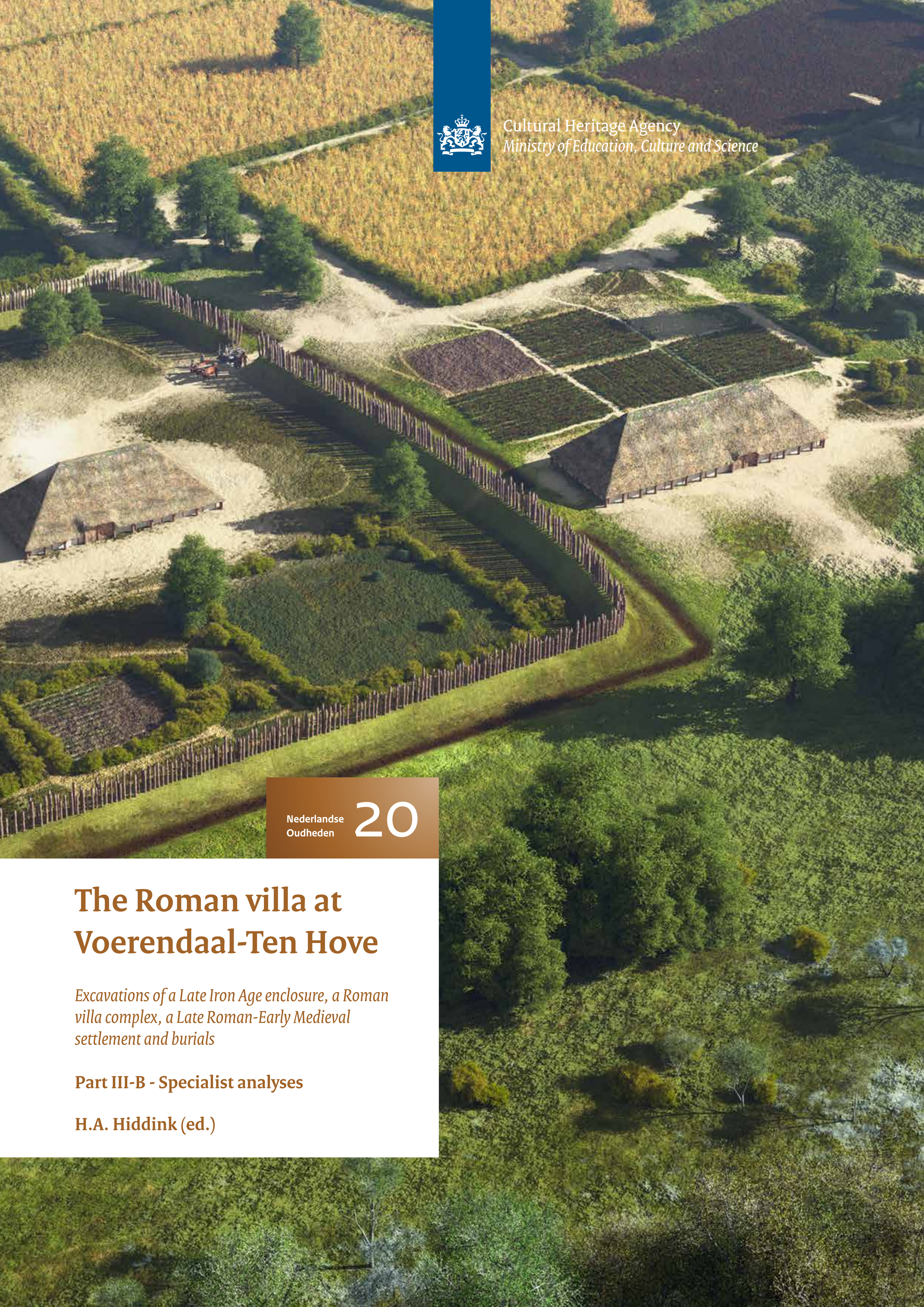


Cultural Heritage Agency
Ministry of Education, Culture and Science

Nederlandse Oudheden 20

The Roman villa at Voerendaal-Ten Hove

Excavations of a Late Iron Age enclosure, a Roman villa complex, a Late Roman-Early Medieval settlement and burials

Part III-B - Specialist analyses

H.A. Hiddink (ed.)

Nederlandse Oudheden 20

The Roman villa at Voerendaal-Ten Hove

Excavations of a Late Iron Age enclosure, a Roman villa complex, a Late Roman-Early Medieval settlement and burials

Part III-B - Specialist analyses

H.A. Hiddink (ed.)

provincie limburg

LIMBURGS MUSEUM
Van ós. Voor iedereen.

Nederlandse Oudheden 20
The Roman villa at Voerendaal-Ten Hove
Excavations of a Late Iron Age enclosure, a Roman villa complex, a Late Roman-Early Medieval settlement and burials
Part III-B - Specialist analyses

Editor: H.A. Hiddink (BCL Archaeological Support)

Authors: J.J.H. van den Berg (province of Zeeland); G.L. Boreel (Aardewerk en Archeologie); O. Brinkkemper (RCE);
T. Derks (VU Amsterdam); E. Drenth (BAAC); F. van den Dries; T. Ernst (municipality of Venlo); D.S. Habermehl (Image02);
S. Heeren (VU Amsterdam, PAN); J. Hendriks (municipality of Nijmegen); H.A. Hiddink (BCL Archaeological Support);
M. Janssen (SAGA Archeologie); J. Van Kerckhove (Aardewerk en Archeologie); L.I. Kooistra (BIAX);
E. van der Linden (ArcheoFocus); L. Megens (RCE); B. van Os (RCE); R. Reijnen (PAN); P. Schut (RCE)

Authorisation: T. de Groot (Cultural Heritage Agency)
Illustrations: H.A. Hiddink unless otherwise stated
Cover image: M.H. Kriek
Design and layout: Xerox/Osage

ISBN/EAN 978-90-76046-86-0

Cultural Heritage Agency of the Netherlands
P.O. Box 1600
3800 BP Amersfoort
The Netherlands
www.cultureelerfgoed.nl

This research was supported by the Province of Limburg (Maastricht) and Cultural Heritage Agency (RCE, Amersfoort)

Contents

Part III-B - Specialist analyses

30 Terracotta figurine and mask fragments

Henk Hiddink

30.1 Description of the fragments

The site at Voerendaal-Ten Hove yielded eight fragments of terracotta, most belonging to figurines, one probably to a mask. First, a short description of the finds will be given, with some concluding remarks regarding the interpretation in a separate section.

30.1.1 Minerva

A fragment found in trench 115 comes from the lower part of a figurine (115-2-16/10243; Fig. 30.1). Parts of the legs and/or an undergarment are fragmentary and vague, but above it the folds of a *palla* are clearly visible, horizontally/diagonally to the left and right with vertical folds in between. At the left side of the figure, part of the round edge of a shield can be seen. Because of this attribute, the figurine can be identified as Minerva. It is (nearly) identical to examples from Worms (D/RP) and Köln, probably produced in the latter town in the late first or second century AD.[2750]

30.1.2 Venus

The largest fragment of a statuette was not found during one of the excavations but was picked up from the surface in 1979. According to Van Boekel, the findspot was at the location of the first main building (399),[2751] but this seems a rather precise location considering the large size of the field. The terracotta is a representation of Venus in a semi-nude pose, standing between the columns of an *aedicula* (0-0-0/14907; Fig. 30.1). Part of the base, the hands, head and pediment are missing. The figurine is believed to be a product of Köln and is dated to the second century AD.[2752]

30.1.3 Man or deity

Three fragments of a terracotta figurine were collected from drain 317 in trench 13 (317-13/13-3-34; Fig. 30.1). Because they were found during the first ROB campaign, the fragments were included in the last part of Van Boekel's thesis.[2753]
The remaining part of the figurine shows part of the upper chest and right arm or upper back and left arm, with a garment draped over the shoulder. The way the clothing is worn and the relatively large size or robustness of the figurine point to a male person or deity, possibly Sucellus or Vulcanus. Again, this statuette is attributed to a Köln workshop.

30.1.4 Unknown figure

Two small fragments from trench 27 show folds in a garment (27-3-11/5295 and 1927; Fig. 30.1).
The location of the finds is situated above or in the upper fill of pit 729. Because the distance to drain 317 is only 20 m, there is a chance that the fragments belong to the figurine described above.

30.1.5 Mask

The thickness of one of the terracotta fragments, combined with the deep and wide grooves, suggests that it is part of a mask (319-14/110-2-1; Fig. 30.1). The grooves could represent something like hair or a hairband with a medallion at the forehead.[2754]

30.2 The interpretation of figurines and masks

Terracotta figurines are found in different types of archaeological context: mainly at cult places, in graves and in settlements, both in residential and 'industrial' areas.[2755] The finds at cult places – found in only a small portion of these sites – point to a use as votive offerings, while examples near artisans' workshops could have had a 'religious' meaning and should probably be understood as ritual depositions. Statuettes in residential buildings such as villas are often thought of as originally being placed in *lararia*, small private shrines. However, Kaufmann notes that in Augst (CH) and in Gaul many sets of bronze statuettes should be interpreted as part of *lararia*, but none merely consist of or contain terracotta figurines.[2756] Perhaps the latter had an even more personal significance than the statuettes in *lararia*, something also conveyed by their use as grave goods.

At least two statuettes from Ten Hove were at one time placed somewhere in, or deposited near, the main building. These were Minerva and

[2750] Van Boekel 1985, 70, 87, fig. 74; De Beenhouwer 2005, 408, series 276.
[2751] Van Boekel 1985, 206-207, no. 115.
[2752] Van Boekel, *loc.cit.*; for variations on this theme, see Van Boekel 1987, 98, fig. 3 (same pose; different *aedicula*); De Beenhouwer 2005, 522-525, series 180-187.
[2753] Van Boekel 1986, 94-95, no. 169.
[2754] Rose 2006, 40-41, fig. 15; pl. 6, cat. 85c; pl. 7, cat. 91, 93 (Oosterhout series); 41, fig. 16, pl. 7, cat. 96 (Viehmarktplatz series).
[2755] Van Boekel 1986, 373-375; De Beenhouwer 2005, 821-841; 1168-1169.
[2756] Kaufmann-Heinimann 1998, 159. On a bronze statuette said to be found at Ten Hove, see section 20.2.2.

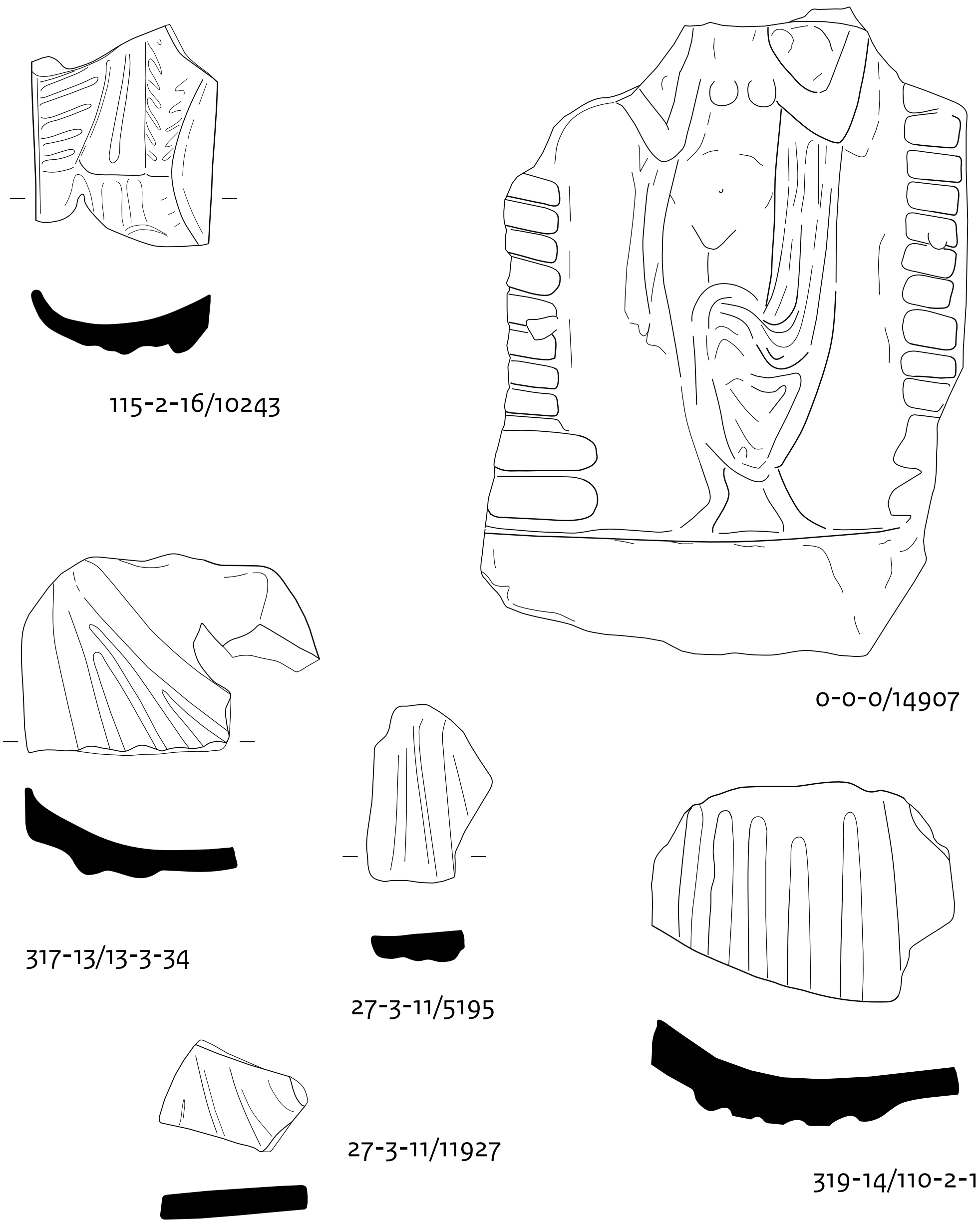


Fig. 30.1 Voerendaal-Ten Hove. Fragments of terra cotta statuettes and a mask; Scale 2:3. (source: H.A. Hiddink; 0-0-0 after Van Boekel 1985, 206)

Venus, although the latter was not found in one of the excavations. The figure of a male (deity) 317-3 and the fragments from trench 27 could originally have been placed in building 401, suggesting that this was not merely used as a barn but also served to accommodate people.[2757]

The 'original meaning' of terracotta masks is not clear but probably related to cults, notably that of Dionysius.[2758] They were possibly used as gifts during the Saturnalia and certainly used as decorative elements with some religious or apotropaic significance. It is important to note that clay masks were not actually worn in theatrical performances. They were unsuitable for this purpose because of their weight, their production in moulds – not adapted to the human face and the distance between the eyes – and were sometimes rough on the interior.

[2757] Cf. section 9.3.3 and the graffiti discussed in the previous chapter.

[2758] Rose 2000, 76ff.

The holes along the edges were for ribbons to hang them up, a practice shown on many wall paintings. Many archaeological finds of mask fragments come from cult places or residential buildings.

The fragment from Ten Hove was found in basin 319, situated in the garden close to the portico and entrance of the second main building. An interesting parallel is a large piece of a grotesque man's head from Reinheim, collected from the large water basin along the rear portico of the villa.[2759] At the villa of Bad Neuenahr-Ahrweiler (D/RP), one mask fragment was found in the yard at the rear, one near the stairs to the front portico. At the villa of Walferdingen-Helmsingen (L) two pieces were collected in front of the portico.[2760] These examples show that masks were often hung in gardens and (the intercolumnia of) *portici*, some probably even over the main entrance.[2761]

2759 Rose 2000, 57; 2006, 57-59; Fehr 2003, 110, fig. 64 (Bad Neuenahr); Stinsky 2016, 24-25, 18 (Reinheim).
2760 Rose 2000, 58-60.
2761 On evidence from Lyon supporting this interpretation Rose 2006, 87-90, fig. 59-60.

31 Glass

Henk Hiddink

The first group of glass to be discussed below is that from the Late Iron Age, the 'La Tène bracelets'. The second section is devoted to the vessels, which can be divided into those from the Early and Middle Roman period and those from the Late Roman period and Early Middle Ages. The third section describes the beads and bracelets from the Roman period and Early Middle Ages. The final fourth section discusses Roman window glass.

31.1 La Tène bracelets

Five or six find numbers represent fragments of glass La Tène bracelets (Fig. 31.1; Appendix XVIII). Two blue fragments are 5-ribbed and undecorated (Haevernick type 7a). Another has the same characteristics but is decorated with yellow zigzag trails (Haevernick 7b).[2762] A fourth fragment is possibly secondarily bent, considering the small diameter. This blue bracelet has three ribs and a yellow zigzag trail and therefore belongs to Haevernick type 6b. Two bracelets do not have separate ribs and have a D-shaped cross-section. The first is blue with a zigzag trail (Haevernick type 3b), the second is purple and undecorated (type 3a). Finally, a small molten fragment seems to belong to a ring of the latter colour (504-9/101-3-17; not shown in Fig. 31.1). However, on the basis of the context, a sunken-floored hut, this fragment could also be (Late) Roman.

La Tène bracelets were worn in the southern part of the Netherlands and adjacent regions throughout the Late Iron Age, from c. 250 BC onwards. Although accurate dates for individual finds are scarce – the majority are stray finds, and wiggles cause wide-ranging ^{14}C dates for graves – some trends are visible.[2763] Five-ribbed bracelets are relatively early and rapidly became less popular in La Tène D (after c. 125 BC). D-shaped bracelets were already produced in La Tène C, but especially in La Tène D. Concerning the colour, blue bracelets occurred during the entire Late Iron Age, but especially before D2 (c. 80 BC), while purple was used mostly in the younger La Tène D phase. The opinion that these bracelets were worn well into the (Middle) Roman period can be rejected on the basis of recent finds.[2764] There are no bracelets found in graves with ^{14}C dates in the Roman period. A rare example of a grave with a bracelet and Roman pottery must in fact be a combination of two separate features.[2765]

Most fragments from Voerendaal-Ten Hove were collected from structures and only two were found during the preparation of excavation levels. One of these was found in building 401 in trench 20 and the other far to the east in trench

Fig. 31.1 Voerendaal-Ten Hove. La Tène glass bracelets. Scale 2:3.

[2762] Haevernick 1960.
[2763] Roymans & Verniers 2010, 201-205, appendix 1. For examples of 14C-dated grave finds, see Hiddink 2003b, 194-197, fig. 37 (Weert-Molenakkerdreef); 2006, 58-62, fig. 9.1; appendix 2 (Nederweert-Rosveld; Weert-Molenakkerdreef); 2011a, 16, fig. 5.2; 2011c, 166-167 (Someren-Waterdael III).
[2764] Hiddink 2003b, 196, n. 142-143; Roymans & Verniers 2010, 204-205.
[2765] Hiddink 2006, 136-137, fig. 20.29; Roymans & Verniers 2010, 204, n. 15 (Nederweert-Rosveld grave 803).

55. In both cases a granary (255, 261) was situated in the vicinity, but a relationship between the glass and these outbuildings cannot be proven. Fragment 219-8/68-2-50 was found in one of a series of postholes with handmade Late Iron Age pottery. Although the building possibly does not date to the Late Iron Age, there were clearly activities in this area during that period.[2766] Item 794-5/101-2-24 was found in a pit with pottery and a brooch fragment from the Late Iron Age, the latter date confirmed by a ^{14}C date. All in all, the pit dates between c. 200 and 100 BC. The remaining two fragments were collected from the fill of a Late Roman sunken hut (504-9/101-3-17) and pit (745-3/101-3-19), but from the same trench as pit 794 (5-10 m away). It is therefore possible that the glass was not intentionally used and deposited in the Late Roman period, but was residual material from a period many centuries earlier.

31.2 Glass vessels

Henk Hiddink and François van den Dries

31.2.1 Introduction

During the excavations by Habets, the RMO and ROB, 119 fragments of glass vessels with a total weight of 842 g were collected (Table 31.1).[2767] The majority of the ROB finds had already been identified in the past – with data in the original database or on the find labels – or in 2020 by the first author, who also identified the finds at the RMO.[2768] The second author provided detailed descriptions of the ROB finds, checked the

Table 31.1. Voerendaal-Ten Hove. Quantitative data on the glass vessels.

Form/period	N records	N	%	Wt (g)	% Wt
Ribbed bowl Isings 3	16	20	24.4	247	33.8
Bowl Isings 17	1	1	1.2	2	0.3
Unguentaria Isings 26-28	2	3	3.7	7	1.0
Tableware Isings 42ff.	4	4	4.9	22	3.0
Bottles Isings 50-51. 90	26	27	32.9	313	42.9
Jar Isings 67	3	4	4.9	41	5.6
Flask von Boeselager 41	1	1	1.2	65	8.9
Opaque white	1	1	1.2	4	0.5
Netted bowl. jar	1	1	1.2	6	0.8
Remainder	16	20	24.4	23	3.2
Total Early/Middle Roman	**71**	**82**	**100.0**	**730**	**100.0**
% all glass	69	69		87	
Cup Isings 96	10	14	37.8	18	16.1
Helle cup	1	1	2.7	3	2.7
Beaker Isings 109b?	1	1	2.7	1	0.9
Conical beakers	6	8	21.6	12	10.7
Bowl? 501-5	1	1	2.7	1	0.9
Dish	1	1	2.7	18	16.1
Jug	1	1	2.7	38	33.9
Remainder	11	10	27.0	21	18.8
Total Late Roman/Merovingian	**32**	**37**	**99.9**	**112**	**100.1**
% all glass	31	31		13	
Grand total	**103**	**119**		**842**	

[2766] Cf. Chapter 7. On a bracelet fragment from the upper fill of cellar 409, see below section 31.3.1.

[2767] A (very) few pieces were either lost, not available for study or overlooked (the latter at the RMO). The weight of fragments from a single vessel was set at 1 g.

[2768] And is responsible for the text and illustrations in this chapter.

identifications and provided some more accurate ones. The types and fragments found are illustrated in Figures 31.2-31.6 and a small sample of these also in Appendix XVIII.

31.2.2 The Early and Middle Roman glass assemblage

Eighty-two fragments of Early/Middle Roman glass is quite a modest number in comparison with the villa of Hoogeloon-Kerkakkers, where 720 fragments (1,319 g) were collected.[2769] One of the explanatory factors is that at Hoogeloon the fill of a number of contexts was wet-sieved in its entirety, which was quite easy because of the sandy soil. At Voerendaal, the loess prevented extensive sieving for purposes other than archaeobotanical sampling and all finds were hand collected (hence the different average fragment weights of 1.8 g at Hoogeloon and 8.9 g at Voerendaal). At the villa of Kerkrade-Holzkuil some 163 fragments of glass vessels are found,[2770] but this material has not been investigated properly. All we learn is that 28 fragments of bottles Isings 50 were found, five of ribbed bowls Isings 3 and 'some dozens of small, not identifiable fragments' of other forms. At Maasbracht-Steenakker also 'dozens' of fragments – including beads and window glass – were also found, but only 10 glass vessels whose type could be determined were described.[2771] Quantitative data on the glass from the Heerlen baths are not very accessible in the report, but it concerns 272 fragments (including some Late Roman pieces).[2772] The most important forms are ribbed bowls (48 fragments), bottles (about 30), *balsamaria/unguentaria* (28), jars and beakers (about 30) and bowls and dishes (18).

In this perspective, the glass assemblage of Voerendaal is a relevant data set for the study of glass vessels at villa sites in the Netherlands and neighbouring countries.[2773] However, here and even at Hoogeloon and the Heerlen baths, the assemblages are still quite small and consist only of highly fragmented material. Therefore, there is a small chance that more special forms could be found or recognized. At many sites, sturdy forms like Isings 3 and 50 prevail and lower numbers are found of other forms, such as bowls and beakers used at the dinner table.[2774]

At Voerendaal, perhaps the most 'luxurious' glass consists of the unidentified forms with netted decoration and that in opaque white glass. Of course, the flask Von Boeselager 41 is also special, but it is from a grave context and should, strictly speaking, not be considered part of the settlement assemblage.[2775] At Hoogeloon, the most special forms are a few small *carchesia* in black glass. At the Heerlen baths, three black glass fragments were found and one of a green first-century 'circus beaker'.[2776]

31.2.3 Late Roman and Early Medieval glass vessels

With 37 fragments (112 g), late glass is relatively well represented at Ten Hove, most likely because of the number of quite large contexts or 'artefact traps' (pits, sunken huts). The sherds are smaller than those from the preceding period (3 g/sherd). In addition to some two-thirds of the fragments belonging to identifiable forms/types, there are sherds dated to this period on the basis of the colour and the quality/character of the glass. It is possible that some fragments classified as 'Roman' glass belong in reality to the later periods.

Factors such as excavation methods, site type and chronology make comparisons with other sites difficult. With 37 fragments, the glass from Voerendaal is abundant compared, for instance, with Alphen-Kerkakkers, a rural site on the sandy soils of Noord-Brabant (c. 15 sherds).[2777] Slightly larger or equal amounts were collected at the rural settlement of Holtum (c. 47 fragments), Neer-Wijnaerden (49 fragments) and Maastricht-O.L.V., next to the Late Roman *castellum* (50 fragments).[2778] However, many hundreds of glass fragments were collected at the rural site of Gennep-Stamelberg, probably the result of extensive sieving.[2779] The amount of glass found at most villa sites with Late Roman and Early Medieval habitation is very small. If more glass is present, the vessels were found in graves, as at Köln-Müngersdorf and Hambach 132.[2780]

In terms of glass types, the predominance at Ten Hove of cups/beakers Isings 96 and, to a lesser degree, conical beakers is what is to be expected. At Maastricht-O.L.V., for instance, they represent 40 and 32% of the Late Roman

2769 Van Lith 2014, 421, table 1.
2770 Van Dijk 2005, 249: total glass fragments approx. 250 including 87 of window glass.
2771 Van Lith & Driessen 2017.
2772 Van den Dries *s.a.*, 16 (pdf page number).
2773 For older finds of Heer-Backerbosch and Houthem-Vogelenzang, see Van Lith 1984. On the assemblages of different kinds of Roman sites, see Van Lith & Randsborg 1985.
2774 In comparison with Hoogeloon and Maasbracht, it is perhaps remarkable that fragments of the common cup Isings 85 are missing. At Heerlen-Thermenterrein the variety of glass forms is somewhat larger, with only 18% ribbed bowls and 12% bottles; the *unguentaria* constitute about 10% of the glass vessels (Van den Dries *s.a.*)
2775 From grave contexts, far more intact and sometimes special specimens of glass vessels are known, compared to settlements.
2776 Van den Dries *s.a.*, fig. 5.
2777 Sablerolles, appendix 2 in De Koning 2005.
2778 Sablerolles 2010; Anon. 2012 (Holtum); Van den Dries 2021 (Neer); Van Lith 1987a, esp. 50 (Maastricht-O.L.V. plein 14-16). Percentages below for Maastricht are calculated on the basis of 50 sherds of the Late Roman period and the transition to the Early Middle Ages. An additional 26 fragments were Early Medieval.
2779 Heidinga & Offenberg 1992, 99; Sablerolles (1993) mentions some 200 vessels, but provides little information on numbers per type.
2780 Fremersdorf 1933, 93ff., pl. 49-57 (Köln-Müngersdorf); Brüggler 2009, 163ff. (HA 132).

and 'transitional forms', with 12% for various bottles and jugs. A similar picture holds true for Neer-Wijnaerden (c. 6 of 11 vessels) and Gennep-Stamelberg, with 68 fragments of Isings 96.[2781] The dominance of Isings 96 can also be observed in many Late Roman cemeteries, such as Krefeld-Gellep and Hambach 132.[2782] At the rural sites of Alphen-Kerkakkers and Holtum conical beakers are represented better than the cups/beakers.

Glass seems to have been readily available to the inhabitants of Late Roman and Early Medieval sites in the southern Netherlands and surrounding regions,[2783] although this is not often obvious unless we encounter intact vessels from graves. There is every reason to believe that the people living at Ten Hove had a considerable quantity of glass at their disposal, although only some fragments illustrate the presence of somewhat more 'luxurious' forms (such as a beaker Isings 109, a Helle cup and a dish with threaded decoration).

31.2.4 Description of the Early and Middle Roman vessels

Ribbed bowls Isings 3

One of the types most frequently found at Voerendaal is the ribbed bowl Isings 3, with 20 fragments (247 g; 16 records; Fig. 31.2). However, the type is without doubt somewhat overrepresented because many examples of this mould-shaped form have quite thick walls and are therefore less fragmented than other types. Moreover, the ribs add to the strength and make them easily recognizable. Only 1953-2.5/12151, found by Braat, has a light brownish colour; the remainder are light blue or green.

These bowls were produced in the first and the beginning of the second century AD,[2784] but some were still used or kept until the third century. This is shown, for instance, by the association with houses from that time at Hoogeloon-Kerkakkers, where these bowls are also the best-represented vessel type.[2785] A bowl from Esch-Hoogkeiteren was placed in grave 4 in the last quarter of the second-first quarter of the third century AD.[2786]

--/1895-12.51/11376	rim fragment (91 g); blue-green (Fig. 31.2).
--/1953-2.5/12150	rim fragment (12 g); blue-green.
--/1953-2.5/12151	rim fragment (22 g); light brown/amber-coloured (Fig. 31.2).
317-23/13-3-39/1710	wall fragment, 1.5-6 mm (8 g); light green; moulded, many small bubbles; single, no pronounced rib; slightly weathered; impression of mould and two abraded bands (5 mm wide) on the inside.
319-20/110-2-7/10078	wall fragment, 2 mm-rib 9 mm (4 g); light blue; moulded; some small bubbles; one high rib; polishing marks and horizontal groove at the inside.
333-1/20-4-35/3638	5 rim fragments, 7 mm (10 g); blue-green; moulded; burnt and many tension cracks.
409-84/68-4-14/7058	wall fragment, 2 mm-rib 7 mm (8 g); light blue glass; moulded; two wide, somewhat oblique ribs; some small bubbles; inside impression of mould, slightly polished; large bowl.
409-85/68-4-15/7063	rim fragment, 4 mm-rib 8 mm (5 g); blue-green glass; moulded, one rib; few bubbles; marks of polishing inside and below rim on outside.
760-1/107-3-61/9710	wall fragment, 4 mm-rib 9 mm (5 g); blue-green glass; moulded; one rib; some bubbles; inside polishing marks, and horizontal groove.
765-3/1953-2.19/11450	rim fragment (48 g); blue-green (Fig. 31.2).
--/16-3-22/2512	wall fragment, 7-9 mm (3 g); blue-green glass; moulded; many bubbles; end of one rib; polishing marks on the inside.
--/68-1-3/6271	wall fragment, 5 mm-rib 11 mm (18 g); blue-green glass; moulded; one wide, slightly oblique rib; smaller and larger bubbles; polishing marks beneath rim and on inside; tool mark next to rib; large bowl.

2781 Sablerolles 2010.
2782 Brüggler 2009, 165-167 (at Hambach 132 represented by 22 examples as against 6 conical beakers).
2783 Also because glass was produced at many rural or non-urban sites.
2784 Isings 1957, 17-21; Van Lith 1977, 19; Rütti 1991/1, 40, type AR2.
2785 Van Lith 2014, 422-423 (over 20 examples).
2786 Van den Hurk 1975, 77-78, fig. 10; 1984, fig. 6.

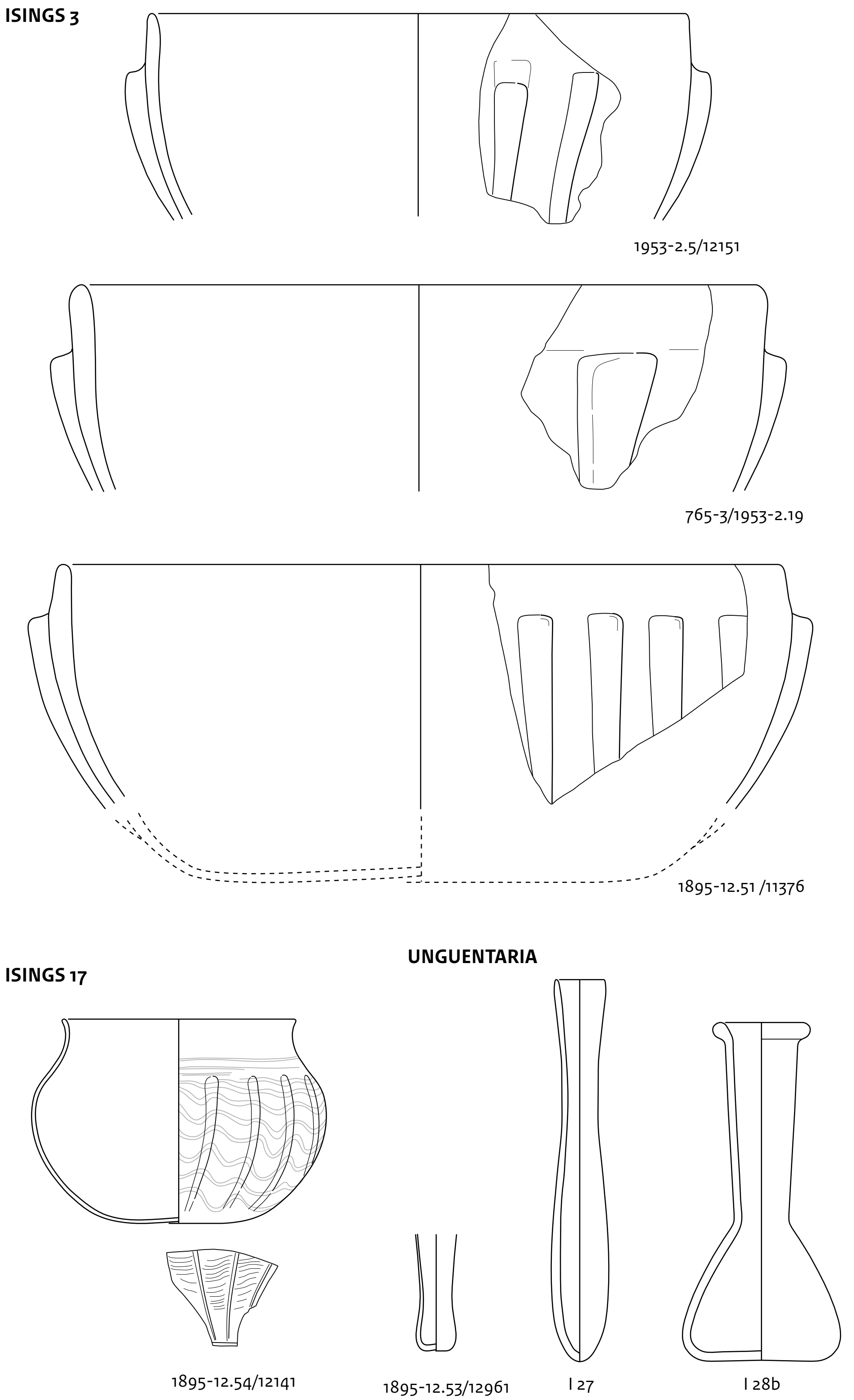


Fig. 31.2 Voerendaal-Ten Hove. Ribbed bowls Isings 3 and 17; unguentaria. Scale 1:2. (source: complete examples after Van Lith & Randsborg 1985, fig. 1; 11)

--/68-1-14/6274	base fragment, 4 mm (2 g); blue-green glass; moulded, two narrow ribs; no bubbles; many tension cracks.
--/89-2-8/8201	wall fragment, 4 mm-rib 9 mm (3 g); light blue glass; moulded, one wide, slightly oblique rib; no bubbles; polishing marks on the inside.
--/95-1-19/10854	wall fragment, 3 mm-rib 7 mm (1 g); blue-green glass; moulded, one rib; some bubbles.
--/115-1-17/10299	wall fragment, 2 mm-rib 6 mm (1 g); light blue glass; moulded; one rib; some small bubbles; abrasion marks inside; some tension cracks.

Ribbed bowl Isings 17

A single glass fragment from Habets' investigations belongs to the type Isings 17 (Fig. 31.2). This is a small bowl with a slightly outsplayed rim, narrow ribs and marble-like threads (often called *zarte Rippenschale*, literally 'fragile ribbed bowl'). Isings dated these bowls from the Tiberian into the Flavian period,[2787] but they are presently dated Augustan-Neronic.[2788] In the Netherlands, examples are known from the fortress Velsen I, the 'proto-urban' settlement of Nijmegen/*Oppidum Batavorum*,[2789] as well as its cemetery.[2790] The type was also found at Heerlen.[2791]

--/1895-12.54/12141	wall fragment (2 g); dull-greyish colour, nearly opaque with very thin threads of almost the same colour (Fig. 31.2).

Unguentaria

Two fragments of *unguentaria* or *balsamaria*, small bottles for ointments or (powdery) cosmetics, were found. One from Habets' excavations is of an elongated, test tube-like form (Isings 27; Fig. 31.2), dating from Neronian/Flavian times into the fourth century AD.[2792] The other is a fragment of a bottom, either of the small globular/pear-shaped Isings 26 or the more elongated, flat-based form 28 (Fig. 31.2).[2793] It probably dates from c. AD 50-200/230.

--/1895-12.53/12961	two base fragments (3 g); light green (Fig. 31.2).
326-2/46-1-21/11303	base fragment; 4 mm, at transition to wall 1 mm (4 g); blue-green glass; free-blown, many small bubbles; base slightly pushed in to create base ring; remains of pontil mark.

Tableware

This category, bowls and dishes to be used at dinner, is represented by only four fragments.
Item 1895-12.54/12143 may belong to a bowl Isings 42/AR 80-81 with horizontal rim and pushed in base (Fig. 31.3), while 1895-12.54/12962 is probably from a deep bowl Isings 44/AR 109.1 (Fig. 31.3).[2794] Both types were produced from around the middle of the first until the third century AD.[2795]
Two fragments represent two other vessels of unknown form: either one of the types mentioned or Isings 43, 45 or 49. These fragments probably date from c. AD 50-150.

1895-12.54/12143	base fragment (8 g); colourless (Fig. 31.3).
1895-12.54/12962	base fragment (11 g); hollow footring; green (Fig. 31.3).
520-2/20-1-66/3045	base fragment, 2 mm (2 g); diameter c. 11 cm; blue-green glass; free-blown; small bubbles; hollow base ring.
--/23-1-5/4322	base fragment, 1.5 mm (1 g); blue-green glass; free-blown, small bubbles; hollow base ring.

Jar Isings 67c

This is a bulbous jar with a collar-shaped (folded) rim and a decoration of small ribs (Fig. 31.3).[2796]
It is dated from the Flavian period until the middle of the second century AD (some are younger).
The rim from Habets' excavations has a narrow neck and is made of brown glass. It probably belongs to the more slender variant Isings 67b,[2797] with a Tiberian-Flavian date because of the colour.[2798] These jars were used for everyday purposes in the household, but also quite frequently as cremation urns.[2799]

[2787] Isings 1957, 35-36, type 17.
[2788] Van Lith 2009, 59; Rütti 1991/1, 66, tab. 6; 1991/2, 46, pl. 43 (AR 28).
[2789] Van Lith *loc. cit*.
[2790] Vermeulen 1932, pl. 11, type 116.
[2791] Isings 1971, 80, fig. 19, no. 151 (Heerlen-Uilestraat 1967), maybe identical to Van den Dries *s.a.*, section 3.2.2.
[2792] Isings 1957, 41.
[2793] Isings 1957, 40-43.
[2794] Most of Habets' finds have an individual find number, but both these fragments come from a lot with several smaller fragments (cf. the fragments of Isings 17).
[2795] Rütti 1991/1, 48-50, fig. 35.
[2796] Isings 1957, 88, type 67c; Rütti 1991/1, 51; 1991/2, 111, pl. 96 (AR 118.2).
[2797] Isings 1957, 87-88; Rütti 1991/1, 51; 1991/2, 110-111, pl. 95-96.
[2798] Rütti 1991/1, 111.
[2799] E.g. Landgraaf-Valderveste (Hiddink 2004, 24, no. 32=Isings 1971, 88, fig. 23, no. 234); tumulus Berlingen (B/LI; Roosens & Lux 1973, 22-23, fig. 14-15, no. 1); tumulus Gutschoven (B/LI; Vanvinckenroye 1987; Massart 2015, 159, fig. 3); tumulus Séron 2 (B/NA; Plumier 1987, 24, fig. 12. no. 22).

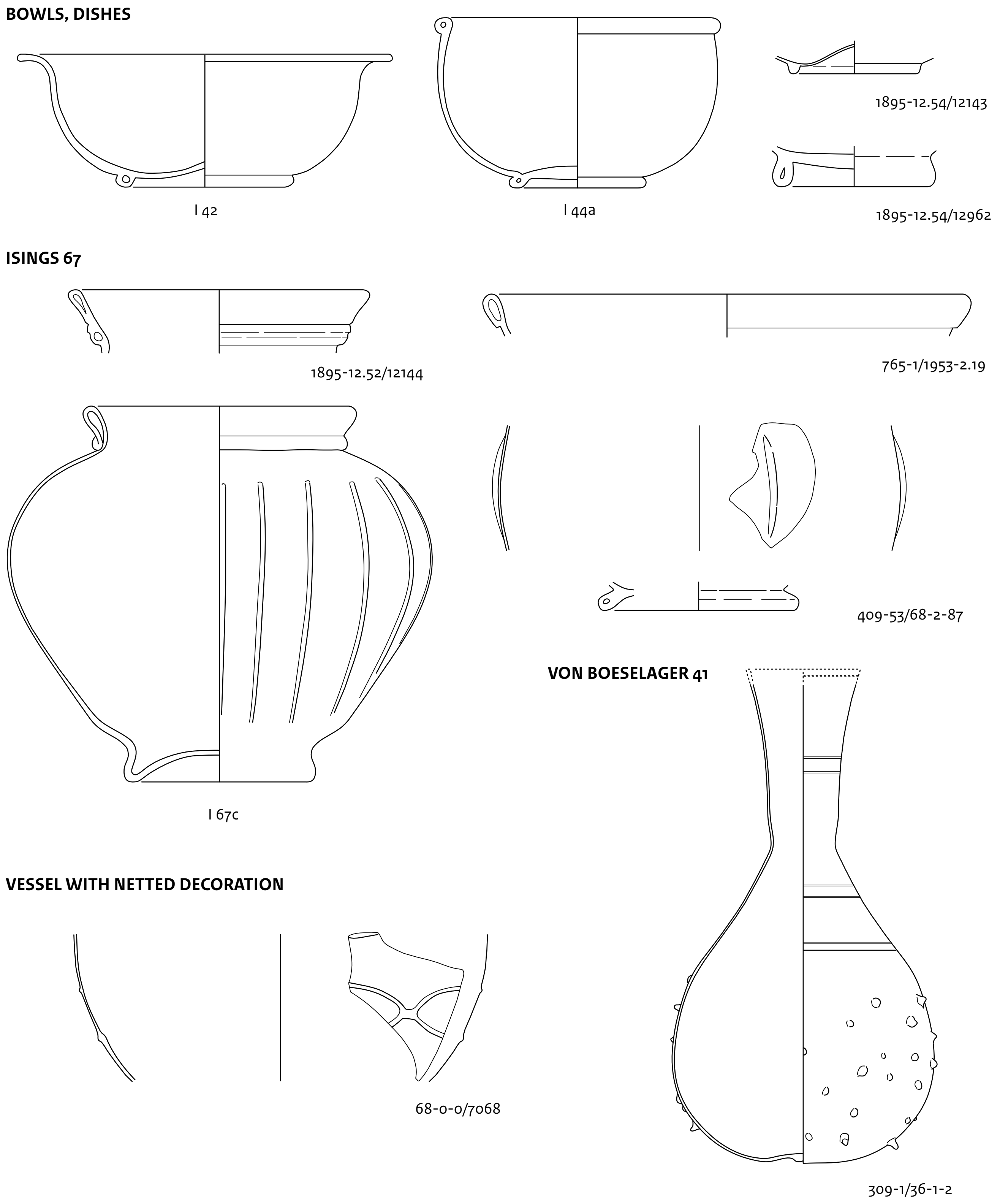


Fig. 31.3 Voerendaal-Ten Hove. Bowls, jars, flask and unknown form. Scale 1:2. (source: complete cups after Van Lith & Randsborg 1985, fig. 1; jar after Rütti 1991/2, pl. 96, no. 2221)

--/1895-12.52/12144	rim fragment (20 g); brown (Fig. 31.3).
765-1/1953-2.19/11451	rim fragment (16 g); light green (Fig. 31.3).
409-53/68-2-87/7249, 11938	wall fragment, 1-2 mm-rib 4 mm; base fragment 1.5 mm (5 g); blue-green glass; free-blown, many small and larger bubbles; large pulled and blown-out rib; Isings 67c (Fig. 31.3).

Flask Von Boeselager 41

A nearly complete flask was found in grave 309; only small parts of the wall and the neck/rim are missing (Fig. 31.3).[2800] The body is globular, with a smooth transition to the neck. One decoration element consists of pairs of incised lines on the shoulder, neck and beneath the rim (latter reconstructed). The other, most distinct decoration are small spikes on the body, pushed outwards from the inside (as opposed to applied to the outside). Two flasks of this rare type were found in the cemetery of Köln-Luxemburgerstraße (grave 60).[2801] Some ten more glass vessels were present in the same grave (one in the shape of a fish, six pieces of pottery, gold earrings and a sestertius of Severus Alexander (222/231 AD)). It is likely, but not completely certain, that the coin belongs to the grave. Therefore, the flask seems to date from around the middle of the third century AD (or beyond).[2802]

309-1/36-1-2/5729	nearly complete, part of rim missing (65 g); thin-walled, colourless with a hint of very light green (Fig. 31.3).

Bowl, jug or beaker with 'netted' decoration

A large wall fragment of a vessel could belong to a bowl, jug or beaker. The decoration consists of glass threads forming a kind of chain. We use the term 'netted' decoration as a translation of the German '*Netzverzierung*'.[2803] This kind of glass was made in the third and (first half of the) fourth century AD.[2804]

--/68-0-0/7068	wall fragment, 1.5 mm-decoration 3 mm (6 g); blue-green glass; free-blown; many smaller and larger bubbles; relatively many inclusions; striations; decoration with glass threads in same colour in a chain-like pattern (Fig. 31.3).

Unknown form

A wall fragment in free-blown glass is opaque white and belongs to a bulbous form. It dates to the first century AD.

--/23-7-1/4473	wall fragment, 1-3 mm (4 g); opaque white; free-blown; bulbous form.

Bottles

Like the ribbed bowls Isings 3, bottles are well represented at Ten Hove (27 fragments; 313 g; Fig. 31.4). Again, this overrepresentation is due to the thick walls, sturdy bases and rims (and characteristic ribbed band ears). Bottles are also found in greater numbers at other sites.[2805] Bottles were made in different shapes and sizes. The majority are square, with a shorter (Isings 50a) and taller (50b) model, or with fewer or more than four sides, such as the 50hex(agonal). Isings 90 is a rectangular bottle and 51 a cylindrical one, again with a shorter and taller variant (51a/b).[2806] For convenience and based on other find categories, we assume that bottles were used in Voerendaal from c. AD 50 onwards. They were produced until the (end of the) third century and were sporadically used even later.[2807]

Bottles had many functions in the kitchen and at the table but, when packed in wooden boxes, were also very suitable for transport. The shoulders of bottles often show traces of rubbing against each other. Sets of four square bottles were found in tumuli at Penteville (B/WB), Gors-Opleeuw and Helshoven (both B/LI), originally placed in small wooden boxes.[2808] They probably held cosmetics or massage oil.[2809]

Although they are well represented, it is often difficult to identify the type to which the fragments belong. The three illustrated rims, for instance, could belong to any of the types mentioned above (Fig. 31.4). Some of the wall fragments could belong to either four- or six-sided bottles. A base fragment from a sunken-floored hut (516-6/29-1-18) has the onset of two walls, a larger and a tiny one. Both appear to form an angle of 60-65° and if this really the case, the bottle could be a rare triangular specimen.[2810]

Two bottles have letters on their base (Fig 31.4). On 18-1-1/2746, belonging to a large bottle or jar, part of a line is visible: ?]MA[... The mark may have been M A R.[2811] The rather small fragment

2800 Reconstructed on the basis of the drawings in Von Boeselager 2012.

2801 Von Boeselager 2012, 162-163, 379-381, fig. 230-231, pl. 90, no. 1-2; cf. Doppelfeld 1966, fig. 94 (wrong height).

2802 There was an intersection with another grave. A third specimen from Köln is not dated (Von Boeselager 2012, 163, n. 753).

2803 The same term is often used for '*Diatretglas*', which is obviously a completely different category.

2804 The decoration is common on high beakers such as Isings 109/Trier 58/Gellep 194 (Isings 1957, 136-138; Goethert-Polascheck 1977; Pirling 1966, 101-102, type 194. Examples are HA 132, grave 63.6 (Brüggler 2009, 451, pl. 108); Nijmegen, grave B 197, 749, (Steures 2013, 641, 665). A beaker from Köln-Luxemburger Straße: Doppelfeld 1966, 58, fig. 133 (Gruppe 3.7). Decoration on a drinking horn: Hambach 132, grave 39.6 (Brüggler 2009, 434, pl. 99). For finds in Gaul, see e.g. Foy *et al.* 2018 forms IN 287 and 292; Dilly & Mahéo 1997, cat. 103, 303 and 312.

2805 E.g. some 25 MAI at Hoogeloon-Kerkakkers (Van Lith 2014, 440-442).

2806 See Isings 1957, 63-66 (50a); 66-67 (50b) and Rütti 1991/1, 54-55; 1991/2, 131ff., pl. 111ff. (I50/AR 156); 1991/1, 55 (I50hex/AR 158); 1957, 67-68 (51a); 68-69 (51b); Rütti 1991/1, 55; (I51/AR160); 1957, 81 (62); Rütti 1991/1, 51; 1991/2, 112, pl. 97 (I 62/AR 119); 1957, 108 (90); Rütti 1991/1, 55; 1991/2, 131ff., pl. 111ff. (I90/AR 157).

2807 For the dates, see esp. Rütti 1991/1, 51, 54-55, fig. 35.

2808 The presence of boxes can be deduced from the position of bottles, but also from wood remains and metal fittings/locks (e.g. Plumier 1986, 77-79, 81f.). Of course, graves often contain bottles in different numbers and configurations, cf. Koster 2010, 241.

