, it could be demonstrated that imported flint was now also employed for a much wider range of uses than in earlier periods. Exotic flint was now used for the same range of tasks as non-exotic local or regional flint. This demonstrates that exotic flint was now fully incorporated in the local technological system. Finally, it can be noted that flint procurement was embedded in taskscapes which also involved the procurement of other materials such as non-flint stone, ochre, and pyrite.

Technological system

Flint technology in the VLC period was geared towards the production of functional edges, rather than specific tool types. The emergence of this ad hoc technological system coincides with the emergence of flint mines in the southern Netherlands and Belgium. During the Palaeolithic and Mesolithic communities traveled around the landscape. On their yearly cycles these hunter-gatherer communities likely also visited areas with access to abundant lithic raw materials. Ethnographic comparisons with hunter-gatherer societies show that such areas often serve as training grounds for novice knappers. With the emergence of the Neolithic, people begin to settle down in specific areas in the landscape. Some of these communities, for example in the south of Limburg, have access to high-quality flint, and thus training grounds. Others, such as communities that settle in the Rhine-Meuse delta have no direct access to high-quality flint. This unequal distribution of access to raw materials resulted in the emergence of exchange networks. These in turn led to the emergence of communities that specialise in the procurement of flint and the production of specific flint artefacts such as axes and blades. This can be linked to the establishment of flint mines in Limburg and Belgium. At the same time, we see that communities in the Rhine-Meuse delta increasingly rely on ad hoc technologies. These technologies require a minimal investment of raw materials, especially because little training is needed to fulfil the technological needs for these communities. For more complex technologies, such as the production of flint axes, they chose to rely on exchange, rather than investing time acquiring the skills to produce these objects. We could thus observe that the Neolithisation process, the emergence of flint mines and the emergence of ad hoc technologies in the delta were closely intertwined developments.

At Den Haag Steynhof the intensive focus on hide working seems to be related to part-time specialisation. The overproduction of hide products was likely directed at exchange. We can imagine that hide products were exchanged for flint axes and other imported flint objects. For the levee sites it can be noted that a remarkable diversity of activities took place. The extensive evidence for bone working suggests that bone artefacts might also have been exchanged. It could also be demonstrated that cereals were cultivated locally at Vlaardingen Arij Koplaan, based on the presence of multiple flint sickles with use-wear traces related to cereal harvesting. Based on these analyses and a re-evaluation of the nature of the house plan from trench 15, it is now argued that (at least part of) this site was likely permanently inhabited.

A remarkable discovery was presented by three horn working tools, which could now be recognised due to the newly conducted experiments. Horn objects are not known from the Dutch Neolithic. These tools thus provide the earliest evidence for the use of horn in craft activities in the Netherlands.

Overall, the image that emerged is one in which the VLC should be seen as a mosaic of micro-groups who have different foci in terms of craft and subsistence strategies. Inhabitants of the levees relied on the exploitation of wild resources while they also maintained extensive long-distance networks, facilitated by their direct access to major waterways. The inhabitants of the coastal dune area focused more on the exploitation of domestic animals. In the case of Den Haag Steynhof they clearly specialised in

hide working. Zandwerven should be seen as being part of the cluster of Vlaardingen-Corded Ware Culture sites in West Frisia. These sites share lithic procurement strategies geared towards the exploitation of local moraines. Subsistence strategies at these sites are diverse, contrary to southern VLC sites they also include shellfish exploitation. Furthermore, these sites were clearly much more receptive to CWC influences than southern VLC sites.

The Vlaardingen Culture seen from a lithics perspective

The presence of these above-described local VLC groups highlights the openness and diversity of VLC people that was central to the resilience of these communities. While the procurement strategies of VLC communities are highly diverse, an overall southern orientation is characteristic of the VLC. When it comes to connections with other groups, we see that the VLC communities maintained a wide network. These connections, however, manifest differently in different material groups. For connections with the Funnel Beaker West group it can be noted that there is virtually no evidence for connections with this group from a lithics perspective. This contrasts sharply with recent studies which demonstrated that Funnel Beaker West and VLC communities extensively shared ceramic technologies. These kinds of discrepancies warrant further reflection because it could well indicate that different groups (for example gender groups) within Neolithic societies maintained different contacts. Although contacts with FBC communities were limited from a lithics perspective we do see that contacts with southern communities were important for VLC people. Contacts with later CWC communities were fairly intensive. The VLC is thus characterised by an openness to other groups. Despite this openness we see that the group is also resilient. In the turbulent period when the CWC phenomenon was introduced across Europe, leading to the disappearance of many local groups and traditions, the VLC persisted and maintained their unique way of life.

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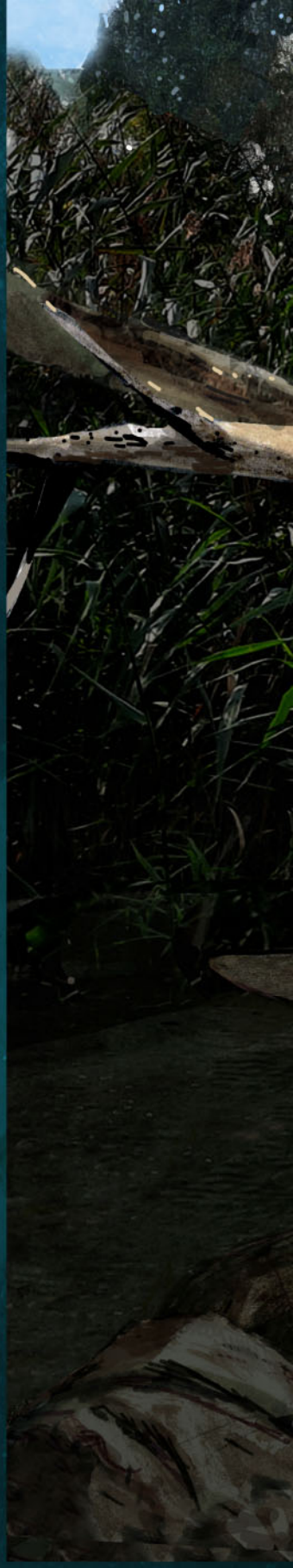
LIVING WITH FLINT

Our understanding of prehistoric life is shaped to a large degree by the study of stone tools. Their exceptional preservation make flint tools ideally suited to reconstruct past lifeways. Use-wear analysis provides insights into the role of the 'missing majority' of perishable organic materials such as hide, wood, and plant fibres in past technologies. Reconstructing lithic biographies, from raw material procurement to use and recycling, reveals the complex dynamics of prehistoric life.

This book explores the lifeways of Vlaardingen Culture communities (3400-2500 BCE) in the Rhine-Meuse-Scheldt delta through the lens of such object biographies. A detailed study of flint assemblages from four key sites reconstructs past exchange networks, technological choices, and everyday activities. Flint was imported across considerable distances, often as finished tools such as polished axes. Once acquired, exotic material was fully appropriated and integrated into the local technological system. Use-wear evidence further reveals the emergence of part-time craft specialisation during the Vlaardingen Culture period.

Finally, the experimental research and use-wear analyses offer new insights into life in the delta, providing the earliest evidence in the Netherlands for the use of horn in craft production. These findings illuminate how communities lived and interacted in the dynamic wetland environment of delta.



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