2809 An analysis of residue in a bottle of the tumulus at Bois de Buis (B/WB) and one from

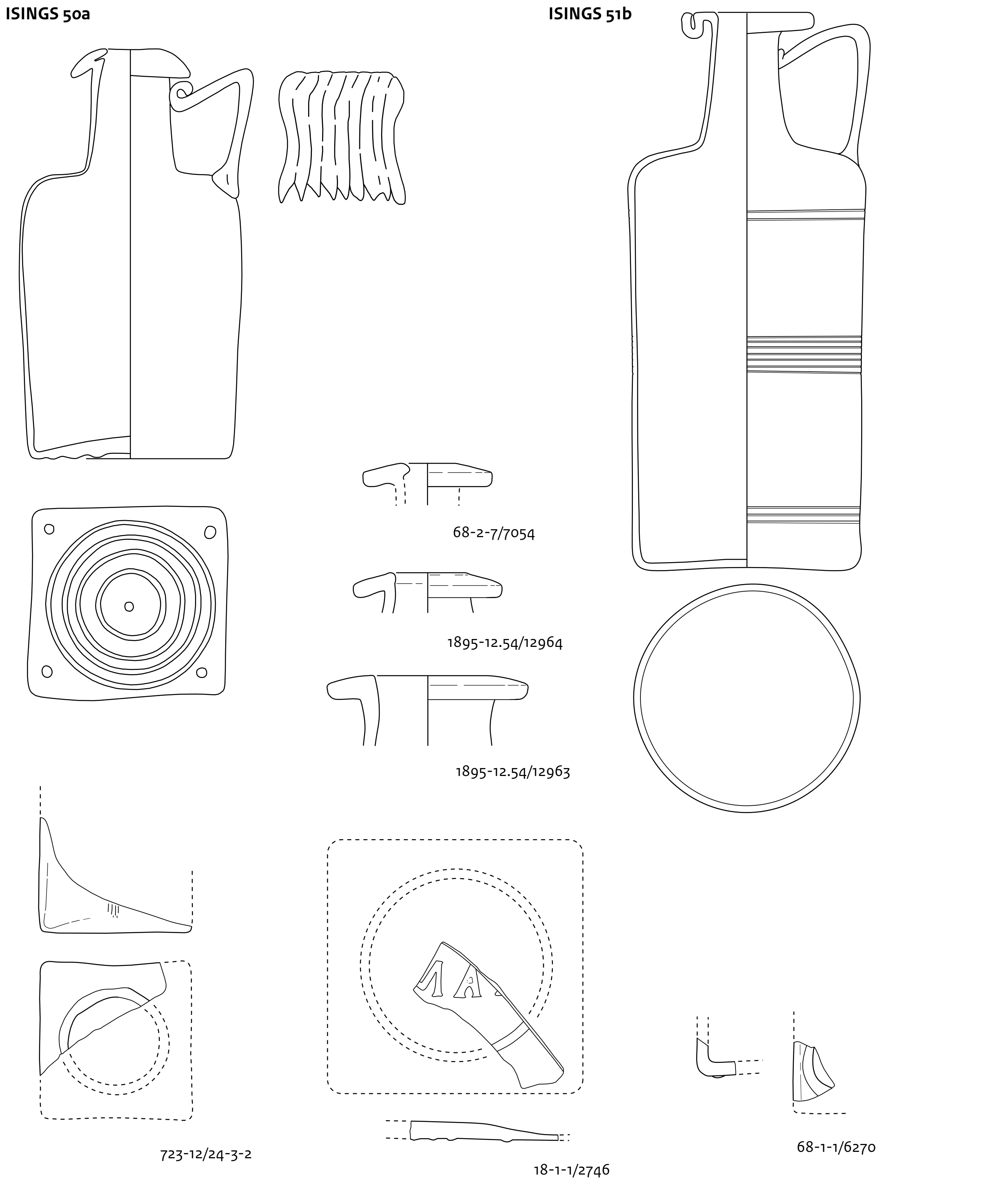


Fig. 31.4 Voerendaal-Ten Hove. Bottles. Scale 1:2. (source: complete examples after Isings 1971, fig. 7, no. 111; 20, no. 159)

68-1-1/6270, probably the lower left-hand corner, shows part of a C. This must be the third of four letters and could be part of several abbreviations referring to the Colonia Claudia Ara Agrippinensium/Köln: CCCP, CCAA, CCPC, CCQC.[2812]

The rim of 68-2-7/7054 seems to have been secondarily used as a large bead or amulet.[2813]

--/1895-12.54/12142 rim fragment (17 g); blue-green.
--/1895-12.54/12963 rim fragment (15 g); blue-green (Fig. 31.4).

Wederath-Belgium (D/RP) grave 2300 showed the presence of 'greasy' material (Plumier 1987, 108-109; Ebbighausen & Karl 1989). See also Koster *loc.cit.*

2810 Morin-Jean (1913) mentions a triangular bottle from

--/1895-12.54/12964	rim fragment (7 g); blue-green (Fig. 31.4).
--/1932-11.20/12147	base fragment (36 g); part of a circle; blue-green.
--/1932-11.20/12148	wall/corner fragment (108 g) of Isings 50; blue-green.
--/1953-2.2/12153	rim fragment of a '*lago[e]na*' mentioned by Braat (1953, 71); not seen in RMO.
--/1953-2.3/12154	wall fragment (9 g); blue-green.
317-24/13-3-39/14479	base fragment, 3-7 mm (14 g); blue-green; mould-blown; impression mould visible, no pontil or base mark visible; Isings 50, 51, 90 or jar 62; on the basis of the colour: c. AD 50-250.
317-25/24-3-31/4691	neck fragment (2 g); blue.
319-21/110-2-7/10077	wall fragment, 2-5 mm (3 g); light blue glass; mould-blown, partly with many bubbles; impression of mould, no base mark visible; Isings 50; on the basis of colour: first/second century AD.
409-86/68-2-87/7066	wall fragment, 2-3 mm (3 g); blue-green glass; mould-blown, a few small bubbles; Isings 50 or jar 62.
516-6/29-1-18/10362	base fragment, 4-6 mm (5 g); blue-green; mould-blown, matte base; many small bubbles; onset of two walls seems – due to a tiny edge – to have an angle of 60-65°, but further on 90°; Isings 50?
712-5/27-2-40/5096	rim fragment (7 g); fragment of flattened rim, onset of neck; blue-green glass; mould-blown; some small bubbles; tension cracks/heat damage; Isings 50 or 51.
723-12/24-3-2/4646	base and wall fragment/corner, 2-6 mm (28 g); blue-green; mould-blown; mould and tool impressions (latter on the wall), small, damaged part in centre but no pontil mark; base mark of irregular, off-centre circle; Isings 50 or jar 62 (Fig. 31.4).
741-1/95-5-3/11198	base fragment, 2 mm (1 g); light blue glass; mould-blown, hardly any bubbles; onset of wall; Isings 50 or jar 62.
757-43/108-2-7/9882	wall fragment, 6 mm (3 g) light blue glass; mould-blown, hardly any bubbles; onset of fine ribbed ear; Isings 50 or 51; on the basis of colour: first/second century AD.
779-2/99-1-17/8381	tiny wall fragment (1 g); light blue; Isings 50.
--/0-0-0/10390	wall fragment (1 g); blue green; Isings 50, 90 or jar 62.
--/7-1-34/274	wall fragment, 4 mm (2 g); light green; mould-blown, very small (pinprick) bubbles; Isings 50, 51, 90 or jar 62.
--/10-1-64/765	base fragment, 2-4 mm (1 g); blue-green glass; mould-blown, very small bubbles; part of wall and corner; base mark: stud in corner and at least two concentric circles; Isings 50 or jar 62; on the basis of thickness a rather small specimen.
--/18-1-1/2746	base fragment, 3-6 mm (11 g); blue-green glass; mould-blown; part of base mark MAR(?); Isings 50 of 62 (large; Fig. 31.4).
--/21-3-18/3808	wall fragment, 2-3 mm (5 g); light blue-green glass; mould-blown, stretched bubbles; (large?) Isings 51, possibly same as 21-4-2; c. AD 50-200.
--/21-4-2/3818	wall fragment, 4 mm (2 g); light blue-green glass; mould-blown, some bubbles; (large?) Isings 51, possibly same as 21-3-18; c. AD 50-200.
--/68-1-1/6270	base/wall fragment, 4 mm (4 g); light blue glass; mould-blown, hardly any bubbles; part of base mark with letter C; Isings 50; c. AD 50-200 (Fig. 31.4).
--/68-2-7/7054	rim fragment, 7 mm thick, diameter c. 5 cm (7 g); blue-green glass; first mould-blown, later free-formed; inclusions/discolouration of (iron)

Naples (National Archaeological Museum, inv. no. 13075), adding that this is a rare find (photo in Fünfschilling 2015, 158, fig. 214,12). She also mentions an example from Kálóz (H).

2811 Price in Foy & Nenna 2011/3, 38; 57 (GB, Baldock, Hertfordshire).

2812 Fremersdorf 1958, 52-53; Isings discusses an example with the letters CCPC from the western cemetery of Coriovallum along the Valkenburgerweg (1971, 80, fig. 20, no. 154).

2813 Van den Dries 2019, 113-115; this piece has the same dimensions as that of Voerendaal-Ten Hove.

	blowpipe; many bubbles; secondary use as large bead/hanger; Isings 50 or 51 (Fig. 31.4).
--/95-3-6/11092	ear fragment, 49 mm wide, thickness c. 6 mm (21 g); blue-green glass; ear with 18 not pronounced ribs; few small bubbles; Isings 50, 51 or 90.

31.2.5 Description of the Late Roman and Early Medieval vessels

Cup Isings 96a/Gellep 180

This type comprises small cups – sometimes more bowl-like – with an outsplayed rim and a round or indented base.[2814] The rims of these free-blown cups can be unworked, but those of our examples are all cracked off (*abgesprengt*). Because of the small size of most fragments, it was not always certain if they were really part of undecorated beakers.[2815] It was often difficult to obtain adequate measurements of the diameters. It is possible that some of the illustrated fragments belonged to the same vessel or vessels and some may even have been part of a different type of vessel. In total 14 fragments (only 18 g) in 10 find numbers/records are present at Ten Hove. All are greenish in colour, except for 510-7 and 744-7, which are almost colourless. Base 737-8 may belong to a cup of this type, but this is not certain (Fig. 31.5).

These cups were used from the second half/late third century until the early fifth century AD and especially in the fourth century.[2816] A considerable number were found in Maastricht, next to the Late Roman fortress;[2817] the type is also present in Heerlen.[2818]

510-7/13-2-3/1395	rim fragment, 1-1.5 mm, diameter c. 7 cm (1 g); almost colourless, light yellow-green; free-blown, many tiny (pinprick) bubbles (Fig. 31.5).
510-12/13-3-30/1619	wall fragment, 1-2 mm (1 g); olive-green; free-blown, many tiny (pinprick) bubbles.
711-3/13-1-27/1365	wall fragment, 1.5-2 mm (1 g); olive-green; free-blown, many small bubbles; cracked-off rim; possibly same as 712-4.
712-4/13-1-26/1362	rim fragment, 1.5-2 mm (1 g); olive-green; free-blown, many small bubbles, cracked-off rim; possibly same as that from pit 711 (Fig. 31.5).
728-10/27-4-17/5377	wall fragment, 1-2 mm (1 g); olive-green; free-blown, many bubbles, striations.
737-9/68-4-25/7065	rim fragment, 3 (rim)-1 (wall) mm (6 g); olive-green; free-blown, many small bubbles; cracked-off rim (Fig. 31.5).
737-10/68-4-25/11939	rim fragment, 1.5 mm (2 g); olive-green; free-blown, many small bubbles; cracked-off rim (Fig. 31.5).
744-7/100-1-10/12104	rim and wall fragment, 2 mm (2 g); colourless glass; free-blown, bubbles and striations visible through weathering, cracked-off rim; fragments do not fit but seem to belong to one vessel (Fig. 31.5).
--/16-5-41/2638	rim and wall fragment, 1.5 mm (2 g); both olive-green; free-blown, with many small bubbles; cracked-off rim; fragments not fitting but belonging to the same cup (Fig. 31.5).
--/70-5-2/7634	rim fragment, 1.5-2 mm (1 g); olive-green; free-blown, many small bubbles and striations; cracked-off rim (Fig. 31.5).

Cup of Helle/Gellep 238 type

A wall fragment of green glass has one pinched-out rib and is therefore easily identifiable as part of a Helle cup (Fig. 31.5). These cups have a bag-like body, a thickened out-turned rim, a glass thread around the upper wall and seven to eleven vertical ribs at the lower wall. The type is named after 'warrior grave 1' of Helle (Niedersachsen).[2819] It is found on both sides of the Rhine, in the northern Netherlands, north Germany, the area around Nijmegen/Gennep – with production probably in Goch-Asperden – and in the area between Bonn and Jülich.[2820] Further west there are some isolated

2814 Isings 1957, 113-116, 131-133. For Gellep type 180, see Pirling 1966, 97, *Typentafel* 15 (always with cracked-off rim).

2815 Isings 1957, type 96b.

2816 Isings 1957, 114; Rütti 1991/1, 95, tab. 16; 1991/2, 66ff. (AR 60.1); Brüggler 2009, 165-166.

2817 Van Lith 1987.

2818 Isings 1971, 71-72, fig. 16, no. 43-46.

2819 Werner 1958, 384-387, fig. 10-13. For Gellep type 238, see Pirling 1966, 153-154, *Typentafel* 19.

2820 On the possible production at the *burgus* of Goch-Asperden, see Brüggler 2014; Brüggler & Rehren 2014.

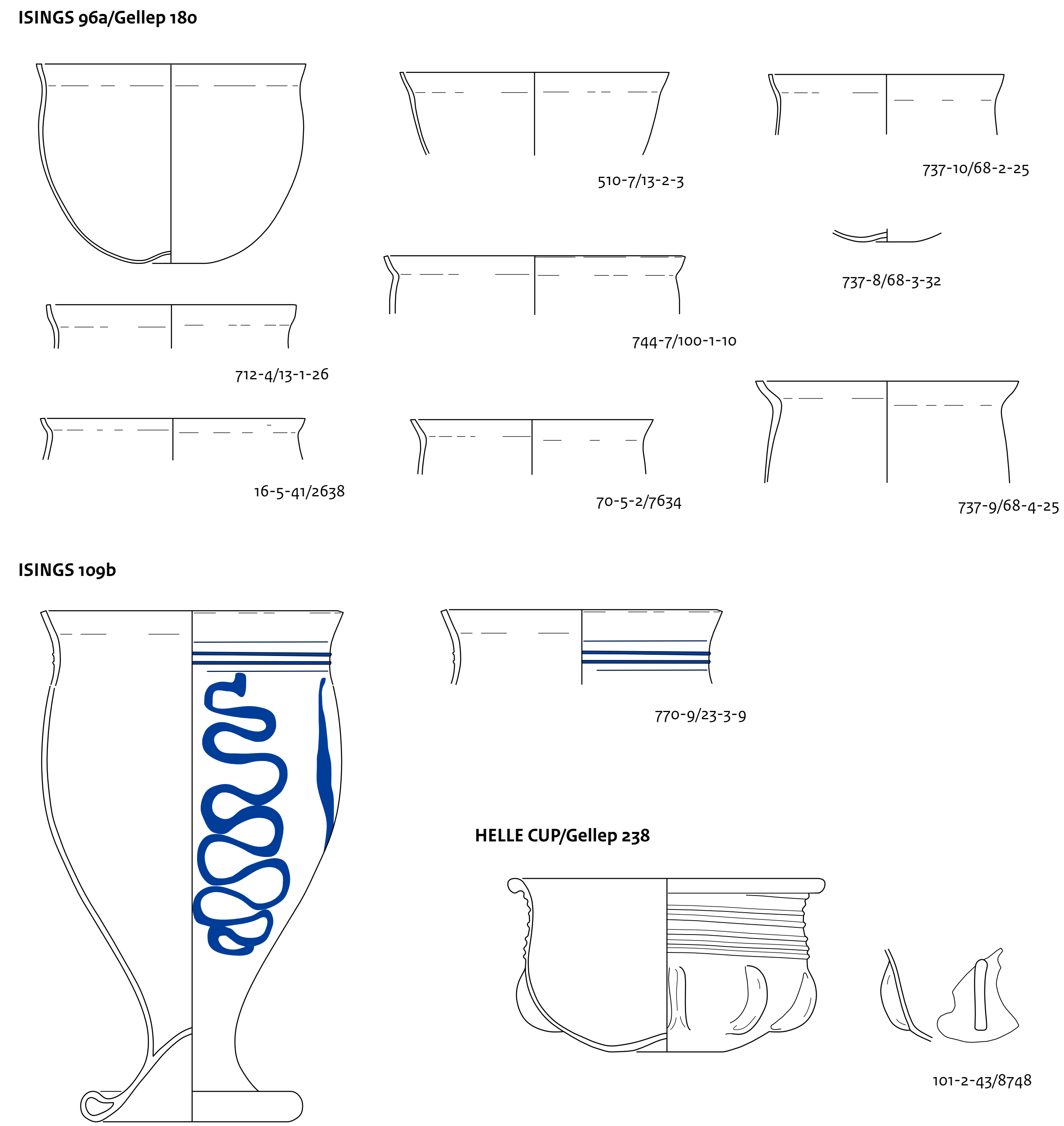


Fig. 31.5 Voerendaal-Ten Hove. Late Roman cups and beakers. Scale 1:2. (source: complete pieces modified after Pirling 1966, Typentafel 15, no. 180; 19, no. 237; Isings 1959, 136, middle; Vogt 2016, fig. 44)

finds, amongst others in Tongeren and Tournai.[2821] The fragment from Voerendaal seems to be the only one (known) in Zuid-Limburg. Helle cups are derived from the Roman Isings 96b2/Krefeld 189-type; they can be dated to the period around 400-first half of the fifth century AD.[2822]

--/101-2-43/8748 wall fragment (3 g); pinched-out rib; greenish (Fig. 31.5).

Conical beaker on foot Isings 109b?

From pit 770 there is a cracked-off rim of olive-green glass with three dark blue threads below it (770-9; Fig. 31.5).[2823] Based on a superficial glance, this looks like just another Isings 96-like cup, albeit decorated. However, a note on the find label suggests that we are possibly dealing with a 'bell beaker on a foot' (*Glockenbecher*). It is indeed possible, although not entirely certain, that the rim stems from a

2821 Rehren & Brüggler 2015, fig. 2.
2822 Werner 1958; Pirling 1966, *loc.cit.*; Rehren & Brüggler 2015, 171.
2823 It is possible that the diameter was approx. 1 cm larger than in our illustration.

beaker Isings 109a/b, characterized by convex sides, a conical or stem-like underside and a pushed-in foot.[2824] A complete specimen from Schwarzenden (Saarland) grave 238 was our inspiration for this determination.[2825] Besides the horizontal threads, this beaker had a snake-like decoration on the sides. The beaker from the Schwarzenden grave and other specimens are dated at the end of the fourth and/or beginning of the fifth century AD.[2826] This date also applies to other finds from pit 770 at Ten Hove, namely an East Roman amphora and two coins struck in or after AD 388.

770-9/23-3-9/4426	rim fragment, 2 mm (1 g); olive-green glass, many small and few large bubbles, cracked-off rim; copper-blue thread in four turns below rim (Fig. 31.5).

Conical beakers

Six find numbers/records contain 5 rims and 3 wall fragments (12 g) of (probable) conical beakers, made of green glass and with a simple, rounded-off rim (Fig. 31.6). Two rims (and a wall fragment) have horizontal brown-red/green threads;[2827] the others have threads of the same green colour as the vessel itself. The beakers are 'optic blown', first pre-formed (paraison) in an open mould, and then finished in free-blown fashion.[2828] Because of the small size of the fragments and the absence of bases, it is impossible to determine the exact form or type. The first conical beakers seem to have been made around the middle of the fourth century. Early variants are relatively low, with steeper sides and often have a pushed-in base (Mayen type);[2829] some were still produced or made in the beginning of the fifth century AD.[2830] From late in the fourth century onwards, the 'real conical' (*spitzkonische*) beakers with a narrow base became popular; they were made well into the sixth century AD.[2831] The contexts of Voerendaal provide few clues about the dates. Sunken-floored hut 509 contained a coin struck in or after AD 388.

509-2/13-2-14/1433	rim fragment, 2-3.5 mm (1 g); olive-green; free-blown, many bubbles; fire-rounded rim; three turns of thread below rim (Fig. 31.6).
757-34/108-2-1/9881	rim fragment, 3 mm (1 g); green-yellow; optic blown, many bubbles; cracked-off and fire-smoothed/thickened rim; at least five turns of thread in same colour (Fig. 31.6).
768-4/15-2-19/2090	wall fragment, 1.5 mm (1 g); olive-green, many small bubbles; free-blown; thread in olive-green and opaque brown-red.
774-1/23-4-6/4447	rim and wall fragment, 1 mm (4 g); olive-green; optic blown; rim cracked-off and fire- smoothed/thickened; many small bubbles; seven irregular turns of wire on rim. (Fig. 31.6).
--/70-4-6/7633	rim and wall fragment, 1.5-3mm (2 g); olive-green; optic blown, rim cracked-off and fire smoothed/thickened; many small bubbles; at least nine turns or thread on rim.
--/95-1-19/10853	rim fragment; 1-4 (rim) mm (3 g); olive-green, some bubbles, optic blown; cracked-off and fire-smoothed/thickened rim; below it eight turns of brown glass; oblique ripples on body (Fig. 31.6).

Beaker or bowl?

Rim fragment 501-5 is in yellow-green glass with an opaque white thread applied (Fig. 31.6). Because the rim is rounded and not cracked off, in combination with the fact that white threads are frequently found on Early Medieval glass,[2832] the date probably lies in or close to the period mentioned. The form of the rim points instead to a beaker, for instance a Gellep 131, although a very large example (measured diameter of 90-100 mm). The diameter could apply to a bowl Gellep 239,[2833] but this normally has a more outsplayed rim. The 'Roman' bowl type is dated to the fourth century, the 'Frankish' type appears until the sixth century AD.[2834]

[2824] Isings 1957, 136-137.
[2825] Vogt 2016, 329-332. This beaker is classified as an Isings 109b on the basis on the pushed-in foot, but is quite slender, somewhere between Isings illustrations of the 109a and b.
[2826] Vogt 2016, 331-332.
[2827] Some threads have two colours. Lengthy use of the glass pots in which glass containing copper was processed could cause this material to end up at the bottom, where reducing resulted in a red-opaque colour. It is not certain whether or not the mixing of this glass and the green glass was intentional. For an example of a glass pot with both glass colours, see Brüggler 2014, 94 (*burgus* Goch-Asperden). For a glass vessel with this discolouration, see Pirling 1986, fig. 95.
[2828] Often with small oblique ribs/ripples, formed by twisting.
[2829] Isings 1957, 127-129, type 106a/b1-2; Pirling 1966, 98-99, *Typentafel* 15, type 185.
[2830] Pirling 1966, 150, *Typentafel* 19, type 230.
[2831] Isings 1957, 130-131, type 106d; Pirling 1966, 150-151, *Typentafel* 19, type 231 (everted rim)-232. The less/more conical forms are also classified as Trier 53b-53a (Goethert-Polascheck 1977, 69-74, pl. 42-43, no. 283-313) and AR 67 and 68 (Rütti 1991/1, 103; 1992/2, 75, pl. 66-67). On the beaker typology, see also Koch 1987, 66-102, type IIIa-j.
[2832] See e.g. Rademacher 1942, pl. 48, no. 2; 50, no. 1; 61, no. 1; 66, no. 1-2; 68, no. 1.
[2833] The designated type in the original database. For Late Roman bowls of this shape (Isings 1957, 147-148, type 117; Von Boeselager 2012, 110-114, type 17). For the Gellep 239 type, see Pirling 1966, 154-155; 1974, 107, *Typentafel* 19.
[2834] Pirling 1974, 107.

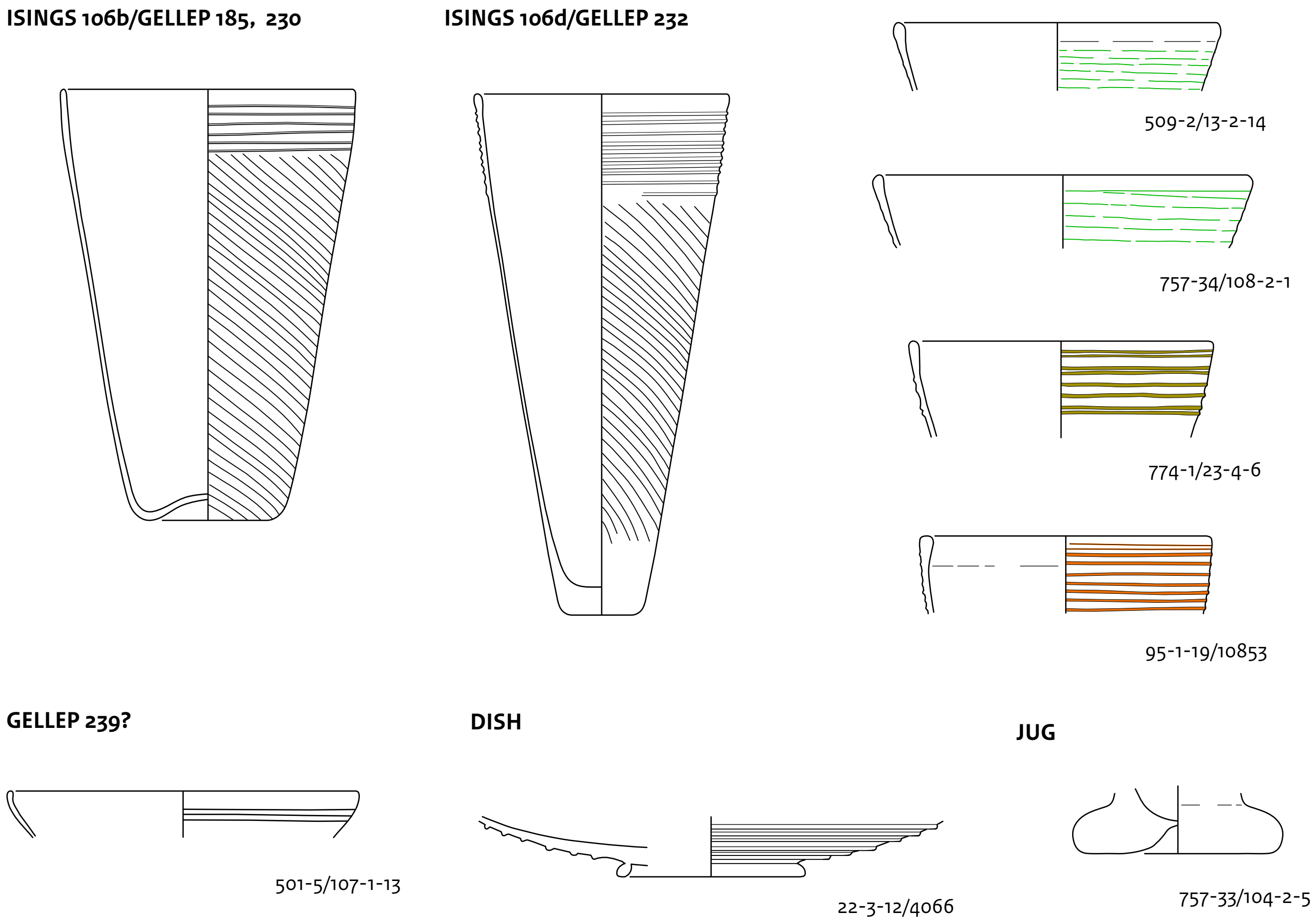


Fig. 31.6 Voerendaal-Ten Hove. Late Roman and Early Medieval conical beakers and fragments of various vessels. Scale 1:2. (source: H.A. Hiddink, complete beakers after Isings 1959, 127; Pirling 1966, Typentafel 19, no. 232)

501-5/107-1-13/9702 rim fragment, 2 mm (1 g); yellow-green and opaque white glass; free-blown, cracked-off and fire-rounded rim, slightly thickened; beneath rim three turns of opaque thread (Fig. 31.6).

Dish

The entire form and type of a dish from trench 22 is unknown; no good parallels for the combination of base shape and number of thread windings were found. Glass threads were applied on dishes and jugs in the late third and fourth century AD.[2835]

--/22-3-12/4066 base fragment, 2 (wall)-6 mm (base) (18 g); olive-green; free-blown, large and small bubbles; base ring of thick thread (3 mm) and wall decorated with 1 mm thread (Fig. 31.6).

Jug

This solid base probably belongs to a pyriform jug in the style of Isings 122 or Trier 127-128.[2836] It seems to have been used secondarily as a large bead or 'amulet.[2837]

757-33/104-2-5/9088 base fragment (38 g); yellow-green; free-blown, many small and tiny bubbles; wall deliberately broken off, base perforated for use as bead/ amulet (Fig. 31.6).

2835 Isings 1957, 106, type 86c; Goethert-Polascheck 1977, 26, pl. 16, form 13; 230, pl. 73, form 136.

2836 Isings 1957, 153 (fourth-early fifth century); Goethert-Polascheck 1977, 127-128, pl. 71, no. 218-219 (no date mentioned).

2837 Van den Dries 2019, 113; 115; Honselersdijk fragment has the same dimensions as that from Voerendaal-Ten Hove.

31.3 Jewellery. Bracelets and beads

The glass jewellery dating to the Roman or later periods consists of (fragments of) three bracelets and eight beads. One fragmented bead appears to be of jet. All these objects are described below and those that could be drawn are illustrated in Fig. 31.7. Two fragments of vessels seem to have been secondarily used as large beads or amulets.[2838]

31.3.1 Bracelets

Bracelets of dark glass
At first glance, two or three bracelet fragments appear to be of 'La Tène glass', but they are (Late) Roman. Bracelet 409-50/68-2-85 is made of very dark purple-black, nearly opaque glass; its cross-section is D-shaped. The context of the ring dates to the period around AD 125. The second fragment, 243-2/16-6-10, is the same colour but has a round section. Some finds provide a terminus post quem of AD 200 for building 243, but the structure is probably Late Roman in date.[2839] A third fragment, 504-9/101-1-6, is very

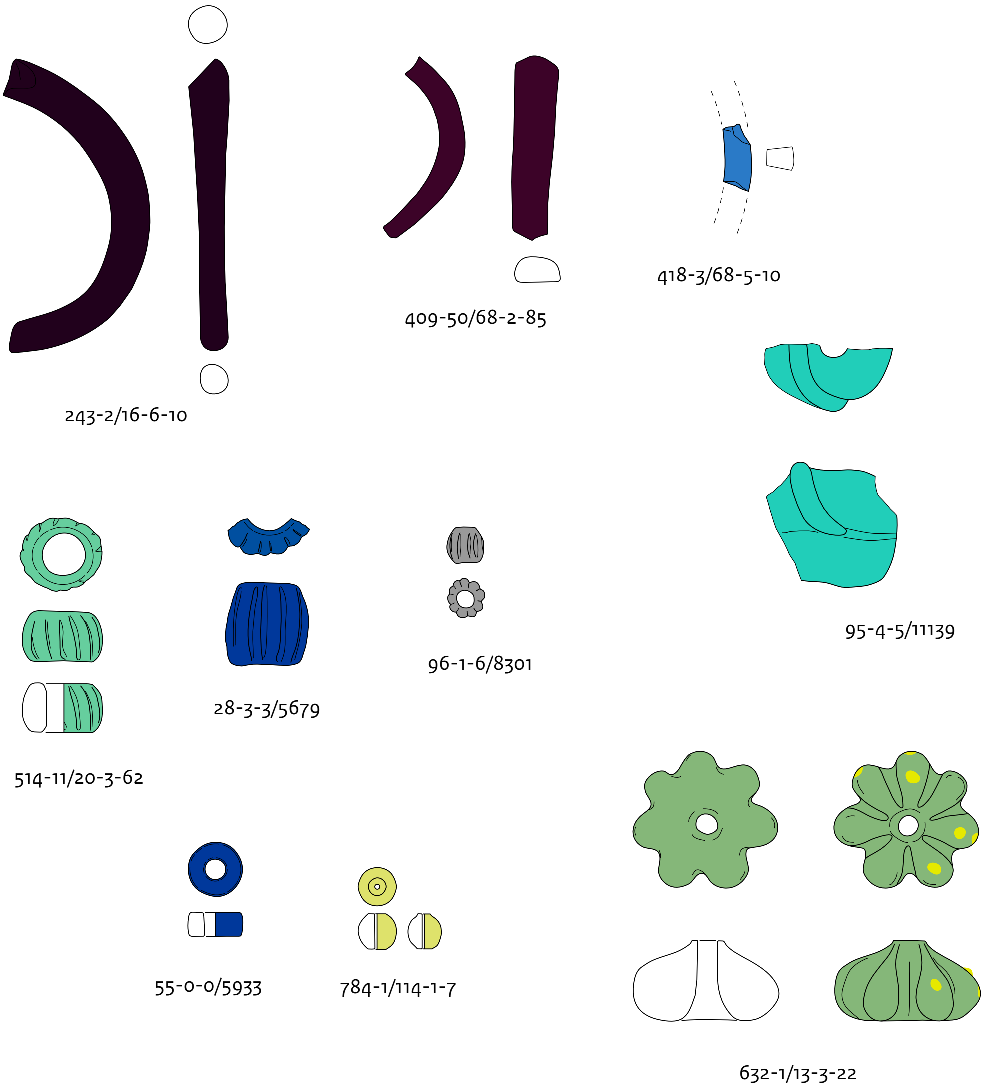


Fig. 31.7 Voerendaal-Ten Hove. Bracelets and beads. Scale 2:3.

[2838] See section 31.2.2 (68-2 757-33; bottle) and 61.2.3 (jug 757-33/104-2-5).
[2839] Late Roman examples: Sablerolles 2010, 111 (Holtum); Brüggler 2014, 99-101 (Goch-Asperden).

small and it cannot be ruled out that it was part of a La Tène bracelet.

Bracelet?
A small fragment of blue glass, 418-3/68-5-10, seems to belong to a ring of 50-60 mm in diameter. Three of the sides are flat, the outside slightly rounded.

31.3.2 Beads

Melon beads
A complete bead, 514-11/20-3-62, is a 'true' melon bead in green faience or *Kieselkeramik*. This kind of bead seems to have been produced in the period c. AD 40-100, but remained in use for hundreds of years after that.[2840] This also holds true for our bead if it did not end up in sunken hut 514 by chance. Fragment 28-3-3/5679 has the same form, but is made of blue glass. Beads like this were used especially from around the middle of the first until the end of the second century AD.[2841] In Germania magna they seem to have been most popular in *Stufe* B2 (c. 70-mid second century AD).[2842]

Small melon bead
Find number 96-1-6/8301 is a very small, ribbed bead of black, or in any case very dark glass.[2843] Outside the Roman empire, these beads are found in contexts of *Stufe* C1-D, from the middle of the second to the middle of the fifth century AD.[2844]

Flat/ring-shaped bead
A small, opaque dark blue bead, 55-0-0/5933, is quite rectangular in cross-section. These kinds of simple ring-shaped beads, although often somewhat more rounded, can date to both the Roman period and the Early Middle Ages. The find location offers no real clues for the date of this example.

Gold-cased beads
Two small beads made of colourless glass with a gold casing (784-1 and 2/114-1-7) were found in pit 784. East of the Rhine, gold-cased (*goldüberfangene*) beads were worn throughout the Roman period, but especially during *Stufe* B2-C1a.[2845]

Jet bead?
Some splinters of a bead in pit or grave 315 appear to be of jet, not glass (315-5/23-2-1; not illustrated).

Large bead with thread
A fragment of a large bead has the same blue-green colour as, for instance, many ribbed bowls or bottles (95-4-5/11139). The hole tapers, indicating that the bead was formed on a mandrel. The glass was pulled out and the resulting thread was wound around the bead.

Large, ribbed bead
A large bead was found in the fill of a hearth (632-1/13-3-22; Fig. 31.7; Appendix XVIII). It is made of olive-green glass with seven broad ribs, each with two inlaid yellow dots (most of which have disappeared). Three beads of this 'type', although with different numbers of ribs and different colours, were part of the girdle of a 'princess' (grave 87) from the Early Medieval cemetery of Zweeloo in the northern Netherlands. The grave in question dates from the period around the middle of the fifth century AD.[2846] Our bead bears some resemblance to green 'melon beads' with yellow dots from Germania libera, which belong to a group of beads dating to the period from the second half of the third until the mid-fifth century AD.[2847]

Beads of a necklace
All beads of a necklace from grave 381 are lost at present. There are 29 find numbers, with one series of two and one of three (possibly beads stuck together), making a total of 29 or 32, depending on how they are counted. The colours and shapes can be found in Chapter 42.

31.4 Window glass

During the ROB excavations, 153 fragments of window glass were collected, with a total weight of 831 g (Table 31.2). Ten fragments from the earlier excavations are held at the RMO (258 g). This quantity of window glass is not large, compared to the material from, for instance, Hoogeloon-Kerkakkers (282 fragments, 1,204 g).[2848] The number of fragments at

[2840] Böhme 1978, 288-289; Riha 1990, 80-82 (type 11.1.1); Tempelmann-Mączyńska 1985, 41-42, 127-128.
[2841] Riha 1990, 82 (type 11.1.3).
[2842] Tempelmann-Mączyńska 1985, 19, 39-40, pl. 3 (group 18, type 162).
[2843] Cf. Riha 1990, 83 (type 11.1.4).
[2844] Tempelmann-Mączyńska 1985, 19, 39-40, pl. 3 (group 18, type 167).
[2845] C. 70-beginning third century AD. Tempelmann-Mączyńska 1985, 22, 64-65, pl. 14 (group 29, type 387a).
[2846] Van Es & Ypey 1977; Van Es & Schoen 2007/2008.
[2847] Tempelmann-Mączyńska 1985, 20, 42, pl. 3, group 18, ≈type 174; types 174-177 are not very numerous and date to *Stufe* C2-D.
[2848] Van Lith 2014, 434, tab. 19.3.

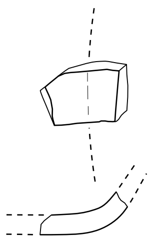
Table 31.2. Voerendaal-Ten Hove. Fragments and weight of window glass per group of features and certain areas.

Context type	Subgroup	N	Wt (g)	N	Wt (g)
Features					
Pits, ditches etc. (300)		22	110		
	302			1	3
	317			12	60
	316, 319, 334			5	29
	remainder			4	18
Hearths (600)		-	-		
Sunken-floored huts (500)		5	24		
Pits (700-800)		27	84		
	Roman			10	27
	LROM/Merov.			17	57
Areas around buildings					
Trench 7, between 400 and 410		8	44		
Main building(s) (399 and) 400		16	67		
Building 401		19	134		
Building 403		19	192		
Horreum (408)		11	89		
Topsoil 413		4	14		
Rest		32	331		
Total		**163**	**1089**		

Ten Hove is larger than that at Kerkrade-Holzkuil, but many of the 87 pieces found there were associated with only a few contexts, mainly the baths integrated into the main building.[2849]

Because most glass fragments are quite small, with an average weight of 5.5 g, only a handful over 20 g and one fragment of 85 g, virtually no relevant details are visible. The varying colours with all tints of green and blue show that many panes from different batches were present. Item 9-1-22/582, found at the rear of the main building, is an intriguing fragment (Fig. 31.8). At first sight, it looks like the corner of a blue-green square bottle or jar. However the matte surface of one side differs from the normal (position/kind of) traces of wear.[2850] Therefore, it is possible that the matte side is the underside, with part of a flange and the onset of a dome. However, viewed from above or below, no curve is visible.[2851]

A first glance at the distribution map of the locations/contexts with window glass fragments suggests that most were not found near the structures in which they were originally used (Fig. 31.9).[2852]

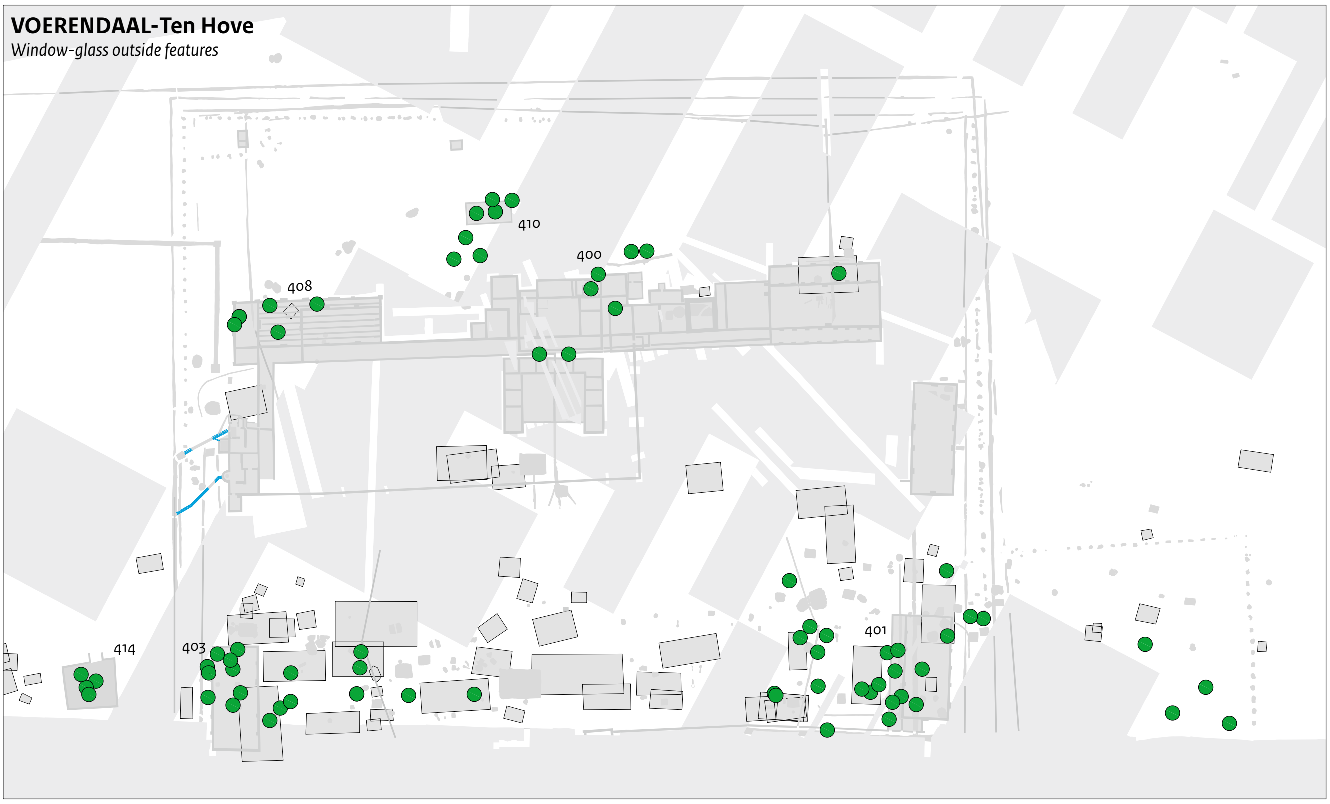


9-1-22/582

Fig. 31.8 Voerendaal-Ten Hove. Fragment of a possible glass dome. Scale 1:2.

One third of the fragments (51) were recovered from features. Almost half of these fragments (27) came from pits, some 40% (22) from ditches and the remaining 10% (5) from sunken-floored huts. Most pits belong to the Late Roman period and Early Middle Ages.[2853]

2849 Van Dijk 2005, 249-250, 252-255, fig. 8.4 (weight not specified).
2850 Observation/identification François van den Dries.
2851 The diameter of a glass dome would be a foot or so. A glass-dome fragment was also found at the baths in Heerlen (inv. no. 02848; Van den Dries 2006; s.a. 7-8).
2852 Because most find numbers/contexts yielded only one fragment, and in the light of the small (average) weight of the fragments, the numbers and weight are not shown on the map.
2853 Cf. section 5.2.4; 9.7.2; 12.5.



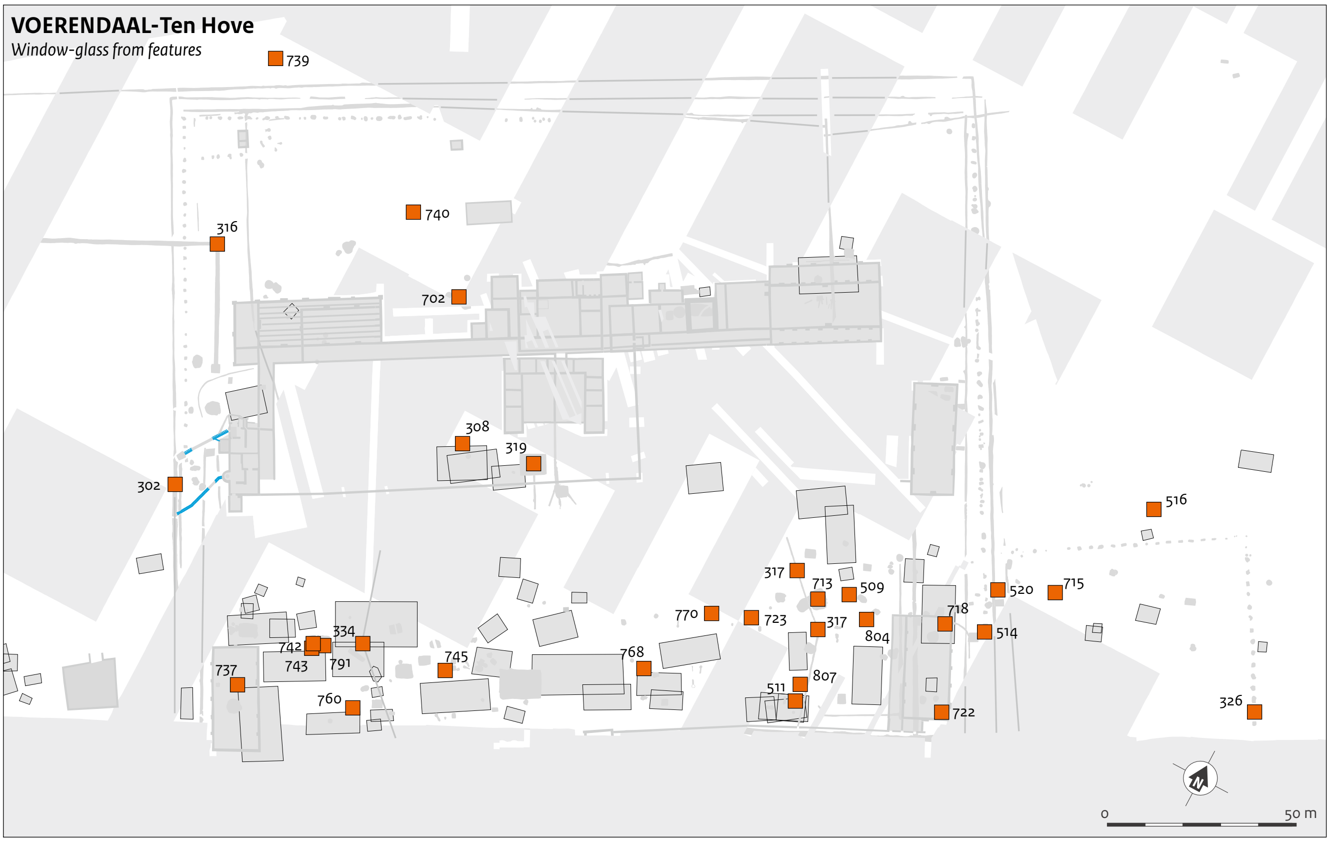


Fig. 31.9 Voerendaal-Ten Hove. Distribution of Roman window-glass.

Many fragments from other contexts also ended up there when the villa was – at least in part – in ruins. Three fragments were found in basin 319, easily explained by the proximity to the main building and the volume of this feature.
The presence of 14 fragments of window glass in drain 317 is remarkable, however, because there was no Roman building in the immediate vicinity.[2854] A later date for the material in this drain is also suggested by some of the pottery.

The finds between or just outside the foundations of the villa make sense when we look at the window glass found outside pits, ditches and similar cut features. The fragments ended up near the location in which they were originally used. Fragments from trench 7 were found because of the relatively good preservation of the subsoil there, also resulting in a large quantity of pottery and building material finds. Some fragments in the upper fill of horse pond 413 can be explained by the large volume of earth involved. More difficult to explain is the glass in front of building 401 and around building 403 (together, 35% of the 'stray finds'). At first sight, we have to consider the possibility that these buildings had glass windows. However, there was a lot of activity in the Late Roman and later periods in and/or around building 401, which was possibly also used to accommodate people,[2855] Some glass is also found in sunken huts and some pits in this area. The same seems to be the explanation for building 403, although there was somewhat less activity there. Pits such as 737 and 742-743 were situated in this area. In any case, the trenches in which buildings 401 and 403 are located are among the most find-rich of the excavations.[2856]

Why some glass was found between the foundations of *horreum* 408 cannot be explained by Late Roman activities. The presence of fragments between the (ruins of the) main building and bath therefore comes as no surprise. However, the use of windows in the baths is not proven, contrary to expectations. Although this building was not investigated again by the ROB, some glass should have been present in the immediate surroundings. Only one fragment was collected from ditch 302 and even more remarkable is the fact that Braat does not mention any glass from the baths.[2857]

2854 Part of the fill was sieved, partly explaining the number of fragments.
2855 Cf. section 9.3.3.
2856 See section 5.2.2. It is remarkable that most find material from the area of building 403 belongs to its predecessors 409 and 418, apparently not equipped with glass windows.
2857 Braat 1953, 73. No glass with find no. 1953/2.9 (= finds of the bath) was present at the RMO. The small quantity of pottery from the bath is unsurprising given that pottery was not used much there.

32 Ceramic building material

Twan Ernst

32.1 Introduction

A considerable quantity of brick and tile was collected during the RMO and especially the ROB excavations at Voerendaal-Ten Hove.
The material kept in the RMO mainly consists of (almost) complete roof tiles and material from *hypocausta*, together with a possible stamp and an inscription *ante cocturam*. The 26 pieces weigh 100.3 kg. Sadly enough, the context of this rather small collection is largely unknown.[2858] Some tile was without doubt still in situ, especially in the bath, as is indicated by mortar quite recently broken off.

The material collected by the ROB was identified shortly after the excavations. The form and colour were registered and the material was counted and weighed. Following this, the majority was thrown away. Exactly how much was originally collected is not known because the number of fragments was not stated in 224 database records.[2859] The weight was rounded off to the next 100 grams and not entered in 7 records. Moreover, there is evidence that some material was not collected. Pit 701 and 702 for instance, contained a 'lot of tile fragments' according to the section drawings, but only 5 fragments were entered in the database. Tile fragments from basin 319 were not kept at all.[2860] Nevertheless, we can obtain some impression of the amount of material found in 1985-87 (Table 32.1).

After the sorting, in which the criteria used were not specified, 400 fragments remained, weighing a total of over 333 kg; only 8.2% and 15.1% respectively of the original numbers c.q. weight. Of course coincidental, but illustrative, is that during the excavations of the Hoogeloon-Kerkakkers villa, also 2.2 tonnes of brick and tile were collected.[2861] Here most of the material was also discarded afterwards; 526 fragments with a weight of 183 kg were kept. Finally, some pieces of *tegulae* and *bessales* were collected by Grontmij during the trial trench investigation in 2004. All in all, 434 pieces weighing 439.5 kg were analysed.

Compared to Hoogeloon and some other villa sites excavated since the 1980s in the Netherlands, the quantity still seems reasonably representative (Table 32.2). In reality it is not. In Hoogeloon only one stone building with two phases existed, in Maasbracht only the main building was excavated. At Voerendaal, ultimately seven large buildings existed, some with two or more phases. Thus on basis of the roof surfaces alone, there should be far more material to study to get an equally 'reliable' dataset.

Looking at the kind of finds actually kept, on the one hand there are a number of (nearly) complete pieces.[2862] On the other hand, however, there is a disproportional number of fragments with footprints of various animals, signatures (*Wischzeichen*), nail holes and traces of burning. From the current point of view, it would have been preferable if more 'ordinary' fragments of *tegulae* were kept, especially the flanges and cutaways of the *tegulae*. Regrettable in this respect are the 'fresh' fracture surfaces found in signatures and paw prints, which show that the pieces were deliberately reduced in size.[2863]

Besides the relatively small number of relevant fragments, our knowledge on the use of tile in actual constructions is hindered by the fact that a considerable part of the material was collected ('robbed') in the Late Roman period and

Table 32.1. Voerendaal-Ten Hove. Building ceramics collected in 1985-1987.

Category	N records	N	Wt (kg)
Tegula	829	3246	1612
Imbrex	429	1232	421
Later	8	11	23
Bessalis	55	59	89
Tubulus/parietalis	99	208	36
Rest/unknown	102	122	23
Total	**1522**	**4878**	**2204**

2858 Like other finds, those made by Habets are numbered individually, albeit without reference to locations; tiles from Holwerda's campaign all go under one find number (l 1932/11.1). Braat indicated some specific tiles on his drawings, but all ceramic building material was stored under one number (l 1953/2.18).

2859 Moreover, it seems that fitting fragments were counted as one.

2860 Comment in database: '*niet binnengekomen*' (did not arrive at the office).

2861 In some 26,500 relatively small fragments (Hiddink 2014, 649, 657, table 1).

2862 The length and width of a number of discarded *tegula* were recorded in the original database.

2863 For example item 14-1-6/2003; original length 39.5 cm, now 10 x 10 cm.

Table 32.2. Quantity of collected and kept Roman building ceramics from four excavations of Dutch villas.

Site	Voerendaal Ten Hove		Hoogeloon Kerkakkers		Kerkrade Holzkuil		Maasbracht Steenakker	
Category	**N**	**Wt (kg)**	**N**	**Wt (kg)**	**N**	**Wt (kg)**	**N**	**Wt (kg)**
Tegula	185	235.1	244	89.2	185	?	117	62.2
Imbrex	65	57.7	65	19.9	77	?	46	9.5
Later	9	38.7	25	29.7	12	?	31	53.0
Bessalis	32	63.4	9	12.5	69	?	8	3.3
Tubulus/parietalis	127	42.5	75	27.7	72	?	85	23.6
Rest/unknown	16	2.1	108	4.5	147	?	184	4.8
Total	**434**	**439.5**	**526**	**183.5**	**562**	**709**	**471**	**156.4**

Early Middle Ages, to be used for various purposes, like the construction of kiln 630. Therefore most fragments were found far away from the buildings to which they originally belonged.

Although the ceramic building material from Voerendaal was for a large part discarded, the selection kept still provides a lot of information. However, it would have helped if the pieces were properly registered and studied by a specialist in the field before (de)selection; much more detailed information would have been gained.

32.2 Research method

Most of the material originally excavated and collected during the ROB excavations had already been identified by type and a number of characteristics per find number were recorded. For many items these were the colour(s), dimensions and any special features. In addition, Braat's publication and excavation plan give details of the building ceramics of the main building and the baths, most of which were not included in the later ROB excavation.

For the present study, all the preserved bricks from the various excavations were reviewed and the earlier determinations corrected where necessary. The existing database was supplemented with notes on the fabric, types, shape characteristics, formats and other details. With a few exceptions, there are no fragments whose type cannot be determined. This is undoubtedly the result of discarding many smaller pieces that could not be identified during the aforementioned selection. To record the shapes and sizes of the roof tile material, generally the most common shapes at a site, a Warry-based recording method was used,[2864] which has been expanded by the author. In doing so, also French publications were taken into account in which this kind of systematic research, with a strong emphasis on form and typology, has been strongly emerging over the last 10 years. The research of the fabrics and rim/flange forms is justified in the paragraphs below.

The starting point of the current study is whether the ceramic building material can say something about the dating and use within the buildings or structures in which it has been incorporated. To this end, an attempt was made to distinguish 'productions'. In a large villa complex such as Voerendaal, which was used for a long time, it is to be expected that building ceramics were supplied and processed at various times. Attention is also paid to production and use traces on the building ceramics. Finally, the author investigated to what extent the material from Voerendaal can be compared to other sites around Heerlen. To this end, the author performed scans on the building ceramics of a large number of sites relevant to this investigation.[2865]

32.3 Fabrics

The Heerlen region is one of the better studied areas in the Netherlands when it comes to the study of Roman building ceramics. This has resulted in dozens of descriptions of bricks.

2864 Warry 2006.

2865 It concerns Heerlen-Valkenburgerweg (cf. Vanderhoeven & Kars 2012); Heerlen-Trilandis (cf. Gazenbeek 2014); Heerlen-Trilandis Domeinen (some remarks on brick and tile: Weekers 2018, 34); Kerkrade-Holzkuil (cf. Kars 2005); Voerendaal-Steenenis (Debunne *et al.* 2002); Voerendaal(Ubachsberg)-Colmont (site: Remouchamps 1925); Voerendaal-Retersbeek (site 62BN-109, Archis 15894, 16377); Winthagen-Overst Voerendaal (site 62B-131; Archis 16381); Nuth-Reijmersbeek II (site 60DZ-48; Archis 15787).

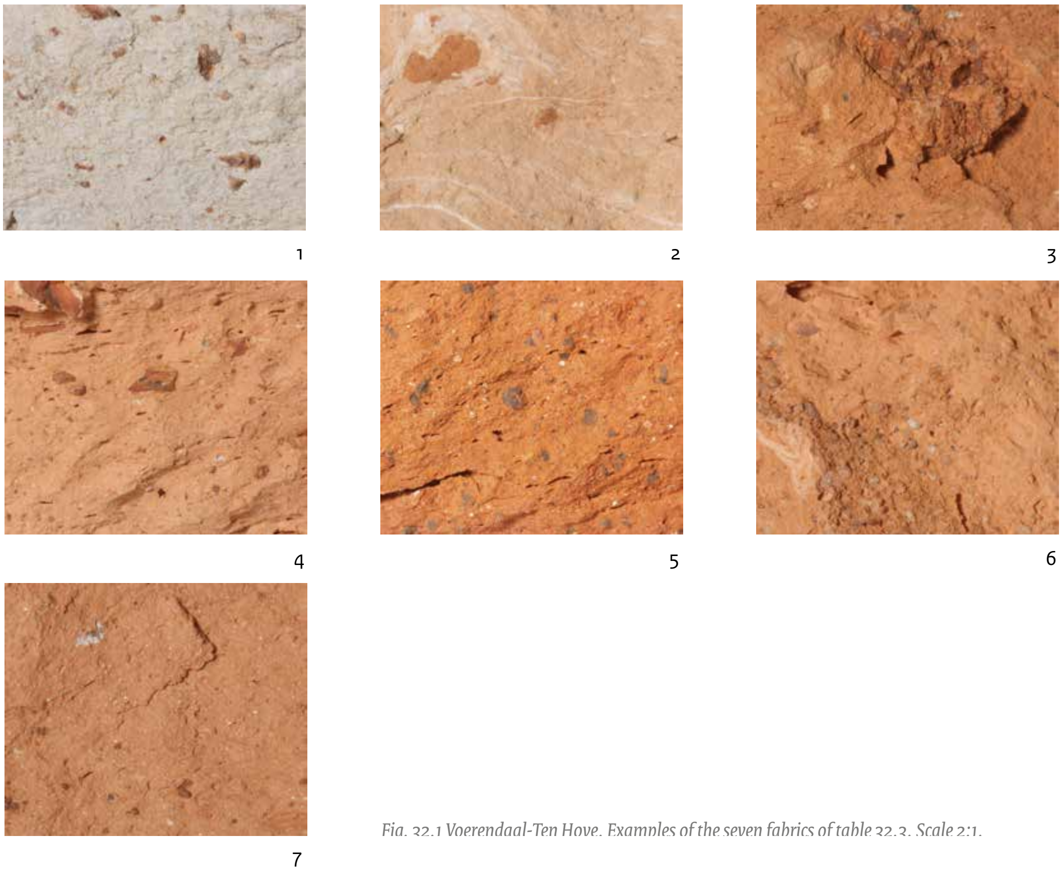


Fig. 32.1 Voerendaal-Ten Hove. Examples of the seven fabrics of table 32.3. Scale 2:1.

Recent research of the Roman bathhouse in Heerlen also provided new insights into the origin and composition of the clays used in the building.[2866] In analysing the Voerendaal bricks, we followed as much as possible the descriptions of bricks already known to us, since similarities can clearly be seen. Although sometimes natural variations in the inclusions within a fabric can be observed, the material was finally classified into seven types. The description is based on a macroscopic observation of the fracture in which colour, inclusions in the matrix, hardness and structure of the fabric are noted (Table *32.3; Fig. 32.1). Many pieces were damaged during selection, the removal of 'irrelevant' parts, repacking and multiple moves, so that 'fresh' fracture surfaces are visible. In one piece, a new fracture surface was made. For understandable reasons, this was not done for complete pieces.

In the 1980s, the colours of the tiles were noted on many pieces. In an attempt to find out whether these colours might reveal something about the fabric of the finds that were removed, they have been classified here according to the dominant colour of the matrix. The order in which the bricks are numbered runs from white to yellow, pink, orange, red and purple. Almost all of the material available has been assigned to one of these fabrics. Only a few glazed and reductive fired pieces could not be assigned to a fabric and have been placed in a separate category (fabric 8; not in Table *32.3).

Fabric group B (fabrics 1 en 2) is made of clay most likely extracted around Brunssum-Schinveld. The difference between the two fabrics can be traced back to the purity of the clay, as analysis of the Heerlen pottery has made clear.[2867] Finer forms of building ceramics, such as *tubuli cuneati*, are usually made in fabric 1, while coarser forms, such as tiles, occur in fabric 2. Apparently, a conscious choice was made by the potter in the selection of the clay. The fabric group is found at many sites around Heerlen.[2868]

2866 Vanderhoeven *et al.* 2018. Fabric descriptions for other sites: Parkstad-Buitenring (Vanderhoeven *et al.* 2012); Kerkrade-Holzkuil (Kars 2005); Heerlen-Valkenburgerweg (Vanderhoeven & Kars 2012); Heerlen-Trilandis (Gazenbeek 2014); Heerlen-Tempsplein (Gazenbeek 2020); Heerlen-Dr. Poelsstraat (Kars 2007).

2867 Kerckhove & Boreel 2014, 242-245.

2868 Eastward to Aachen (Vanderhoeven *et al.* 2018, 30), northward to Echterbosch-Prinsenbaan (author's observation, Archis 15442). The distribution towards the west and south is not (yet) clear.

Fabric 3 is chemically related to 1 and 2 (fabric group B).[2869] If the characteristic red inclusions are missing, it is difficult to see the difference macroscopically. It may well be, therefore, that forms that are identical but occur in both fabric 1/2 and fabric 3, actually come from the same production centre. This type of clay has been found on at least two other sites: Heerlen-Thermenterrein and Valkenburgerweg.

The fourth fabric is also known from Heerlen and its surroundings. The construction ceramics examined in this study make it clear that construction ceramics in this type of fabric have been used in several places. From this, and in combination with other aspects yet to be named, it becomes clear that this also concerns a local fabric. Although chemical research suggests an affinity and origin with the Tegelen clay,[2870] the use of a local source of clay is more obvious.

The brick group A, consisting of two bricks (5 and 6), has a wide distribution in Zuid-Limburg and along the Meuse. This group has also been chemically studied and similarities with (stamped) products from Maastricht and Tongeren have been demonstrated. The origin of the clay is still unclear, but seems to point to the Geul or Meuse valley.[2871]

The Voerendaal fabric 7 can be recognised by the sometimes excessive presence of mica and its striking pink-purple colour.
Almost exclusively round *bessales* were produced in this type of firing. These characteristics are identical to type 5 from the Kerkrade-Holzkuil villa. The provenance of the firing is not clear, but the mica (muscovite) present is possibly the result of the presence of pure quartz sand or glass sand from the Miocene, that can be found north of Heerlen. The common occurrence with fabric group B, which comes more or less from the same region in both Kerkrade and Voerendaal, may be an indication of the location of origin.

Normally, building ceramics are not worked after firing during the production phase, but some of the *tegulae* and *imbrices* in fabrics 1 and 2 are an exception. Apparently a reddish colour was preferred for roofs, because an engobe with this colour was applied to a number of fragments. This colouring of light roof tiles was already used early in the Roman period and has been observed many times before.[2872] A (dark) grey deposit is also strikingly common on the same tiles. These pieces appear to have been deliberately collected and preserved in Voerendaal. It is therefore impossible to determine how much this differs from other sites. Such a deposit, however, is not an uncommon phenomenon and was caused by soot from fires during the firing process.[2873]

32.4 Forms of building ceramics

32.4.1 Tegulae

General

Tegulae are the flat rectangular tiles that are primarily used as roof cover, combined with *imbrices* (Table 32.4; Fig. 32.2, no. 9; 32.3). They are flanged on the long sides. Although *tegulae* were primarily intended as roof tiles, they were also

2869 Vanderhoeven *et al.* 2018, 35.
2870 Jeneson & Vos 2020, 151, fig. 8.19.
2871 Vanderhoeven *et al.* 2018, 35.
2872 Clement 2013, 64-67. In the Heerlen region, too, a slip has been identified on several occasions for this group, e.g. Vanderhoeven *et al.* 2018, 24. For elsewhere, see for example Debruyne *et al.* 2015, 264.
2873 Gazenbeek 2016, 177.

Table 32.4. Voerendaal-Ten Hove. Quantities of the different forms of building ceramics per fabric.

Fabric / Form	1	2	3	4	5	6	7	Unknown	Total
Tegula	16	15	40	29	40	39	1	5	185
Imbrex	3	16	0	7	19	14	0	6	65
Later	0	5	0	0	3	1	0	0	9
Bessalis square	0	15	0	0	1	0	0	0	16
Bessalis round	0	0	0	1	1	1	12	1	16
Tubulus	25	52	9	6	9	19	0	0	120
Wall tile	1	1	3	0	0	1	1	0	7
Total	**45**	**104**	**52**	**43**	**73**	**75**	**14**	**12**	**418**

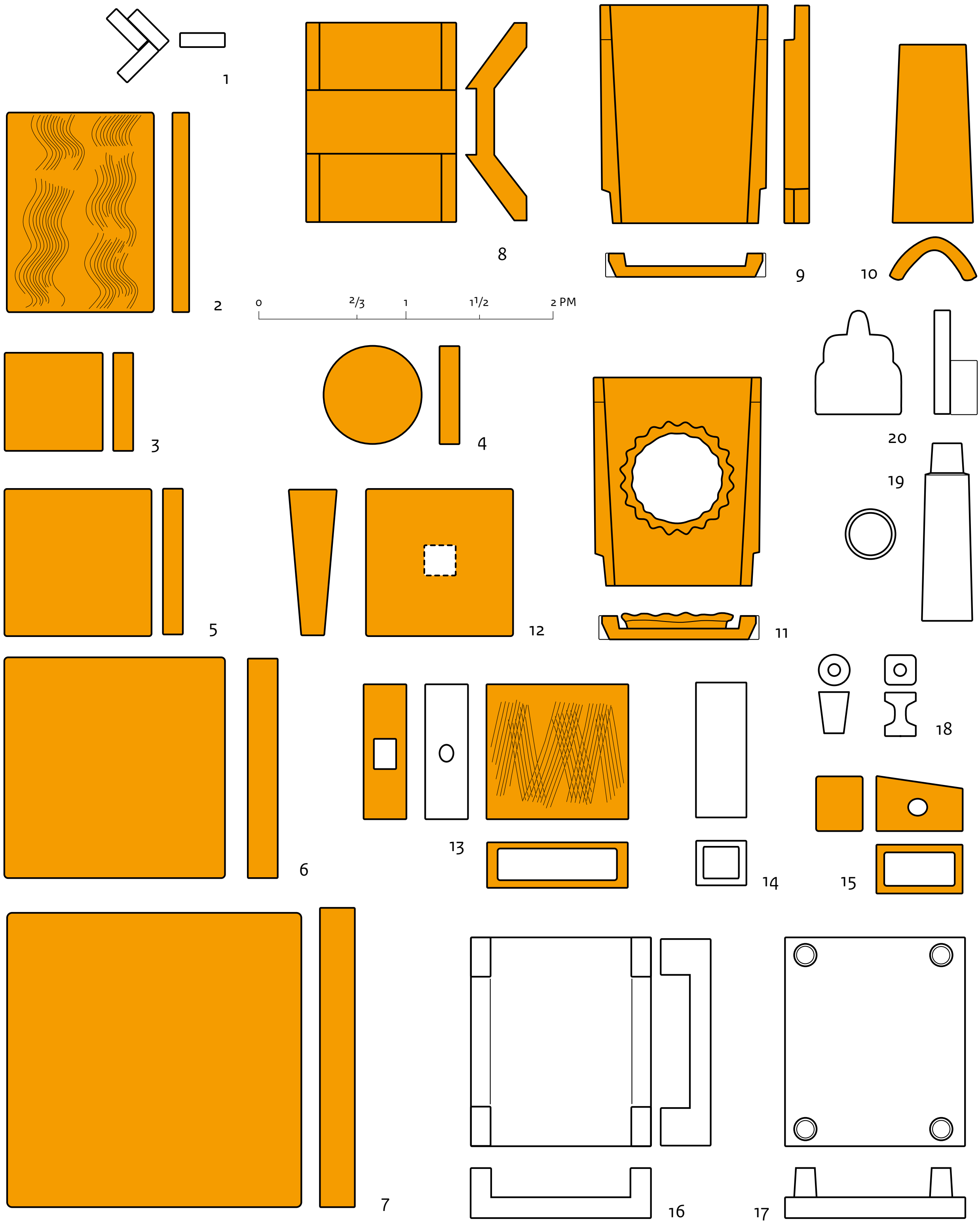


Fig. 32.2 Forms of building ceramics; in orange those found at Ten Hove. (source: modified after DeGroote et al. 2017, fig. 31)
1 brick flooring in opus spicatum; 2 parietalis; 3 bessalis, square; 4 idem, round; 5 pedalis; 6 sesquipedalis; 7 bipedalis; 8 roof ridge tile; 9 tegula; 10 imbrex; 11 tegula con opaion; 12 voussoir tile; 13 tubulus; 14 square tubulus 15 tubulus cuneatus; 16 tegula hamata; 17 tegula mammata; 18 spacer (tube); 19 water pipe; 20 acroterion.

put to other uses. Two complete examples kept from trench 114 (around the bath) are covered in mortar. Probably they came from drain 328 that was constructed from *tegulae*. The northwest side consisted of a wall of five layers of brickwork measuring 39 by 30 cm.[2874] Below the *suspensura* floor of room 2b in the baths the walls were covered with 'large roof-tiles'. [2875] Outside the bathhouse, however, there are no indications that roof tiles or other building ceramics were used in foundations or walls; after all, this is normally the most common form of reuse. In the main building of the villa, however, a round 'floor' with mortar – base for a column? – of worked roof tiles measuring 40 by 35 cm was found (Fig. 43.3).[2876] Finally, the outside of the cellar was lined with tiles, held in place by nails and plastered with *opus signinum*. This lining was apparently intended to solve dampness problems in the basement, a method known from more places.[2877]

Sizes

The lengths of *tegulae* vary considerably. For Britain, Warry demonstrated a chronological tendency towards smaller formats. For central Gaul, Clement has shown the same development, and for the military production at Nijmegen-Holdeurn this can also be observed.[2878] Although the formats may differ per region and/or period, it is evident that large formats are older than small ones. In Voerendaal, a considerable number of specimens are available, the length of which can be determined. The length varies from 46 cm to slightly less than 38 cm, or between 1½ and roughly 1¼ *pes monetalis*. The width lies between 30 and 35 cm, with a dominance of 29.5-31 cm (somewhat over 1 *p.m.*). Two tile types with the largest width are not particularly long (40 x 35 and 41 x 34 cm).

The largest formats in Voerendaal belong without exception to fabric group A (Fig. 32.4B). These large *tegulae* are well finished, have a relatively narrow flange over the entire length and a thin surface. They are skilfully manufactured products. As the length gets smaller, there is a shift to fabric groups B and C. The smallest roof tiles are made in fabric group B. This shift can be followed in more aspects. Although variations caused by shrinking cloud the picture, there seem to be a number of productions in which identical sizes have been used. Several specimens are around 41, 42-43 or 45-46 cm long (respectively top, middle and bottom (left) row in Fig. 32.3). Presumably this is related to different construction phases. It is striking that few complete specimens of the smallest sizes (length less than 40-41 cm) have been preserved, even though these are the youngest roof tiles (20-1-1/11948 is the shortest (40.5 cm) in Fig. 32.3). Complete specimens with a comparable length were found at several sites around Heerlen.[2879]

Lower and upper cutaways

In order to ensure that the *tegulae* fit together properly, cut-outs have been made at the corners at the top and bottom. These cut-outs can take on different shapes at the bottom. Except for one example (114-1-1/10180; Fig. 32.3) with a D1-cutaway in the lower part of the flange, all cutaways (29) are of the C5-type (Fig. 32.4; 20-1-82/3184).[2880] In all cases, the upper, vertical part of these C-cutaways is made by a (sometimes quite narrow) rectangular insert in the mould. The smaller the *tegulae* are, the wider this vertical cut is on average (from 2 to 19 mm).

The chronology proposed by Warry in 2006 for the various lower cutaways is unfortunately of limited applicability. For military production this seems to be reasonably correct, but the C-types occur in a civilian context well before AD 160.[2881] This has since been recognised by Warry himself for southern England.[2882] This does not mean that corners are useless for dating building ceramics. The decrease in length of *tegulae* is accompanied by an average decrease in the height of flanges, thickness of the surface and shortening of the recesses. For the observation of these form characteristics, larger quantities of find material are an advantage.[2883] In Voerendaal, however, there is a strong correlation between the length of the (under-)cut-outs and the size of the roof tiles (Fig. 32.4A). Despite the fact that almost all undercuts are of the same type, the reduction of this length (from 80 to 40 mm) does give an indication of the dating of the corners.
The corner type D1 has an even shorter cut-out of 38 mm. This is consistent with the late dating

2874 RMO field drawing: 'five-layer mortared roof-tile wall'.
2875 Braat 1953, 60.
2876 Braat 1953, 58.
2877 For example Tichelman & Janssens 2012, 49, 131 (*tegulae* Heerlen-Valkenburgerweg), Jeneson & Vos 2020, 58 (plaster Thermenterrein); Small & Buck 1994, 128 (*tegulae* San Giovanni).
2878 Warry 2006, 51; Clement 2013, 59-63; Ernst 2016, 231-232.
2879 At the Roman villa Kerkrade-Holzkuil, the complete roof tiles are only in this format (Kars 2005, 258 and personal observation by author).
2880 Typology based on Warry 2006, 4, figure 1.3.
2881 Gazenbeek 2020, 195.
2882 Warry 2017, 94, note 70.
2883 McComish 2012; Nauleau 2013, 38-43.

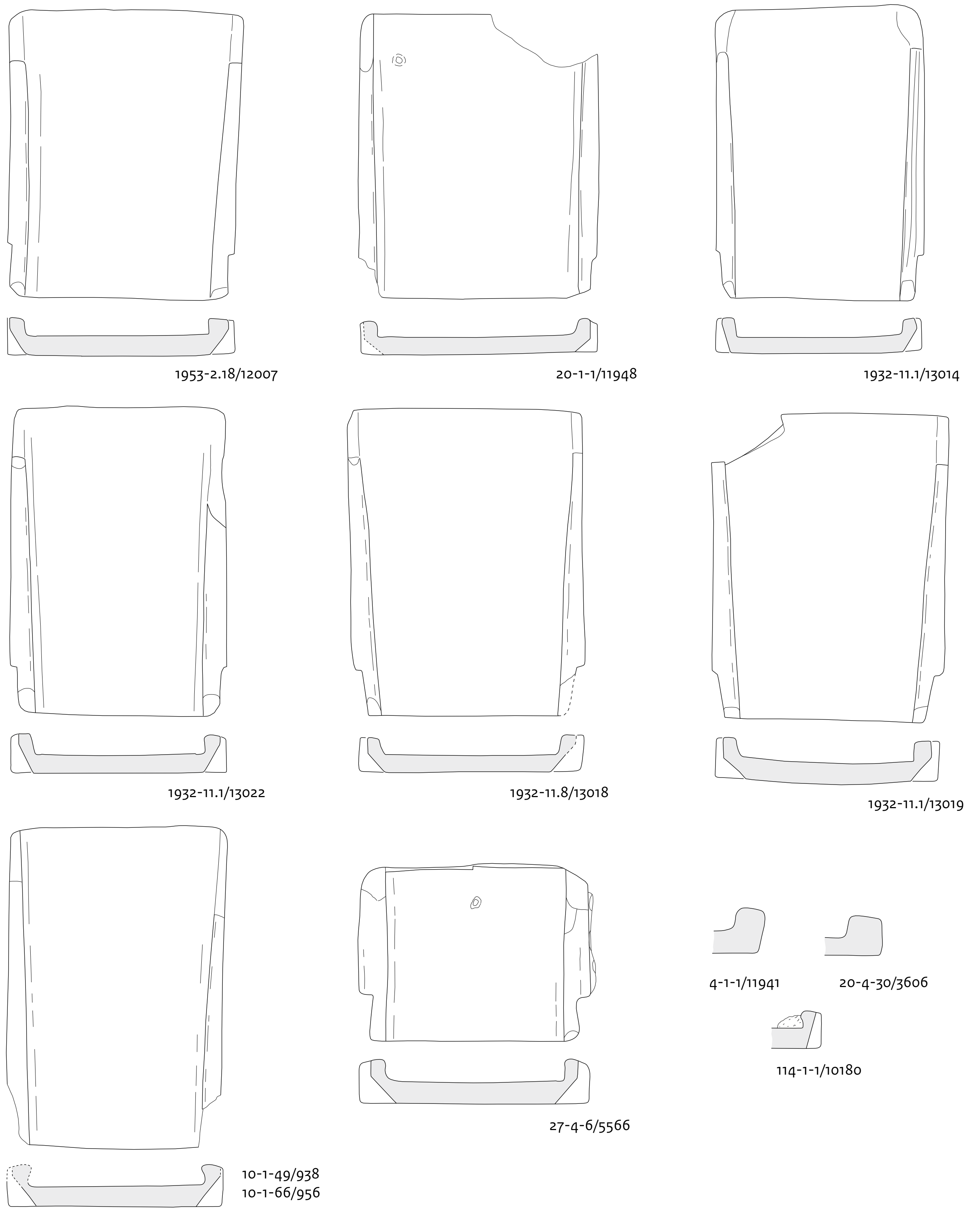


Fig. 32.3 Voerendaal-Ten Hove. Examples of tegulae and flange sections. Scale 1:8.

of this type of angle cut in Britannia (Fig. 32.4). While the cutaways become shorter, the length between them remains constant, around 1 *p.m*.

Flanges

The upright edges at the sides of the *tegulae* often differ in shape, which will undoubtedly have been influenced by the maker's preference. Variation in finish may even occur between both edges and with the same edge on the top or bottom.

The rim shapes in Voerendaal do not differ from the types that are common elsewhere. The flat border with rounded corner on the inside and the convex border with its highest point on the side of the plane dominate.[2884] However, trends are visible. The largest roof tiles, for example, have relatively narrow flanges over their entire length, often slightly undercut at the inside and with a finger-groove alongside. This finger groove, on the other hand, is strikingly absent from the somewhat smaller roof tiles (42-43.5cm). This is possibly due to the tool finish, which also creates a sharp angle between the surface and the flange. Roof tiles found elsewhere, produced in the same size with the CEC/CTEC stamp also have an angled transition and the finger groove is rare.[2885] It therefore seems to be a widespread (chronologically determined) phenomenon. Even in smaller *tegulae* the gully is often visible.

When roof tiles are provided with upwardly tapered flanges, the area near the corners on the underside is relatively wide and substantial. This feature can often be seen in brick group B. An example of such a large rim is find number 4-1-1/11941 (Fig. 32.3), which, however, does not necessarily come from a large roof tile. *Imbrices* covering these *tegulae* are proportionally broader and higher.

Tegula con opaion

A special type of *tegula* is a fragment of a *tegula con opaion* 302-12/75-1-1 (Fig. 32.5). The roof tile has a round or oval opening with a protruding flange bearing a decoration in the form of finger impressions. Similar decorated tiles have also been found at the Xanten-Herbergsthermen excavation.[2886] The opening in the roof tile served as an air or light supply or for the removal of smoke fumes. Comparable *tegulae con opaion*, where the opening has a smooth edge, have been found recently at Nijmegen, Hove (B) and Oudenburg (B).[2887] The decorated, everted rim and the small space between collar and flange of our *tegula* make it less likely that a ceramic 'chimney' was placed over the opening.
The fragment comprises the lower left corner of the *tegula*. The length of the C cut (52 mm) and the low flange (height 43 mm) suggest processing in a later phase of construction.[2888]

32.4.2 Imbrices and ridge tile

Imbrices

Imbrices are the semi-cylindrical tiles covering the space between two *tegulae*. Twenty-two complete or nearly complete examples give information about the dimensions. The length of the 13 complete pieces ranges from 33.5 to 37.7 cm. The dimensions are concentrated around two 'standard lengths' of 34.5 and 37 cm (respectively the four on the left and one on the right in Fig. 32.6). All three fabric groups are represented, without any difference in size.

Like the *tegulae*, *imbrices* were not only used on roofs. In the bath, a single *imbrex* formed the cover of a simple drain between room 3 and toilet 5. A row of *imbrices* was lain along the south side of the foundations of room 12 of the main building (just visible in Fig. 43.3). Probably it was necessary to drain the water coming down from the roof of room 8a, preventing it stagnating in the narrow 'alley' between rooms 8/9, 12 and 13.

Although it is tempting to relate the length of the *imbrices* to the dating, as with the *tegulae*, another factor plays a role here. Little has been written about the relationship between *tegulae* and *imbrices*, except that they are generally shorter than the *tegulae* on the same roof.[2889] Since the *imbrices* lay on top of the *tegulae* that were pushed against each other, their size depends on the net length that each *tegulae* spanned. This can be calculated by subtracting twice the length of the recess from the total length of the *tegula*, or the distance between the recesses in complete specimens. In Voerendaal the net length is often in the region of 30 cm, about 1 *p.m*. In fact, therefore, both standard *imbrices* can be combined with all *tegulae* in the same fabric. The large specimen (37.2 cm) in

2884 In accordance with ADC typology nos. 24 and 25 (Kars & Vos 2004, 31).
2885 Ernst in prep.
2886 Mittag 2018, pl. 76.
2887 Zandstra & Polak 2014, 222, fig. 6.2 (Nijmegen, with stamps of the 10th legion and hole of 18 cm (inv. RMO e 1895/10.1); Debruyne 2015, 262, n. 186 (Hove-Grensstraat); Vanhoutte & Thienen 2013, 168 (Oudenburg).
2888 Its findspot in ditch 302 is situated some 80 m from the bath and 90 m from the main building.
2889 Warry 2006, 22-23; Small & Buck 1994, 130.

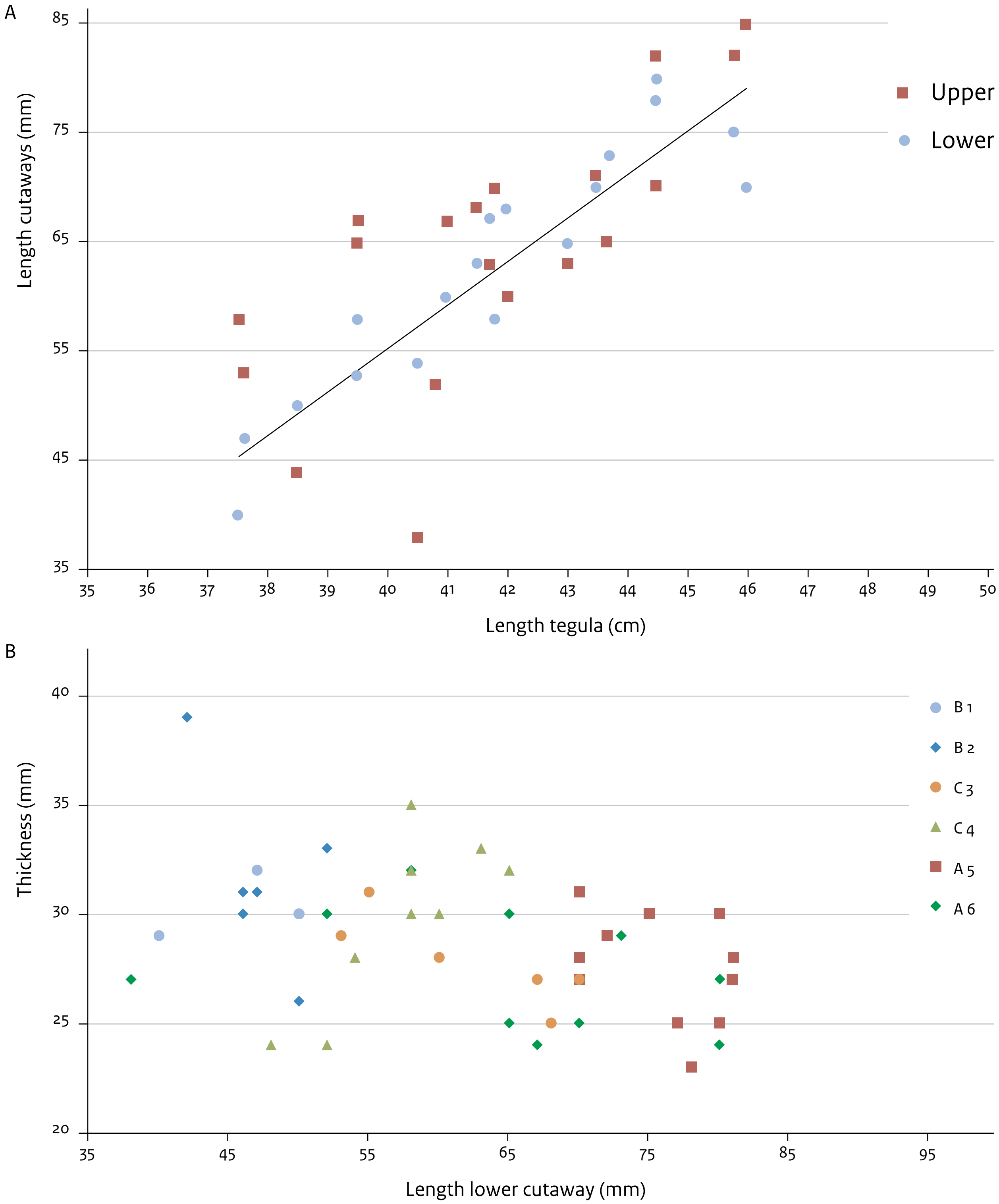


Fig. 32.4 Voerendaal-Ten Hove. Dimensions of tegulae. (source: T. Ernst & H.A. Hiddink)
A relation between the overall length and length of lower and upper cutaways; B Ratio of their thickness and length of the lower cutaway for fabrics 1-6.

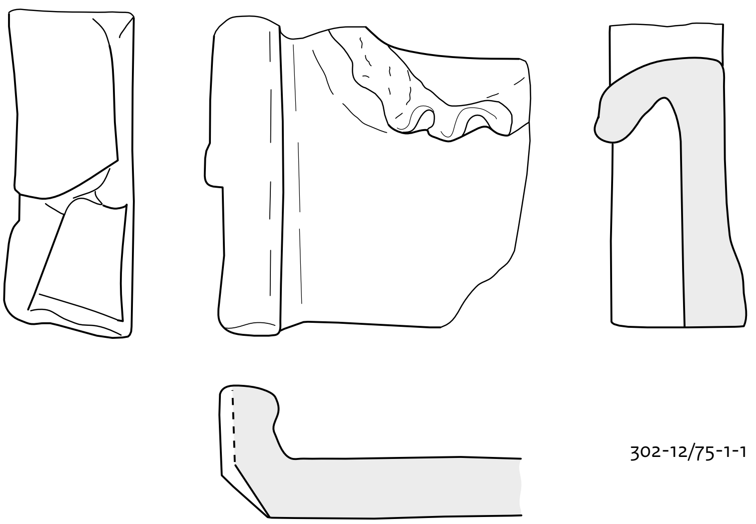


Fig. 32.5 Voerendaal-Ten Hove. Fragment of a tegula con opaion. Scale 1:3.

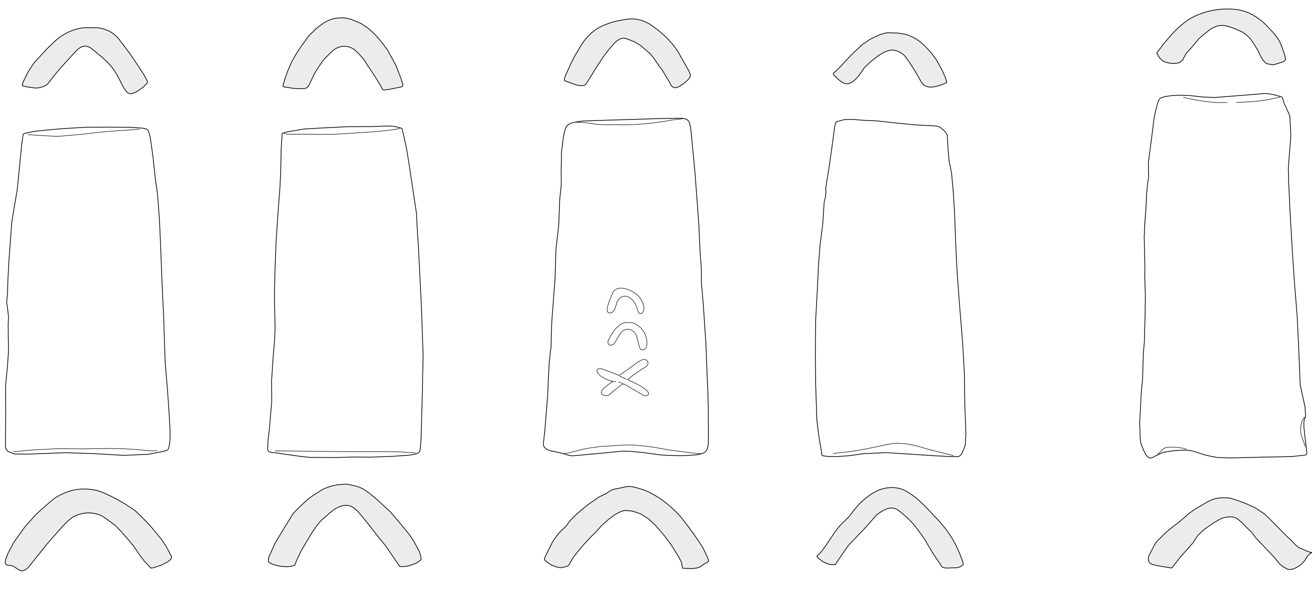


Fig. 32.6 Voerendaal-Ten Hove. Five complete imbrices. Scale 1:8.

fabric group B does not belong to the smallest, carefully finished *tegulae* in this fabric group because of its somewhat coarser design. That *imbrices* belonging to this group are also more finely finished and generally thinner is proven by a number of larger fragments of this type of tile. A complete specimen belonging to this production was not found.

Several *imbrex* fragments are (very) hard-fired, sometimes even with traces of glazing. There are also several pieces that have been fired in a reductive manner. This is not an unusual phenomenon.[2890] The *imbrices* were probably produced separately, using a higher firing temperature and positioned so that the oxygen supply was insufficient at some points in the kiln.[2891]

[2890] Ernst *et al.* 2016, 49.
[2891] In Kaiseraugst, a kiln with part of the remaining kiln load of *imbrices* was excavated. (Tomasevic-Buck 1982).

Ridge tile
A single piece indicates the presence of a special and rare type of ridge tile (*vorstpan*) of which, so far, only comparable sites from Belgium are known (Fig. 32.2, no. 8).[2892] Like the *imbrex* fragments mentioned above, find number 20-4-22/3587 is reductively fired. Apart from the way of firing, the ridge tile is not a variant of the *imbrex*, but rather of the *tegula*. It concerns a flat tile with a flange, the latter partly cut away in the centre, enabling the creation of a curved top. The small number of references in the literature may indicate that this type of ridge furrow was used and distributed only to a limited extent.

32.4.3 Lateres, including round bessales

Lateres are simple flat square or rectangular tiles, used for many purposes: such as floors and walls, in hypocaust pillars and as decorative/bonding courses in stone walls. In the Roman period, a number of standard sizes were used, based on the 29.6 cm long Roman foot or pes monetalis (Fig. 32.2, no. 2-7). The *pedalis* (no. 5) had sides of 1 *p.m.*, the *bipedalis* of 2 *pedes* (no. 7). Intermediate sizes were the *lydion* and *sesquipedalis*, of 1 x 1.5 and 1.5 x 1.5 *p.m.* (no. 2; 6). *Bessales* were small tiles of 2/3 *p.m.*, primarily meant for pillars in hypocausta and coming both in a square and round version (no. 3-4). The larger formats were used in very diverse ways. In Voerendaal they were found in floors, gutters, the heating ducts of *praefurnia* and on top of the pillars of the *suspensura* in room 2b.

Bessales
Relatively many (nearly) complete specimens of the finds related to *bessales* are available. Of these, 13 are square and 16 round. Many intact square specimens were incorporated into drain 328-330 of the baths, but a considerable number were only collected from 330. Without exception, these are made of fabric 2. This undoubtedly means that this type is overrepresented in this form, as 'red' and 'pink' examples from other contexts were thrown away.

Square *bessales* with sides of 20-21 cm and a thickness of 4 cm were found as floor tiles in *praefurnium* 1a of the main building.[2893] Secondly, seven of these square tiles with the same thickness and size (21 cm) made up the pillars of the hypocaust 2b in the bath. Another context is the aforementioned drain 330, with walls of *bessales* 20 cm square (and a bottom of larger tiles, see below).

Only the find context can date this type, as square *bessales* were used throughout the Roman period. Differences in type and size indicate that, apart from a different supplier, there may be a chronological difference between the specimen in type 5 (7-1-45/313) and the other complete pieces. Furthermore, the diagonal placement of *bessales* in the hypocaust of room 3 of villa 400, at the height of the flue pipes cut out of the wall (Fig. 43.3), is identical to the placement in the bathhouse in Lemiers.[2894] Braat dated both our villa and that of Lemiers around the beginning of the second century AD, albeit he presents no firm evidence for this date.

Most of the round *bessales* still present have a diameter of 19-20 cm (2/3 *p.m.*) and a height of about 5 cm (Fig. 32.7). Almost all of these were found in and around building 401 and 403, so probably not in their original position.[2895] However, at least one *bessalis* of this size was found in the bath (room 8).[2896] Braat also mentions a size of 22 cm diameter, used in room 13 of the main building.[2897] Presumably, the specimen of the same diameter kept by Habets also comes from this room. This larger specimen was made in fabric 5, while most of the smaller ones are in the typical fabric 7. Round *bessales* only occur from the second century AD onwards.[2898]

A further clue to the dating is the striking resemblance of the specimens in fabric 7, also in terms of dimensions, to many of the specimens found in Kerkrade-Holzkuil.[2899] Since the bathing area here was only added to the villa from the late second century onwards, this could mean that most of the surviving Voerendaal round *bessales* also date from this period.

Pedales
The collection includes five items that are considered to be *pedales*, among which four complete examples. All pieces were made in fabric 2. The complete specimens come from the bottom of drain 330 and measure 26.5-28 cm square (Fig. 32.7, top row left). These tiles can be

[2892] Smeets 2012, 53. With thanks to Tim Clerbaut.
[2893] Braat 1953, 54.
[2894] Braat 1934, esp. fig. 12, 15; Dodt 2003, 135, 252.
[2895] Neither building had hypocausts and the pads inside building 403 were most likely a late/later addition, although they could have been part e.g. of cattle boxes or interior walls (cf. Chapter 43).
[2896] RMO field drawing: '20 (cm)' written next to a circle/*bessalis*; nearby two more round *bessales* lay upon two square *lateres* of '24 (cm)', allowing for a size of 20 or 22 cm.
[2897] Braat 1953, 57.
[2898] Graciani 2009, 723; Dodt 2003, 135.
[2899] Author's observation.

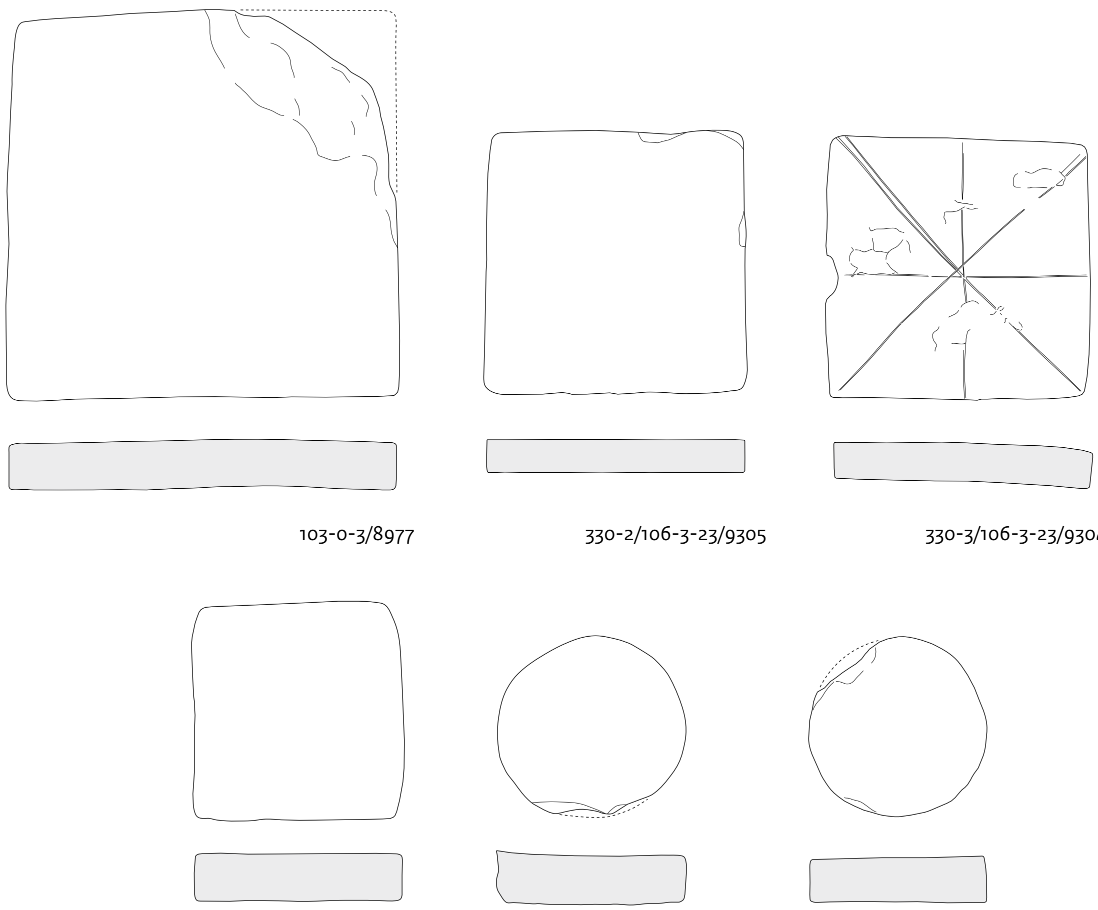


Fig. 32.7 Voerendaal-Ten Hove. Examples of tiles of different sizes, including square and round bessales. Scale 1:8.

equalled to *pedales*, with sides of (almost) one *p.m*.

Next to drain 330, *pedales* were present in the bottom floor of hypocaust 2b in the bath, on top of the aforementioned pillars (29 x 29 x 4.5 cm) in the same room and in the pillars of room 8. Some pillars in this room were of an intermediate size of 24 cm square.[2900] Although none of these tiles have survived, Braat indicates that the 24 cm format is red in colour, whereas a discarded example in the larger format was 'pink' in colour. This makes it impossible for them to have been made in fabric 2. Because they were used in a few (unchanged) rooms and made in a different fabric, the size differences may be due to different dates.

Sesquipedales, lydions and bipedales

The number of inventory numbers with larger format tiles is limited. There are only 5 items that can be attributed to these shapes. One tile is doubtful, as its thickness, different fabric and finish on the underside may relate to a tile fragment.[2901] Excluding this fragment, all pieces are made in the related red fabrics 5 and 6. Only one square tile is complete: 103-0-3/8977 with sides of 41 cm and a thickness of 5 cm (Fig. 32.7). Braat mentions some *bipedales*, in the stokehole of 12/12a in the main building (57 x 57 cm) and as cover on the pillars of hypocaust 2b in the bath.[2902]

Finally, an unknown size tile was present in the chimney holes of rooms 13/13a of the main building. Braat described the floor of the stokehole as made of '...pieces [strips] of tile 9 cm

[2900] Braat 1953, 59-61.
[2901] Item 68-1-3/6233.
[2902] Braat 1953, 56, 60.

high and 75 cm long.' and its walls made out of '...stacked tiles, also 75 m long and ± 30 cm wide.'[2903] Although very large (roof)tiles did exist,[2904] there are no indications for their use at Voerendaal. Braat probably made a mistake or forgot to mention that the 75 cm length was made up of several pieces. It is most likely that broken *sesquipedales* or *bipedales* were used.

32.4.5 Tubuli and wall tiles

Tubuli or box flue tiles were built in walls to conduct heated air from a hypocaust upwards. They have a round or rectangular opening in two sides to make lateral movement of the air possible. The front and often also the back have keying for a better adherence of wall plaster and mortar. The number of preserved fragments (120) is relatively large due to the preference in selecting these types. The weight is therefore relatively high compared with other deposits in the Netherlands; 6.5% of the total weight of building ceramics.[2905] Besides the common rectangular box shaped *tubuli*, some other forms are represented. Below all these types are discussed.

Tubuli

Of the usual rectangular type we fortunately have two complete pieces from Braat's excavations (Fig. 32.8, top row; 1953-2.18/12006 and 12160). Both were found in a broken state, as evidenced by glued fractures and the addition of missing parts. It can be deduced from these fractures that they are identical to two photographic specimens of the wall next to drain 330, which is made up of loose, presumably reused *tubuli*.[2906] Although they both have almost the same size (approx. 26 x 27.5 x 8-9 cm) and thickness (18 mm), they are executed in different fabrics. One *tubulus* in fabric 2 has a pattern of two semicircles with a nine-tooth comb, while the other in fabric 6 has crosswise and parallel to the sides applied comb strokes, also nine teeth wide. Both have rectangular openings, with rounded off corners, in the narrow sides. These features mean that other fragments can also be assigned to this type. It is striking that the fragments in fabric 6 all have the same comb pattern and are often covered with mortar. In fabric 2, more patterns are present, while mortar occurs only sporadically. The fragments do not indicate whether other formats of this type of *tubulus* were used at the site.

Voussoir tiles

Rare is a variant of the above type with the opening in the middle of the wide combed front or back. Ten items with 12 fragments (5,074 g) could be identified. Identical to the 'ordinary' *tubuli*, this type is also manufactured in fabric 2 and 6. It is assumed that the unusually placed hole in these *tubuli* served as a ventilation opening for the connection of a chimney and that the *tubulus* was therefore often placed as a keystone (at the highest point) in vaults.[2907] Similar forms occur almost exclusively in Great Britain and are described there as voussoir tiles.[2908]

In contrast to the normal *tubuli*, at least two models are present in fabric 6 in which the opening can consist of a square or a round hole. In fabric 2, only one type is recognisable in which straight and crossed comb marks of 9 or 10 teeth wide were applied before the square hole was cut out. The difference in teeth may have been caused by wear or the breaking off of one of the outer teeth of the comb. The spacing of the teeth is identical.

Only a few dimensions can be deduced from the fragments. The largest fragment in fabric 2 has a height of 27 cm and an assumed width of almost 30 cm (330-1/106-2-6; Fig. 32.8).[2909] The wall thickness varies from 17 to 23 mm. The height and width thus more or less correspond to the size of normal *tubuli*. The fragments collected in fabric 6 also have a height and width close to the complete *tubulus*, based on the centrally made square or round hole. If the hole in the combed side is not visible in a fragment, it is difficult to determine to which type they belong.

Because mentions of this type are scarcely known outside Britain, its use in Voerendaal is very exceptional. To date, the only comparable find has been in the villa of Bocholtz-Vlengendaal, where an equally wide side of a *tubulus*, without roughening, was fitted with a round hole.[2910]

[2903] Braat 1953, 57; only the note (about the floor) 'ten tiles on their side 9 cm h' appears on the excavation plan.
[2904] Very large *lateres* or *tegulae* (with their flanges removed) were sometimes used in drains, such as the 80/84 x 44 cm ones in some drains at Nijmegen-Holdeurn (Holwerda & Braat 1946, 71). In oven J of the same brickworks a *later* of 73 cm square was used (1946, 17). Dolata (2004) describes a *tegula* of legio XXX with a length of 70 cm.
[2905] Gazenbeek 2014, 241; table 10.3. If both complete specimens were excluded, the percentage would be 4.3%.
[2906] Braat, 1953, 61; pl. 4, 4; field drawing: '2 layers *tubuli* size 26 x 27 x ?'; items 1953-2.18/12006, 1953-2.18/12160.
[2907] Pers. comm. Tim Clerbaut.
[2908] Lancaster 2016, 138-140; For an illustration see Major & Tyrrell 2015, fig. 496.
[2909] The number 330-1 suggests that this *tubulus* was part of the construction of the drain, but it was found in the disturbance above it, in fact a trench made by Braat to uncover the drain.
[2910] Collection Archeologie Limburg (LGOG) item BC2379-4.

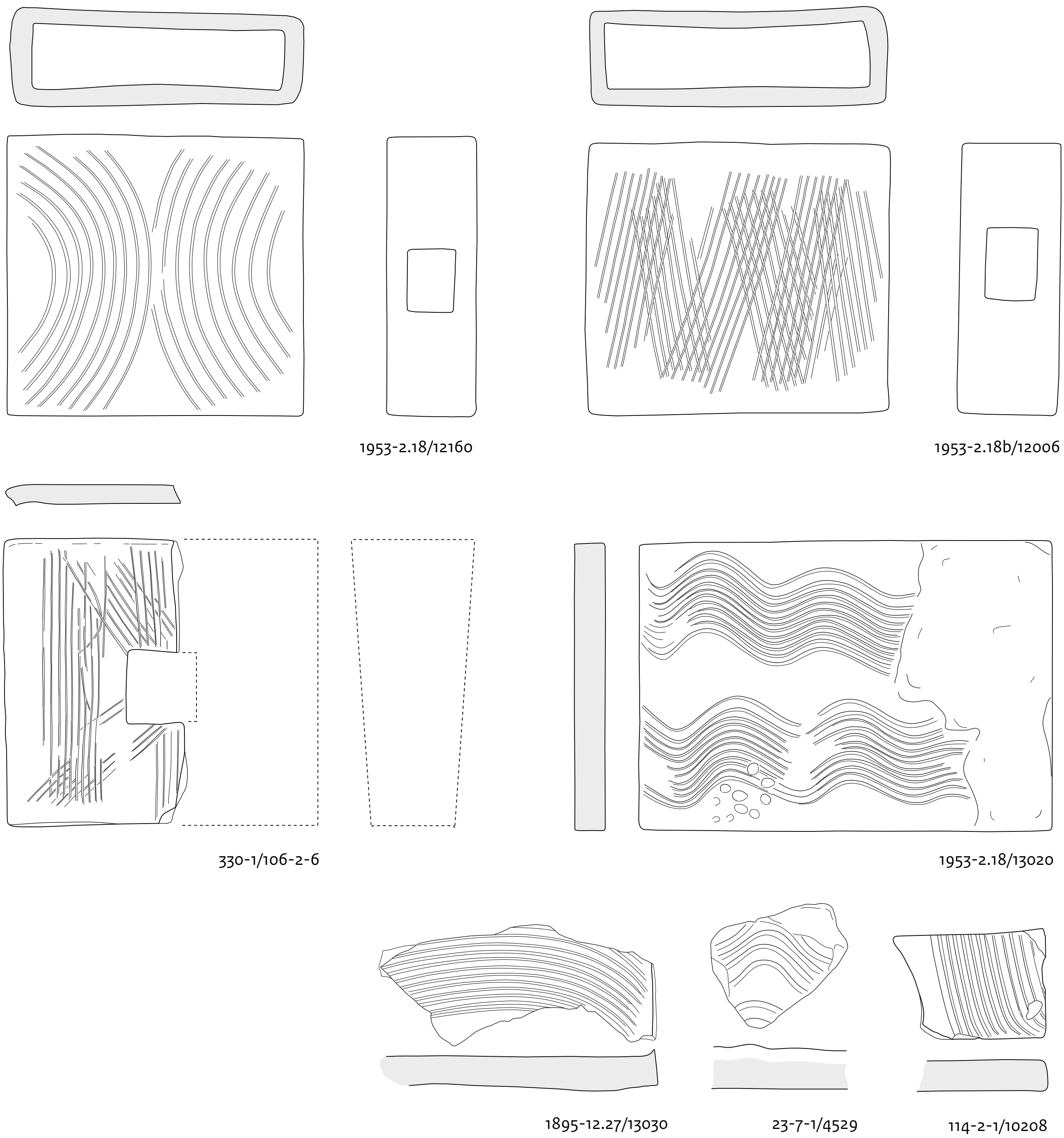


Fig. 32.8 Voerendaal-Ten Hove. Tubuli, voussoir tile and parietales. Scale 1:6.

Tubuli cuneati

Next to fragments of larger *tubuli*, quite a few of the remaining finds belong to smaller ones (Fig. 32.9). It concerns 29 items with 53 fragments and a weight of 5,099 g. Most of these, if not all, have a remarkable shape and are typified as *tubuli cuneatus*. This type is rarely recognised as such, although they have been found at several sites. They are wedge-shaped with a lower front and higher back. Only the front has crests.

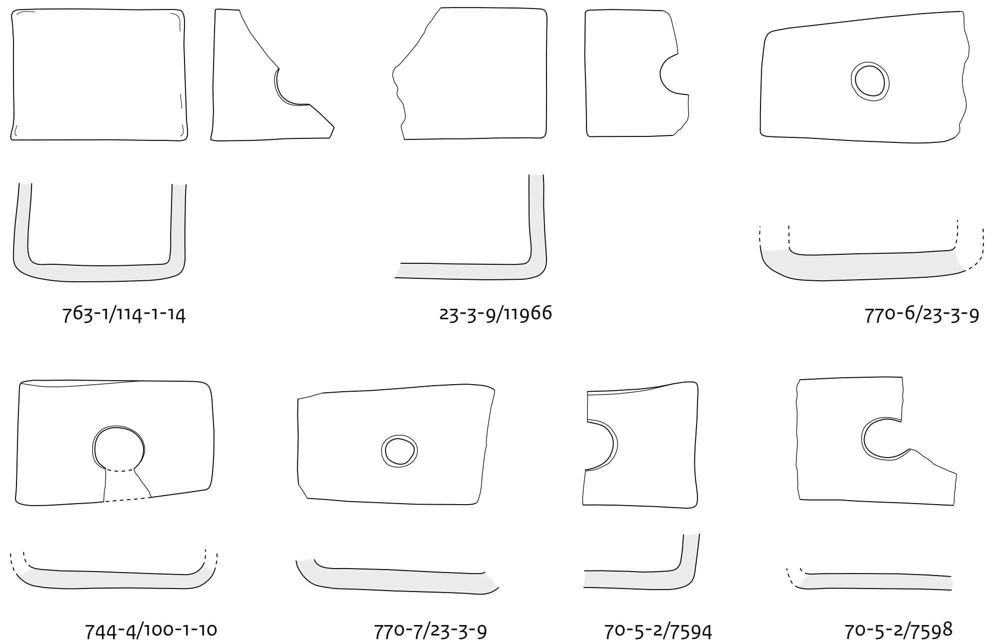


Fig. 32.9 Voerendaal-Ten Hove. Fragments of tubuli cuneati. Scale 1:6.

The sides with the characteristic holes are often longer than the front and back.[2911]
The application of this type is as yet unclear. It is thought to have a function in the 'cavity wall' in the apse of baths or as a building block for vaults, identical to the hollow voussoirs from Britannia. The span calculated from the wedge shape is always small; often less than 3 metres.[2912] They are almost exclusively found in the north-western Roman provinces.[2913]

Only fragments of this form have been preserved in Voerendaal. Apart from a few spatters, there is no mortar at all. However, traces of soot are visible on a large number of them. With the exception of a few pieces in fabrics 3 and 6, the vast majority were made in fabric group B. Although at least four models can be identified, the complete shape of none of them can be reconstructed, although it is clear that the depth is greater than the width and that round holes were always used. In one model, the round hole is only 25 mm in diameter. Such a small opening can hardly have played a role in air circulation. The dimensions of all models are very similar. This makes it often impossible to assign the fragments to a particular model.
The height of the front side varies between 8 and 9.4 cm, the back side between 9.5 and 10.5 cm. The width varies between 12 and 13.5 cm, while the depth is about 15 to 17 cm.

The distribution and find contexts of the fragments in Voerendaal reveal no indications of their use. It is possible that, apart from vaults, the use of this type is connected to the construction in (thick) loam walls, where they were used for chimney ducts of hypocausts and fireplaces leading to the outer wall.[2914]

Wall tiles or parietales
Wall tiles (*parietales*) are related to tubular blocks because they were also used in walls and heated rooms and have grooves made with a comb. Like *tubuli*, the grooves were intended for better adhesion of the stucco layer. Fragments can usually be recognised by their pronounced roughness and greater thickness. Apart from being attached to walls, they were sometimes also attached to ceilings with nails or clamps. To this end, they often have notches in the (long) sides. During his excavation Braat brought back two complete mortar-covered wall tiles (1953-2.18/13020; Fig. 32.8). They may have come from room 2a/b, where they had been placed against the wall.[2915] Moreover, the floor in this room was partly broken off during his investigation. Both tiles (39 x 28 x 2.7 cm) have

2911 See Bontrond 2013, 306-309; Clerbaut 2021.
2912 In Voerendaal, four examples lead to arch spans of 1.3 to 2.85 m.
2913 Ferdière & Jaffrot 2015, 535-538.
2914 In accordance with Gazenbeek 2017, 67-68. Loam leaves no traces on building ceramics.
2915 Braat 1953, Pl. 9, 1-2. In Kerkrade, a specimen completely covered in mortar was found in the *praefurnium* of the bathhouse (Kars 2005, 265).

two wavy ridge lines of 12 teeth wide, running parallel to the long side. The characteristic notches in the sides are absent. Thanks to the characteristics of these complete specimens, the other fragments of this type of tile can also be recognised. In addition to a fragment collected by Habets, four more fragments are available in the ROB collection, three of which show no trace of mortar (Fig. 32.8). In the old ROB database, these and four deselected fragments were wrongly described as *tegulae mammatae*. The wall tiles are made in fabrics 1, 3 and 7. Perhaps wall tiles without notches are a more common phenomenon. Almost identical tiles are used in the walls of the *caldarium* of villa Holzkuil in Kerkrade.[2916]

32.5 Surface markings

Roman building ceramics show different kinds of impressions. They can be divided into intentional and unintentional or accidental impressions. In addition, conscious impressions may have been made before or after firing. Examples of the former are stamps, signatures and tally-marks. Cutmarks and nail holes may have occurred after firing. With the exception of stamps, which are completely absent except for a few doubtful specimens, the surviving material contains a large number of such impressions. From the original database it can be deduced that these were deliberately selected for preservation; only a single (incomplete?) impression was discarded. Not all impressions are dealt with in the following. Many finger marks, for example, are the result of treatment of the material during manufacture. The same applies to the tools used, of which a damage or imprint has been left on the surface of the building ceramics. Sometimes, the potter has allowed himself a frivolous act. The placement of a flint nodule in the middle of a *bessalis* is otherwise difficult to explain (330-4/ l06-3-23/9308).

32.5.1 Signatures

Signatures consist of simple figures drawn with one or more fingers, which were applied to the still soft product immediately after completion of the forming process. Only a limited number of products were provided with these signs. The frequency is not clear and varies. This also applies to the function of these symbols within the production process. Because of the relationship with the forming, signatures are considered to be the trademark of individual potters. The individual aspect of these signs can be seen in series of identical *tegulae* with the same signature and the different design of *tegulae* with other signatures at the same site.[2917]

On the Voerendaal building ceramics, a large number of signatures have been recognised (41), which without exception have been applied to *tegulae* (Fig. 32.10-11). In addition, the majority are complete. On the villas of Hoogeloon (3), Kerkrade (3) and Maasbracht (6) the number of specimens is significantly less.[2918] Only the villa site of Ewijk comes somewhat close to this number with 26 pieces. In addition, several signatures are repeated in Voerendaal and the figures used often deviate from the usual simple arch shape that is by far the most common (Table *32.5).[2919] The importance of signatures cannot be stressed enough, especially at sites where stamps are missing. The documentation and depiction of these figures often falls short, although they can at least partly take over the role of stamps when it comes to the interpretation of the building ceramics.[2920]

In Voerendaal they provide valuable information about the roof tile material, as parallels of three different signatures occur in the region. Strikingly, these are not the characteristic signatures that can be associated with the largest sizes or longest undercuts. One signature from Voerendaal consists of a swooping loop made with two fingers (21-2-1/3856; Fig. 32.10 top left). This is found, sometimes slanted, no fewer than six times in an excavation on the Valkenburgerweg and four times at the Thermen site, both in Heerlen.[2921] The length of the bottom recesses at Valkenburgerweg is slightly shorter than that of the Voerendaal specimen; 5.7 cm against 7 cm. A dating around the middle of the second century is probable.

At least as interesting are three specimens of a circa 8.5 cm high double loop (20-1-1/2867; 20-1-1/11950; 21-1-2/11960; Fig. 32.10, top row).

[2916] Tichelman 2005, 80, fig. 5.2.32. The only difference is the use of a comb with 10 teeth. Incidentally, the tiles in Kerkrade have been interpreted as *tegulae*!
[2917] Betts 1985, 191-195.
[2918] Hiddink 2014, 653-655, fig. 27.4 (Hoogeloon-Kerkakkers); Kars 2005, 260, fig. 9.5 (Kerkrade-Holzkuil); Gazenbeek 2017, 71-74 (Maasbracht). The number from Kerkrade-Holzkuil is certainly too low because three unlisted signatures were noted during the author's scan of some of the building ceramics.
[2919] Gazenbeek 2017, 71, n. 20.
[2920] Hamari 2019, 81.
[2921] Vanderhoeven & Kars 2012, 99, fig. 7.3.8 (Heerlen-Valkenburgerweg 25); Vanderhoeven *et al.* 2018, 65-66; pers. comm. T. Vanderhoeven (Heerlen-Thermenterrein).

Exactly the same signature is known from Heerlen-Trilandis (1), Heerlen-Thermenterrein (4), Heerlen-Coriovallumstraat/Verversstraat (1), Heerlen-Meezenbroek (1) and Kerkrade-Holzkuil (3). *Tegulae* with this signature are characterised by a smoothly finished upper surface and an almost identical fabric. One of the specimens in Voerendaal has a 5 cm long undercut.
The signature from Heerlen-Trilandis has been preserved on an almost complete roof tile measuring 41 cm.[2922] The length of the undercut is 4.7 cm, thus almost identical to that of Voerendaal. The format suggests a dating between AD 150 and 200.

At the Valkenburgweg site, also an example was found of the signature consisting of two parallel short curved lines (68-1-6/6238 (3x); Fig. 32.10). Finally, two signatures were found in Voerendaal consisting of a large arch drawn with two spread fingers (7-1-22/11942; 107-2-22/9626; Fig 32.11). Two more specimens were recently found during archaeological research at the Tempsplein in Heerlen.[2923] Apart from the fact that this form is also found elsewhere, no specific form characteristics can be derived from the Voerendaal specimens, so that further dating of this signature is not (yet) possible. Because of these similarities, it may be assumed that the potters who used these signatures were active for some time in Heerlen and its surroundings.

32.5.2 Tally-marks

Tally-marks are applied to the underside of *tegulae* and are related to the production process. They take the form of Roman numerals scratched or stamped with a sharp object.
The location on the rim seems to be related to the moment when the tiles were placed upright for further drying and had to indicate a certain quantity. Most of the time it concerns numbers between 1 and 10, rarely a slightly higher number.

The signs are incidentally found in military contexts; in civilian contexts they are quite rare. In Voerendaal, one specimen in the form of an I was found (68-1-16/6229; Fig. 32.11). Of the Dutch villas studied, only in Ewijk-Keizershoeve, where there is a military component in the building ceramics, two specimens are known.[2924] In Hoogeloon, Maasbracht and Kerkrade they are absent. However, this may also be due to a perception problem. After all, these marks are hardly noticeable. The Voerendaal specimen was also not registered in the original database.
The object has been preserved because of the signature on the fragment. This is no coincidence, since tally marks usually occur in combination with signatures.[2925] An indirect indication that signatures were (also) used to indicate production quantities.

32.5.3 Graffiti

Two pieces deserve special mention because of the numbers and text applied *ante cocturam*.[2926] An interesting find is a complete *imbrex*, with the number CCX or 210 written with a finger *ante cocturam* (16-3-7/2404; Fig. 32.12-32.13). Probably the number indicates the production of a moulder on a specific day. An interesting similar piece is a partly preserved *imbrex* with the numbers [---]XVII on top found at Heerlen-Kruisstraat.[2927] The interpretation of a second graffito is more difficult (1895-12.25/13028; Fig. 32.12-32.13). Based on the fabric and length of the upper cut, the *tegulae* with this graffito are among the largest and oldest in Voerendaal.
The *tegulae* in question are about 29.5 cm wide, while the preserved width is 21 cm. It is therefore likely that several characters of both lines are missing. The first line can contain a number like [C]C, [C]I or [CC]I (in the same range as that on the *imbrex*); it is followed by a F(ecit). The second line contains the end of a name: [---]AITIVS.

Unique is an impression on the lower right corner of a *tegula*, interpreted as a stamp, in which according to the museum inventory of the National Museum of Antiquities the letters S.O.C. can be read (Fig. 32.12).[2928] On closer inspection, only an indented retrograde S is visible within an irregular 5 cm circle. The other two letters are highly uncertain, which is partly caused by a straight finger stripe (signature) across the impression. The fact that this signature was applied only after the 'stamp' and the unique and primitive character of the impression make an interpretation as a roof tile stamp very unlikely. Due to the lack of similar impressions, the intention of the impression remains unknown.[2929]

2922 This size of *tegula* also occurs several times in Kerkrade-Holzkuil, but unfortunately not in combination with this signature.
2923 Gazenbeek 2020, 158, fig. 79. An arc made by three fingers was also found here, although it seems to be a bit lower than 95-2-9/11008 (fig. 32.11).
2924 Besuijen & Vos 2012, 161.
2925 McComish 2012, 359.
2926 Cf. section 29.1.
2927 Thermenmuseum collection Heerlen, item 8860.
2928 Item 1895-12.24/12018.
2929 It is somewhat similar to a circular impression with two tiny holes on a find from Hoogeloon-Kerkakkers (Hiddink 2014, 667, fig. 27.9, no. 604-41).

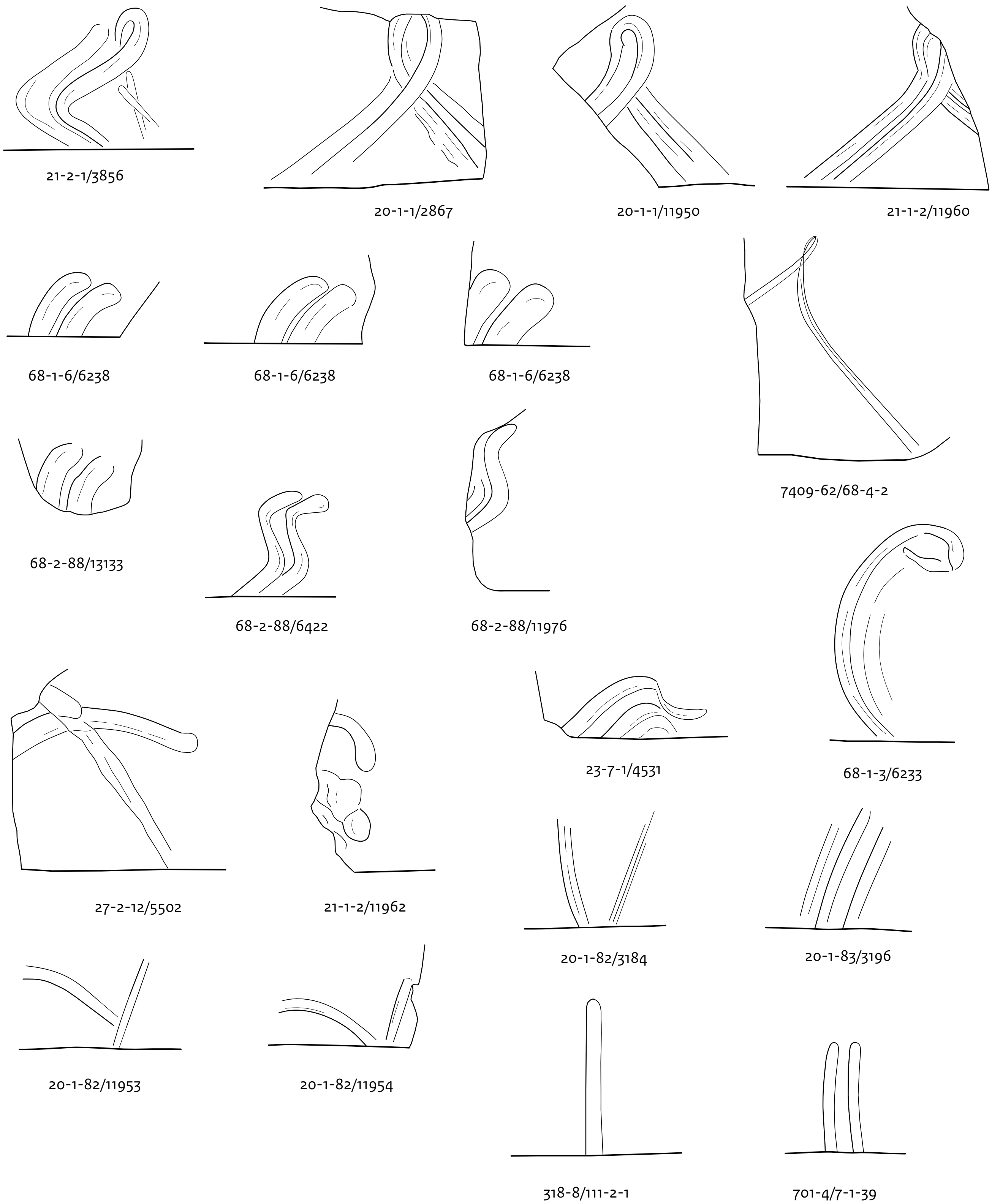


Fig. 32.10 Voerendaal-Ten Hove. Signatures on tegulae. Scale 1:3.

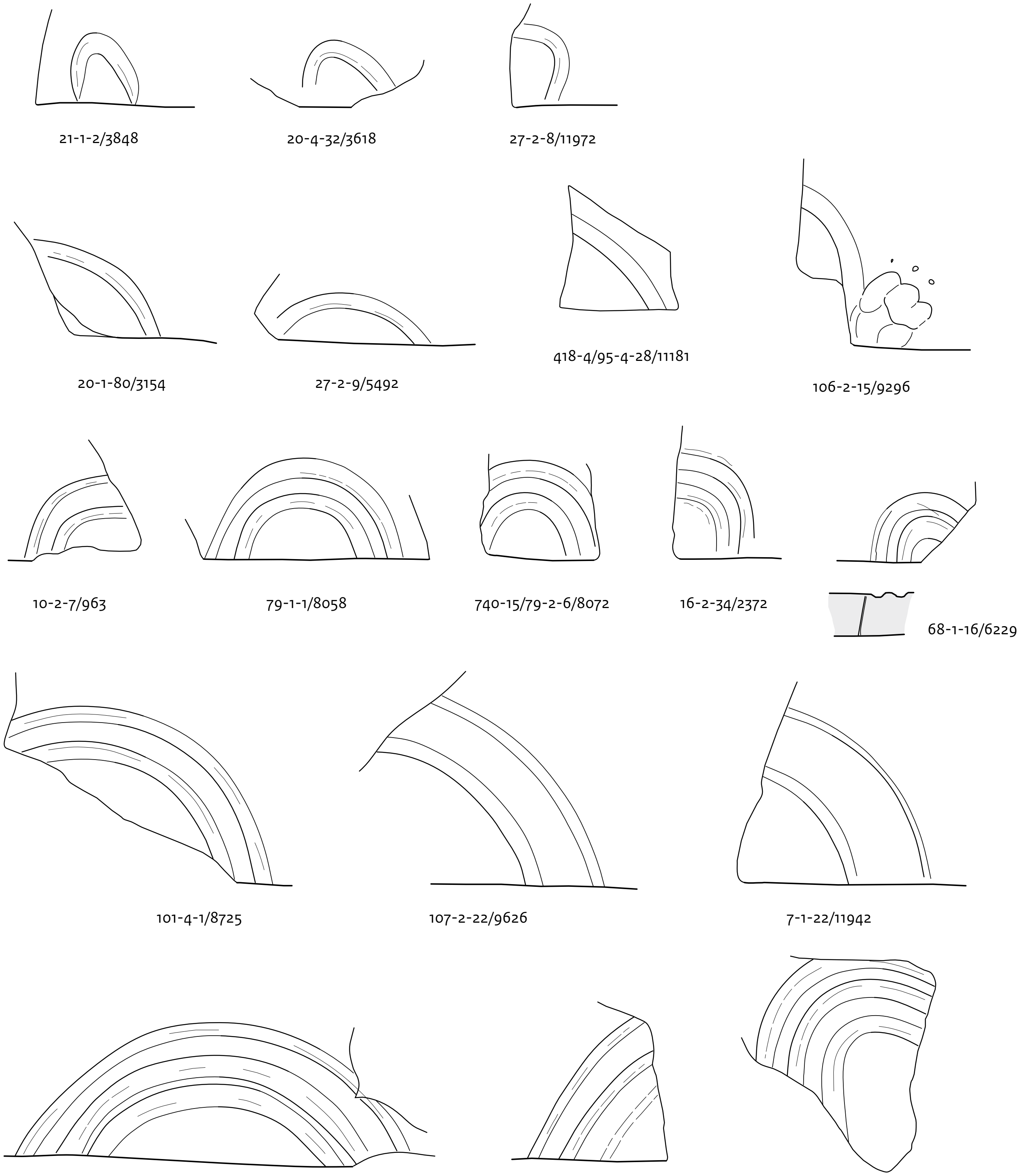


Fig. 32.11 Voerendaal-Ten Hove. Signatures on tegulae, cont. Scale 1:3.

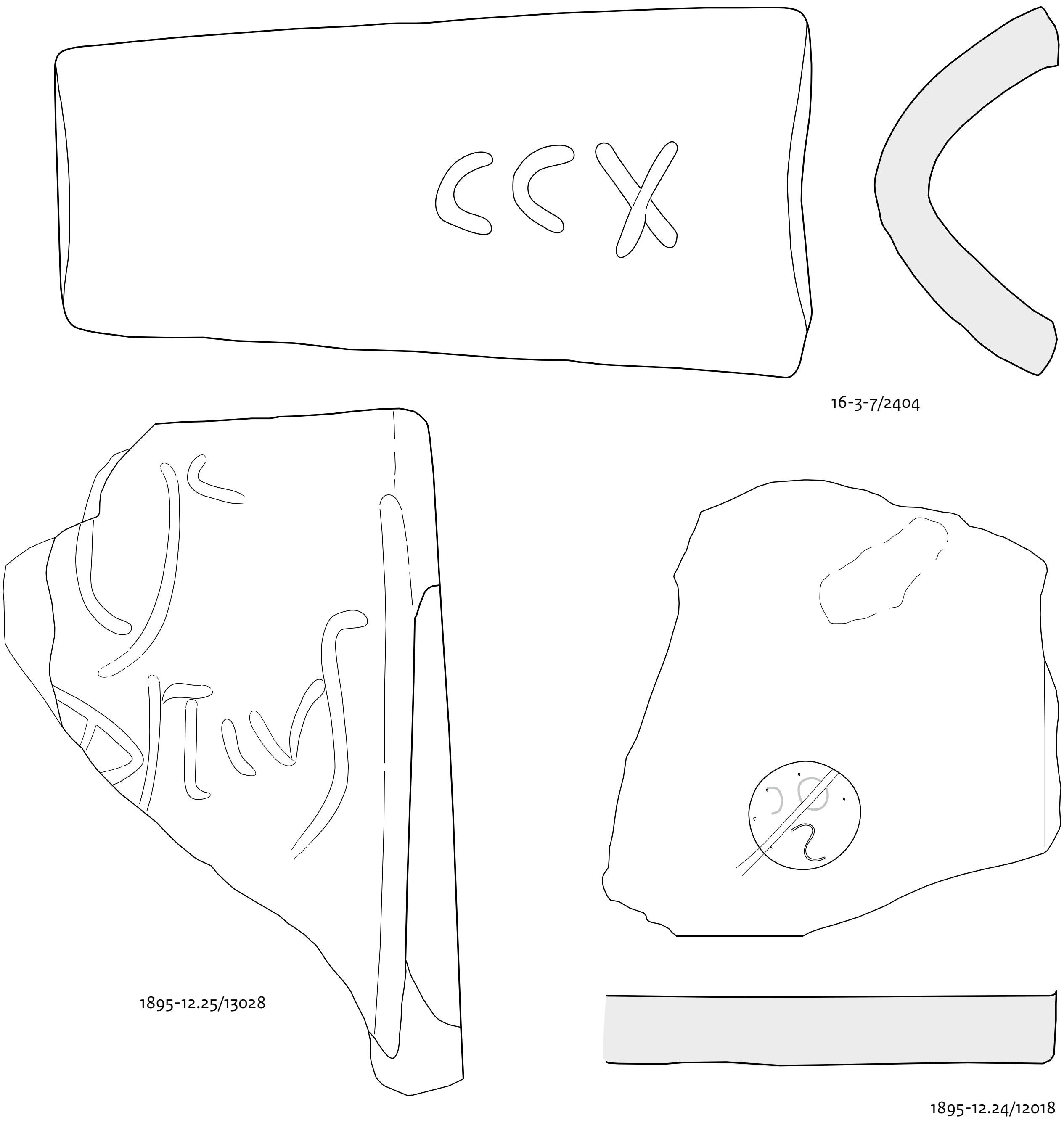


Fig. 32.12 Voerendaal-Ten Hove. Two graffiti ante cocturam and a stamp(?) on roof tiles. Scale 1:3.

A carelessly placed X and four coarse stripes on two *imbrex* fragments from Voerendaal are probably unintentional indentations that occurred during manufacture.[2930]

One of the tiles from drain 330, measuring 28 cm square and 4 cm thick, has a 'graffito' *post cocturam* (Fig. 32.7; 32.13). Four incised lines – one partly double – divide the surface in eight triangular fields. The tile seems to be used as a game board for *terni lapilli* before it was used as a floor tile, based on the mortar on the bottom.[2931]

[2930] Items 13-1-12/1934 and 1932-11.1/13012.

[2931] On *terni lapilli* or Three Men's Morris, see Austin 1935, 79-80; Holliger & Holliger 1983, 17-18.

Fig. 32.13 Voerendaal-Ten Hove. The roof tiles with graffiti and a gaming board.

32.5.4 Animal and human prints

Paw, foot and sole impressions are common on Roman building ceramics. They were often preferentially collected from sites, as was the case in Voerendaal. Almost all impressions of this kind (45 pieces) were therefore preserved when the building ceramics were sorted out (Fig. 32.14). When re-examining the material, a few more impressions were found, which gives the impression that small animal species were not noticed at first, because the pieces on which they occur were not noted as such in the old database. Paw prints of smaller animal species will therefore be underrepresented.

It is assumed that the presence or absence of animal paw prints is related to the nature of the tile making operations.[2932] The fact is that even in large-scale production centres, animals walked on the products laid out on racks or on the ground to dry. The cause may be sought in the location of the kilns. The production of building ceramics was mainly a rural activity.[2933] As is usually the case elsewhere, dogs and, to a lesser extent, cats are also the main source of material from Voerendaal (Table *32.6).[2934]

In contrast to other aspects described in this contribution, fabric group B is exceptionally well represented in these impressions. Moreover, these impressions often involve animal feet that can be associated with cattle breeding. This observation confirms the conclusion of the study in Kerkrade-Holzkuil where animal footprints are also over-represented in the same fabrics. Obviously, fabric group B was mainly produced in small-scale workshops that were run as a sideline to agricultural activities.

While the animal footprints can be considered unconscious, the same cannot be said of the sole impressions (Fig. 32.14E-F). It is difficult to imagine that shodden adult persons 'accidentally' walked over the products as they dried. An explanation related to the production process, such as testing the degree of drying of the roof tiles, is more likely.[2935] Prints of soles that are reasonably complete can, apart from the shoe size, sometimes even give an indication of the type of shoe that was worn and thus a date, based on the way the nails are arranged under the shoes.[2936]

In some cases, several types of impressions are present on the same piece and the order in which they were made can be deduced. On three tile fragments, for example, two signatures have been trampled on by later animal paw impressions (Fig. 32.10-11), and a shoe impression overlaps the impression of an even-toed ungulate.[2937]

32.5.5 Nail holes

According to the original database, 16 nail holes applied after firing have been identified, 12 of which have been preserved. This number is relatively large, based on the original 3246 tile fragments.[2938] The distribution over the fabrics is remarkable, with six nail holes belonging to fabric group A and the other six distributed over fabrics 3 and 4. Fabric group B is not represented.

The distance to the upper edge of the *tegula*, if any, varies from 3 to as much as 10.5 cm. The latter distance, however, was established in a fragment whose flange was chipped off. It is likely that the nail hole was made when the tile was reused, as it is questionable whether the nail would have been covered by the tile above it when placed on a roof. Moreover, the perforation is placed eccentrically in relation to the middle of the tile. In the same fabric there is also an almost complete *tegula* with the nail hole placed to the left of the centre, whereas they are normally placed in the middle.

Although the low roof slope made securing the heavy tiles superfluous, it is assumed that sometimes only the lower row(s) was or were provided with a nail hole, which may explain the low incidence of this phenomenon. A fine example of a nailed-in *tegula* from the bottom row is item 27-4-6/5566. In this lower half of a horizontally bisected *tegula*, the flanges at the top have been trimmed to compensate for the missing notches (Fig. 32.3).

32.6 Synthesis. Manufacture, provenance and (re)use of the ceramic building material

Despite the fact that most of the building ceramics had already been removed prior to this

[2932] Kars 2005, 266.
[2933] Ferdière 2012.
[2934] With thanks to Hans Hovens, a biologist at Fauna Consult, for the determination of the animal footprints.
[2935] Warry 2006, 16.
[2936] Dobosi 2016, 225-227; Hiddink 2014, 673.
[2937] Items 21-1-2/11962, 106-2-15/9296 and 23-4-21/4513.
[2938] Compare Gazenbeek 2020, 164 table 27.

A. 20-3-2/14470

B. 326-3/14-1-6

C. 68-2-88/6423

D. 740-16/79-2-6

E. 68-2-9/11975

F. 630-1/23-4-21

Fig. 32.14 Voerendaal-Ten Hove. Examples of footprints of animals and humans. Scale 2:3. (source: D.S. Habermehl & H.A. Hiddink)
A cat; B-C dogs; D bird, probably chicken; E hobnailed shoe; F idem, with sheep / goat.

research and that the documentation of this find category in the oldest excavations leaves much to be desired, the analysis yielded a lot of new information. More insight was gained into the construction history of the Voerendaal villa, but certainly also into the production of building ceramics in the vicinity of Heerlen. The long Roman occupation history resulting in a large variety of material and the many complete pieces are important assets. On the basis of the roof tile material, a (rough) dating of the building ceramics is possible, which reveals trends in the supply of the material and its chronological use in the building ensemble.

32.6.1 Manufacture and provenance

Due to the often required large quantity and weight, building ceramics were usually manufactured in the vicinity of the consumer. The presence of suitable clay deposits for the production of building ceramics in the immediate vicinity of the villa is proven by the Late Medieval brick kilns found 600 m to the southeast along Hoensbeek.[2939] Moreover, clay was used as lining of the aqueduct, garden basin and other structures at Roman Ten Hove itself. It is possible, however, that the 'cerithium' clay used was not found in the immediate vicinity of the site.[2940]

However, the material and excavation data do not contain any indications of local production. In any case, the presumably first batch of high-quality roof tiles to be brought in does not seem to come from the immediate vicinity. The absence of distinctive signatures in the vicinity and the fabric itself are important indications of this. In addition, this fabric is scarcely represented in the surrounding villa areas. It may be that Voerendaal was a 'forerunner' in the large-scale local application of building ceramics and that, by necessity, an appeal was made to (a) manufacturer(s) elsewhere. Another explanation is that this beautiful red building ceramic was deliberately brought from further away because it could confer status.

The light pale local fabric would have been less popular for roofing, untreated, judging by the (dark) red layer of silt applied to the larger formats of roof tiles.[2941] A deliberate action to obtain the desired colour. It is impossible to determine when this fabric was first used in Voerendaal. The roof tiles, which were covered with a layer of silt, have only been incompletely preserved. Due to the lack of size and length of the incision, they provide no indication of dating.

If Voerendaal and other studied sites of building ceramics in Heerlen and its surroundings are normative, the situation with regard to the civil production of building ceramics is similar to that in north and central Limburg. The oldest building ceramics (fabric group A) may have been brought in from the Meuse valley,[2942] but was increasingly replaced by local production in fabric group B and fabrics 3 and 4 in the course of the second century AD.[2943] In fabric group B, a shift can also be seen towards the use of purer clays, with the application of a silt cover to make the tiles redder being omitted for the younger smaller *tegulae*. The chronological aspect of the different fabrics is clearly shown if compared with the length of cutaways and thickness of *tegulae* (Fig. 32.4B). Further research into these trends is needed, however.

32.6.2 Use

The first century

Building ceramics that can be attributed without doubt to the first century AD, are not kept or recognized. Firstly, typical forms from that period, like spacer tubes, notched *parietales*, *tegula hamatae* and *mammatae* are missing, as well as cutmarks or scratches on elements of heating systems (Fig. 32.2). One has to bear in mind, however, that the first villa was probably built quite late in the first century and had no heated rooms or a bath. Secondly, apparently no *tegulae* with a length of more than 46 cm were used at Ten Hove, suggesting construction date after c. AD 100 (Table 32.7). Thirdly, as far as we know, no tile was found in the foundations of the second villa.[2944] Reuse of building ceramics in foundations and walls is a very common secondary application of building ceramics. Therefore, it is questionable whether the oldest villa of the first century had a ceramic roof. The lack of such a roof may have been one of the reasons to replace the building with a more

2939 Archis3 16320.
2940 Section 33.4.
2941 Just over 8 kilometres away as the crow flies, a probable kiln site was discovered along the Roode Beek near Brunssum (Goossens 1918, 5; Archis record 38494). A recent attempt to retrieve the material collected at that time yielded no results.
2942 An overheated and deformed large fragment of an *imbrex* (without traces of reuse), found north of the *vicus* in Maastricht in this firing, indicates that oven locations in the vicinity must be taken into account (Collection LGOG BC 2349-1).
2943 Because of the similar chemical composition of the clay of fabric 4, this probably also applies to fabric groups C, F, G and H from the Heerlen baths.
2944 A possible explanation could be that the first villa was still being lived in while the foundations for the second main building were being laid.

Table 32.7. Province of Limburg.Tentative relationship between the length of tegulae and their approximate date in civilian contexts.

Length tegula (cm)	Date
> 46	before AD 100
46-44	AD 100-150
43-42	AD 140-late second century
41-38	late second century-AD 250
< 38	after AD 250?

attractive one at an early stage. However, small quantities of brick fragments were found in structures preceding the second large villa.[2945] Therefore it cannot be ruled out that the first villa still had a tiled roof.

The second, large villa

As already noted in the discussion of the tiles, the size is an indication for the dating of this type of building material (Table 32.7). The largest *tegulae* from Voerendaal measure 46 cm, which makes them a few centimetres smaller than the specimens used for the cladding of the walls of the Heerlen thermal baths, of which it is assumed that this building was erected between AD 63 and 73.[2946] On the other hand, the roof tiles are slightly larger than one and a half Roman feet (44.5 cm), a size which in a civil context seems to have been used mainly in the first half of the second century AD.[2947] The 46 cm *tegulae* could point to a relatively early dating in the second century for the second main building.[2948] Also noteworthy is the professional finish, the high-quality red/reddish-brown fabric and the application of nail holes. The main building had high-quality roofing that, based on the applied signatures and fabric, was brought in from elsewhere.

The decreasing length format of the *tegulae* and/or undercutting in combination with the use of square or round *bessales* give us some insight into the further development of the complex. Room 3 in the original main building is indeed older than room 13 in the eastern extension. In 1929 Holwerda collected complete *tegulae* from the eastern part of the site, measuring between 43.5 and 41.7 cm in length. These do not necessarily belong to room 13; 12 and 14 are also later additions, as is building/room 406.
The smaller formats suggest continuous extensions into the third quarter of the second century. After AD 150, the *tegulae* must also have been placed against the outer wall of the cellar. It is difficult to determine from the building ceramics to what extent the outbuildings were already covered with ceramic roofing at that time. If the fabric and length of the cut-outs in the *tegulae* are decisive, the building material in building 403 of the 2004 study could also be taken as AD 150-200. The round *bessales* present in this building also contradict an early building phase, unless they ended up in this building later. From the late second century onwards, building activity seems to have decreased. The 'lack' of smaller roof tile formats is striking. This is where villa Voerendaal differs essentially from Kerkrade-Holzkuil, for example. Where they have been found, they support later alterations, such as the 40 cm *tegulae* at porticus 16.

The baths

Although a large number of different types of building ceramics were found in and around the bathhouse, the lack of detailed excavation data is particularly problematic for this building. Nevertheless, some aspects can be mentioned that reveal something about both the building's history and its construction.

The large roof tiles and red tiles (fabric group A?) in the rooms that, according to Braat, remained unchanged, fit in with the characteristics of the presumed oldest building ceramics. The material in fabric group B may be of later date. Simultaneous supply from several production sites, as was observed in the public baths of Heerlen, would be strange for the limited amount of ceramic building material in the Voerendaal baths. Heating elements in fabric group A also show traces of mortar more often than building ceramics in fabric group B. Mortar is also rarely found on the *tubuli cuneati* and voussoir tiles which probably formed part of vaults over one or more rooms of the bathhouse. These specific building elements made it possible to realise lightweight arch constructions.

[2945] Building 209, 210, 211, 212, 213 and 247 (cf. Chapter 40).
[2946] Peterse 2019, 86.
[2947] Ernst 2017, 162.
[2948] Or maybe reuse of roof tiles from the first villa?

The impression is that the bathhouse continued to be used well into the third century AD. Evidence for this can be found in the different constructions of the drains, especially gutter 328. It is striking that the two side walls of this drain are constructed differently, with two small *tegulae* probably completely covered in mortar being preserved from the northern side wall. The drain was certainly not part of the first phase of the baths and was probably deepened at a later date, leaving the southern wall made of three layers of halved *tegulae* and rebuilding the counterpart from complete specimens in five layers.[2949] Its small size (< 38 cm), as mentioned above, suggests a dating at the beginning of the third century. Even later, the connecting channel 327 must have been closed.

Late Roman period and beyond

Building activities in the Late Roman period cannot be determined from the building ceramics. Since during this period building ceramics were reused almost exclusively, which were undoubtedly still present in large quantities, no (late) dating can be derived from this material category.

32.6.3 Spatial distribution

As with many other material categories, a lot of ceramic building material was found in a strip along the Steinweg (Fig. 32.15). However, (weaker) concentrations are also visible further north, such as in working trenches 9/18, 10 and 7/79. The first mentioned trenches are located near the main villa building, so the discovery of a relatively large number of roof tile fragments is not surprising. Trench 10 and 7/79 had a kind of rubble layer in which some material was found, although in the latter two much of it came from a few pits. Broadly speaking, the distribution here is similar to that of the pottery (Fig. 5.6; 32.15).

Further south, there is also a similarity in the distribution of both categories at first sight, but on closer inspection there are many differences. In particular, it is striking that the western part of the yard is much more empty in terms of building material. In the eastern half more was found, more in line with, for example, the pottery. Here, building material has emerged from a number of pits and sunken-floored huts, as well as from the construction of hearth 630 (trench 23). Most of these structures date from after the Middle Roman (villa) period. However, a considerable amount of roof tile was also collected here by digging through layers under the building soil, one level in trench 13 and even four in 24.

Other concentrations of building material seem to be related to the stone buildings in the relevant trenches, but different factors appear to play a role in the quantity/density of building material. Pit 10 with building 405 has already been mentioned; here the rubble 'behind' the building may originally have been on its roof. The small amount of brick in building 402 can be explained by the fact that it was barely examined in 1985. Relatively few bricks were also collected from the *horreum*, which in this case seems to be explained by erosion; the topsoil was very thin at this location (Appendix XIII). Figure 32.15 shows at first glance a concentration of building material around the bath, but on closer inspection little has been collected here.[2950] In 1987, the baths in trench 114 were not investigated and Braat, too, brought back relatively little material. In contrast, in trench 68 near building 403 there is a substantial amount of building material. However, the material collected comes for a considerable part from bricks that were part of features probably constructed inside the building at a later stage and only in part from remains of its roof (see above). Finally, the concentration at Building 401 is again related to several factors. In trench 20, some of the finds were collected from younger structures (pits, sunken-floored huts), but also many from sections excavated at level 1. This material could have been part of the roof of the building, but possibly also of that of 402, situated upslope. It is remarkable that the spits in trench 27, level 1, situated next to trench 20, yielded no brick and tile at all. Here all material was collected from layers at level 2 and other features.

Despite the major influence of factors like the manner of collecting and the number of 'artefact traps' from the Late Roman period and beyond, we see striking spatial patterns in a number of aspects. While the distribution of the signatures more or less keeps pace with the quantities of building ceramics in the excavation

2949 For the further deepening and widening of a drain, see Jeneson & Vos 2020, 66.
2950 Calculated with 350 instead of 600 m2; not fully investigated in 1987.
2951 Two 'concentrations' can be identified: 17 specimens around trench 68 (95, 101, 106 and 107) and 17 specimens around trench 20 (16, 21 and 27).

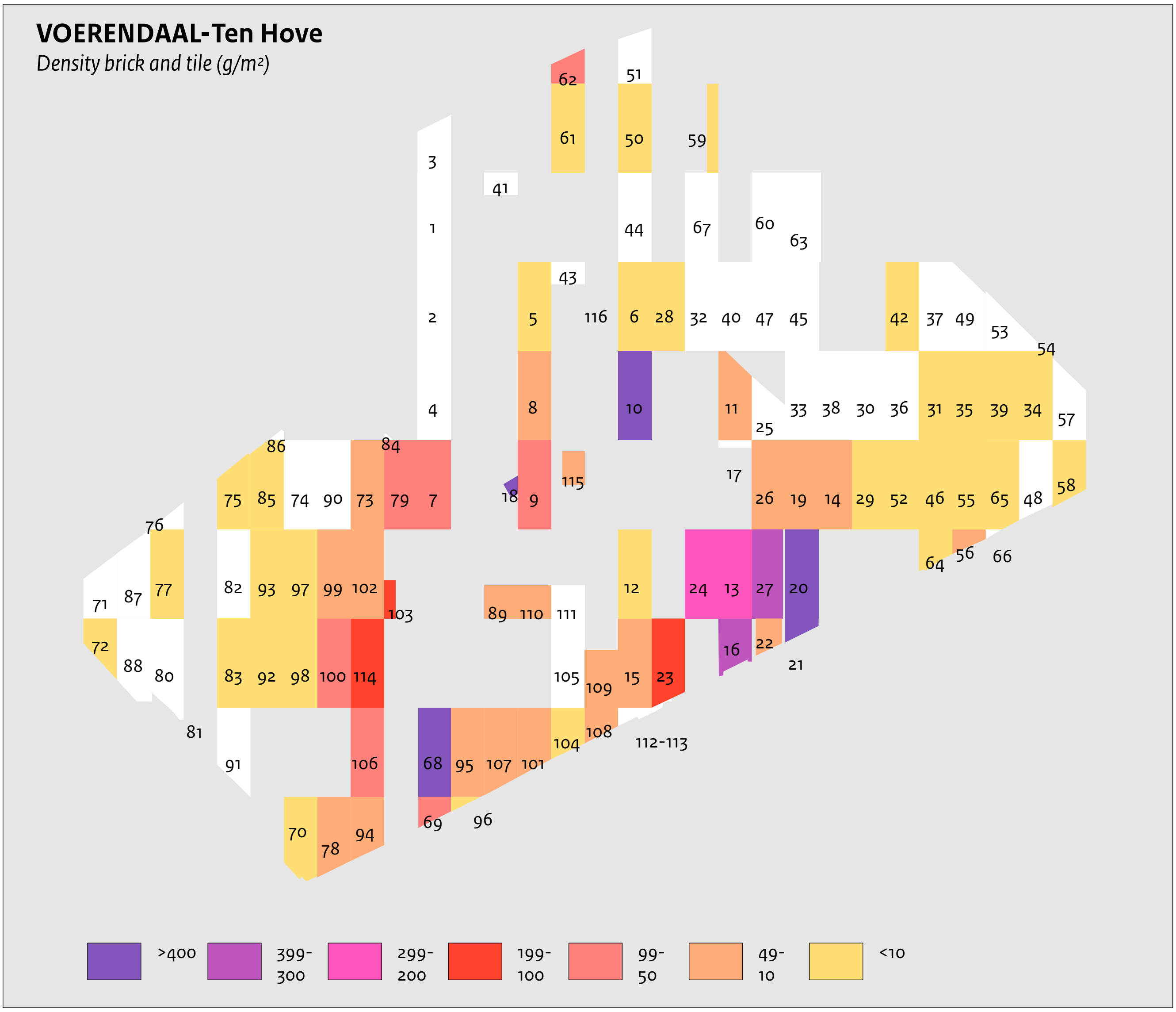


Fig. 32.15 Voerendaal-Ten Hove. Distribution of the building ceramics (g/m2).

trenches,[2951] *tegulae* with nail holes in the western trenches are completely missing. This could suggest that no nailed roof tiles were applied in buildings 403, 404 (baths) and 408 (*horreum*) located in this area. The fragments of light-coloured roof tiles with a dark slip were all found, with one exception, in trench 20 and 21 near building 401.[2952] Perhaps this building or an addition (the portico or room at the south end?) had been fitted with these typical roof tiles.

In the description of the fabrics, a relation has already been made with the colours that are included in the original database. The light colours white, yellow or yellow-rose will most probably correspond to fabric group B, whereas the colours orange, orange-red, red and pink are more likely to be related to the other fabrics. This allows us to include a considerably larger quantity of building ceramics in the interpretation. Even though many records lack an indication of colour and a considerable number of them mention several colours that were left out of our quantification, remarkable differences can still be observed. If we take only

2952 This includes the discarded fragments with '*verf*' (paint) or 'besch(ilderd)' (painted). The exception was found in nearby trench 16.

the roof tile material, in trench 10 no less than 59.4 kg is recorded in the light colours, against only 19.6 kg in the 'red' colours.[2953] This is the complete opposite of the ratio shown in table 32.4. Trench 10 is located near building 405. This composition does not seem to be a coincidence, for although the amount of material is much less, the picture is identical in nearby building 402 if we take trenches 11 and 26 as our starting point. The opposite is also true for the roof tiles: in trench 68, south of the bathing building, 'red' predominates with 187.1 kg, while the light colours combined weigh only 3.7 kg.[2954] Leaving the bathing building aside for a moment, trenches 99 and 102/103, of which almost all find numbers have a colour indication, appear to be completely lacking in light colours. These trenches cover the western half of building 408, the *horreum*.

Reconstruction drawings of the Roman villa in Voerendaal show a uniform orange-red roof landscape, but the above shows that a much more varied picture must be taken into account. This applies at least to the later phases, after several rooms were added to the main building and older roofs were replaced or repaired.

32.6.4 Reuse

Even broken, building ceramics held some worth. Re-use is already seen in Roman times when it is processed and reworked for other purposes. The use of tiles other than for roofing has already been mentioned. Examples of reworking are only sparsely surviving, but is probably not representative for the site due to the focus on preserving special pieces. Items with chipped flanges or secondary firing seem to be underrepresented, although post-Roman constructions in which brick was used are sparse (kiln 630; Fig. 12.5).

A disc with a diameter of approximately 8 cm was made from a piece of hard-fired *tegula* (420-1/27-5-3). Similar discs were found at several Roman sites and are usually interpreted as playing discs, although they could also be used as e.g. fishing net sinkers or loom-weights.[2955] Hard-fired ceramics were frequently used as grinding or polishing stones. A small fragment was originally assessed as a whetstone, but the soft fabric and indistinct grinding surface make this highly unlikely.[2956]

[2953] In total, 243.1 kg *tegulae* and *imbrices* were collected in this trench.
[2954] There is a total of 223.5 kg of *tegulae* and *imbrices* in this trench.
[2955] Like an example from Nederweert-Rosveld (Hiddink 2005b, 172, fig. 12.1).
[2956] Item 46-1-7/11272.

33 Stone construction material and artefacts

Gerard Boreel and Henk Hiddink

33.1 Introduction

Huge amounts of stone must have been present at Voerendaal-Ten Hove after the villa had fallen into ruin. Much of it will have been reused during the Late Roman period, the Middle Ages and beyond, to build farms, chapels and churches in the vicinity. A mass of stone was removed from the site to enable agriculture. There are also indications that stone was removed directly after the excavations by Habets (or Braat).[2957]

Habets collected only three pieces of stone;[2958] both Holwerda and Braat also took a few stones from the site.[2959] A large sample of the stone material was collected during the ROB excavations, both (possible) artefacts and building material. Some material initially stored was discarded: certainly a number of unworked cobbles, but possibly other stones as well. Part of the limestone and some sandstone was sampled by the late geologist Werner Felder and was lost. Compared with the numbers in the original database, some 775 fragments with a weight of about 250 *kg* were no longer available (roughly half of the fragments, one third of the weight). A total of 815 fragments of natural stone with a weight of 685.4 *kg* were available for the present analysis (Table 33.1). Nearly all the flint was excluded from our analysis and was investigated separately.[2960] Table 33.1 gives an overview of the numbers and weights per type of rock. Important rocks are conglomeratic sandstone, limestone, sandstone, '*tauw*' and vesicular basalt lava.

The material has been analysed by the first author.[2961] This was done macroscopically, sometimes aided by a lens or a stereoscope. In some cases hydrochloric acid (5%) was used to check for lime content. Besides the type of rock, the number of fragments and their weights, data was stored in a database on the shape, size, provenance, traces of tooling and/or burning, the type of artefact and any peculiarities. The second author provided data on subjects such as the regional geology and the use of particular types of stone in the Roman period. He is also responsible for the find drawings and maps.

Already during excavation it was presumed that the limestone used was a variety of Kunrade limestone, possibly quarried near Craubeek.[2962] One of the important research questions is whether the preserved assemblage can still shed light on the building materials used for both villas and where they came from. Natural stone was also used for agricultural and artisan tools. What has been found and what were the kinds of stone used?

The most important functional groups of Voerendaal-Ten Hove will be discussed in the following sections. Section 33.2 is devoted to the building material, Section 33.3 to stone 'furniture' and 33.4 to the gravel and clay used at the site. Section 33.5 analyses the querns and millstones are analysed, while 33.6 analyses the grinding/sharpening tools and 33.7 some other stone tools.

Table 33.1. Voerendaal-Ten Hove. The numbers and weights of the different rocks available for analysis.

Rock type	N	Wt (g)
Amphibolite	1	128
Basalt	8	258
Chert	1	12
Coal	41	187
Conglomeratic sandstone	20	17111
Flint	2	872
Granite	8	9659
Hornstone	1	114
Indet.	22	136
Limestone	60	143609
Marl	14	125240
Marble	1	128
Phyllite	15	1130
Quartz	1	27
Quartzite	8	1937
Quartzitic sandstone	1	70
Sandstone	191	351871
Shale	7	1089
Siltstone	4	261
Slate	18	332
Tauw/flint	8	77292
Tuff	1	9
Vesicular basalt lava	382	43974
Total	**815**	**685446**

2957 When investigated in 1985, the cellar of the main building was more damaged than in the drawings commissioned by Habets (Chapter 43; fig. 84035-84037).

2958 RMO l 1895/12.19-21: a disc of 'Limburg marble', a piece of 'Schiefer' and 'black marble (Limburg or Belgium)'. These stones were not searched for at the RMO.

2959 RMO l 1932/11.2: 'Pieces of limestone with some traces of sculpturing' were collected by Holwerda. Two blocks of 11.5 kg were inspected by the second author, but no more than tool marks were visible. Braat collected a piece of a granite basin and fragments of a shale column, used as part of a table (see section 3). A flint nodule shaped like a tree branch (cf. section 33.2.3) was not searched for at the RMO (inv. no. 1953/2.18j, see below).

2960 By Erik Drenth (Chapter 37).

2961 Data on some pieces not easily accessible or transportable were provided by the second author. It concerns e.g. the finds from the RMO (see above) and a column fragment of c. 200 kg on display in the Limburgs Museum.

2962 Willems & Kooistra 1987, 29.

Section 33.8 contains some conclusions and an interpretation of the stone assemblage.

33.2 Building material

The worked stone used as building material that was found at Ten Hove consists predominantly of Kunrade limestone and to a lesser degree of Nivelstein sandstone (Table 33.2-3). The Kunrade limestone was used for building blocks, but also in the foundations of buildings. In the latter case it took the form of irregular blocks, probably the tailings resulting from quarrying and the preparation of neat rectangular blocks.
The Nivelstein sandstone was used for making both building blocks and columns. Besides these widely used types of stone, some other material was used, for instance 'marl', '*tauw*' and flint (mainly as a cover for drain 317), and decorative marble. The use and provenance of the various types of stone is discussed in the following sections.

Table 33.2. Voerendaal-Ten Hove. Quantitative data on the rock types used as building material (tooled stones) and its applications.

				Application (number of individual artefacts)							
Rock	**Type**	**N**	**Wt (g)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Limestone	Meuse valley	4	7359	2					2		
Limestone	Kunrade med. hard	18	53366	12		1					1
Limestone	Kunrade hard	7	58782	7							
Limestone	indet.	12	3923	3						9	
Limest/flint	tauw/flint	3	76500	3							
Marl	Maastricht	14	125240			4					5
Slate		5	149					3			1
Marble		1	128				1				
Siltstone		1	10						1		
Sandstone	Nivelstein brown	40	51003	3	1						3
Sandstone	Nivelstein white	39	264242	3	13	2					10
Total		**144**	**640702**								

1 building blocks; 2 columns; 3 decorative building elements; 4 wall/floor; 5 roof slate; 6 lumps with mortar; 7 (incomplete) burned limestone; 8 indet.

Table 33.3. Voerendaal-Ten Hove. Numbers and weights of the non-tooled rock types mainly used as building material.

Rock	**Type**	**N**	**Wt (g)**
Limestone	Meuse valley	4	418
Limestone	Kunrade medium hard	1	346
Limestone	Kunrade hard	5	8343
Limestone	tauw	4	680
Sandstone	Nivelstein brown	3	4828
Sandstone	Nivelstein white	44	16155
Total		**61**	**30770**

33.2.1 Kunrade limestone

Description

Kunrade limestone is a light grey to yellow-grey and sometimes brown-grey hard limestone, a calcarenite with a high content of fossil fragments of a few mm in size.[2963] The stone is quite dense and could contain up to 7-27% (weight) of silica. It is a good-quality building stone and is weather-resistant. In the quarries, beds of hard Kunrade limestone are typically 20-30 thick, although some are very thick (1 m) and thinner banks are also found. The hard beds are found alternated with softer ones, consisting of grey/white to dark-coloured (orange-yellow) layers of granular limestone.

The characteristic features of Kunrade stone are observable among the building material of Voerendaal-Ten Hove. Several stones show burrows and have shell-bearing softer limestone attached to the top and/or base. The building blocks still present today vary greatly in size. They generally have a rectangular shape, like huge massive bricks (10-2-13/1043; Fig. 33.1). Their thickness varies between 80 and 160 mm, their width between 100 and 235 mm. Some blocks are plates rather than blocks. Find 20-3-6/3408 is a complete, plate-like building block of 250 *x* 250 *x* 75 mm (Fig. 33.1-2). It was probably used in the corner of a wall, as two adjacent short sides are not finished and show tool marks. Another application is demonstrated by 103-0-0/8978, which was probably used as a floor tile. The rectangular plate of 260 *x* 190 *x* 60 mm has mortar on one side and a very smooth upper side, caused by intensive wear.

Provenance

Kunrade limestone is a particular facies of the Upper Cretaceous Maastricht Formation (Fig. 33.3A).[2964] It is harder than the typical Maastricht limestone ('marl'; see below, Section 33.2.3). Both were formed in a fully marine environment, but the Kunrade stone in relatively shallow water closer to land (lagoonal facies). Therefore, it contains a relatively large terrigenous, clastic component.[2965] Laterally, there are strong stratigraphic differences, shown by published profiles from different historic quarries in the area south of Voerendaal.[2966]

There are many potential sources close to Ten Hove just south of the Kunrade Fault.[2967] In the recent past, a number of small quarries operated in a roughly 10 km-long zone south of Voerendaal-Heerlen, about 1 km from our villa and 1.5-2.5(-5) km from the *vicus* (Fig. 4.1A).[2968] The only quarry still operating today is the Kunrader Steengroeve. There were more outcrops of Kunrade stone in Zuid-Limburg, also at the northern edge of the Geul valley and to the southeast towards Aachen (Fig. 33.3B). As mentioned above, the limestone of Ten Hove was believed to derive from a quarry near the hamlet of Craubeek, 1 km to the southwest.[2969] Although this is probably true, the criteria used by the late Mr Felder for identifying the limestone at Ten Hove specifically as 'Craubeker' limestone are unknown and the documentation on the samples taken at Ten Hove seems to be lost. It is impossible to prove the provenance today, even by means of microscopically investigated thin sections. Firstly, the composition of the stone is highly variable both vertically and laterally (see above), making it difficult to link particular samples from Ten Hove to specific layers in outcrops or quarries. Secondly, most historic quarries were backfilled and only a few small outcrops still exist today, with only the top levels of the limestone being exposed.

For the same reasons, it is impossible to link Kunrade limestone found at other sites to specific quarries, although in general the nearest one would be used to minimize transport costs. Besides the Craubeek variant of this limestone, 'Kunrader', 'Ransdaler', 'Benzenrader' and 'Bocholter' stone were distinguished in the past; these designations are also found in older archaeological publications. Kunrade limestone in the broad sense appears to have been used in Heerlen, especially in the baths,[2970] the villas of Simpelveld-Stampstraat,[2971] Nuth-Vaesrade,[2972] Heerlen-Bovenste Caumer,[2973] Schaesberg-Overstenhof,[2974] Heer-Backerbosch,[2975] as well as Bocholtz-Vlengendaal.[2976] Although Kunrade limestone was of good quality, its distribution was limited, mostly because of the generally wide availability of stone in Limburg. It does not appear to have been used, for example,

2963 Cf. Felder 1978, 89-90; Nijland *et al.* 2017, 22ff.; Dreesen *s.a.*, 2ff.

2964 There has always been, and still is, discussion about the stratigraphic classification of the Kunrade stone, but this is less relevant here. Although there is interfingering and a gradual lateral change into Maastricht stone, the Kunrade stone is generally considered to be older (see Felder 1977; 1980, 49-53; Felder & Bosch 2000, 71-73; Nijland *et al.* 2017, 22-23.).

2965 Pollock 1976.

2966 Felder 1978; 1980, 50, fig. 16.

2967 See Chapter 4.

2968 Felder 1973, fig. 5; 1978.

2969 Willems & Kooistra 1987, 29.

2970 Dreesen *s.a*.

2971 Braat 1941, 43 (cellar).

2972 Braat 1934, 29.

2973 Peters 1922, 104-105.

2974 Peters 1922, 104-105.

2975 Habets 1895, 269. Confusingly, Habets calls the same stone '*mergel*' and '*Krouberger*'. The material used at Colmont-Stokveld is also called '*mergel*', but it was hewn and not sawn, which suggests that it was actually limestone (Remouchamps 1923, 65). The stone at Groot Haasdal-Op den Billich was described as '*harden mergel*' (hard marl), again suggesting limestone rather than marl (Goossens *et al.* 1908, 26)

2976 Goossens 1912, 426 (the local Benzerader stone).

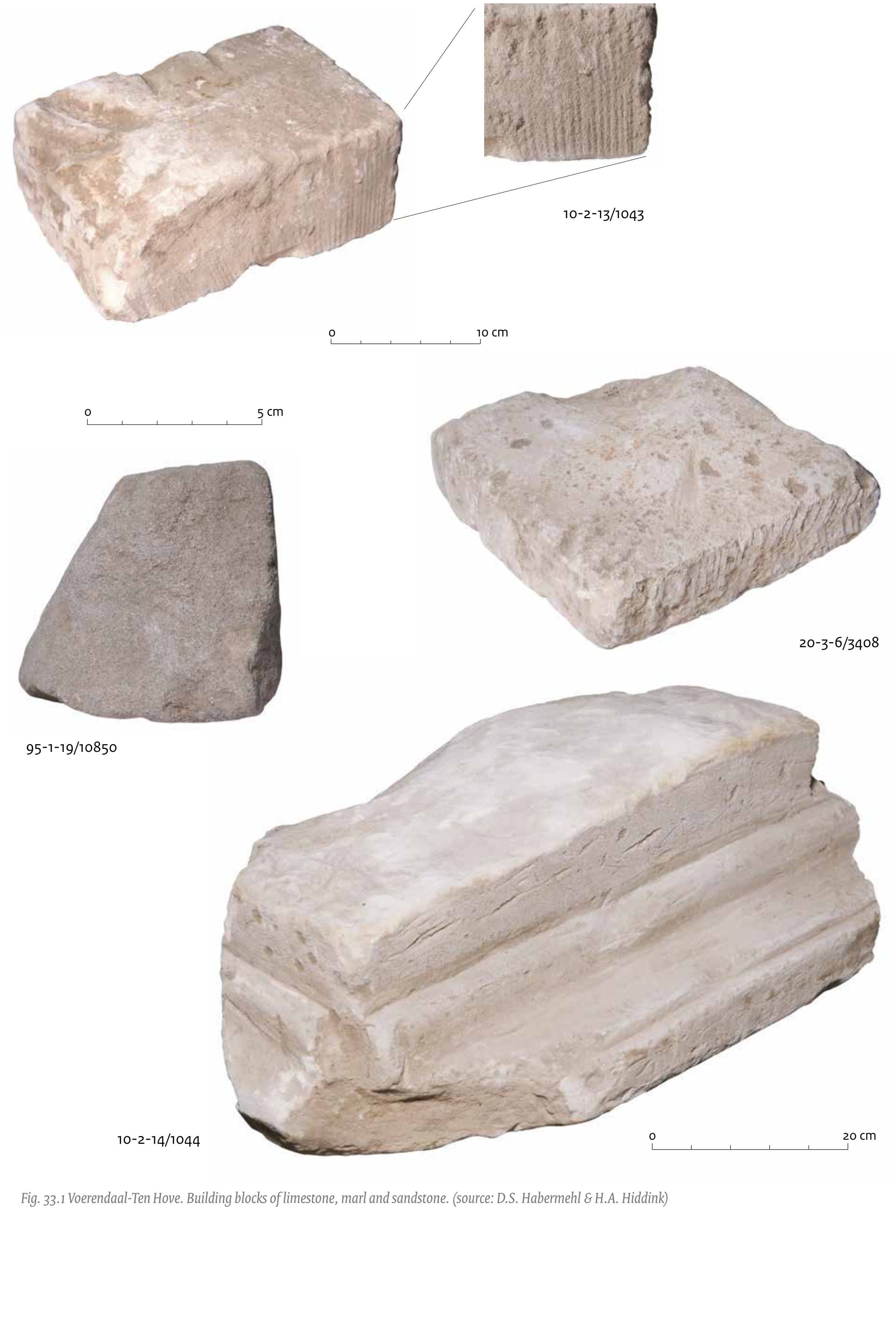


Fig. 33.1 Voerendaal-Ten Hove. Building blocks of limestone, marl and sandstone. (source: D.S. Habermehl & H.A. Hiddink)

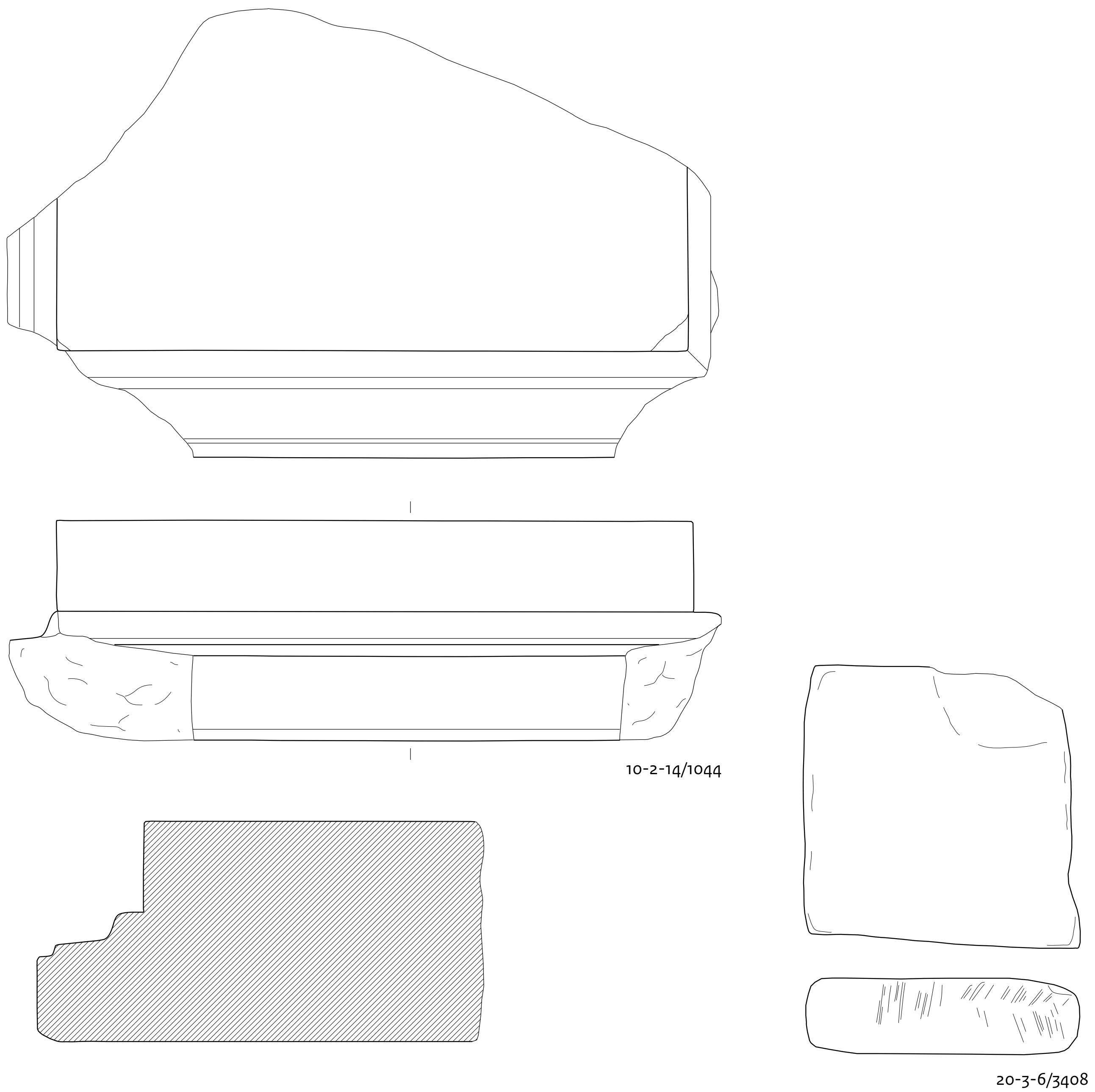


Fig. 33.2 Voerendaal-Ten Hove. Building fragments of limestone and marl. Scale 1:6.

at Maastricht, Kerkrade-Holzkuil and Maasbracht-Steenakker.[2977]

33.2.2 Nivelstein sandstone

Description

Nivelstein sandstone is a grey-white, fine-grained, well-sorted, pure, silica-rich sandstone. Due to contamination with iron, it can be orange or brown. The colour after weathering is a dull brown. This sandstone occurs in both very weak and strong, well-cemented varieties.[2978] Its homogenous, fine-grained structure made it very suitable for sculpture and architectural elements.

At Voerendaal-Ten Hove, building blocks were made not only of limestone, but also of Nivelstein sandstone, both the light grey to white and the orange to light brown variant.

[2977] Panhuysen 1996 (Maastricht); Kars 2005, 269, table 9.10 (Kerkrade-Holzkuil; limestone only 8 of 306 sampled pieces); Gazenbeek 2017, 74-75 (Maasbracht).

[2978] Nijland *et al.* 2017, 30-32.

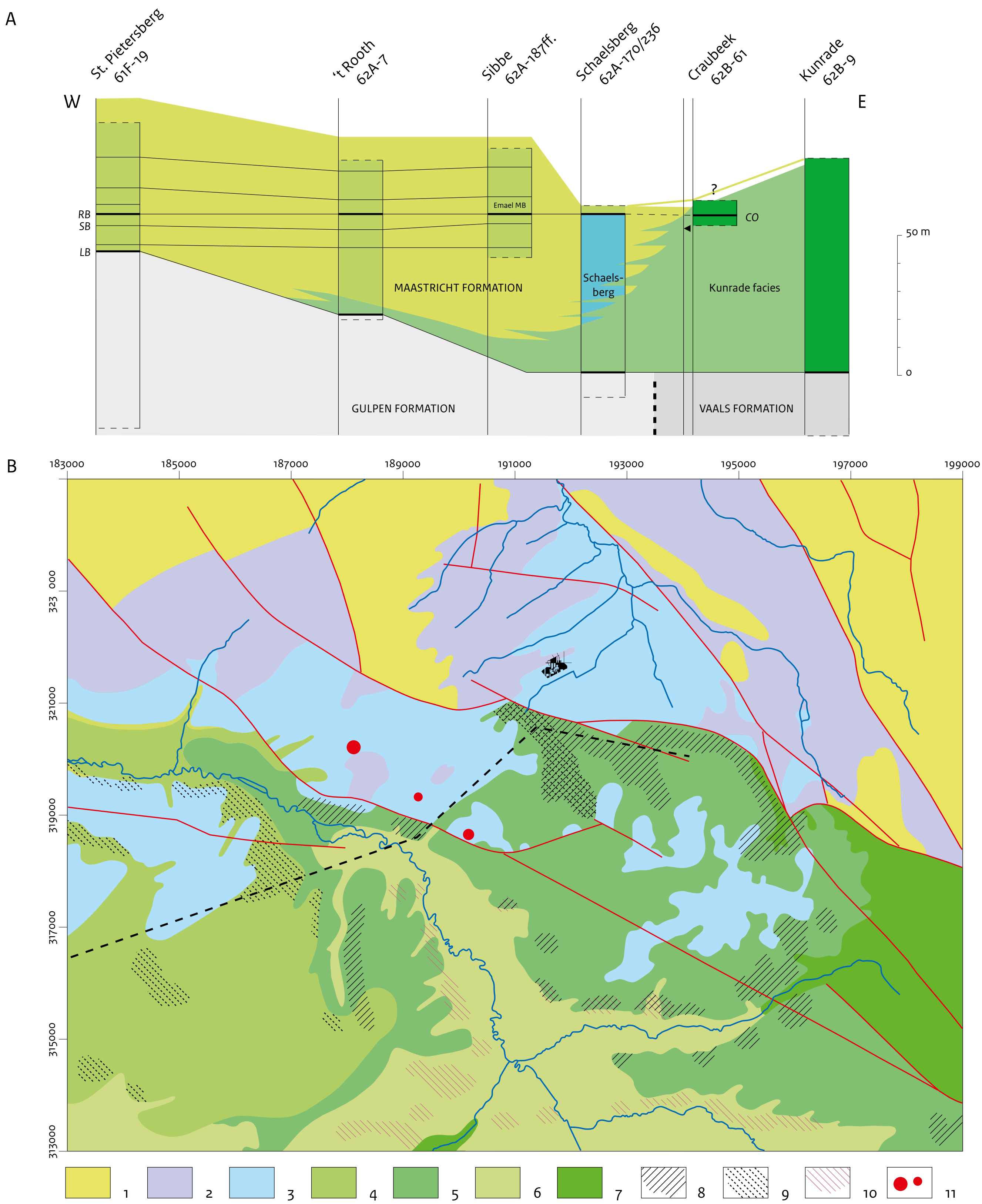


Fig. 33.3 Limestone stratigraphy and distribution in South Limburg. (source: modified after Felder 1977, fig. 1; 1978, fig. 19; Felder & Bosch 2000, fig. 4.2; 4; 8; 11; 6.2; Geologische kaart 1984)
A section with simplified stratigraphy; for location, see B.
CO Craubeek oysterlayer; LB Lichtenberg horizon; RB Romontbos horizon; SB Schiepersberg horizon.
B pre-Quaternary geology of the area around Voerendaal, with faults (red) and location of stratigraphical section.
Tertiary: 1 Breda Formation; 2 Rupel Formation; 3 Tongeren Formation; Cretaceous: 4 Maastricht Formation; 5 idem, Kunrade facies; 6 Gulpen Formation; 7 Vaals Formation; Potential quarrying areas: 8 Kunrade limestone; 9 Maastricht limestone; 10 Gulpen limestone; 11 'Cerithium clay' (Goudsberg member, Tongeren Formation).

Find 95-1-19/10850 shows three square-angled surfaces with saw marks; its thickness is 80 mm (Fig. 33.1). Find 107-2-3/9651 is a small building block with a preserved length of 145 mm and an almost square section of 70 *x* 60 mm. The other four blocks still present appear to be reclaimed older building material or show signs of demolition. Find 114-2-1/10174, for example, has two square-angled surfaces, one with chisel and the other with saw marks. Mortar on the fractures shows that it must have been reused after fragmentation. Another example, from basin 336 (111-2-2/10122), has chisel marks over a partly damaged decorative rim. These could be result of both demolition activities and reuse.

By far the most important application of the light-coloured Nivelstein sandstone seems to have been as decorative architectural elements. In total, 19 fragments represent 13 individual parts of columns. One of them was made out of the light brown variety, showing several darker bands (770-8/23-3-9/4548). The rest were made from the white variety of Nivelstein sandstone. Most fragments are severely damaged and some were used secondarily as sharpening implements, such as 702-17 and 737-6/68-3-32 (Fig. 33.4-6). It is difficult to measure the precise diameter of many fragments. The best-preserved piece is 16-3-31/2546, with a length of 93 cm and a diameter of 34 cm, with at least one mortice (Table 33.4; Fig. 33.4).[2979] One of the other better-preserved fragments is 768-3/15-2-19, with a shaft diameter of 34 cm and a 45 mm square, 25 mm deep mortice (Fig. 33.4; 33.6). A dark-coloured band is probably not an applied decoration, but a brown-coloured layer in the stone. A comparable mortice has also been found on 737-6/68-3-32 (Fig. 33.4; 33.6). A rectangle of 50 *x* 55 mm and 25 mm deep can be seen on this piece. Another mortice (50 *x* 50 *x* 15 mm) was found on an amorphous lump of sandstone (737-4/68-4-25/6995). Item 737-5 is possibly a base fragment (30 cm diameter?), with a vertical smooth band in the centre, bordered by irregular sloping parts (Fig. 33.5). Item 737-4 was found in the same pit, perhaps part of a capital with the annulet preserved below the *ovolo* (Fig. 33.7). A fragment from pit 702(-17) is somewhat enigmatic. It is possibly also part of a capital, with part of an astragal. Apart from some grooves originating from a use as a sharpening tool, there seems to be the edge of a rectangular field below the astragal, while the other side has an unfinished appearance. However, as the pick marks are quite regular, it may never have been the intention to finish this side (Fig. 33.5).

Looking at all the measurements and estimates of diameters, we note two fragments – 768-3 and 16-3-31/2546 – with a diameter of 34 cm. Other estimates range from about 26 to 32 cm. The difference may be the result of tapering columns, but it is also feasible that different column sizes were present in different parts of the main building or buildings. A fragment (770-8) with a diameter of 38 cm could also be a base fragment or a drum from

Table 33.4. Voerendaal-Ten Hove. Sandstone column fragments of which the approximate diameter could be determined.

Structure-item	Find no.	Id	Colour	Wt (g)	Diam. (cm)
737-5	68-3-32	6991	white	5700	≈30
770-8	23-3-9	4548	light brown	7600	38?
737-4	68-4-25	6995	white	3048	28
768-3	15-2-19	2093	white	30000	34
737-6	68-3-32	6992	white	9600	30-32?
702-17	7-2-4	303	white	5910	18-20
-	16-3-31	2546	white	180000	34
-	68-3-41	6517	white	2800	26

[2979] As this column is in the permanent collection of the Limburgs Museum, Venlo, the base could not be inspected. The same holds true for the sides and back, preventing a thorough assessment of the deep diagonal grooves. These represent post-Roman damage, probably caused by ploughing: the column was found at a fairly high level in the colluvium/topsoil.

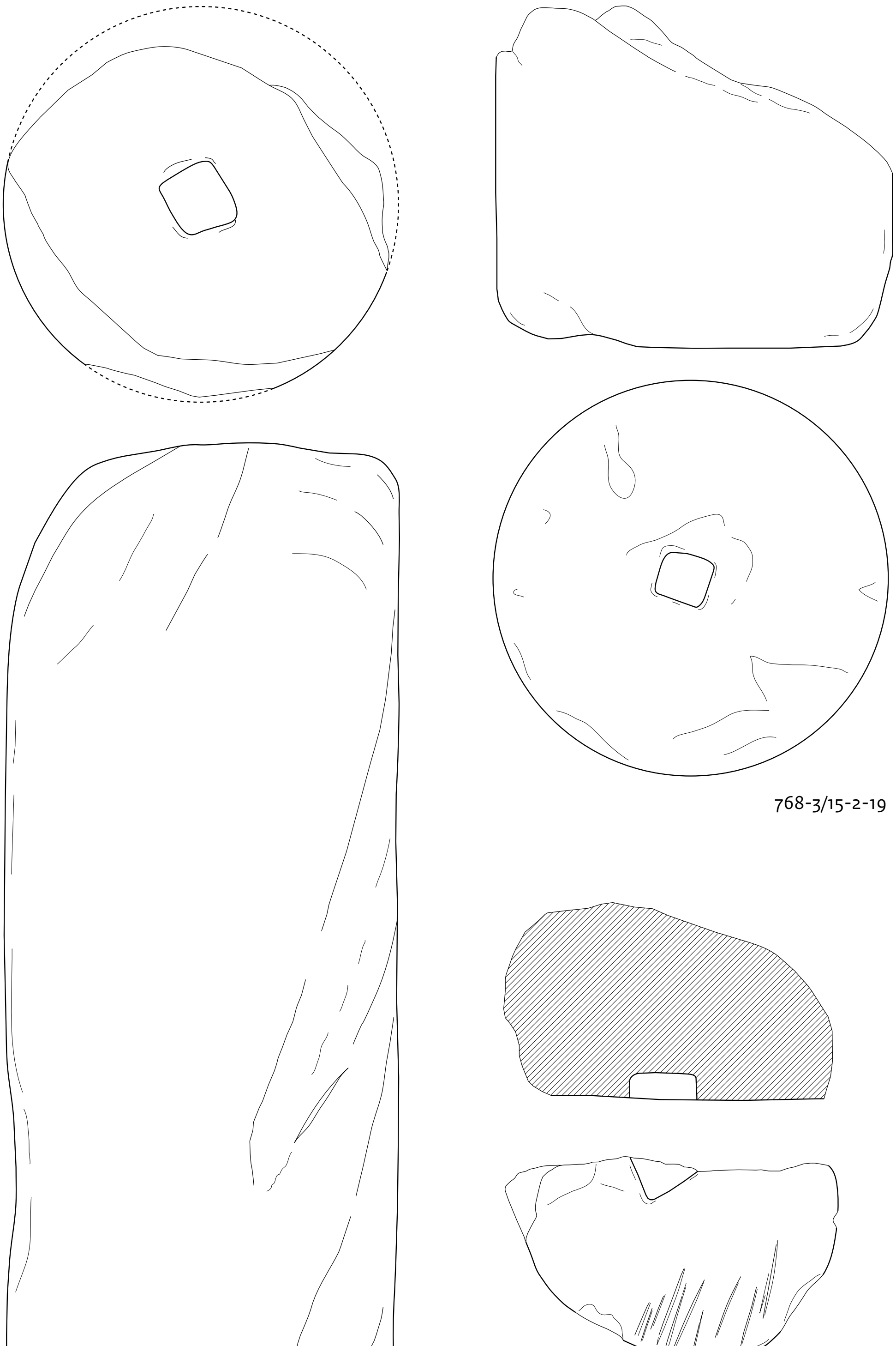
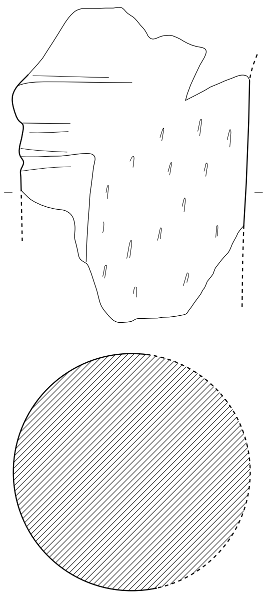
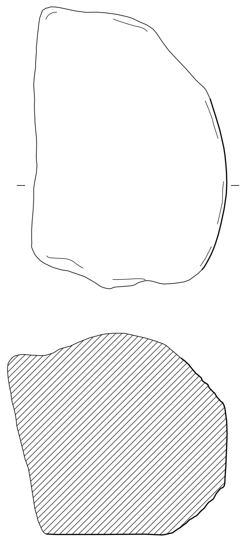


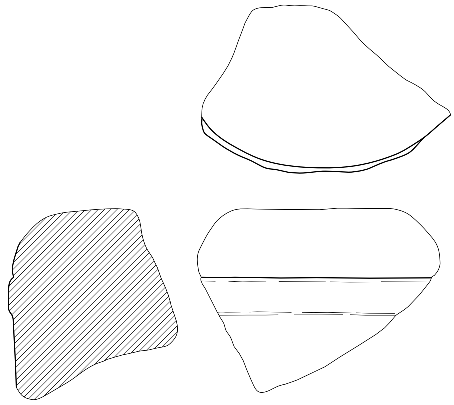
Fig. 33.4 Voerendaal-Ten Hove. Fragments of columns made of Nivelstein sandstone. Scale 1:6.



702-17/7-2-4



737-5/68-3-32



737-4/ 68-4-25

Fig. 33.5 Voerendaal-Ten Hove. Fragments of columns made of Nivelstein sandstone, cont. Scale 1:6.

768-3/15-2-10

737-6/68-2-3

0 10 cm

Fig. 33.6 Voerendaal-Ten Hove. Fragments of two columns of Nivelstein sandstone. (source: D.S. Habermehl & H.A. Hiddink) higher up; 720-17 may have belonged to a small column with a diameter of 18-20 cm.

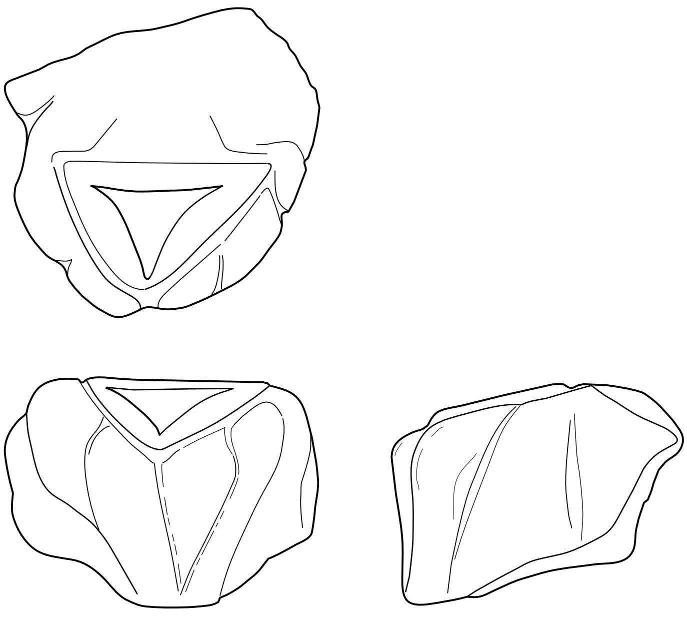
The column fragments have no fluting and could therefore belong to the Tuscan order. However, columns of other orders are most often fluted, although certainly not invariably.[2980] There is indeed one stone fragment indicating the presence of other orders. Item 20-1-90/3253 is probably part of a capital, of either the Corinthian or composite order. It shows a triangle between some sort of leaf/leaf tip or a bud (Fig 33.7). A somewhat similar element can be seen on a composite capital from Linnich-Tetz (near Jülich).[2981]

Finally, a piece of sandstone should be mentioned that could have been part of a kind of cornice (736-1/62-1-1/6127).

Provenance

Nivelstein sandstone was quarried just east of the border of Zuid-Limburg, north of Kerkrade and Herzogenrath (Fig. 33.13). The sandstone is part of the Heksenberg Member of the Breda Formation.[2982] During the climate optimum of the Miocene with subtropical conditions (17-11 My), thick layers of quartz-rich sand were deposited near and on beaches.[2983] During regressive stages, thick layers of peat developed, later transformed into lignite.[2984] Humic acids from the peat layers caused the leaching of nearly all components in the sand except for the quartz. Sandstone was formed in some areas by cementation/silicification of the top layers, resulting in lenticular layers.

The Heksenberg sand and sandstone are present near the surface north of Heerlen (Heerlerheide, Brunssumerheide) and at the eastern side of the Worm valley in Germany (Nivelstein). Whereas the stone in the Netherlands is not well cemented and therefore seldom usable,[2985] the German equivalent is of good quality. It was widely used in the Roman period (see below). Later, in the High and Late Middle Ages, it was used for castles (Valkenburg) and religious buildings (Aachener Dom).[2986] Today, the quarrying of stone has ceased, but the very pure sand was highly valued after the mid-nineteenth century for industrial purposes (glass, porcelain, enamel, silicon). While the Tranchot map from the early nineteenth century shows only one small quarry (*carrière*) south of the hamlet of Neivelstein/Nivelstein,[2987] nowadays nearly the whole area is dug up and the hamlet has disappeared.



20-1-90/3253

Fig. 33.7 Voerendaal-Ten Hove. Capital fragment of Nivelstein sandstone.

2980 E.g. Peterse 2005, 54-55, 59; 2007, 40-42, 46, fig. 34-35, 40.

2981 Noelke 2010/2011, 199, fig. 41.

2982 TNO-GDN (2020). Laagpakket van Heksenberg, http://www.dinoloket.nl/stratigrafische-nomenclator/laagpakket-van-heksenberg (9-10-2020).

2983 Kuyl 1980, 67-72; Laban 2007; Van der Meulen *et al.* 2011.

2984 In the Netherlands some three-four layers of lignite can be present, of which the Morken and Frimmersdorf Members (Ville Formation) are the most important, near the bottom and top of the Heksenberg Member.

2985 Cf. Anon. 1989a, 129 for a photo of this weak stone.

2986 Berends *et al.* 1982, 66-68; Nijland *et al.* 2017, 33.

2987 Tranchot map, sheet 76 Herzogenrath, west of the hamlet of Vildnus/Wildnis and the Neivelsteiner Hof further to the northwest. The whole area was already transformed into one large quarry at the beginning of the twentieth century (CTK, sheet 764).

2988 De Groot 2006, 116, no. 501 (Bocholtz-Vlengendaal); Mater 1997, 81; https://www.rmo.nl/collectie/collectiezoeker/collectiestuk/?object=122216 (consulted 20-11-2020; Simpelveld). Sandstone is sometimes identified as Nivelstein without a proper analysis. For instance, a milestone at Rijswijk (Z.H.) and votive altars for Nehalennia at Colijnsplaat are described in some publications as made of Nivelstein, while they were originally published as '*Buntsandstein*' (Bogaers 1964, 45) and 'sandstone mainly from the Eifel (Stuart 2003, 46).

2989 Goossens 1912, 429.

2990 Kars 2005, 269, table 9.11

Because it is homogenous and not too hard, Nivelstein sandstone was widely used in the Roman period not only for building blocks but especially for 'sculpted elements' such as columns (including many Jupiter columns), other architectural stone and (grave) monuments. For instance, it was used in the crude 'sarcophagus' of Bocholtz-Vlengendaal as well as the superb one of Simpelveld.[2988] The occurrence in a 20 km radius around the quarry is not surprising, with examples of columns and capitals in the villa of Ten Hove, Vlengendaal,[2989] Kerkrade-Holzkuil,[2990] and probably a Iuppiter-column at Inden.[2991] However, the material was also used in places some 30-45 km from the quarry, such as Maasbracht and Tongeren, albeit on a lesser scale.[2992]

33.2.3 Other types of building stone

Marl

Maastricht limestone in particular – but potentially all limestone, as we have seen – is called '*mergel*' (marl) in the vernacular of Zuid-Limburg. This name is not correct from a petrological point of view because marl contains clay and Maastricht limestone does not. This limestone is porous and very soft; therefore, it is not carved but sawn and ground.[2993] With a compressive strength of (less than) 5% of that of Kunrade stone, it is not generally a suitable building material. However, it was used on a large scale in the vicinity of quarries during the Middle Ages and later. The reasons for this are that the stone is easily workable and the properties of some variants are quite advantageous in practice.[2994] They are weather-resistant due to their porosity and to the formation of a '*calcin*' (thin surface layer of calcite).

Some decorative building elements at Ten Hove are made of marl or marl-like rock. Two show only one level surface, one of these with deep sawing slots (typical of marl-working). A third must have been part of a cornice, framing a door or window for example (97-2-6/8349). A last piece to be mentioned most probably originates from the base of some kind of monument, such as a statue (10-2-14/1044; Fig. 33.1-33.2). This piece is relatively hard and could therefore also be a softer variant of Kunrade limestone or imported limestone (see below).

Although layers of quite soft stone are abundant in Kunrade limestone, this material differs significantly from marl in the sense of Maastricht limestone. It is granular, more brittle and quickly disintegrates if sawn or worked in another way. However, Maastricht limestone is reported to be present in relatively thin layers on top of the Kunrade limestone around Craubeek and south of this village in the Termoors dry valley. Felder described the 'Crauberger' and 'Ransdaler' stone as '...[quarried from the] higher part of the Kunrade limestone, forming the transition from this stone to the 'Sibber' or 'Valkenburgerstone' (Maastricht limestone).'[2995] In two published sections, we would expect the Maastrichter facies above the 'Craubeker Oysterlayer', being equivalent to the Romontbos horizon, the lower boundary of the Emael Member (RB in Fig. 33.3A).[2996] Instead, the sections show the typical alternation of hard and soft beds of Kunrade limestone, with little flint (see below). However, Felder described the softer stone as '...white-yellow coarse-grained [sic!] limestone, differing little from the Maastricht limestone to the west'.[2997] The correlation is not certain, however, and still too vague for a positive identification with the 'marl' found at Ten Hove.

There were some small underground quarries around Craubeek in the first half of the twentieth century.[2998] Marl or limestone of the Maastricht Formation was reportedly present there, but one that was completely unsuitable for building stone, only applicable for marling arable. If the marl found at Ten Hove was not quarried in Roman times, a provenance near the Geul valley – 3 km further to the southeast, 4 km from the villa – cannot be ruled out. This possibility relates to the origin of the *tauw* and flint discussed below.

Not surprisingly, Maastricht stone was used in the Roman period at the villa of Valkenburg-Heihof near the Geul valley.[2999] It was probably also used at the villa of Meerssen-Onderste Herkenberg near the same river,[3000] although the underground workings nearby – maybe of Roman date – seem to have produced harder limestone.[3001] The stone was found at the villa of

(190 pieces vs 104 of the 'Carboniferous or coal sandstone').

2991 Noelke & Geilenbrügge 2010, 130 ('*aus hellem weißlichen Sandstein*').

2992 Gazenbeek 2017, 74-75 (Maasbracht-Steenakker); Dreesen *s.a.*, 20-23, 28 (Heerlen, Tongeren); Panhuysen 1996, 91, table 1 (Maastricht; 8.6% of estimated volume); Goossens 1924 (part of well (at villa site?) Grevenbricht).

2993 Nijland *et al.* 2017, 13ff.

2994 With the 'Sibberblok' by far the best (Felder & Bosch 2000, 82).

2995 Felder 1978, 108.

2996 Section 62B-56 and especially 61 (cf. fig. 4.1A); Felder 1978, fig. 18-20; cf. 1977, fig. 1. A more detailed discussion on the correlation of sections on the basis of fossil remains, see Felder *et al.* 1985, esp. 186-187, fig. 17 (Romontbos horizon).

2997 Felder 1975, 56; cf. 1977, 171.

2998 The underground workings are described on Wikipedia (consulted 18-3-2021), s.v. Auvermennekesloak (Felder 1978, fig. 15, 62B-249), Croateloak/Penderskoolhof, Craubekergroeve (both 62B-248), groeve Sevensprong, groeve Kaardenbeek (62B-61). The locations can be found in the 'Atlas Limburg': https://portal.prvlimburg.nl/viewer/app/default > layer Historische geografie' > layer Ondergrondse werken (consulted 18-3-2021). Underground workings are typical for the quarrying of marl, see e.g. Diederen 1989.

2999 Holwerda & Goossens 1907, 11).

3000 Habets (1871, 383-384) mentions '*tuffreau* (*mergelsteen*)', which he differentiates from '*chaux*' (lime).

3001 De Groot 2005, 29.

Borgharen,[3002] in Tongeren,[3003] as well as in Maastricht.[3004] However, although a quarry was situated only 2.5 km from the latter *vicus*, Maastricht limestone was only represented by 4% of the 195 limestone samples analysed. It is also quite rare at Heerlen, and was mainly used for decorative stonework.[3005]

Other types of limestone

A small quantity of limestone is from the Meuse valley or of unknown provenance. It concerns 12 fragments (4 *kg*), three parts of building blocks and nine of unidentifiable burnt material (lime production?). Given the small quantity of limestone – respective to the original amount – in the material that we analysed, it is possible that the regional limestones were supplemented to a much higher degree than observable with imported stones from the Meuse valley. These kinds of stone were transported over quite large distances, even from northern France, to be used for high-quality decorative stonework.[3006]

Flint and tauw

A considerable amount of flint was present at Ten Hove, although small in comparison to the Kunrade stone, the main building material.

A striking category of flint consists of strangely shaped nodules, almost like tree branches or antlers, found in the foundations of porticus 16a and building 405, in the latter case in combination with limestone blocks. One piece was collected by Braat and some others ('flint pipes') are shown on the field drawing of trench 10.[3007] This flint is without doubt of local provenance; it can be observed even today in a few layers high up in the Kunrader Steengroeve.[3008] This flint is grey/light brown and present as small irregular flat nodules and in the 'tree-branch' shape. It is likely that this type of flint was simply a waste product of the quarrying of Kunrade limestone, but still suitable for foundations. The peculiar branch-like form is caused by the formation of flint in or around (deformed) lobster burrows.[3009]

The provenance of the flat slabs covering drain 317 is less clear. Four were collected in the 1980s, one (317-17/24-3-24/4737; Fig. 33.9) as a sample of the flint pieces, the others interpreted as limestone (317-18, 19, 20/24-3-25, 26, 27; Fig. 33.9). The slabs are quite heavy: 27.8, 33.8, 18.7 and 27.7 kg. Although the brown-grey colour is more or less similar to that of the flint in the Kunrade limestone, the size is different. Flat pieces of flint in this formation are generally much smaller. However, large flint slabs are common for Maastricht limestone, especially in the Schiepersberg and Emael members (layers above the SB and RB horizons respectively in Fig. 33.3A).[3010] Some 3 m of the latter member is present, for instance, at the Schaelsberg, on the northern side of the Geul, only 4 km from Ten Hove (Fig. 33.3A).[3011]

The three other sampled slabs of drain 317 are not of flint proper, but *tauw* (hardground), silicified limestone – often including flint nodules – formed during interruptions in the sedimentation.[3012] Several hardgrounds mark the boundaries of limestone members in the Maastricht Formation; relatively many are found in the Meerssen Member.[3013] However, the Romontbos horizon forming the base of the Emael member is also a hardground, albeit weakly developed,[3014] In the small quarry at the Schaelsberg, we personally found some flat slabs of *tauw* similar to those from Ten Hove, although of a smaller size.[3015] If the Emael member was indeed present in the (underground) quarries at Craubeek, it may have been possible to obtain flint slabs there.

On the basis of the above, it can be assumed that flint and *tauw* slabs could almost certainly have been collected 4 km south of Ten Hove. Perhaps there were outcrops containing this kind of material closer to the site, but there is no real evidence for this at present.

7-1-37/301

0 5 cm

Fig. 33.8 Voerendaal-Ten Hove. Fragment of a marble plate. (source: D.S. Habermehl)

[3002] De Kort *et al.* 2014, 69-71.
[3003] Dreesen & Vanderhoeven 2017, 78-81, fig. 2.9-10; 2.27-28.
[3004] Panhuysen 1996, 97-98, table 1.
[3005] Dreesen *s.a.*, 10 (quantity/percentage not given).
[3006] Hiddink & Dreesen 2014, 680 (Hoogeloon-Kerkakkers); Panhuysen 1996, table 1 (Maastricht); Coquelet *et al.* 2013; Dreesen *et al.* 2014 (Tongeren).
[3007] The piece in the RMO collection (1953/2.18) can be found at: https://www.rmo.nl/collectie/collectiezoeker/collectiestuk/?object=171342 (18-3-2022)
[3008] Felder (1977, 171) apparently saw these nodules ('very typical flint nodules') as indicative of the Emael horizon; nowhere does he mention large plates near Craubeek-Kunrade, however.
[3009] Felder & Bosch 1998b, 67, pl. 2,5. In the Maastricht chalk of the eponymous formation, these forms are particularly found in the Schiepersberg and Emael chalk, like the Kunrade chalk belonging to the lower part of the formation (according to Felder 1980).
[3010] Felder & Bosch 1998, 69, pl. 2,9; 2000, 160-162, fig. 7.1.2, 7.1.9. Erik Drenth identified 317-17 as 'Valkenburg' flint (pers. comm.) This often coarse-grained flint was quarried from the Schiepersberg and Emael members in the Neolithic, mainly south of the Geul, among others at Valkenburg-Plenkertstraat (Brounen & Ploegaert 1992).
[3011] Felder & Bosch 2000, 111-112, fig. 4.8. (62A-170, see also Felder 1978, 120, fig. 27). This site was also used as an extraction site in prehistory (Brounen & Ploegaert 1992, 193, fig. 1, no. 8).
[3012] Dusar *et al.* 2011.
[3013] Felder & Bosch 2000, 88-92, fig. 3.50.
[3014] Felder & Bosch 2000, 82.
[3015] The largest measuring c. 25 x 25 x 6 cm, with a weight of c. 7.5-8 kg. A collected specimen of 3 kg looks very much like flint at first sight, having a dark grey colour. The fractures are not

Fig. 33.9 Voerendaal-Ten Hove. Plate-like slabs used to cover drain 317, the upper one of flint (317-17/24-3-24/4737), the lower of 'tauw' (317-20/24-3-27). (source: D.S. Habermehl & H.A. Hiddink)

Marble

A small piece of white-rose marble has been found in trench 7 (Fig. 33.8; 7-1-37/301). One of the sides of this approx. 12 mm thick plate has been polished and it probably originated from one of the floors or walls of the main building or the baths. Although perhaps only petrographic research would be able to give a definite answer, the one small piece of white-rose marble almost certainly comes from the Mediterranean. The truly metamorphic, crystalline, sugary rock does not compare with any of the limestones used in the region as a substitute for marble (see below).

The fact that our find was part of a thin plate fits the pattern of marble use in the north, very often cut into wall or floor tiles to make optimal use of the material given the huge transportation costs.[3016] For villas in Dutch

conchoidal, however, and small fossils (including shells) are visible throughout the stone.

3016 Marble was, certainly outside the Mediterranean region, mostly used for small architectural elements and especially as tiles and panels, which – as thin slices of larger blocks – resulted in an optimal surface-to-weight ratio (Russell 2013, 162, 165).

Limburg, marble is also reported for Bocholtz-Vlengendaal, Heer-Backerbosch, Haelen-Melenborg and Meerssen-Onderste Herkenberg.[3017] These older reports should be read with caution because the name 'marble' was also – and continues to be – used in the stone trade for very fine, polished limestone. Examples are the black 'Theux marble' and 'Namur marble', the latter being present – according to Habets – at Meerssen.
Both 'marbles' were also used for tesserae and the *labrum* in the baths of Coriovallum. Here – as at Ten Hove – only a single fragment of Mediterranean white marble was found.[3018]

33.3 Furniture

Henk Hiddink

Some stone finds can be classified as falling somewhere between architectural elements and furniture proper. A first find is 400-17/1953-2.6, consisting of three fragments (1,041 g) of a small column (Fig. 33.10). Braat described it as a 'small sandstone column base'.[3019] It is probably not the base of a column, but the upper part. From the fact that is not a capital proper (although there could have been an astragal just below the preserved part) and the large hole in the centre, we can deduce that it is not a 'normal' architectural column. Moreover, the material is not (Nivelstein) sandstone, as Braat identified it, but a kind of dark grey shale. The object must have been used as the single, central leg of a stone table.[3020] Our fragments were found 'in room 18' of the main building, but this was not necessarily the original location. Stone tables were often placed in the cellars of buildings.[3021]

Eight fragments of apparently three granite basins were found at different locations (9,659 g; Fig. 33.11). All fragments have a rough, unfinished outer surface. The top or the rim and inner surface are smoothed/polished and a ridge separates a slightly concave upper section.
The reconstruction of the basin or basins is quite problematical. All fragments are just too small to obtain reliable measurements of the diameters. That of the base of 102-1-2/8919 – or rather, the ridge on the interior – seems to be c. 40 cm. The diameter of the inside of the rim is perhaps slightly larger and, in combination with the thickness of the walls of both fragments, we can deduce a height of c. 17.5 cm. However, it is not certain that the basin was round, for the outer edge of the everted rim seems to be straight, not curved like the inner one. The basin may have been fixed against a wall. A fragment from Braat's excavation (1953-2.18/13095) possibly had an inner top diameter of about 48 cm and a second one from the ROB excavations (20-1-61/2975) of approx. 50 cm.[3022] The positions of the ridges suggest that the fragments belong to two different basins. Again, it is not certain that both were round.

The six fragments (6,347 g) from trench 102 (102-1-2/8919) could have been placed in the bath originally, but as the findspot is situated halfway between the bath and the main building, it could also have been located in the latter.
The findspot of fragment 1953-2.18/13095 is unknown and could also have been part of the 'furniture' of the baths or the main building. Fragment 20-1-61/2975 was found in the vicinity of building 401 and must have ended up there after the villa fell into ruin.

The provenance of the granite is unknown. The nearest potential source is the central and northern Netherlands (130-250 km from Voerendaal), where large erratic boulders from Scandinavia can be found.[3023] These regions were situated outside the Roman empire, but this by no means excludes them as a source. Other areas with granites in Germania magna are the Harz and the Thüringer Wald, over 300 km away or northern Hessen (Felsberg), 250 km away. Granite from the latter location was used at Trier in the Roman period.[3024] The regions inside the empire where granite could be quarried were also quite far away, the nearest being the Vosges (over 250 km). Other potential source regions are the Schwarzwald (300 km) and Bretagne/Normandy (500 km).

33.4 Gravel, clay

Besides stone, some other materials from quarries – gravel and clay – were used in constructions at Ten Hove.

3017 Goossens 1916, 5 (Bocholtz-Vlengendaal); Habets 1895, 278 (Heer); Byvanck 1947, 62; Habets 1881, 222-244 (Haelen, some thought to come from Italy or Greece); Byvanck 1947, 19; Habets 1871, 390-391; De Groot 2005, 26-27 (Meerssen).

3018 Dreesen *s.a.*, 14-19; 26. On 'pseudo-marbles', see e.g. Dreesen *et al.* 2014, 18-19. In the Roman period, the question of what constituted 'real' marble was not relevant; it was simply all stones that could be polished (Russell 2013, 10). Of course, different kinds of stone were valued for their colour/pattern, rarity, etc.

3019 Braat 1953, 72, fig. 13, no. 61.

3020 Haug 1919; Mutz 1986 (Augst and other sites, a good deal of information on production); Gaubatz-Sattler 1999, pl. 130 (*vicus* Rottenburg, BW); Schmidt *et al.* 2005, 306-307 (building 19, *vicus* Walheim, BW).

3021 Haug 1919 (including possible examples), 104, no. 17-20; 105, no. 25, 26, 30, 35 (villas and *vici* D/BW); Wamser 1977, 39. It is not known to the author whether the table of Walheim was originally found in the cellar.

3022 A *labrum* from Jemelle (B/NA) illustrated by De Maeyer (1937, 186, fig. 61) has an outer diameter of c. 50 cm, although it is not clear whether this is a reconstruction.

3023 These boulders were used in some Medieval churches in the Betuwe but had been transported over distances ranging from only 10 to 30 km (Berends *et al.* 1982, 32).

3024 Russell 2019, 163.

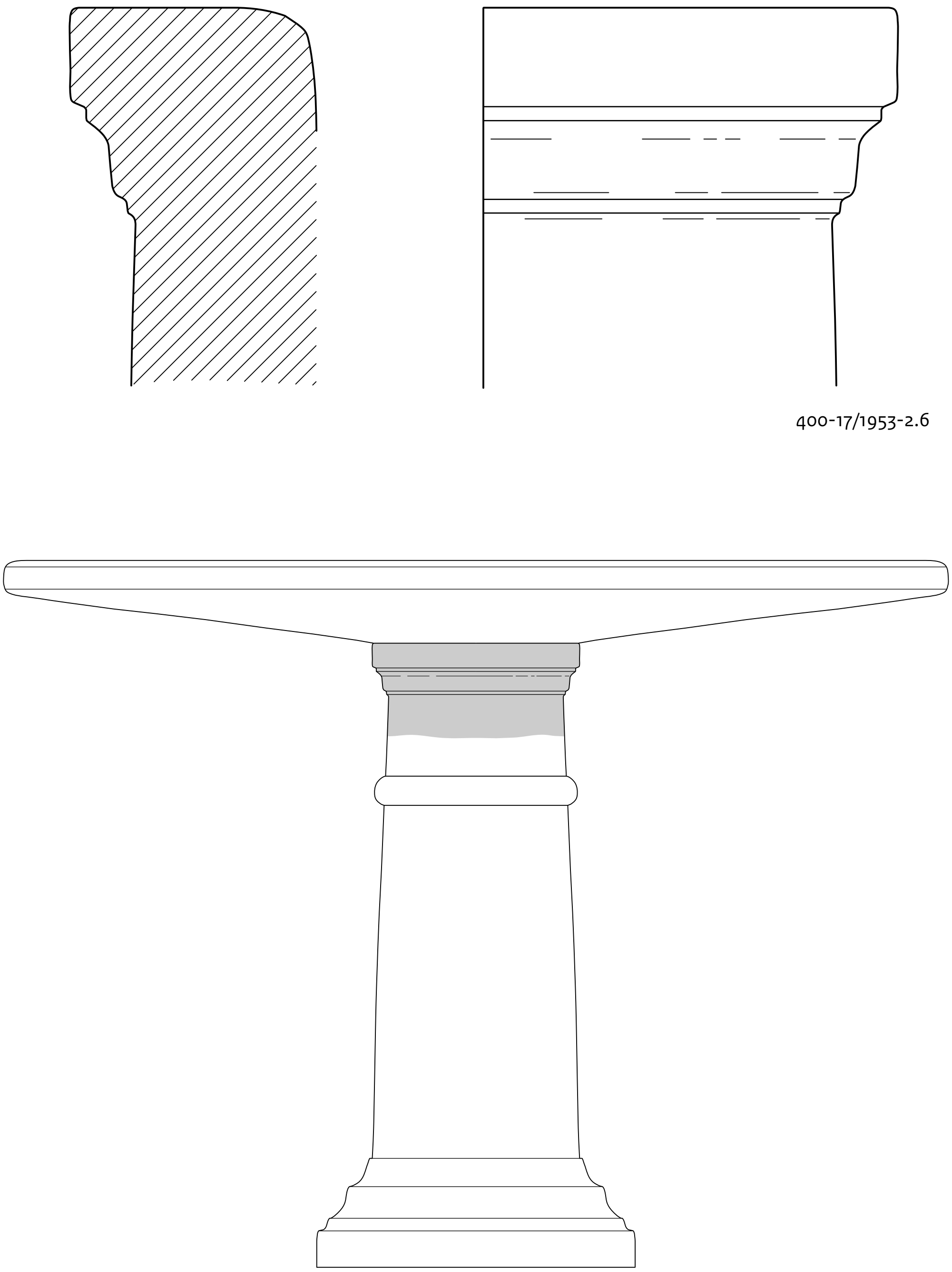


Fig. 33.10 Voerendaal-Ten Hove. Fragment of a table leg shaped as a column and reconstruction. Scale 1:2, reconstruction 1:8.

33.4.1 Gravel

Gravel was used as a bottom layer in basin 319 and for the foundations of small temple 411.
In both cases neither the size, sorting, colour nor type of stone were recorded. Therefore, the exact provenance will remain unknown. Gravel was also found at the bottom of well 314 and if this was not brought from elsewhere to serve as a filter, it could have been part of a natural layer (slope deposits?).[3025] In the latter case, it is possible that this and other wells were the

[3025] Section 4.1.1.

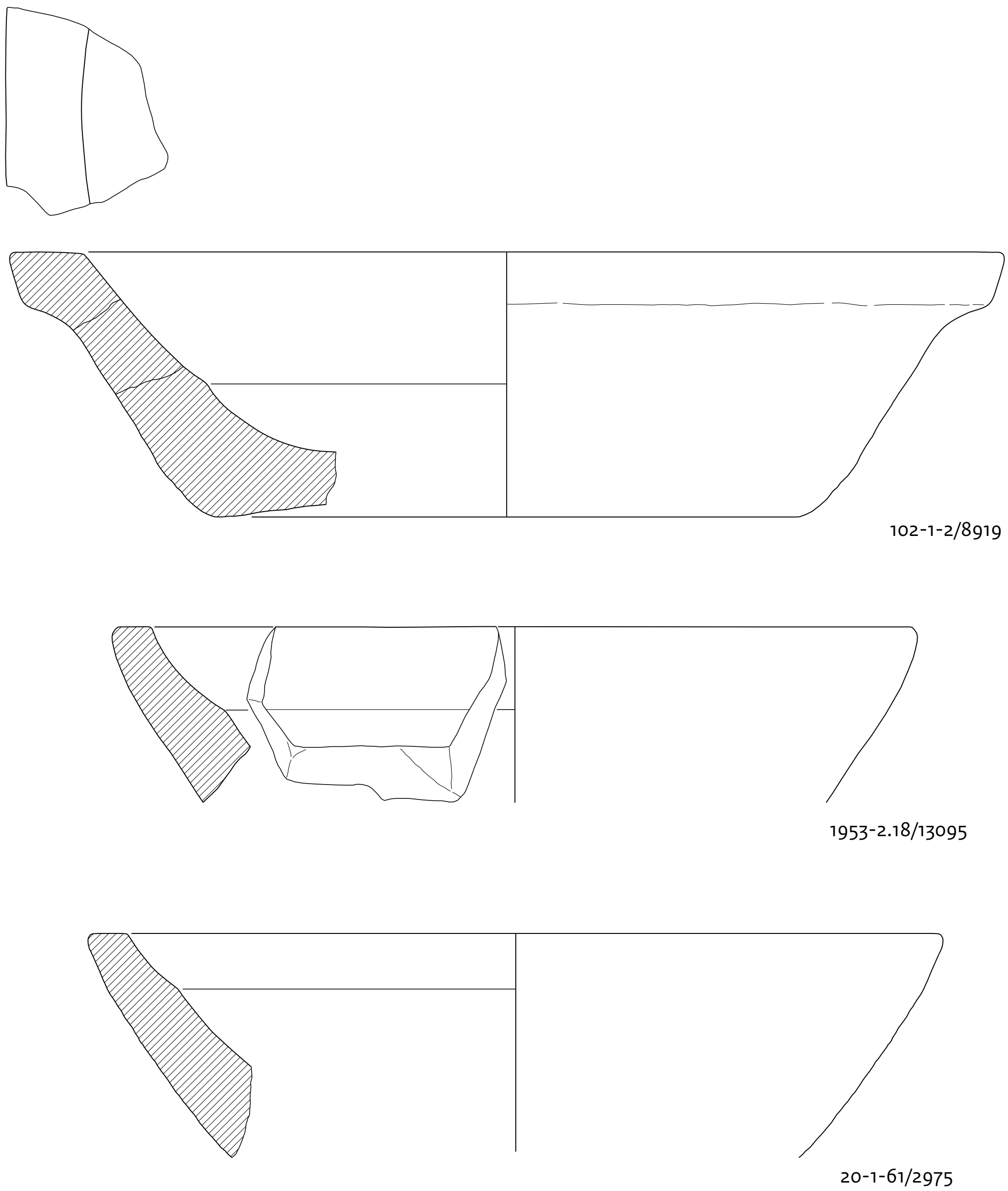


Fig. 33.11 Voerendaal-Ten Hove. Fragments of granite basins. Scale 1:5.

'quarries' for modest amounts of gravel. If all the gravel at Ten Hove came from elsewhere, the sources could have been situated only 1 km away (slope deposits), but most likely at a distance of somewhat over 5 m. While Voerendaal and Heerlen are situated on an 'island' outside the sedimentation area of the Pleistocene Meuse, fluviatile gravels and sands are present almost everywhere else in Zuid-Limburg, albeit often under a loess cover.[3026] As gravel was used on a large scale for Roman roads around Heerlen, it was probably also readily available in the close vicinity of Ten Hove.

33.4.2 Cerithium clay

A second kind of unconsolidated material used at Ten Hove is clay. Braat mentioned blue clay, applied at the base of some foundations, apparently to prevent rising moisture. Blue clay was also observed at the location where drain 328/β was connected to the wall of the baths.[3027]

[3026] Felder 1989.
[3027] Braat 1953, 50.

In the first year of the ROB excavations, green clay was documented at the end of drain 317 in trench 13. It was probably identical to the blue (the colour used in the drawings) clay found during the 1987 campaign in several structures (aqueduct 316, drain 217, basin 319, 413).
On several occasions this clay is named 'Cerithium clay' (or misspelt as 'Siricium clay') and once '*beekklei*' (brook clay), described as 'putty-like'. Photographs show a grey-light blue clay, sometimes with lumps of green or yellow (Fig. 10.3B-C; 10.9B; 10.11B; 10.12C).

Cerithium clay is named after a frequently occurring fossil,[3028] and is presently named a Goudsberg Member of the Tongeren Formation.[3029] The clay, together with some sand, was deposited under lagoonal conditions with local influences from a coastal plain, the latter represented by layers of lignite. Deposition took place in the Oligocene, after c. 34 My ago. Although the Tongeren Formation is indicated on the geological map in a large area around Ten Hove (Fig. 33.3B),[3030] north of the Kunrade Fault it was eroded away in the stream valleys, while the remaining parts are covered by metres of loess. There are also large areas with Tongeren Formation deposits south of the fault, but most of these are also covered by loess. The available geological maps give no clues about outcrops or clay under a thin layer of loess. The only published data on outcrops of the Cerithium clay/Goudsberg Member proper can be found in an article by Felder.[3031] The area around the Goudsberg is one of them, together with an area near the Krekelenbos and a road cutting located south of Ransdaal.[3032] These sites are some 4-5 km south of Voerendaal.[3033]

Because there is no concrete evidence that the blue clay at Ten Hove is Cerithium clay, or that all the clay used was of this type, we investigated whether any clay was present in the subsoil in the vicinity. The use of 'brook clay' as a synonym for Cerithium clay on the field drawing of trench 93 suggests that eroded and redeposited (Cerithium) clay could be found in stream valleys. The commentary on the geological map does not mention clay as part of Holocene brook deposits, however,[3034] nor was clay found in the bore holes in the Hoensbeek valley just south of our villa.[3035] Another way in which clay could be associated with valleys is that layers covered by loess ridges, (nearly) outcropped at the edges of valleys. However, only a small portion of the loess and colluvium layers that filled the post-Oligocene valleys was eroded later. The clays of both the Tongeren and Rupel Formation appear to be hidden under some metres of loess, even at the valley edges.[3036]

If the focus is shifted away from only the stream valleys and their edges, the available geological data indicate the presence of clays at depths of 6 m or more around Ten Hove, increasing to 11-25 m close to the Kunrade Fault.[3037] South of the fault, the areas with clays are those around the Cerithium clay outcrops mentioned above. Even in a large part of these areas the clay is reached only at a depth of several metres.

33.5 Querns and millstones

In total, 96 fragments were identified as parts of querns and millstones (Table 33.5). Over 81% are made of vesicular basalt lava, but a significant proportion consist of coarse sandstones and conglomerates (in three variants).
Three fragments of two millstones are of sandstone. This section will discuss the millstones according to rock type.

33.5.1 Coarse sandstones and conglomerates

Description
Table 33.6 gives an overview of the typological characteristics and measurements of the millstones made of coarse sandstones and conglomerates. For the majority of the

Table 33.5. Voerendaal-Ten Hove. Number and weights of querns and millstones according to rock type.

Rock	N	Wt (g)
Coarse sandstones, conglomerates	13	14678
Sandstone	3	3286
Vesicular basalt lava	78	52038
Total	**96**	**70932**

3028 Cerithium (plicathus, lamarcki and others) was renamed Potamides (Spaink 1963; Janssen 1963).
3029 Ebbing *et al.* 2003; Kuyl 1980, 59; Wouters & Vandenberghe 1994, 91-92 (Belgium: lagoonal green Henis Clay in Borgloon Formation). The clay was probably identified by Werner Felder, although there are no notes or remarks in daily reports on this. We tried to locate a sample from the clay in aqueduct 316 (93-2-1) but this does not appear to have been kept.
3030 Geologische kaart Zuid-Limburg 1984.
3031 Felder 1965; cf. Spaink 1963.
3032 In the Krekelenbos area, we found clay at a depth of 10-20 cm at some locations. The road cuttings near Ransdaal are grown over at present. According to Felder, there is no outcrop proper near the Goudsberg, but fossils at the surface hint at the presence of clay in the subsoil (1965, 4; Romein 1966, (caption) photo 16).
3033 According to Felder (1989, 106), there are also outcrops further west, in the northern slopes of the Geul valley.
3034 Kuyl 1980, 106, section 7.2.1.
3035 According to the data in Dinoloket (cf. Chapter 4).
3036 Only bore hole B62B4478 just north of the Retersbeek indicates 58 m of clay under a 3 m loess cover. It is unclear how to interpret this, also because B62B0772, a few dozen metres away, gives only some thin clay layers below 8 m of loess.
3037 All bore holes (https://www.dinoloket.nl/ondergrondgegevens) in the area with Tongeren-Goudsberg (ToGo) clay, as indicated by the hydrogeological model Regis version 2.2 (https://www.dinoloket.nl/ondergrondmodellen), were checked for the presence of any clay.

Table 33.6. Voerendaal-Ten Hove. Typological characteristics of millstones from coarse sandstone and conglomerates.

Item	Findno.	Id	Rock	Wt (g)	Part	Diam. (cm)	Thickn. (mm)	Section
222-4	107-2-36	9667	light-coloured arkosic	235	indet.	-	35-45	-
409-49	68-4-18	7001	light-coloured	4600	catillus	560	75	pl-cc
409-75	68-2-96	6989	light-coloured arkosic	1256	meta	-	80	-
409-76	68-2-96	14046	light-coloured	1009	meta	-	50-65	-
409-77	68-2-96	14047	light-coloured arkosic	749	indet.	-	55	-
409-78	68-4-2	6508	light-coloured arkosic	858	meta	-	80	-
409-79	68-3-19	6504	indet.	930	meta	-	90	-
715-2	14-1-21	2040	light-coloured	1137	indet.	-	75	-
-	16-3-23	2522	light-coloured arkosic	1267	indet.	-	80	-
-	68-0-0	7005	light-coloured	300	indet.	-	30	-
-	96-2-1	8292	dark red	630	indet.	-	65	-
-	101-2-1	8733	light-coloured arkosic	533	indet.	-	50	-
-	107-2-1	9649	light-coloured	1174	catillus	-	60	pl-pl

All represented by 1 fragment. pl-pl plan-parallel; pl-cc plan-concave.

fragments, only the thickness can be established. The thickest stones are 80-90 mm, the most worn ones 30-50 mm. Five of 13 stones are *meta* or bedstones, seven could not be identified and one of the fragments belongs to a *catillus* or runner stone (409-49/68-4-18; Fig. 33.12). Its diameter is 560 mm, and its thickness at the circumference is 75 mm, tapering to 50 mm. The grinding surface has an angle of 15° relative to the horizontal, while the upper side of the *catillus* only slopes a few degrees. The rough grinding surface shows little pits, left behind by dispatched pebbles. Concentric grooves due to wear are faintly visible. Part of a rounded rectangular, 15 mm deep hole is visible on top of the *catillus*. It was used to mount the (wooden) structure to drive the millstone. The peripheral drive will have been performed by either human or animal force.

The *catillus* from find 107-2-1/9649 is typologically different. This central piece has a thickness of 60 mm and a plan-parallel section. Both the upper side with clearly visible chisel marks and the rough grinding surface are horizontal. Part of the central 50-60 mm wide axle hole is preserved. Find 409-79/68-3-19 also has a plan-parallel section. Both the level and smooth grinding surfaces and the basis of this *meta* are horizontal.

Most millstones show chisel marks on their non-grinding surfaces, attesting to their production from quarried rock. One of them also shows a simple curved furrow pattern (type 5) on the grinding surface (409-77/68-2-96).[3038] The slightly curved lands are 20-25 mm apart, separated by a furrow a few millimetres deep.

Distribution

Most conglomeratic millstone fragments were found in the cellar of structure 409, in the trench where this building was situated (68), as well as other trenches in this zone. The upper part of the cellar was used as a refuse pit, where large quantities of pottery fragments and iron slag were also found.[3039] The presence of two fragments reused as a grinding stone or muller is striking. Find 409-80/68-2-96, for example, is a millstone fragment of 80 *x* 65 *x* 35 mm showing a number of facets caused by grinding. It is unclear whether it was used to grind metal or grains, seeds and nuts. The same applies to 409-81/68-2-87. This almost cylindrical piece of a conglomeratic millstone has a diameter of around 70 mm and a height of 75 mm. Six slightly convex facets are ground along the circumference of the stone. It is possible that both stones were used by a blacksmith working in this area and that he

[3038] Lepareux-Couturier 2014, 153, fig. 11.
[3039] See Chapter 23 and 34.

Fig. 33.12 Voerendaal-Ten Hove. Fragments of (conglomeratic) sandstone querns. Scale 1:5.

collected the other millstone fragments for future use. However, the stones could have been grinding stones for the preparation of foodstuff.

Provenance

Five fragments of coarse and conglomeratic sandstone appear as a white to pale grey rock with yellowish and rose shades as weathering colours. Dark-coloured (rusty) small crystals, mica flakes and small white spots are present. Macroscopically, these rocks are identified as Lower Devonian coarse sandstone and conglomeratic sandstone. Two major outcrops are known in the Ardennes: the Rocroi Massif (F/Ard. and smaller part B/HT) and the Stavelot-Venn Massif (B/HT; Fig. 33.13).[3040] Within these outcrops, two major quarrying areas have been identified based on the landscape and the presence of semi-finished querns and millstones. For the area of Salmchâteau and Recht (Stavelot-Venn outcrop), only prehistoric, Medieval and modern extractions can be proven. Roman exploitation is only known from the Hirson and Macquenoise area (Rocroi Massif; Fig. 33.13).

Six fragments of coarse or conglomeratic sandstone appear as a grey, pink or pale red rock. Abundant feldspar crystals are partly weathered to white spots, and occasionally lithoclasts from sandstone, siltstone or quartzites can be seen. Macroscopically, these rocks are identified as Lower Devonian coarse sandstone and conglomeratic sandstone.[3041] Although no Roman quarry is known at present, deposits are known in the south and southeast of the Rocroi Massif and in the area around Transinne (B/LX).

One fragment of a millstone consists of a dark red conglomerate. The poorly sorted and well-rounded granules and pebbles appear in a dark red matrix. Macroscopically, this rock is identified as a Lower but probably Middle Devonian conglomerate (Burnot Formation).[3042] No Roman quarries are positively identified, but the number of possible sites is large because there are many outcrops in the valleys of the Sambre, Meuse, Vesdre and their tributaries.

33.5.2 Sandstone

Two pieces of sandstone are identified as part of a saddle quern and rotating millstone.
The saddle quern is only a corner of a larger stone with a smoothed, concave grinding surface (107-1-3/9640; Fig. 33.12). It is made out of an unknown, pale red and poorly sorted sandstone

3040 Reniere *et al.* 2016, 412-413.
3041 Reniere *et al.* 2016, 413-415.
3042 Reniere *et al.* 2016, 410-412.

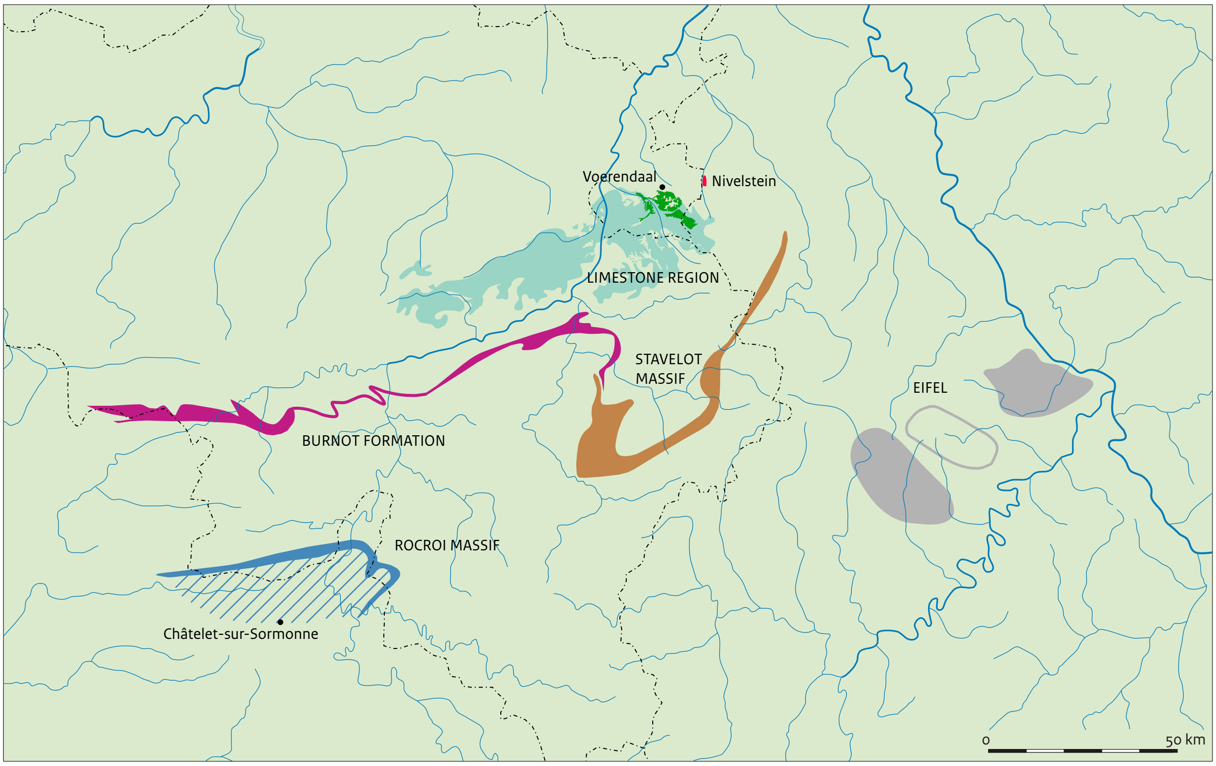


Fig. 33.13 The possible provenance areas of millstones, sharpening tools etc.

with subangular grains. Typologically, the saddle quern can be characterized as type 1, which can be dated in the Neolithic and the Bronze Age.[3043]

The sandstone rotating quern has a plan-parallel section and a remaining thickness of 28 mm (68-1-3/6251; Fig. 33.12). Chisel marks can clearly be seen on the roughly hewn basis of the 560 mm diameter *meta*. The level and smooth grinding surface is confined by a ridge a few millimetres high and 20 mm wide, demonstrating that the *catillus* had a 40 mm smaller diameter.

33.5.3 Vesicular basaltic lava

Description

Table 33.7 gives an overview of all the fragments of vesicular basaltic lava that have been identified as parts of millstones or querns, including their measurements and typological characteristics. Only 47 of the 78 fragments from 13 individuals show any typological characteristics. The rest are highly fractured and only parts of either the grinding or outer surface can be recognized. Table 33.7 shows clearly that the Westerwijtwerd type of quern was the most widely used at Ten Hove. This typically Roman-period quern type replaced the 'Celtic' quern around the middle of the first century AD and remained in use throughout the Middle Roman period.[3044] Catilli or runner stones of the Westerwijtwerd type typically show a raised rim, a wedge-shaped section and a decorative pattern of grooves on the outer sides.

Variability in the Westerwijtwerd querns from Voerendaal-Ten Hove can be observed in their section. Three of them show a typical wedge-shaped section. Three querns have a plan-parallel section and one of them has a concave, sloping grinding surface and a horizontal upper side (775-3/16-5-44; Fig. 33.16). On the other hand, the angle of the grinding surface to the horizontal is quite consistently confined to 10-12 degrees, with 775-2/16-5-44 as an exception (Fig. 33.16). Runner stone 409-48/68-4-18 can be taken as an example of the wedge-shaped Westerwijtwerd type of quern (Fig. 33.14). Both the top and the rim show faint decorative grooves at an angle to the radius.

3043 Hörter, 2000, 60, fig. 1; Holtmeyer-Wild, 2014, 162, fig. 6.

3044 Van Heeringen 1985, 378. Both Westerwijtwerd and Brillerij (see below) are in the province of Groningen, northern Netherlands.

Tabel 33.7. Voerendaal-Ten Hove. Typological characteristics of millstones and querns from vesicular basalt lava.

Item	Findno.	Id	N	Wt (g)	Part	Typology	Diam (mm)	Thickn (mm)	Section	Angle(°)
409-46	68-3-6	6502	1	3000	catillus	Haltern	-	135	wedge	17
409-48	68-4-18	7000	3	929	catillus	Westerwijtwerd	380	80	wedge	11
419-1	111-1-3	10118	1	2419	catillus	Westerwijtwerd	400	70	wedge	10
510-11	13-2-9	1951	1	111	indet.	-	-	-	-	-
633-2	16-5-52	2654	1	12	indet.	-	-	-	-	-
756-3	105-3-5	9196	2	62	indet.	-	-	-	-	-
757	108-2-7	9874	1	960	indet.	-	-	65	pl-pl	-
761-3	107-3-11	9672	11	1045	indet.	-	-	-	-	-
775-2	16-5-44	2647	17	12000	meta	Westerwijtwerd	572	90	pl-cc	2
775-3	16-5-44	12026	9	12100	catillus	Westerwijtwerd	610	55	cv-cc	12
794-6	101-2-11	8738	1	30	indet.	-	-	-	-	-
801-2	108-2-3	9872	1	81	indet.	-	-	-	-	-
-	16-2-24	2330	1	98	indet.	-	-	25	pl-pl	-
-	16-3-10	2449	4	62	indet.	-	-	-	-	-
-	27-2-7	5612	2	6200	catillus	Westerwijtwerd	420	65	wedge	12
-	68-2-20	6496	7	1619	meta	-	-	-	pl-cc	
-	95-1-13	10720	1	9300	meta	Brillerij	300	55	cv-cc	-
-	96-4-1	8296	2	474	catillus	Westerwijtwerd	-	75	-	12
-	101-2-4	8735	3	90	indet.	-	-	-	-	-
-	102-1-1	8917	1	547	meta	-	-	55	-	-
-	104-2-6	9075	1	146	indet.	-	-	-	-	-
-	105-5-2	9198	1	21	indet.	-	-	-	-	-
-	106-1-6	9248	5	606	indet.	-	-	-	-	-
-	107-1-16	9645	1	126	indet..	-	-	25	pl-pl	-

Two other Westerwijtwerd querns of 400 and 420 mm diameter show a hole through the rim (419-1/111-1-3; 27-2-7/5612; Fig. 33.14; 33.15). The typical hand mill was driven by a rod fixed to the quern by means of a rope inserted through this hole on the circumference of the stone.

The archaeologically complete, 572 mm diameter *catillus* 775-3/16-5-44 has an upper surface with faint decorative grooves (Fig. 33.16). These grooves are confined by an 8 mm wide, shallow and concentric groove around the 112 mm wide central axle hole. Its sloping (12°) grinding surface is smoothed and no dressing can be seen. Part of a rectangular hole has been made tangential to the axle hole; it carried the *rynd* (a crossbar for the bearing) of the quern. One of the fragments of the *catillus* also shows part of a rectangular hole on the upper side. It will have been used to mount the (wooden) installation for the peripheral drive, powered by either human or animal power. The shape of its section, combined with signs of wear, suggests a clockwise direction of rotation.

A bedstone or *meta* from a quern with a 610 mm diameter was found in the same pit (775-2/16-5-44; Fig. 33.16). Although from the same context, this bedstone did not originally belong to the runner, given the different degree of weathering of the two grinding surfaces. The smoothed surface of the *catillus* contrasts with the clearly visible, complex, straight furrow pattern (type 6) of the *meta*.[3045] The estimated number of harps in which the furrows are divided is ten and the direction of rotation was

[3045] Lepareux-Couturier, 2014, 153, fig. 11.

BASALTIC LAVA

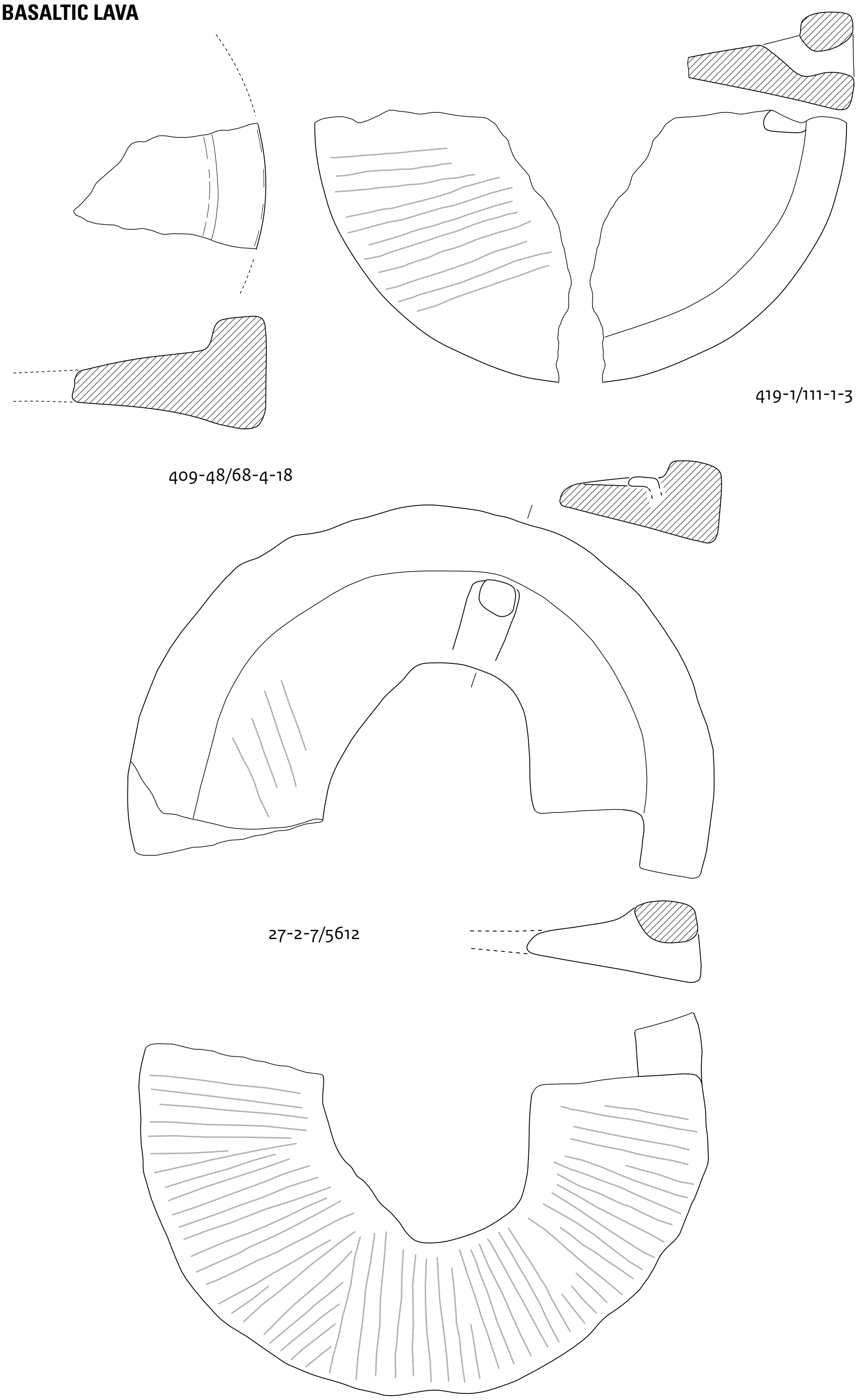


Fig. 33.14 Voerendaal-Ten Hove. Fragments of querns of vesicular basaltic lava. Scale 1:5.

Fig. 33.15 Voerendaal-Ten Hove. Two examples of querns of vesicular basaltic lava. (source: D.S. Habermehl & H.A. Hiddink)

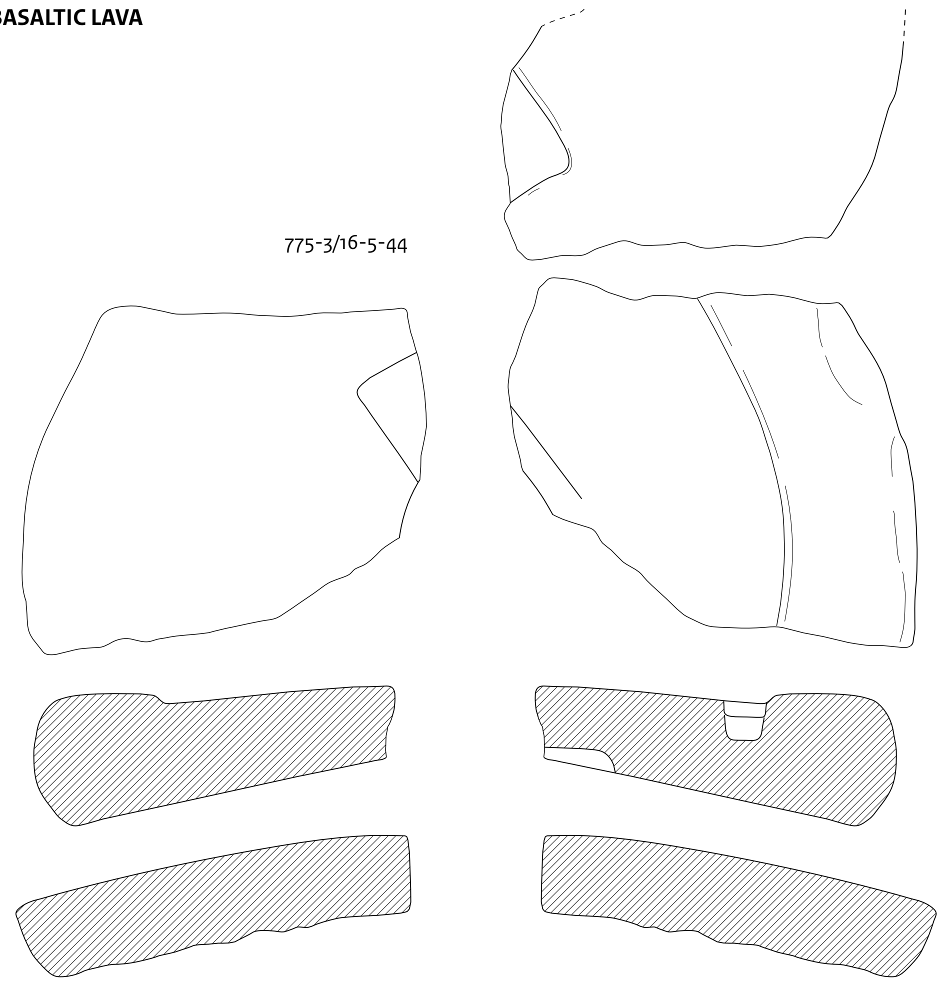
clockwise. The base of the *meta*, with a 70 mm central axle hole, shows long, parallel chisel marks from the quarry confined by a worn skirt, a few centimetres wide, forming the support base of the quern.

Furrowed dressing patterns are recognized on three other querns. Heavily weathered wedge-shaped runner stone 419-1/111-1-3 faintly shows a simple straight furrow pattern (type 4; Fig. 33.14).[3046] Find 102-1-1/8917 also shows some straight furrows fanning out from the non-preserved centre (probably type 3). A last example, a small piece of a *catillus* rim, also shows faint traces of furrowing (96-4-1/8296).

Typologically different from the Westerwijtwerd querns, but also Roman in date, is the larger Haltern- type millstone (409-46/68-3-6; Fig. 33.17). Typically driven by two people or by animal power, it was used in diameters ranging from 480 to 900 mm.[3047] The diameter of the Voerendaal-Ten Hove find cannot be measured as its preserved circumference is too small. What can be observed is a straight grinding surface sloping at 17 degrees and an outer rim decorated with grooves. Part of a hole

[3046] *Ibidem.*
[3047] Hartoch & Manteleers, 2015, 35.

BASALTIC LAVA



775-3/16-5-44

775-2/16-5-44

Fig. 33.16 Voerendaal-Ten Hove. Fragments of querns of vesicular basaltic lava, cont. Scale 1:5.

with a rectangular section (50 x 100 mm) can be observed in this rim. It was typically applied to mount the (wooden) beam for the peripheral drive, powered by either human or animal power. The millstone has been used intensively given the small, preserved radius and very small thickness at the apex of the wedge.

A last quern to be described here can classified as a Brillerij type of the Late Iron Age (95-1-13/10720; Fig. 33.17; 33.15). The *meta* with a 300 mm diameter typically shows a highly convex and smoothed grinding surface. The central axle hole has a width of 30 mm, measured on the grinding surface and tapering out to 50 mm at the bottom of the stone.

Distribution

While 24 fragments of basaltic querns were found during the preparation of excavation levels, 54 fragments from 13 individual querns were found in dated contexts. The earliest contexts are from the Iron Age. Find 105-3-5/9196 was collected from Middle Iron Age pit 756. Most probably part of a non-rotating quern, it consists of two small fitting fragments, showing a small part of a highly smoothed grinding surface. Find 101-2-11/8738 was found in Late Iron Age pit 794. This small rim fragment only shows a small portion of its grinding surface. The quern of the Brillerij type was found in trench 95, inside enclosure 308 and near the (possible) Late Iron Age buildings 222 and 223.

Two fragments of basaltic querns were recovered from the upper fill of cellar 409, dating before c. AD 125. One of these fragments is the above-described Haltern-type millstone 409-46 and the other is the typical Westerwijtwerd wedge-shaped runner stone 409-48.

Eleven fragments were found without any typological characteristics in pit 761. The other finds from this context suggest a terminus post quem of c. AD 150/175, suggesting that the millstone fragments could belong to the villa period or beyond. The pit is situated close to Late Roman building 226. Both the *catillus* 775-3 and *meta* 775-2 were found in a pit with a similar imprecise date to that of 761. The pottery sherds are from the late second or third century AD; therefore, the querns could have been used in or near building 401, 15 m to the east. However, the pit lies in an area with Late Roman/Early Medieval structures (building 241, sunken hut 511, hearth 633-634). It is even possible that Roman millstones were reused in a later period.

Most of the other quern fragments have been found in Late Roman and Early Medieval contexts. Although highly fragmented, pieces of querns have been found in sunken hut 510,

BASALTIC LAVA

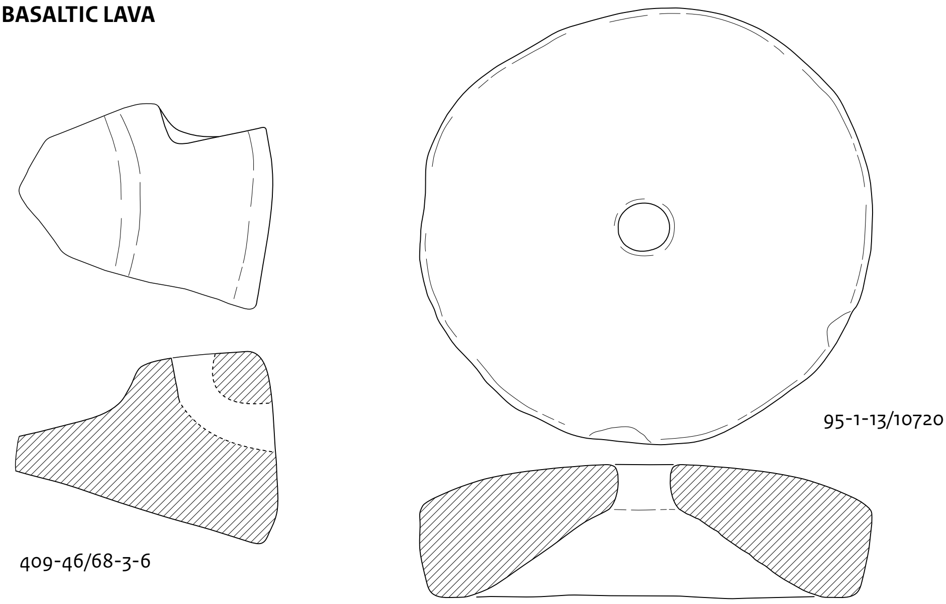


Fig. 33.17 Voerendaal-Ten Hove. Basaltic lava querns of the Haltern (left) and Brillerij type (right). Scale 1:5.

furnace 633 (cf. above) and pits 757 and 801. Finally, 757-42/108-2-7 from pit 757, which shows a plan-parallel section, is worth mentioning.

Provenance
The basalt-like lava of the Voerendaal finds is a fine-grained, grey and highly vesicular rock with common xeolith inclusions. Clinopyroxene phenocrysts as well as occasional larger sanidine phenocrysts can be observed on a fresh surface. The vesicular basalt lava can in fact be characterized as a tephritic phonolite.[3048] These volcanic rocks were mined in the Vulkaneifel in Germany from pre-Roman times until modern times.[3049] Three volcanic fields are known in this region. The Hocheifel is of Tertiary age, while the East and West Eifel are of Quarternary age (Fig. 33.13).[3050] Although only geochemical research could enable differentiation,[3051] most (pre)historic quarries are known from the eastern and western area, with most extensive Roman-period activities in the former one north of Mayen.[3052]

33.6 Grinding and sharpening tools

Description
A total of 32 stone fragments are identified as parts of grinding tools. Eleven fragments can be characterized as a grinding block, or as parts of larger grindstones. They are generally made of different kinds of sandstone, without a known provenance (13-2-6/1948; 107-1-16/9644; Fig. 33.18). One is a rounded quartzite boulder (102-1-3/8920; Fig. 33.18) and another is made from a fragment of a conglomeratic millstone (409-82/68-4-10). Item 222-2/107-1-18 shows faint scratches at one end and could have been used as a handheld grinding tool or perhaps a pestle (Fig. 33.18).

The largest group of grinding tools is made up of whetstones (Fig. 33.20-21). Table 33.8 gives an overview of the different rocks that the whetstones are made of and the shape of their sections. Most numerous are stones from the typical dark grey 'Roman' phyllite. Only a few are made out of sedimentary rocks and one of them consists of amphibolite (418-2/95-4-23; Fig. 33.20).

All the whetstones are longitudinal, with the shape of the section depending on the raw material and use Table 33.8 shows clearly that the whetstones from sedimentary rocks and amphibolite all have a rounded rectangular section. This is mainly determined by natural cleavage of the raw material. Even collected boulders often have a more or less rectangular shape. The phyllite whetstones are manufactured with an oval section, indicating that any difference in shape is caused by use.

Provenance
Although only proper petrographic research can give a definite answer, the 'Roman' phyllite whetstones probably originated from the Roman workshop at Le Châtelet-sur-Sormonne (F/Ard.; Fig. 33.13). An important whetstone industry developed there, quarrying the sedimentary and low-grade metamorphic rocks extracted from the Caledonian inliers, in particular those from the Rocroi Massif.[3053] Most of the manufactured whetstones are from a blue to dark blue micaceous siltstone or fine-grained, well-sorted argillaceous sandstone with a slaty cleavage.

Table 33.8. Voerendaal-Ten Hove. Overview of the different rocks used for the whetstones and the shape of their section.

Rock	N	Round section	Oval section	Sharp oval section	Rounded rectangular
Amphibolite	1	-	-	-	1
Phyllite	15	2	9	1	3
Quartzitic sandstone	1	-	-	-	1
Siltstone	3	-	-	-	2
Sandstone	2	-	-	-	2
Total	**22**	**2**	**9**	**1**	**9**

3048 Reniere *et al.* 2016, 409.
3049 Mangartz 2008.
3050 Reniere *et al.* 2016, 409.
3051 Gluhak & Hofmeister 2009; 2011.
3052 Hörter 1994, esp. 31; Reniere *et al.* 2016, 410.
3053 Thiébaux *et al.* 2016, 582.

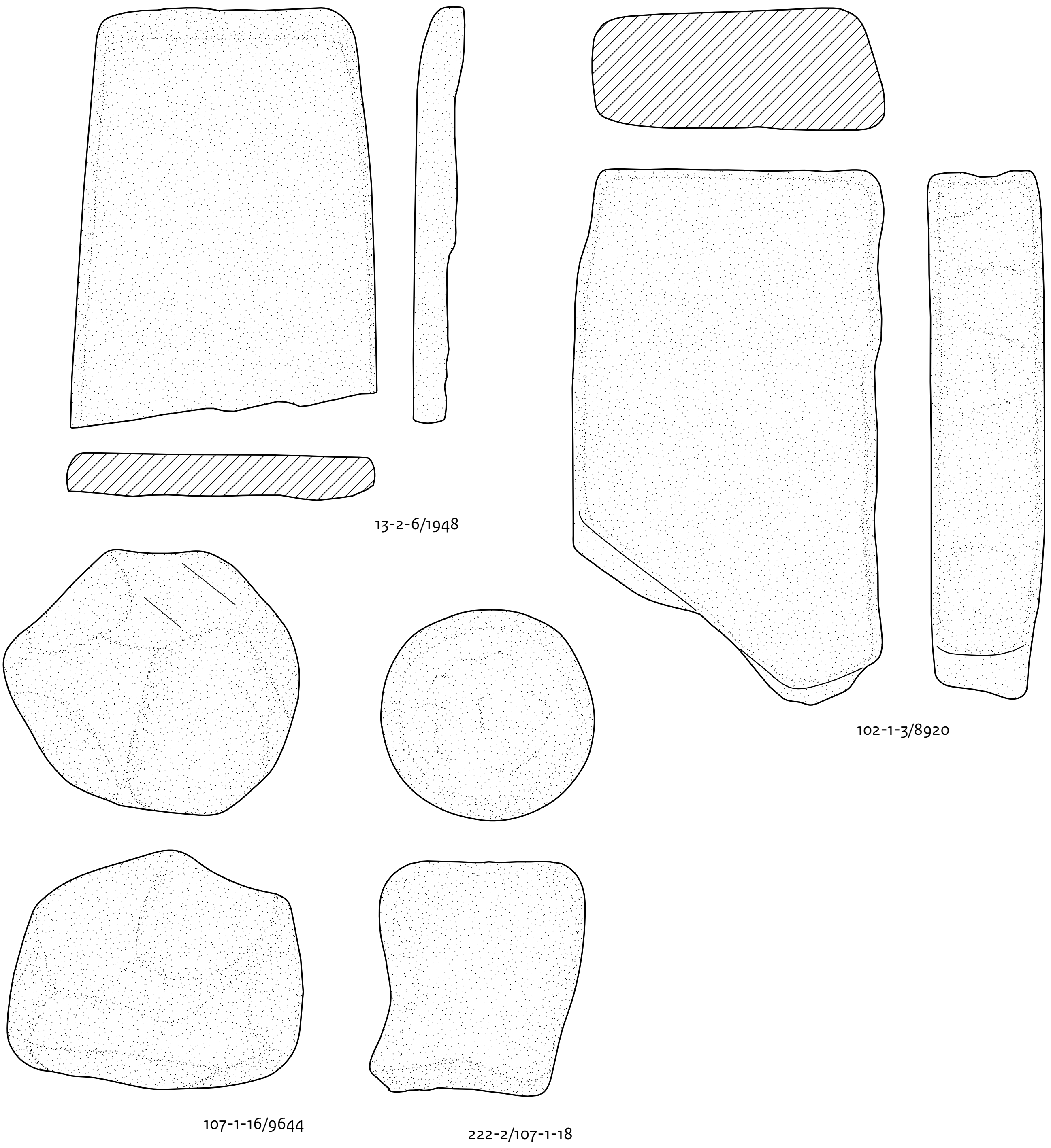


Fig. 33.18 Voerendaal-Ten Hove. Stone grinding tools and a hammering stone (lower right). Scale 2:3.

The intensity of colour is inversely proportional to the average grain size. Its black colour is due to the presence of finely disseminated organic matter. Low-grade metamorphism causes its slaty cleavage.

33.7 An anvil and a hammerstone

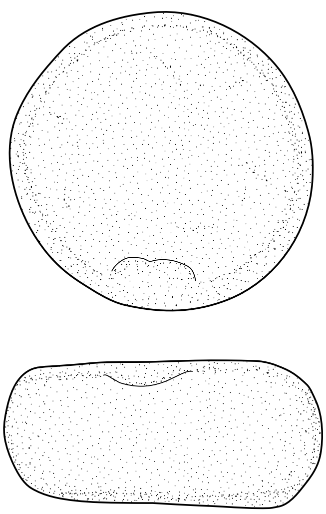
One of the field drawings suggests that anvil 401-2/20-3-97 (Fig. 33.19) was built into one of the walls of building A (structure 401). However, it could also have been placed against the wall. The anvil was a river boulder of dark grey Revinien quartzite. This Cambrian guide rock for the Meuse river originally came from the area around Revin in the French Ardennes. The anvil measures 120 x 50 mm and has a thickness of 30 to 50 mm. The base of the anvil is formed by an old and weathered fracture. The rest of its surface shows numerous shallow pits caused by hammering. One of its ends shows facetting. A round, flattened sandstone was used as a hammerstone (107-1-3/9641; Fig. 33.19). The edges show small pits resulting from use. The stone could have been used in any period from the Late Neolithic to the Early Middle Ages.

33.8 Interpretation of the lithic assemblage

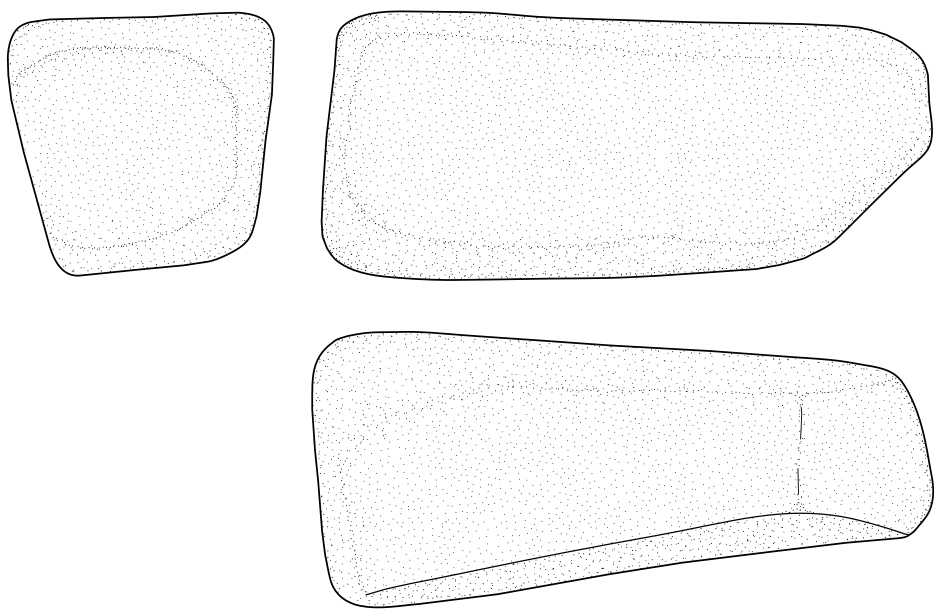
33.8.1 Building material

Although some finds and documentation are lost, the lithic assemblage at Ten Hove is still able to inform us about the materials used for building and tools.

Most frequently used was the Kunrade limestone, a variety or facies of the Upper Cretaceous Maastricht Formation, probably quarried within 1 km of the villa around Craubeek, or somewhat more to the west, still within a distance of 1.5 km (Fig. 33.3B). This stone was made into small and medium-size building blocks and plates, determined by the thickness of the beds in the quarries. The production 'waste', rounded and irregular stones as well as strangely shaped flint nodules, were used in the foundations of the Roman buildings. Some blocks of sawn, softer limestone ('marl') are less likely products from the softer beds of the Kunrade limestone and originated instead from Maastricht limestone proper. There is a chance that quarries at Craubeek yielded this material, but it was certainly present in the Geul valley,



107-1-3/9641



401-2/20-3-97a

Fig. 33.19 Voerendaal-Ten Hove. Stone 'anvil' and hammering stone. Scale 2:3.

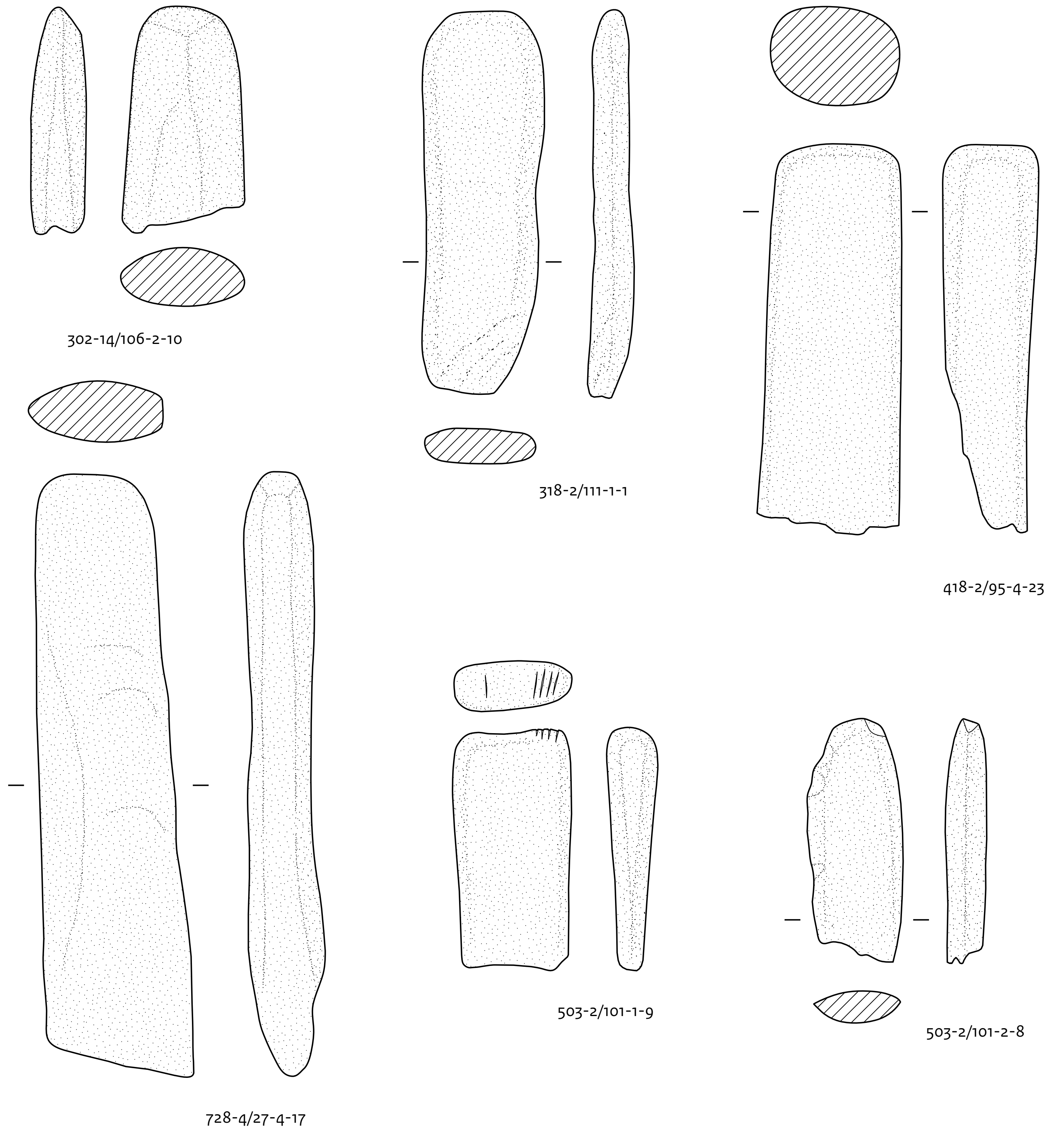


Fig. 33.20 Voerendaal-Ten Hove. Whetstones. Scale 2:3.

4-5 km to the south. The latter also holds true for large slabs of flint and 'tauw' (hardground), used as cover on drain 317. The source of the clay used in the lining of the aqueduct and basin 319 is also not entirely clear but would not have been further away than 3 km to the south(west).

Besides Kunrade limestone, Tertiary Nivelstein sandstone was extensively used; it was quarried 12 km east of Ten Hove in the Worm valley near Herzogenrath (Fig. 33.13). It was easy to work and, when freshly quarried, it appears grey-white, sometimes with orange to

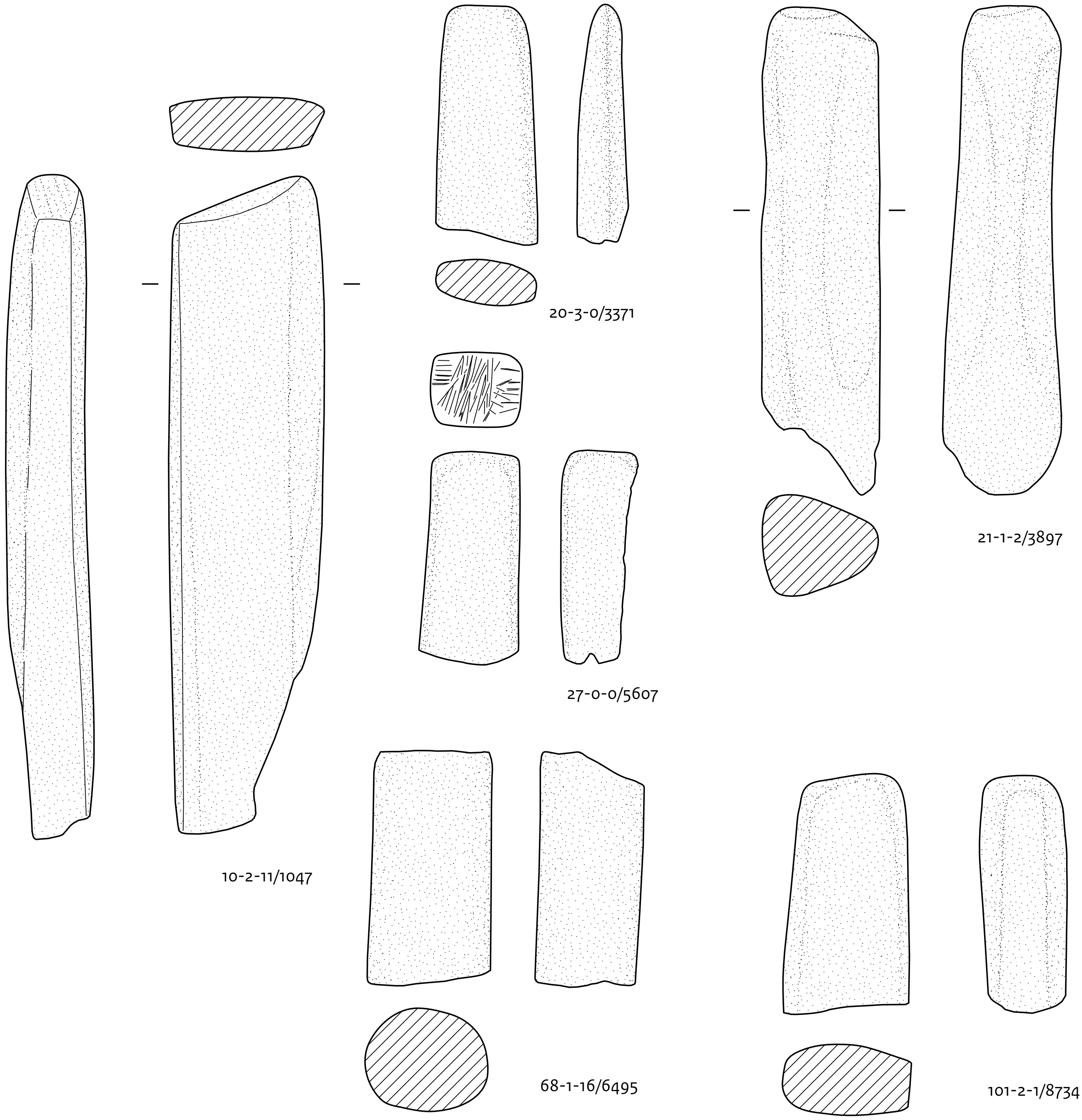


Fig. 33.21 Voerendaal-Ten Hove. Whetstones, cont. Scale 2:3.

light brown flames. Most of it was made into columns, with a diameter of 20-35 cm, and capitals, in one case a Corinthian or Composite one.

Compared to the villas of Kerkrade-Holzkuil, Maasbracht-Steenakker and the baths of Coriovallum, the absence, for instance, of Jurassic limestone (such as Norroy, Savonnières, Chémery in northern France), limetuff, volcanic tuff and Belgian 'marbles' is striking.[3054] One possible explanation is that the availability of local limestone and regional sandstone held off the import of these materials. However, it is even more likely that the finds assemblage is not representative because most stone was removed from the site after the Roman period. Finds of some limestone from the Meuse valley, fragments of granite basins and especially a tiny piece of marble show that other, costly stone was used at the site. The white-rose marble must have been imported from the Mediterranean and was sawn into a thin plate, probably a wall or floor tile. The fact that only a

[3054] Dreesen *s.a.* (Heerlen); Gazenbeek, 2017, 73-82 (Maasbracht); Kars 2005, 267-287 (Kerkrade).

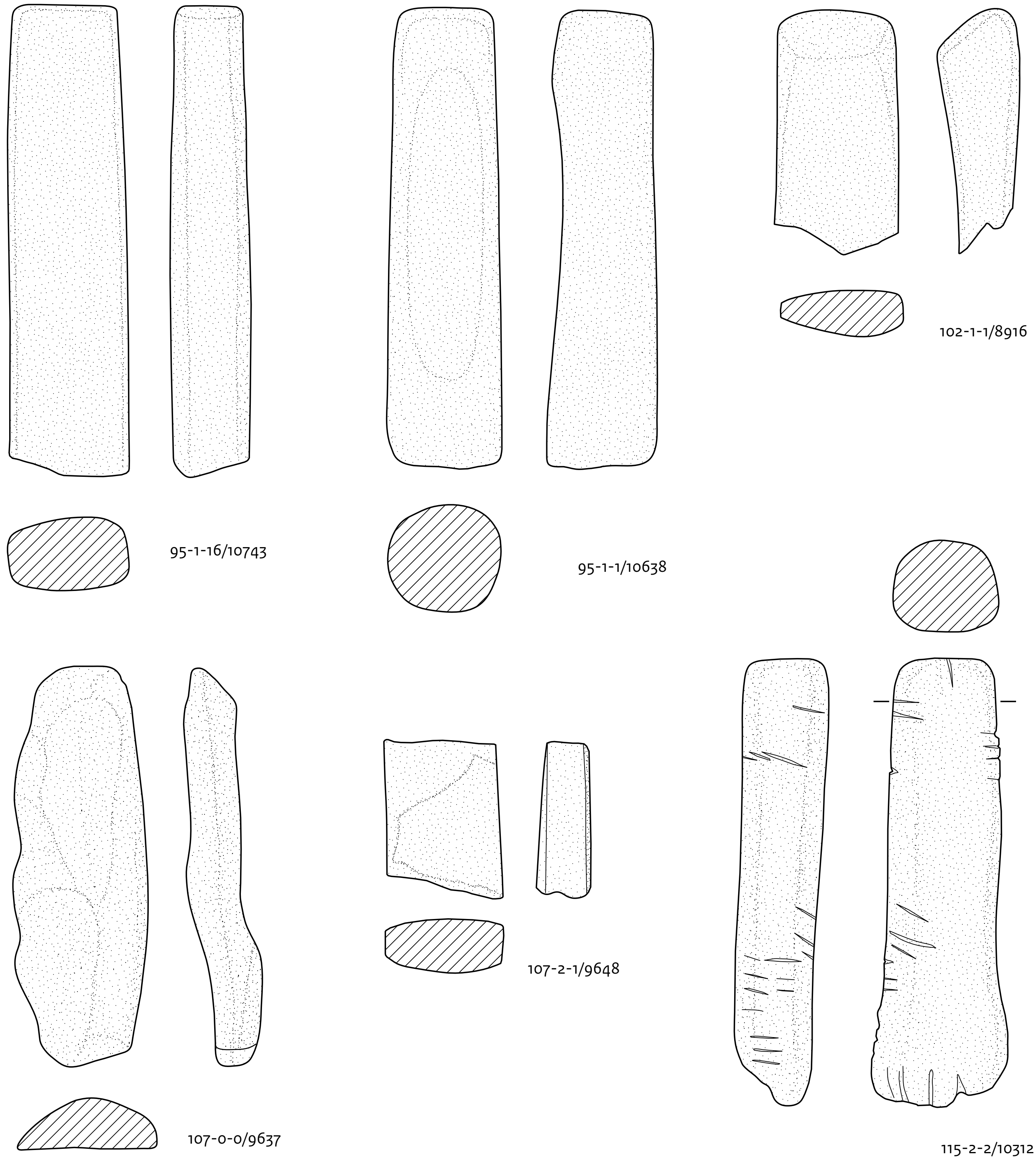


Fig. 33.22 Voerendaal-Ten Hove. Whetstones, cont. Scale 2:3.

small, single piece of marble was found illustrates the small chance of stone types less abundantly used ending up in the collection of archaeological finds.

Our analysis cannot clarify the question of whether the villa owner traded limestone from his quarry to Coriovallum/Heerlen. It is virtually impossible to pinpoint the exact origin, to a specific quarry, of the limestone used in this *vicus*. There were certainly sources of Kunrade limestone closer to Heerlen, although peak demands may have made transport costs less important.

33.8.2 Querns and millstones

The querns and millstones were used in different sizes, shapes and materials. A considerable proportion consists of coarse sandstone and conglomerates. Macroscopically, their provenance has been assigned to the Rocroi Massif in Belgium/North France, some 125-150 km from Ten Hove (Fig. 33.13). Other examples are in tephrite, quarried in the Eifel, 80-90 to the southeast.[3055] The conglomeratic millstones probably formed the larger stones on the site, as one of them measured 560 mm in diameter, had a grinding surface angled at 15 degrees and was rotated by humans or animals. Comparable in size is a millstone from basalt lava with a diameter of 572 mm, which also shows signs of peripheral drive. This runner stone, however, has a barely sloping grinding surface of 2 degrees. Furthermore, a rynd could be used to set the distance between this *catillus* and its *meta*. Both systems most probably reflect different materials to be milled. It has been proposed that conglomeratic millstones were used to crush minerals, for example for making ochre.[3056] On the Voerendaal site they also come with a plan-parallel section. The actual application is unclear as yet. Compared to the villa of Kerkrade-Holzkuil and Heerlen-Thermenterrein, it stands out that 13 fragments have been found at the former site against only one fragment at the latter, although this can be related to the function of the site.[3057] Fragments of conglomeratic millstone on the other hand have also been found in non-villa sites in the Dutch river area.[3058]

The Haltern-type millstone is typically found at military sites, often bases along the *limes*.[3059] They can be dated from the Augustan period to the middle of the second century AD and can be seen as the provincial equivalent of the biconical 'Pompeian' mill. Besides the examples from military contexts, they also appear in civilian contexts such as Tongeren and Heerlen.[3060] Hand-driven querns were also used at the villa of Voerendaal-Ten Hove. Ranging in diameter from 380 to 420 mm, all are of the Westerwijtwerd type and some show a hole through the rim of the runner stone. A rope would have been attached to it to hold a rod. Three plan-parallel fragments are found among the basalt lava querns. One of them comes from a Late Roman context. Plan-parallel rotary querns are typically dated from the Early Middle Ages, but a transition from the wedge-shaped quern to the plan-parallel type started during the Late Roman period.

Besides a few whetstones made from natural pebbles, most of them are typically Roman, longitudinal, dark-coloured whetstones. These commonly found 'Roman' phyllite whetstones were probably manufactured at the Roman workshop at Le Châtelet-sur-Sormonne (F/Ard.), where an important whetstone industry developed quarrying sedimentary and low-grade metamorphic rocks.

The querns, millstones and grinding tools all played an important role in the agricultural activities at the Roman villa. Processing cereals, seeds, nuts and maybe even minerals can be imagined as regular activities. Broken and wasted parts of these millstones and querns were still useful as grinding tools, which were also imported. Many tools had to be sharpened or resharpened at the site on a daily basis.

[3055] As the crow flies; it was transported over much larger distances, albeit mostly by river.
[3056] Hartoch *et al.* 2015, 39-41.
[3057] Kars 2005, 267-287; Dreesen *s.a.*
[3058] See for example Boreel 2017, 573-672
[3059] Hartoch & Manteleers 2015, 35.
[3060] Hartoch 2015, cat. no. 49; Picavet *s.a.*

34 Iron-working remains from the Iron Age to the Middle Ages

Gerard Boreel

34.1 Introduction

Especially during the 1986 excavations, large amounts of slag were collected near building 403 (formerly designated as C). Because of this, building 403 was interpreted as a smithy.[3061] An important question in the analysis of the slag material in this chapter is whether it was indeed the result of iron working. Another question is whether the interpretation of building 403 is correct; the slag possibly related to buildings 409 or 418, which preceded 403. The excavators saw circular features 614-616, preceding the *horreum*, as related to iron production.[3062] Besides the slag material associated with the first villa or the early stages of the second, many finds were collected from sunken huts and pits from the Late Roman period and/or Early Middle Ages. This chapter will describe, analyse and interpret the slag material. We will consider the kind of activities reflected by the finds. Was it only iron forging or were the inhabitants of the site also involved in the production of iron? What kind of objects were made and were they only for use on the site or were they also traded?

34.2 The operational sequence of ancient iron production and iron working

Metal slag is quite regularly found at archaeological sites dating from late prehistory until the Early Modern period. This slag is mostly well preserved and represents the waste of several artisan activities involving the production and working of metal. Most slag is associated with the production of iron, but remains of the processing of copper, lead, tin, alloys and precious metals can also be found.[3063]

This chapter is concerned with the '*chaîne opératoire*' or 'operational sequence' of ancient iron production and iron working. Figure 34.1 gives a schematic overview of the different stages in this sequence in the form of raw materials, actions, finished and semi-finished products and waste products.

Iron is extracted from ores, or iron oxide- or hydroxide-bearing rocks. People were mainly dependent on locally available ores until well into the Middle Ages. In Dutch contexts, this was mainly 'rattle stones' and bog ore or bog iron.[3064] To extract usable metal from an ore, the oxides had to be reduced. Whichever type of ore was used, it had to be prepared, or dressed. The ore was roasted to expel the water of crystallization and to increase the surface area. After the ore was crushed to hazelnut size, it could be reduced by being burnt together with charcoal. Metallic iron clusters would form as spongy blooms (Sbl) in the hottest parts of the furnace, just below the air inlet. Molten (production) slag (Spr) consisting of silica, fuel ash and impurities from the ore dripped into – or was removed from – the deepest part of the furnace.

Production slag from bowl furnaces, domed furnaces, slag pit furnaces and slag-tapping furnaces is known from archaeological contexts (Fig. 34.2).[3065] Bowl furnaces are the earliest type of furnaces, used throughout the Iron Age for small-scale production. Domed furnaces were in use in the same period, albeit slightly later. This type of furnace generally has a diameter of over one metre and a dome-shaped superstructure of loam or stone. They were used until the Roman period. After that time, Europe was divided in technological terms. Outside the empire, iron was mainly produced in slag pit furnaces, in which the slag ended up in a cylindrical space at the bottom of the furnace. Often the pieces of slag remain in situ, whereas the superstructure has disappeared. Relatively few furnaces are known inside the Roman empire, but the known examples are mainly slag-tapping furnaces (e.g. Montagne Noir (F), Noricum (A), Weald of Sussex and the Forest of Dean (GB)).[3066]

The iron blooms from the furnace had to be processed further to turn them into wrought iron, from which utensils could be made. The spongy and heterogeneous bloom needed to be compacted and refined. Reheating enabled the brittle slag to be expelled through compaction and was typically carried out in reheating hearths, resembling smithy hearths. The smithy hearth bottoms that are formed (Ssmr) are quite similar to those from smithy hearths. Having an identical appearance, comparable kidney-shaped with a plano-convex section, the two can only be distinguished by means of chemical analysis.

3061 Willems & Kooistra 1987, 35.
3062 Willems & Kooistra 1988, 140-141.
3063 Tylecote 1987, 291.
3064 Laban *et al.* 1988, 1-11; see further below, section 34.5.
3065 Pleiner 2000, 141-195; Joosten 2004, 12-15.
3066 Pleiner 2000, 44.

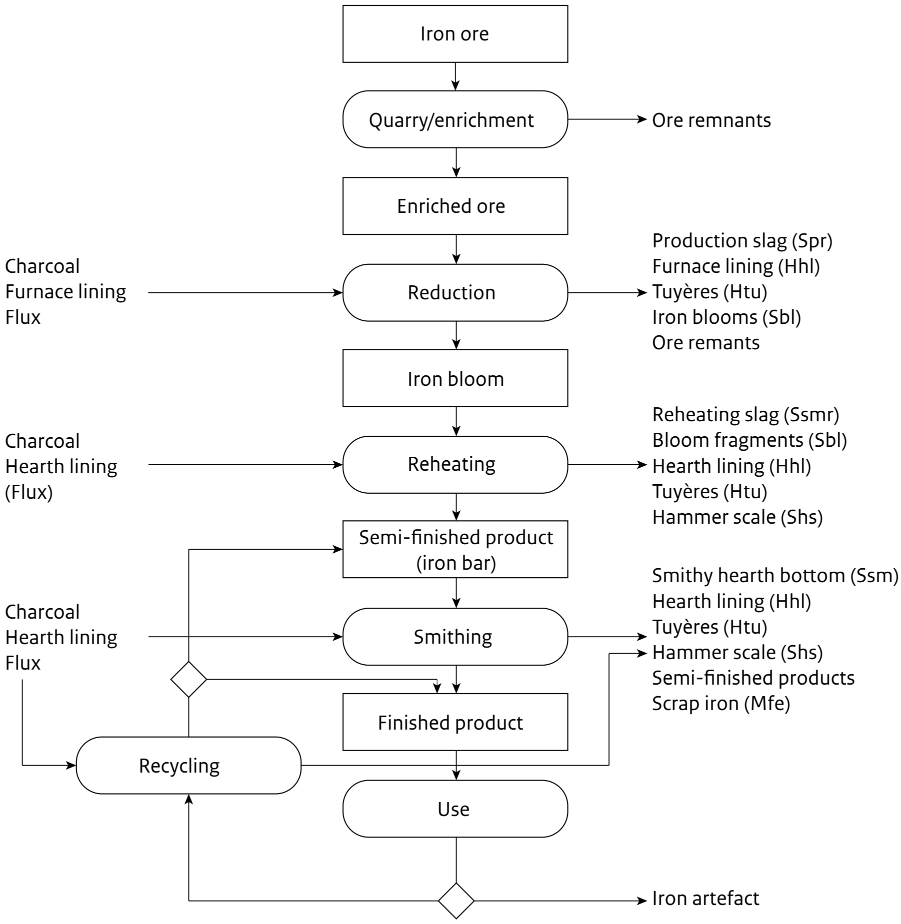


Fig. 34.1 Chaîne opératoire or operational sequence of ancient iron production and working. (source: G. Boreel after Henrich et al., 2009, 90, fig. 8)

Often, the hearths used consisted of not much more than a slab of clay or loam (Fig. 34.3). Besides a small pit, made to keep the fuel (charcoal) together, a pierced screen of clay or loam at one of the sides was made to shield the bellows, made of wood and leather. The nozzle or tuyère (Htu) connected the bellows to the hearthstone and sometimes projected from it.[3067] Tuyères were of ceramic material and had a cylindrical or block shape (plates and discs are also known). Smelting furnaces and smithy hearths were often made of richly tempered clay (often with coarse, organic material such as straw).[3068] This kind of clay was also applied to the interior of stone furnaces.[3069] Because local clays usually had a low melting point, the inside of the furnaces and hearths is often sintered and vitrified. All the sintered and glazed pieces of clay/loam are classified as hearth or furnace lining (Hhl).

During the next production phase, the wrought iron was heated until red or white hot in a smithy hearth and worked on an anvil. With sand, loam, ash, iron filings or chalk used as a flux, this heating caused the still remaining impurities to melt into an iron silicate that flowed out as slag. This smithing slag is often irregularly shaped, heterogeneous in composition and can have a rusty appearance (Sgd, Sfr and Smi).

The smithy hearth bottom (Ssm) is a typical example of smithing slag,[3070] formed just below the air inlet of the smithy hearth. It has a plano-convex or concavo-convex section (Fig. 34.3). These pieces of slag also have a heterogeneous composition, consisting of

[3067] Craddock 1995, 185-189; Tylecote 1987, 115-125.
[3068] Joosten 2004, 15.
[3069] Craddock 1995, 172.
[3070] Often referred to as smithy hearth bottoms (SHB), Tylecote, 1986, 173 or plano-convex bottoms (PCB), Crew 1991, 32.

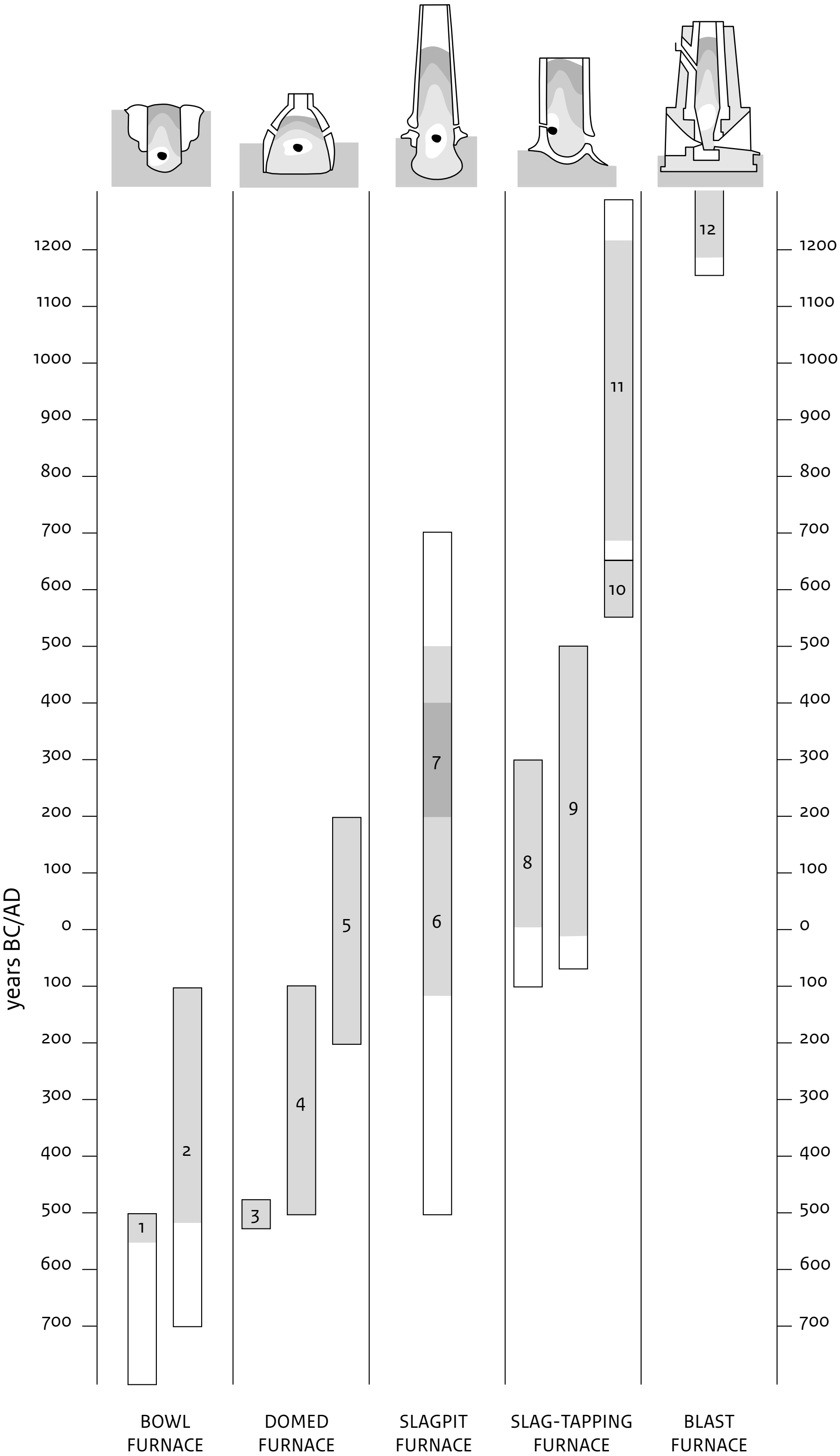


Fig. 34.2 Overview of historical bloomery furnaces. (source modified after Joosten 2004, 24, fig. 11)
1 Waschenberg, Králová and Moravia (Austria - Czech Republic); 2 Populonia (Italy); 3 Schwäbische Alb (Germany); 4 Burgenland (Austria - Hungary); 5 Cléromois (France); 6 Bohemia (Czech Republic); 7 large scale bloomery smelting in the Swietokrzyskie mountains (Holy Cross mountains, Polen), Schleswig-Holstein (Germany) and Jutland (Denmark); 8 bloomery smelting in the Roman Empire: Montagne Noir (France), Noricum (Austria), Weald of Sussex and Forest of Dean (Great Britain); 9 bloomery smelting outside the Roman Empire: Eisenbergen, Salzgitter-Lobmachtersen (Geramany) and Lodenice (Czech Republic); 10 Boécourt (Switzerland); 11 Central Europe; 12 Schwäbische Alb, Sauerland (Germany) and Lapphyttan (Sweden).

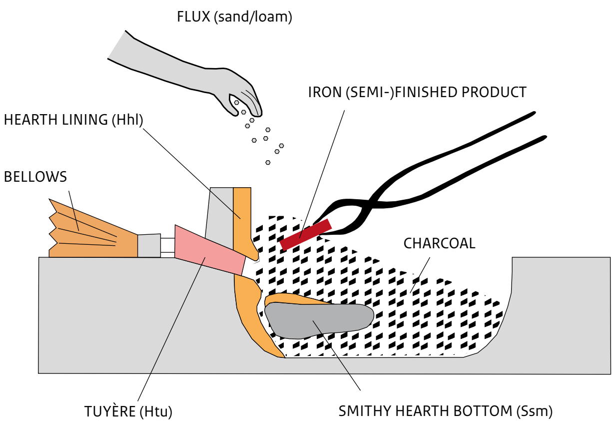


Fig. 34.3 Schematic section of a smithy hearth. (source: G. Boreel, after Henrich et al. 2009, 91, fig. 10).

oxidized iron, iron silicate (fayalite), sand, loam, charcoal and ash. Before modern times, their size generally did not exceed some 15 cm in diameter.[3071]

Hammering hot iron on an anvil produces small flakes of oxidized iron and – through compression – slag droplets. These flakes and droplets are often magnetic and are called hammerscale (Hhs). A final type of slag frequently encountered is cinder (Ssc), formed during all the processes described above (only revealed by its chemical composition). Working as a flux, the fuel ash lowers the melting point of silicates, causing them to smelt into a highly porous and vitreous slag or cinder. Silica was supplied by the hearth or furnace lining and probably also from added sand, loam or clay.

34.3 Classification and quantification of the slag waste

From the above-described ancient *chaîne opératoire* or operational sequence of iron (Fig. 34.1), a few items appear frequently in the archaeological record. Most numerous is the slag because it is highly resistant to weathering. Hearth linings, finished and semi-finished iron products and vestiges of the installations used are more fragile. Table 34.1 gives an overview of the classification used for the material from Voerendaal-Ten Hove.

Identification was made visually or with a 10x magnifying hand lens. A small magnet was used to test whether or not the fragments were magnetic, differentiating between non-magnetic and weakly, moderately and very magnetic. The dimensions were recorded of all complete smithy hearth bottoms, as well as the weight, level of magnetism, overall shape and section. The smithy hearth bottoms are classified based on their composition and structure (Table 34.2).[3072] The length, width and thickness are given in mm,

Table 34.1 Voerendaal-Ten Hove. Overview of the used classification of slags found.

Type	Subtype	Code	Remarks
Amorphous smithing slag	grey and dense	Sgd	(fragments of) iron silicate-rich slag
	iron-rich and rusty	Sfr	(fragments of) iron-rich and rusty slag
	mixed	Smi	(fragments of) mixed composition slag
	indet.	Sin	
Bloomery slag		Spr	slag formed during production or smelting of iron
Iron bloom		Sbl	spongy lump of iron, permeated with slag
Cinder	rich in sand and clay	Ssc	(contaminated) silicate from fuel ash, sand and clay
Hammer scale		Shs	microscale flaky or spheroidal iron oxide
Hearth or furnace lining		Hhl	
Hearth or furnace tuyère		Htu	
Iron scrap		Mfe	
Smithy hearth bottom		Ssm	smithy hearth bottom (SHB, Tylecote, 1986, 173) or plano-convex bottoms (PCB, Crew, 1991, 32)
Smithy hearth bottom (reheating)		Ssmr	Ssm formed during reheating of iron bloom

[3071] Tylecote 1987, 318.
[3072] Classification after Perret 2002.

Table 34.2. Voerendaal-Ten Hove. Summary of the classification of complete smithy hearth bottoms.

Type	Code	Composition			Remarks
		sand/clay-rich facies	grey dense facies	iron-rich rusty facies	
Rich in sand and clay	SMsc	vvv			(contaminated) silica
Idem, mixed	SMscm	vvv	v		in general with grey and
Layered	SMl	vv	vv		dense facies below and sand- and clay-rich facies on top
Grey and dense, border	SMgdb	v	vvv		sand- and clay-rich facies next to attachment to hearth lining
Grey and dense	SMgd		vvv		(fayalithic) iron silicate
Grey and dense mixed	SMgdm		vvv	v	
Iron-rich rusty mixed	SMfrm		vv	vv	
Iron rich rusty	SMfr			vvv	iron(hydr)oxide

with the length parallel to the orientation of the hearth wall at or along which the slag was formed. Obviously, the width is perpendicular to the length, and the thickness is the maximum thickness of the cross-section. All identifications were entered into a database, together with descriptions and comments, to allow for the quantification of various characteristics. Chemical and physical analyses were not essential for the interpretation and were therefore not performed.

34.4 Results

34.4.1 The assemblage of slag finds

General characteristics

For an analysis of the slag finds, 1,800 fragments with a total weight of 105.4 kg were available (Table 34.3). The table shows that the material found is likely related to the production of iron, as well as iron working. The blooms (Sbl) are the product of the reduction process that transformed ore to iron. After compaction and purification they could be made into utensils by the smith. Most slag is connected to the smithing, especially the smithy hearth bottom slag (Ssm). The number of fragments constitute almost a quarter of the material, the weight more than 60%. Part of the smithy hearth bottom slag could be a by-product of reheating (Ssmr) the bloomery slag, when wrought-iron ingots were produced by compaction and purification. Both types of slag are macroscopically identical; only their chemical composition differs. Hammerscale (Shs) is often found at smithing locations. By coincidence, five tiny fragments of

Table 34.3. Voerendaal-Ten Hove. Summary of the number and weight per slag type.

Type	N	Wt (g)
Bloomery slags		
Sbl	26	3043
Smithing slags		
Ssm	404	64829
Shs	5	1
Smithy hearth/bloomery furnace		
Hhl	204	8267
Iron scrap		
Mfe	157	3634
Indeterm. iron working slags		
Grit and dust	-	1575
Sfr	236	7461
Sgd	5	285
Sin	2	183
Smi	82	2957
Ssc	679	13161
Total	**1800**	**105396**

hammerscale were found in a botanical sample (115-1-4, from a trench dug by Holwerda).

Materials not unambiguously related to bloomery smelting or smithing activities are hearth linings, iron scrap and the indeterminate iron-working slag. The hearth lining (Hhl) could have been part of both bloomery furnaces and smithy hearths; some fragments have parts of a smithy hearth bottom (Ssm) attached, however. On the basis of its association with large quantities of slag, the iron scrap (Mfe) found is probably connected to the working of iron.[3073] The scrap was in part a waste product, in part a raw material. The remaining indeterminate slag cannot be assigned to the by-products of either iron production or iron working. Most pieces have an amorphous shape and a rusty appearance (Sfr), while some have a fayalithic, dense composition (Sgd), or are a mix of both (Smi). Finally, a large part of the material consists of a silica-rich cinder composed of fuel ash, sand and clay (Ssc).

Distribution

A distinction is made in the distribution maps between finds from structures/features on the one hand and those from the preparation of the excavation levels (layers) and features without a structure number (Fig. 34.4 and 34.5). The ratio, both of numbers and weight, is about 3:2 (Table 34.4). This is of some importance because only the first group can be dated with some

[3073] One should be aware, however, that these iron fragments were selected during the processing of the finds to go with the slag – on the basis of criteria unknown to us – and separated from a multitude of other iron fragments.

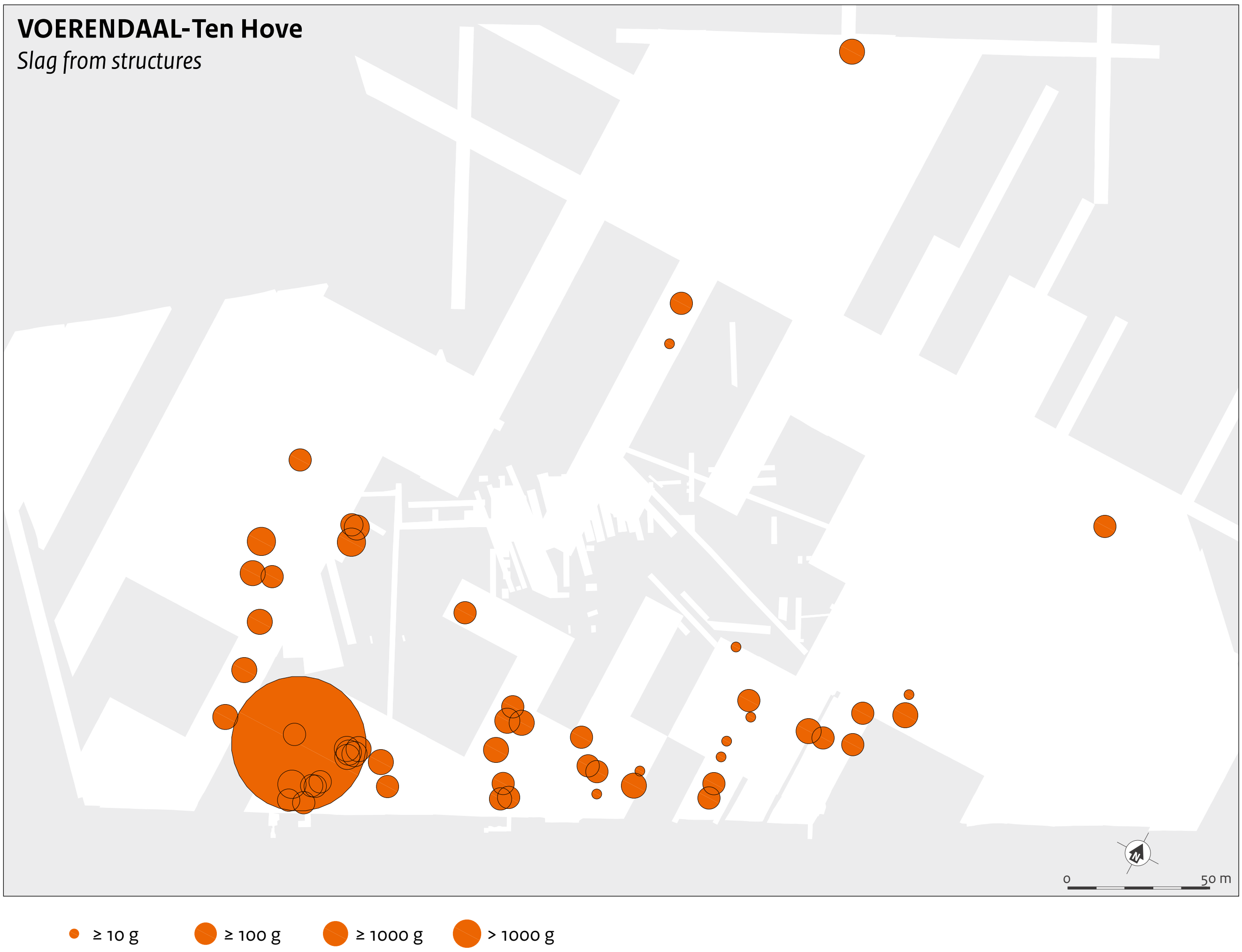


Fig. 34.4 Voerendaal-Ten Hove. Distribution of slag from structures; with the largest circle representing 52 kg from the cellar-pit.

certainty. The map shows that most finds are from a roughly 80 m wide strip along the modern Steinweg, which is also the case for many other categories of finds. Especially in the east, a cluster of finds could belong to the Late Roman and Early Middle Ages. Distinct from the general pattern is a concentration in the southwestern part of the yard towards the *horreum*, with the most significant finds from hearths 615 and 616, building 409 and the area around it (trench 68, 69, 95 and 96; Fig. 34.6). The upper layers of the infill of the cellar of 409 yielded 882 fragments, the layers around it 532 fragments.

Assemblage representativeness

In many investigations of slag material, the quantity of material is used to give an indication of the scale of iron working and/or production. However, the assumption that the material found reflects what was originally present is often incorrect. Part of the material is likely to have been removed during the Roman period or later (cf. the building stone!), and part of it will have been missed by the excavators because it was contained in the topsoil. Dumps in non-excavated areas such as the Hoensbeek valley can also be missed. Therefore, many of our conclusions about the slag from Ten Hove will be qualitative and based on the character of the material and the chronology of relevant contexts.

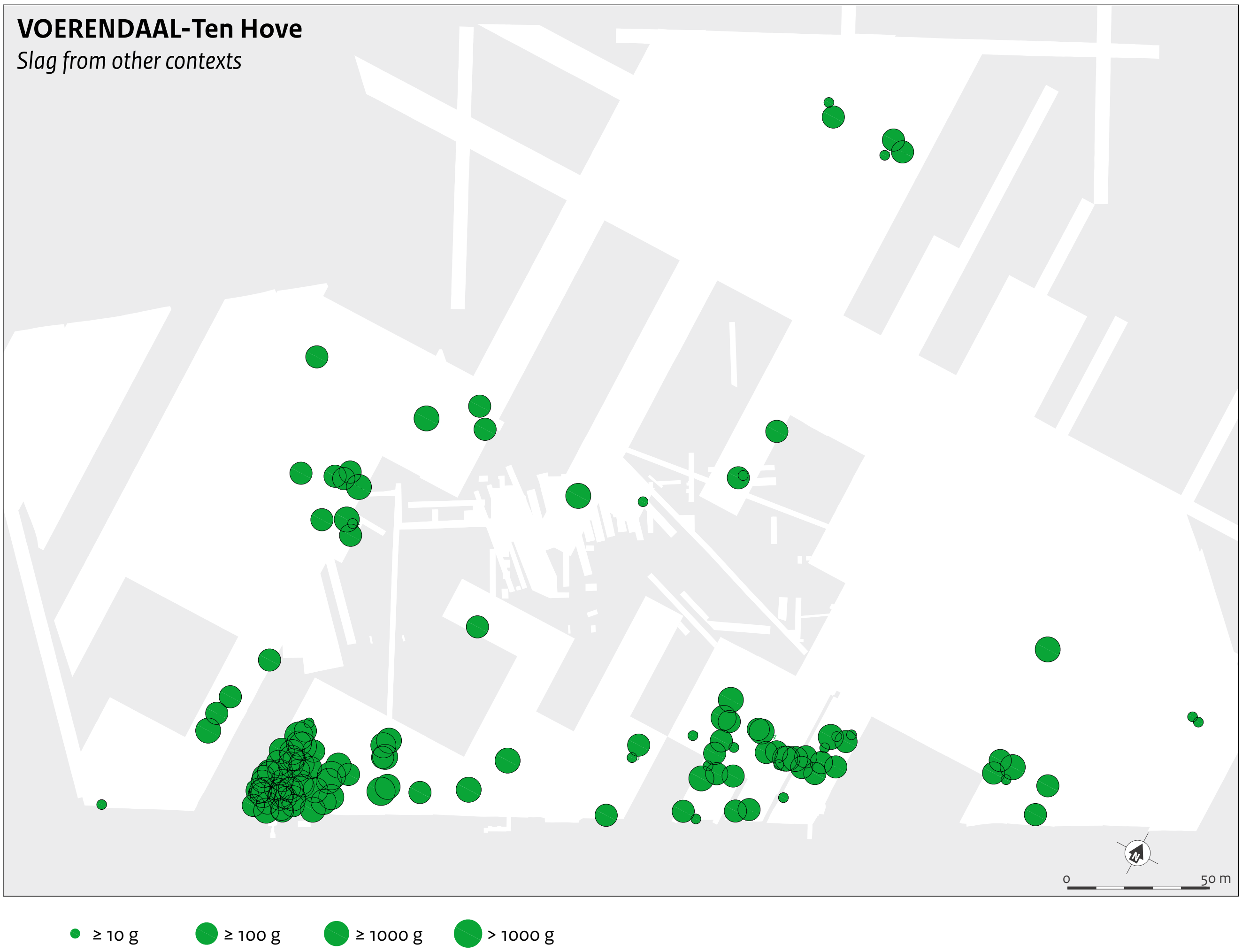


Fig. 34.5 Voerendaal-Ten Hove. Distribution of slag from other features.

Table 34.4. Voerendaal-Ten Hove. Proportions of the number and weight of slag from structures and other contexts.

Context group	N	N %	Wt (g)	Wt %
Structures	1063	59	63828	61
Non-structures	737	41	41568	39
Total	**1800**	**100**	**105396**	**100**

34.4.2 Slag possibly from the Iron Age

The quantity of slag found in Iron Age contexts is small compared to that from the Roman period (Table 34.5). The finds from building 214 are included here. Although this building seems to be Early Roman on the basis of the type of construction and one pottery sherd, most pottery dates to the Middle Iron Age.[3074] Therefore, it is possible that the slag is also pre-Roman in date. The finds from Iron Age ditch 308 come from the upper infill and are most likely Roman. Pit 776 provides the earliest indication of iron working at the site, dated by pottery from the Middle Iron Age. The slag material consists of six fragments of glazed hearth lining (Hhl 776-5/105-1-5). The other finds are possibly Iron Age in date. A small piece of light green glazed hearth lining was collected from pit 769 (Hhl 769-2/15-2-3). A feature of building 221 yielded a tiny fragment of cinder (Ssc 221-1/95-3-5) and a non-magnetic fragment of smithy hearth bottom (Ssm 221-2/95-3-5). The material from building 214 consists of three fragments of glazed and sintered hearth lining (Hhl 214-4/105-1-9), a piece of cinder (Ssc 214-5/105-1-10) and six fragments of smithy hearth bottom (Ssm 214-6/105-1-9), one of them magnetic. The Iron Age slag material can be interpreted as smithing waste and fragments of the smithy hearth. Although it shows that iron working took place at the site, it reveals nothing about its scale and exact nature.

Table 34.5. Voerendaal-Ten Hove. Slag from Iron Age contexts.

Type	N	Wt (g)
Smithing slags		
Ssm	7	89
Smithy hearth		
Hhl	10	267
Indeterm. iron working slags		
Ssc	2	11
Total	**19**	**367**

[3074] Cf. Chapter 21 (Iron Age pottery) and 40 (catalogue of buildings).

34.4.3 Slag dating before c. AD 125

Quantities and distribution

The majority of the slag finds belong to the first phases of the Roman period. If only the finds from structures are taken into account, these 1063 fragments represent 85% of the total (Table 34.6). The distribution over the features from these phases is also very uneven. Besides two small fragments of cinder from building 218 and ditch 307, as well as

Table 34.6. Voerendaal-Ten Hove. Number of finds and weight per slag type from contexts dating before ca. AD 125.

Type	N	Wt (g)
Bloomery slags		
Sbl	26	3043
Smithing slags		
Ssm	161	30416
Smithy hearth/bloomery funace		
Hhl	130	5466
Iron scrap		
Mfe	59	1338
Indeterminate iron working slags		
Grit and dust	-	1096
Sfr	133	4626
Sgd	2	43
Smi	64	3031
Ssc	329	7043
Total	**904**	**56102**

six fragments from building 418, all finds were collected from the cellar pit of building 409 (Fig. 34.6). The 12 fragments – Smi, Hhl, Ssm and Sbl – from furnaces 615 and 616 are interesting because of the kind of context in which they were found.

Most of the slag from the features of building 409 and the surrounding area was collected from the upper fill of its cellar – some 70% of the finds – and some pits next to it (Fig. 34.6). This is already an indication that the material is possibly not related to the period in which the building functioned, but to its latest phases or even a later period.[3075] The upper layers of the infill (partly subsided) of the cellar seem to have been deposited before c. AD 125, or just before building 403 was constructed. Because building 409 probably preceded building 418, the latter could even be a smithy. A few pieces of slag were found in its features, suggesting that iron processing was taking place – or had taken place – when it was dismantled to make way for 403.

Bloomery slag
Twenty-four of 26 fragments of iron bloom were found in features of building 409 and furnaces 615 and 616 (Table 34.7). There are four intact, complete blooms, one from furnace 616 (616-1/103-3-1) and the others from the cellar pit (all 68-2-87/7204). The latter three have a comparable weight of 200-355 g and are irregular to irregular kidney-shaped. They are convex-convex to plano-convex in section. The average size is 77 x 57 x 32 mm. The iron bloom from furnace 616 is larger, with a weight five times larger. The remainder of the blooms found are only fragments. All pieces show more or less metallic iron in a 'spongy' matrix. As an example, find 409-55/68-2-87 was cut and polished (Fig. 34.7).

Smithy hearth bottoms
One hundred and twenty-four of the 161 smithy hearth bottoms, mainly from structure 409, are complete. Based on their composition, four main groups can be distinguished (Table 34.8). The first is that of the smithy hearth bottoms mainly consisting of silicate (SMsc), sometimes with some iron silicate (SMscm). This kind of slag represents almost half of all the complete smithy hearth bottoms and slightly more than a third of the total weight. About a quarter belong to the group of iron-rich, rusty slag (SMfr). A third, still significant group is that of layered slag, partly with iron silicate, partly with silicate (SMl). Smithy hearth bottoms composed of large quantities of dense, grey iron silicate (SMgd, SMgdb and SMgdm) represent only slightly more than a tenth of the assemblage. The weight distribution of the four main groups is illustrated by the histograms in Figure 34.8.

The silicate-rich smithy hearth bottoms (SMsc and SMscm) are mainly dark grey, with shades of green, grey and even white (409-56/68-2-87; Fig. 34.9). They are the smallest smithy hearth bottoms but are the largest group. The weight varies from 29 to 382 g

[3075] Cf. Chapter 43.

Table 34.7. Voerendaal-Ten Hove. Characteristics of the iron blooms.

Item	Find no.	Id	Cat	N	Wt (g)	Compl.	L	W	Thickn.	Shape	Section
615-1	103-3-02	8974	1	1	286	-	-	-	-	-	-
616-1	103-3-1	8973	3	1	1159	1	125	125	60	round	pl-cv
409-69	68-2-87	7204	24	1	355	1	90	70	40	irregular	cv-cv
409-71	68-2-87	7204	25	1	216	1	60	50	25	irregular-kidney	pl-cv
409-72	68-2-87	7204	35	1	200	1	80	50	30	irregular-kidney	cv-cv
409-70	68-2-87	7204	36	19	648	-	-	-	-	-	-
409-73	68-2-87	7204	54	1	115	-	-	-	-	-	-
409-74	68-2-87	7204	55	1	64	-	-	-	-	-	-

Section: pl plano; cv convex.

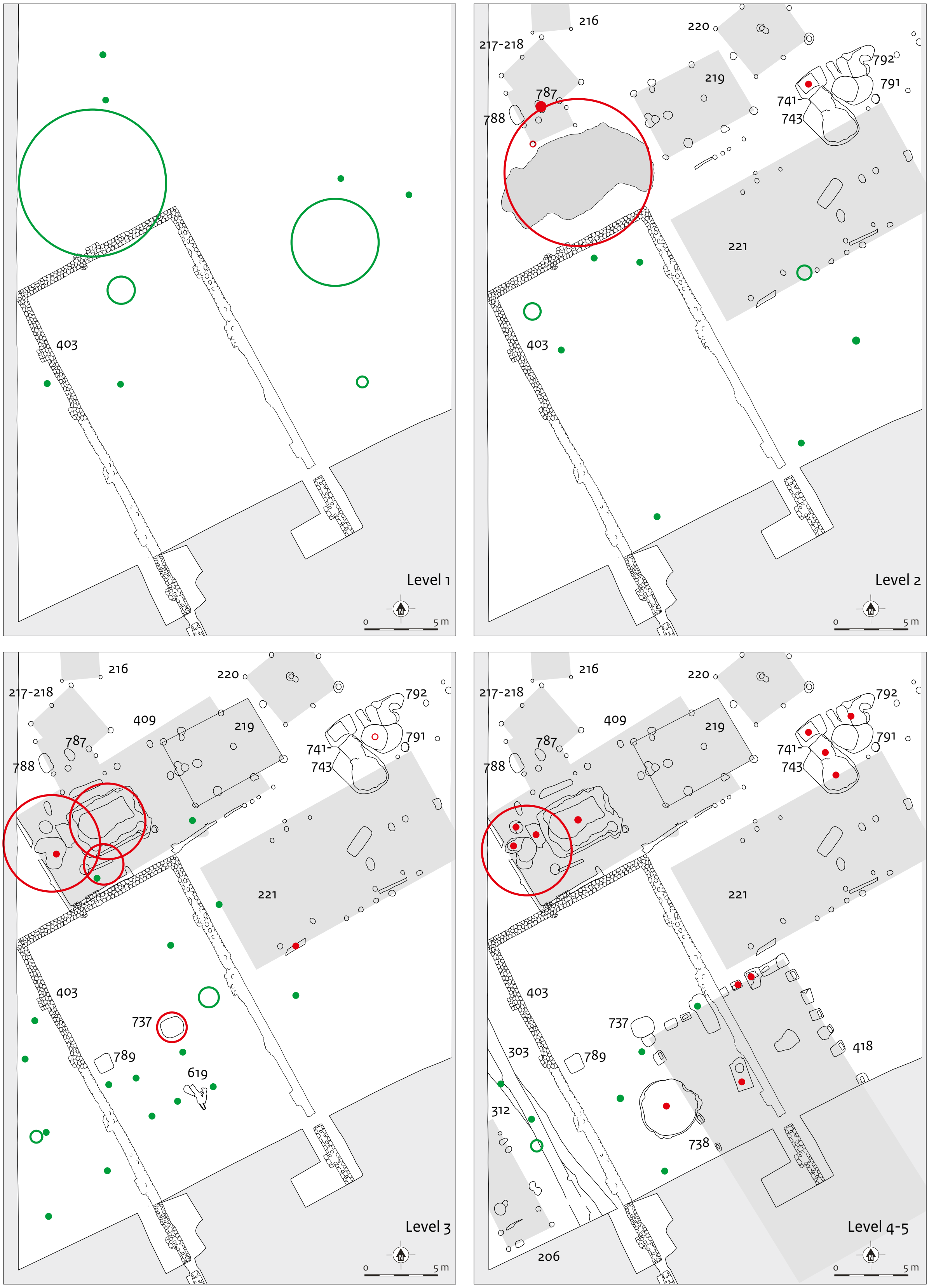


Fig. 34.6 Voerendaal-Ten Hove. Distribution of slag in trench 68, 69, 95 and 96; diameter circles in proportion to weight (minimum 200 g).

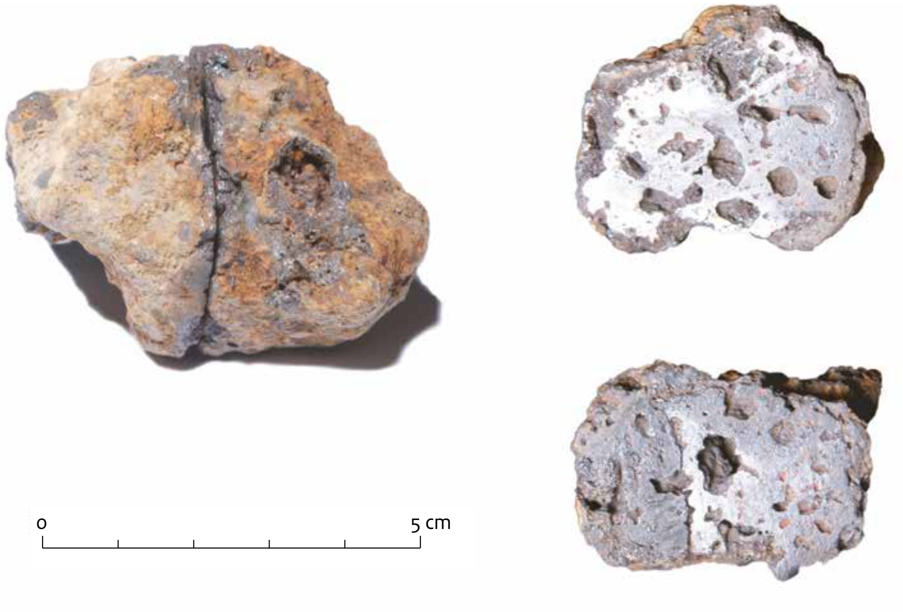


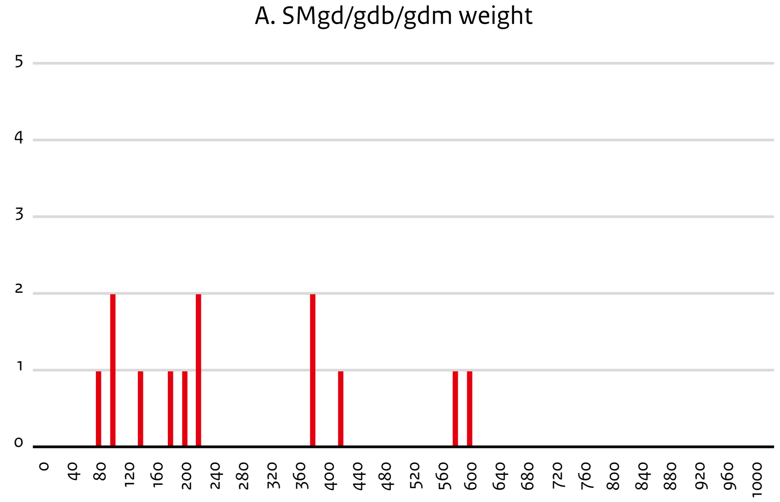
Fig. 34.7 Voerendaal-Ten Hove. Cut and polished iron bloom from feature 409 (409-55/68-2-87). (source: D.S. Habermehl & H.A. Hiddink)

Table 34.8. Voerendaal-Ten Hove. Summary of the main properties of the complete smithy hearth bottoms dating before ca. AD 125.

Type	N	N%	Wt	Wt%	Wtmed	Lmed	Wmed	Tmed	Hhl%	Cavity%
SMsc	53	43	6690	26	113	66	50	35	79	10
SMscm	8	6	1563	6	"	"	"	"	"	"
SMl	22	18	7350	29	271	80	70	40	73	-
SMgdb	1	1	66	0	211	70	55	40	62	-
SMgd	6	5	1344	5	"	"	"	"	"	-
SMgdm	6	5	2062	8	"	"	"	"	"	
SMfrm	0	0	0	0	222	70	70	35	54	21
SMfr	28	23	6660	26	"	"	"	"	"	"
Total	**124**		**25735**							

n number; wt weight in g; wt-med median weight in g; Lmed median lenght in mm; Wmed median width in mm; Tmed median thickness in mm; Hhl visible attachment to hearth lining; cavity distinct cavity on top of smithy hearth bottom caused by forced airflow

and the median size is 66 x 50 x 35 mm. It is remarkable that several of these pieces of slag show small fragments of iron scrap as inclusions. Eight pieces have rusty surfaces, which – together with the iron scrap – are indicative of products for iron working. The silicate-rich smithy hearth bottoms were formed in charcoal-filled hearths or furnaces as several pieces of slag have impressions made by the charcoal. That the hearths were smithy hearths is assumed on the basis of the iron scrap, which was not generally added to a bloomery furnace. Silicate-rich smithy hearth bottoms are not usually found frequently and must be the result of a specific process involving the lavish use of silicate-rich material, sand or clay. One of the techniques implied is iron welding. When the iron was heated, and also during the actual welding, the surface had to



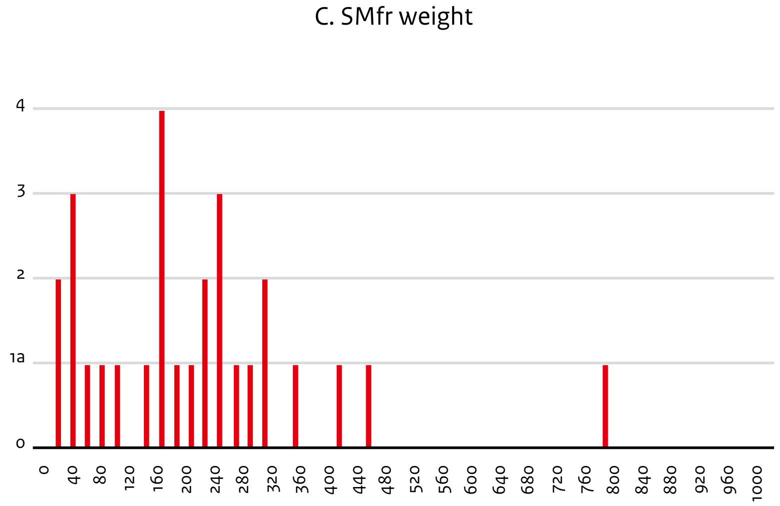
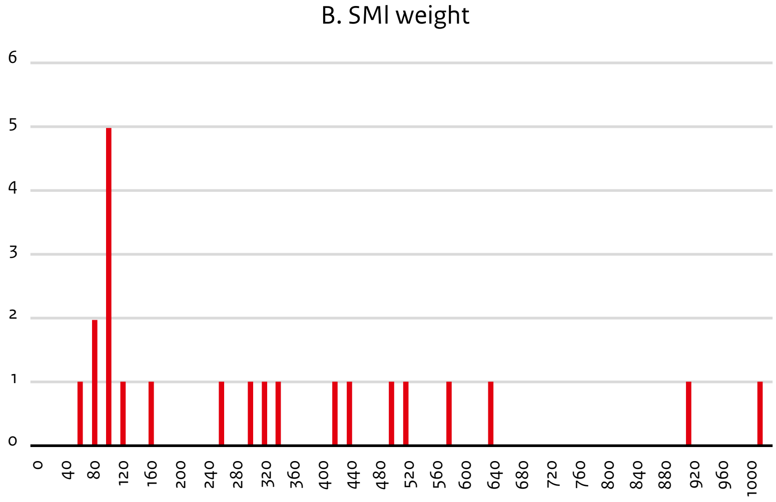


Fig. 34.8 Frequency histograms of the weight in grams for the main four groups of smithy hearth bottom types. (source: G. Boreel & H.A. Hiddink) A grey types; C iron-rich, rusty.

be protected against oxidation by a thin layer of molten silicate. The resulting slag contains, besides silicate, a considerable quantity of iron oxides and iron silicates, because of the high temperatures involved. Another technique involving the use of a large amount of sand is the welding together of several more or less compacted iron blooms.

The heaviest and largest pieces of slag show a layered structure (SMl 409-57/68-2-3; Fig. 34.9). These smithy hearth bottoms have a weight of 49 to 1,311 g and a median size of 80 x 70 x 40 mm. They are considerably larger than the silicate-rich smithy hearth bottoms. Most of the layered slag represents a single pass, from the start to the finishing of a product or semi-finished product. Generally, the slag attached to the hearth lining was removed after the smithy hearth had cooled. Sometimes the slag was left in place and a second smithy hearth bottom formed on top of the first. By far the most layered smithy hearth bottoms have a dense, grey and sometimes rusty iron silicate as the first stage of the slag. The second stage is the top layer of silicate-rich material. This kind of layering generally represents the following pass:



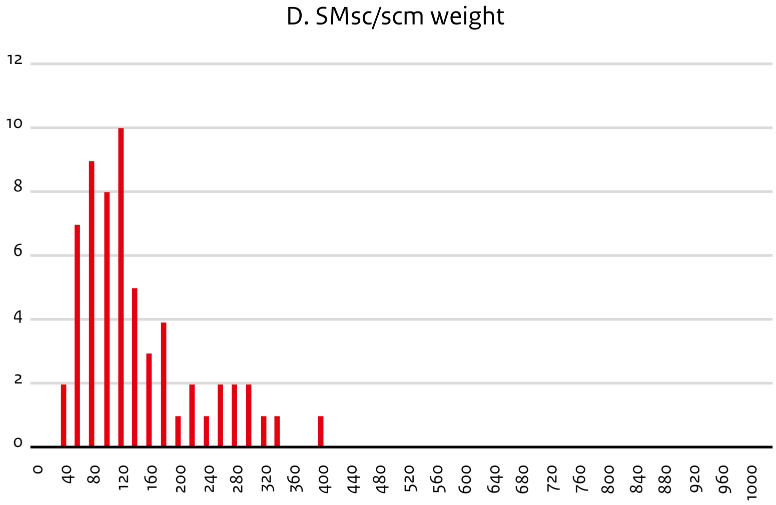


Fig. 34.8 Frequency histograms of the weight in grams for the main four groups of smithy hearth bottom types, cont. (source: G. Boreel & H.A. Hiddink) B layered; D rich in sand and clay.

starting with wrought-iron bars or iron scrap, an object is shaped at the expense of a large quantity of iron. A dense, grey iron-silicate slag is formed as a by-product. Finishing the object requires that the surface be protected by means of a silicate melt; thus, a silicate-rich facies is formed as a top layer. Three smithy hearth bottoms show an upturned layering, with a silica-rich part at the bottom and an iron-rich part on top of the slag. Welding iron scrap before shaping it could explain the observed order of layers. The use of iron scrap is suggested by the numerous isolated fragments of iron as well as the small fragments enclosed in many smithy hearth bottoms.

The iron-rich, rusty smithy hearth bottoms show a slightly lower median weight compared to the layered slag, which is reflected by their slightly smaller dimensions (SMfr 409-58/68-2-96; Fig. 34.9). Their weight range is also smaller, between 55 g and 788 g. While uncertainty remains regarding the process that created these pieces of slag, the noticeably lower percentage of visible attachment to the hearth lining, combined with many cavities on top of the slag (21%), suggest the use of high airflow and

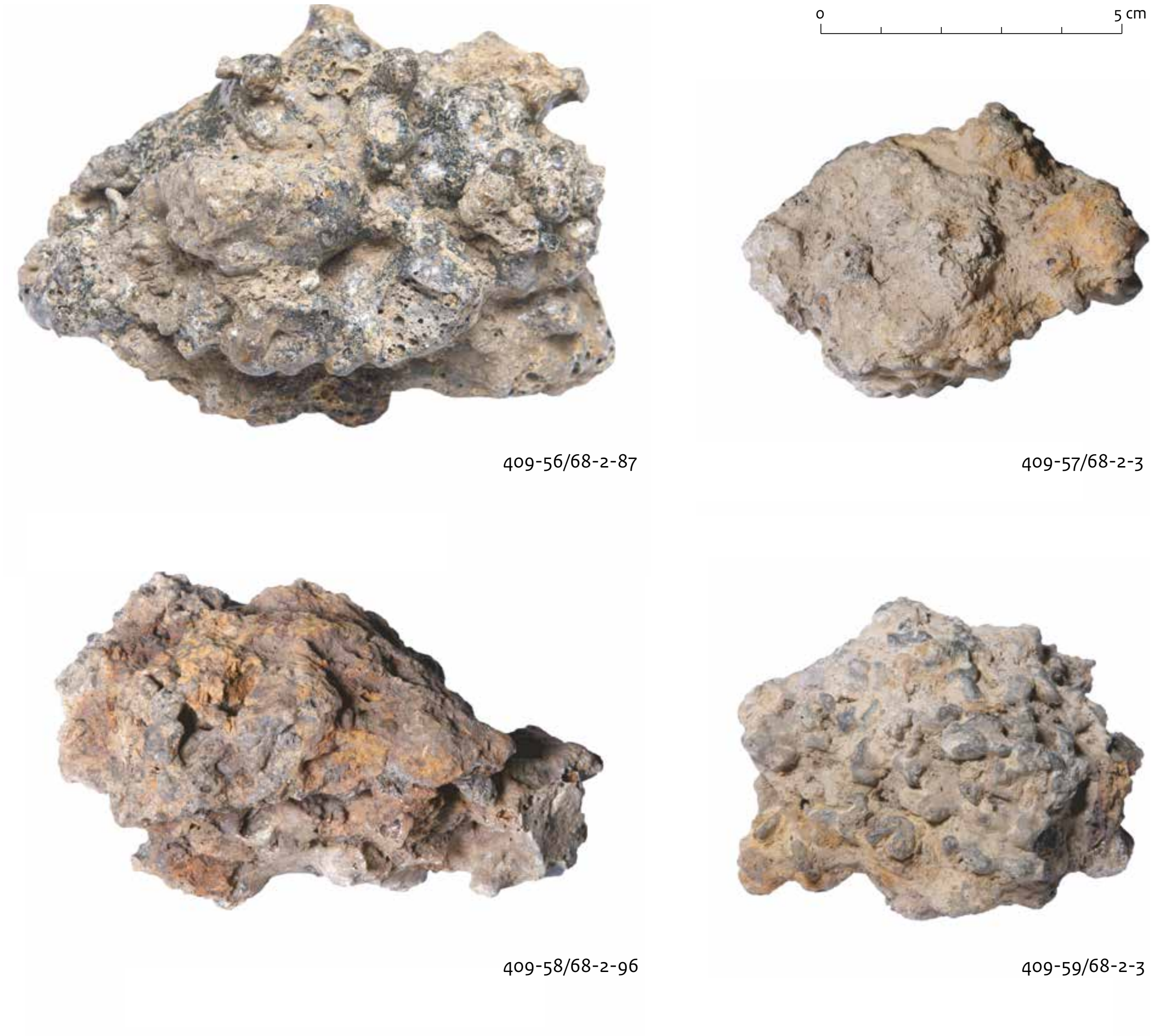


Fig. 34.9 Voerendaal-Ten Hove. Examples of smithy hearth bottoms. (source: D.S. Habermehl & H.A. Hiddink)

therefore high temperatures. If the surface is not protected, iron will lose a large amount of iron oxide, giving the slag a rusty appearance. High airflow is used to reach high localized temperatures, preparing the piece of iron for upsetting, riveting or for hammering down a nail head. No surface protection is needed for this kind of work.

The dense, grey smithy hearth bottoms, predominantly consisting of (fayalithic) iron silicate, make up only 11% of the assemblage (SMgd, SMgdb and SMgdm; 409-59/68-2-3; Fig. 34.9). Only slightly lighter, their weights range between 66 and 584 g; their size is comparable to the iron-rich, rusty slag. The slightly higher percentage of fragments joined to hearth lining, together with the absence of cavities on the slag surface, suggest a medium airflow. The iron silicate could originate from the sand used as a flux, but also from raw material already containing a large amount of slag.

Hearth or bloomery furnace lining

Four fragments of hearth or furnace lining derive from two furnaces that were probably bloomery furnaces. Find 89-2-6/8136 was found in Late Iron Age enclosure ditch 308, but high in the infill and therefore probably from the nearby furnace

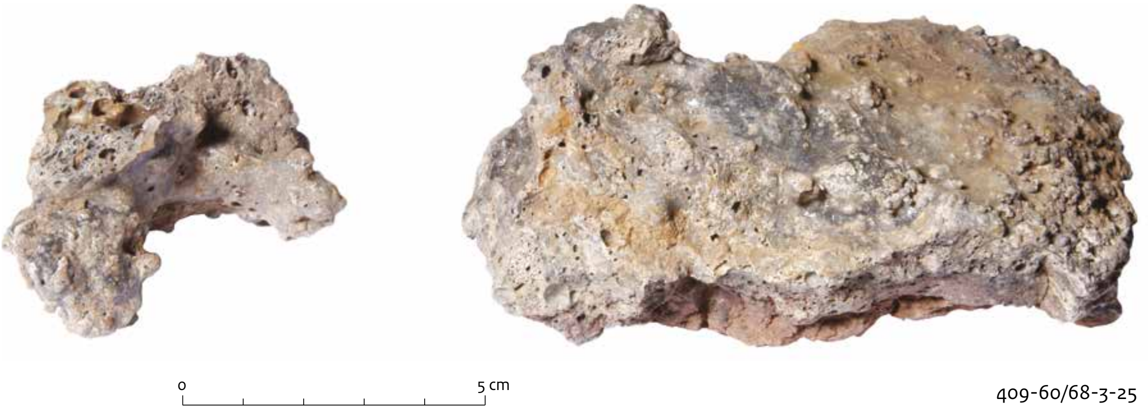


Fig. 34.10 Voerendaal-Ten Hove. Example of a fragment of hearth lining with an air inlet, diameter 30-35 mm (409-60/68-3-25). (source: D.S. Habermehl & H.A. Hiddink)

617. Three other fragments were collected from the fill of furnace 616 (616-1/103-3-1). All four fragments show considerable sintering in contrast to the highly vitrified hearth lining from building 409 and can most probably be interpreted as furnace lining. Among the remaining pieces, 124 are from building 409 and two from building 418. Almost all the fragments are highly vitrified. Two fragments show part of the air inlet. An air inlet diameter of 30-35 mm could be identified from cellar 409 (409-60/68-3-25; Fig. 34.10). From the same find, a vitrified fragment relined with clay suggests occasional repairs of the smithy hearth.

Iron scrap

A total of 59 fragments of iron scrap were found in building 409. In fact, they should be seen as fragments erroneously allocated to this group of finds because of their amorphous shape and highly corroded appearance. Almost 2500 pieces of iron nails and scrap were found in and around this building. Ten nails or parts of nails are present among the 59 fragments of iron scrap that resembled slag at first sight (68-2-84; 68-2-96). Find number 68-2-84 also yielded three rectangular slabs of iron (35 *x* 35 mm, 40 *x* 20 mm and 40 *x* 30 mm). The latter consists of three separately folded pieces of sheet metal, slid into each other (409-61/68-2-84; Fig. 34.11). Building up an object from separate sheets of iron typically suggests the use of Damascus steel or multi-layered steel. We could think here of the production of weapons or cutting tools.

Indeterminate iron-working slag

Iron-rich slag is represented by 199 fragments, 133 of which have a rusty appearance and often an undefined shape (Sfr). Part of this group (181 pieces) are probably fragments of smithy hearth bottoms (Ssm), the remainder originating somewhere in the smithy hearth. Another 64 pieces of slag have a mixed composition of rusty iron-rich parts, dense grey iron silicate and silica-rich cinder (Smi). By far the largest group is composed of sand/clay-rich or silica-rich cinder (Ssc), formed in smithy hearths or bloomery furnaces. It is likely that 59 fragments derive from silicate-rich smithy hearth bottoms (SMsc). One find (409-67/68-4-10) encloses a tiny pottery sherd, a second (409-68/68-5-1) adheres to a larger grey (burnt) sherd. It is possible that the pottery was part of the smithy hearth.

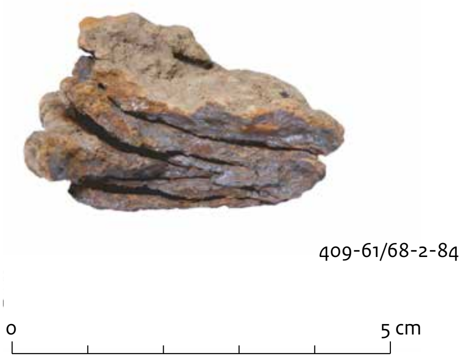


Fig. 34.11 Voerendaal-Ten Hove. Example of three separately folded pieces of sheet metal, slid into each other as iron scrap (409-61/68-2-84). (source: D.S. Habermehl & H.A. Hiddink)

34.4.4 Late Roman and Early Medieval slag

Because it is often difficult to assign individual features to the Late Roman period or the Early Middle Ages, all possible features of these periods are discussed together. A concentration of slag in the south-eastern part of the excavated area has already been mentioned (Section 34.4.1). The relevant features here are sunken-floored hut 509, 510, 511, 514 and 520, as well as pit 713, 715, 728 and 807. Pit 757 and 768, together with hearth 629 and 630, are located slightly to the southwest, but belong to the same cluster and period or periods. Table 34.9 gives a summary of the slag from these features. Four of the 11 smithy hearth bottoms are complete. Because the amount of slag from this period is too low for comparison with the slag from the villa periods, the material from trench 13, 16, 20-22, 23, 24 and 27 has also been taken into account (Table 34.10). Apart from the iron scrap, the same types of slag are found, but in larger numbers. Sixteen of the 34 smithy hearth bottoms are complete.

A closer look at the complete smithy hearth bottoms shows that the assemblage is different from the Middle Roman material. Not only are the weights less, but also the dimensions (Table 34.11). The median weight varies from 55-75 g and the median size is 53 x 49 x 28 mm, compared with 211-217 and 73 x 65 x 38 mm around building 409. Another remarkable fact is the absence of the silica-rich smithy hearth bottom, frequently found near 409.
Although some older material may be mixed in, the assemblage is still markedly different.
An extra clue to a different character of the activities in the Late Roman and Early Medieval period is the occurrence of highly porous, brown-red smithy hearth bottoms. It concerns one from pit 713 and four without context. They consist largely of silicate, but the cause of the brown-red colour is unknown.

Table 34.9. Voerendaal-Ten Hove. Number and weight of the different types of slag in Late Roman and Early Medieval contexts.

Type	N	Wt (g)
Smithing slag		
Ssm	11	700
Smithy hearth		
Hhl	1	9
Indeterminate iron working slag		
Sin	6	189
Ssc	8	80
Total	**26**	**978**

34.5 Interpretation of the assemblage

A main question concerning the slag finds was whether they indicated iron production and iron working at Voerendaal-Ten Hove. Our analysis proves the latter and shows that iron was also likely produced. Only a few pieces of slag can be dated to the Iron Age, but they are indicative of iron working in both the Middle and Late Iron Age. The question remains whether this slag is representative of the scale of activities.

By far the most slag material dates from the first part of the Middle Roman period, prior to c. AD 125. There are clues for both the production and working of iron, which are discussed in more detail below. But first, the presence of some finds in features belonging to the second,

Table 34.10. Voerendaal-Ten Hove. Summary of the numbers and weight of the different types of slag, collected during the preparation of the levels in the northeastern trenches.

Type	N	Wt (g)
Smithing slags		
Ssm	34	3180
Smithy hearth		
Hhl	8	288
Iron scrap		
Mfe	22	717
Indeterminate iron working slags		
Sin	17	220
Ssc	22	239
Total	**103**	**4644**

Table 34.11. Voerendaal-Ten Hove. The main characteristics of the compleet smithy hearth bottoms from period 4.

Ssm from	N	Wt	Wtmed	Lmed	Wmed	Tmed
Structures	4	367	74	53	50	30
N structures	16	2.261	55	53	48	25

n number; wt weight in g; wt-med median weight in g; Lmed median lenght in mm; Wmed median width in mm; Tmed median thickness in mm

large villa must be mentioned. This is probably waste material from the preceding phase. There were blacksmiths working at the site in the Late Roman period and Early Middle Ages, as is shown by the location of the slag and the characteristics of the smithy hearth bottoms. The latter are smaller and less heavy than those from the Middle Roman period. The composition of the slags is also more diverse. All in all, the iron working had a smaller scale than before.

Most pieces of slag were found in the upper fill of the cellar in building 409, dating around AD 125 or before the construction of 403. Contrary to the excavators' interpretation, it was not the latter building, but probably 418 preceding it that was a smithy. The iron production and processing activities probably took place in the context of constructing the second main building, the baths (see below) and/or stone buildings such as 403. Such a large-scale but temporary activity is reminiscent of finds at the villa of Hoogeloon-Kerkakkers, where iron fittings and other objects were probably made for phase 2 of the main building, when a bath was added to the building.[3076]

Finds with a connection to the smithy are firstly the slag and secondly a large amount of iron (nearly 2500 fragments) in the vicinity of buildings 403, 409 and 418. This was mainly nails, but also unidentifiable fragments. The production of nails by the blacksmith at Ten Hove is also suggested by the slag. A considerable number of rusty, iron-rich smithy hearth bottoms is indicative of the use of a high airflow to obtain high temperatures is some places. This is typical of activities such as hammering down nail heads, riveting and upsetting. The latter two indicate the making of joints, found in structural fittings as well as certain tools (tongs, hammers and even knives).

The layered smithy hearth bottoms demonstrate that the blacksmith had wrought iron or wrought-iron bars at his disposal as raw material. An iron-rich slag would have been formed as the product was shaped. Adding sand to prevent an excess of oxidation during the final stage would have caused a second, silicate-rich layer on top of it. An upturned layering, with a silicate-rich facies at the bottom and an iron-rich facies on top of the slag, suggests that the iron scrap was welded before it was shaped. The use of iron scrap is also suggested by the numerous isolated fragments of iron as well as the small fragments enclosed in many smithy hearth bottoms.

Not only wrought iron or wrought-iron bars and scrap were used as raw material, but probably also fresh iron, produced at the site itself. Indications are iron blooms or parts thereof in the upper fill of the cellar in building 409 and in two of the four probable bloomery furnaces (615 and 616). The iron blooms are usually compacted and refined after reheating or directly from the bloomery furnace. The reheated smithy hearth bottom (Ssmr) that is formed during this process can only be properly distinguished from the smithy hearth bottoms by means of chemical and microscopic investigation. Nevertheless, the presence of crude iron bloom compels us to accept the probable but – macroscopically – unrecognized presence of reheating slags. By far the largest group of smithy hearth bottoms in numerical terms consists mainly of silica-rich material. These were presumably formed when more or less compacted iron blooms were welded. The use of an excess of sand could create a liquid join in which the iron could establish a metallic bonding. Evidence for the use of this kind of technique during Roman times is found in the metallurgical examination of an iron bar from

[3076] Boreel 2014; the slag from this production was dumped in a well (Hiddink 2014, pl. 21).

the *castellum* Saalburg.[3077] It was demonstrated that the core of the beam consists of slightly to moderately compacted iron blooms and that the closed outer surface was made of fully compacted blooms. This saved on valuable iron and the beam was much lighter, without making any concessions to its strength. The beam is believed to have been forged as a support beam for the boiler in the baths. Heavy beams are found more often in the context of Roman baths.[3078] As the silica-rich slag predates or is contemporaneous with the use of the baths at Ten Hove, the hypothesis that they originated from the construction of this kind of beam is tentatively proposed. In the absence of required quantities of iron in stock or on the market, production in situ was needed.

No direct evidence for the production of iron at Voerendaal-Ten Hove was found, such as features that can be interpreted with certainty as a bloomery furnace, bloomery furnace slag or iron ore (even attached to slags). The iron blooms found suggest the production of iron, but could have been bought elsewhere. However, some iron blooms of a lesser quality point to local production because they would have been rejected at the market. A second indication are the blooms in two of the furnaces (614, 617) mentioned above. Although these could in theory have been features of a field smithy, the remarkable shape and the lesser quality blooms indicate that they were indeed bloomery furnaces (Fig. 34.12). The question is how these features functioned, since slag pit furnaces or

Fig. 34.12 Voerendaal-Ten Hove. Furnace 614 and 615 seen from the north, with the latter cut by the foundation - with 'buttress' - of the horreum.

shaft furnaces usually result in shallow round pits, sometimes with a working pit attached. The features probably represent the impressions left after removal of the bases of freestanding shaft furnaces, backfilled with charcoal, and not the central slag pit, which was located slightly higher, above the first excavation level.

It seems justified to conclude that iron was both produced and worked at Ten Hove in the first part of the Middle Roman period. These activities could date from period 2 of the first villa, but the location of furnaces 614-617 near its main building and the amount of slag deposited shortly before the construction of building 403 suggest a relationship with the construction of the second villa and its baths. There are no indications of iron production for non-local needs during a substantial period.

It is not known what type of iron ore was used at Ten Hove. In areas with Pleistocene sands in the southern Netherlands, the ground water often contains dissolved iron, which oxidizes as bog iron, or bog ore.[3079] These deposits were exploited until the beginning of the twentieth century. In general, bog ores consist primarily of iron hydroxides, commonly goethite (FeO(OH)). However, the groundwater from the sources of the Hoensbeek at the Sevensprong, as well as other water from limestone, contains little iron.[3080] The presence of substantial iron deposits in the valley south of Ten Hove therefore seems very unlikely. Bog iron is also not indicated in Zuid-Limburg according to a map compiled by Brongers and Woltering.[3081] The bog ore may have been brought to Voerendaal from the north, over distances of 30 km or more. Another source of iron in Dutch Limburg mentioned in the literature are limonite concretions ('rattling stones'/'*klapperstenen*'), apparently present in some gravel deposits.[3082] However, there are no indications that these concretions were actually quarried for iron production in Roman times or other periods.

Finally, in the southernmost part of Zuid-Limburg, slag heaps were found near places such as Camerig, Holset and Elzet.[3083] Near these slag heaps, clay ironstone nodules (siderite) can be found in Carboniferous sediments, which were used as an iron ore in early industrial times.[3084] The slag heaps were supposedly

3077 Rehren & Hauptmann 1994.
3078 See for example Wacher 1971 and Chedworth 1976; Baatz 1991, 24-38; Precht & Zieling 1996, 492.
3079 See e.g. the situation around the villa of Hoogeloon-Kerkakkers (Boreel 2014).
3080 Kimpe 1980, 133; Van Rooijen 1989, 257, table 1.
3081 Brongers & Woltering 1978, 99, fig. 55.
3082 Laban *et al.* 1988, 4 (without data on locations/deposits); Felder & Engelen 1989, 246 (Pleistocene Rhine and Meuse deposits, many found at specific locations, especially in clayey sands and mixed clayey sand/gravel); Klarenaar 1998 ('older' Meuse deposits).
3083 Felder & Engelen 1989, 243; Brongers & Woltering 1978, 100, fig. 56.
3084 Weertz & Weertz 2004, 91-92.

Roman in date, but there is a lack of evidence to support this claim and a later date is possible. However, in the area around Baelen-Nereth, in the Ardennes foreland 25 s south of Voerendaal, iron ore was actually quarried and processed during the Roman period.[3085] Perhaps there were similar, as yet unknown, sources of iron further north.

[3085] Hanut *et al.* 2012, 251 (with references to other sites); For the site, see also section 12.6, fig. 12.6.

35 Wall paintings

Henk Hiddink

35.1 The painting fragments. Contexts and description

35.1.1 Introduction

This short contribution is devoted to 162 fragments of painted wall plaster, the poor remains of the many wall paintings that decorated both main buildings and the baths at Voerendaal-Ten Hove (Fig. 35.1-5). Eighteen fragments from Braat's excavations (1947-1950) are held at the RMO.[3086] These had already been discussed in an article by Moormann.[3087] The other 144 fragments were collected during the ROB excavations from trenches 110, 111 and 114 (most either red or white). Many more mortar fragments were collected during these investigations, but these bear no traces of paint.

35.1.2 Contexts

In his publication Braat mentions, without specifying find numbers, fragments of painted wall plaster from three locations (Table 35.1; Fig. 35.1). Some red and soft green fragments were found 'between the rubble of room 13…' of the second villa.[3088] It must be emphasized that the rubble and plaster came from a hypocaust, an artefact trap, and had already been investigated by Habets. Therefore it is not certain that it concerns parts of the original decoration of room 13. More fragments were found in '[t]he north corner of room 18…'[3089] We know that this room had no hypocaust and was not dug – or rather, disturbed – by Habets, but it is still unlikely that the plaster was found in situ on a wall stub. A third location at which fragments of painted plaster were found was '…in the bath, near the latrine.'[3090] This could apply to room 1, 2, 3, 4 and/or 5!

Like the RMO finds, those from the ROB excavations are also related to the main building or buildings and the bath, albeit indirectly. Two fragments were retrieved from basin 319, which was filled in during or after the destruction or decay of the second villa.[3091] Twenty-three came from the possible predecessor of 319, pit/basin 336. Although the excavators thought that the pit was associated with the first villa 399, it could in principle belong to an early phase of the second villa. Pit/basin 336 was intersected by drain 318, the context of 35 fragments of painted wall plaster. However, this attribution is mainly an administrative one, including the fill of 336 at level one. Moreover, drain 318 was ultimately filled with soil from the pit.

Most plaster was collected in trench 114 or the immediate surroundings of the bath: the upper fill of well 314 and pit 762, 763 and 783. Most fragments were found in pit 763. Theoretically, all these contexts could have been dug and filled in when the baths were modified and redecorated. However, it is possible that all were filled in only (long) after the baths fell into ruins.[3092]

Table 35.1. Voerendaal-Ten Hove. The contexts with fragments of painted wall plaster.

Context	Find no.	N
Main building		
Second villa 400/room 13	1953/2.4	2
Second villa 400/room 18	1953/2.6	11
Basin 319	110-2-4, 110-2-7	2
Pit/basin 336 =	111-2-3, 111-2-4	23
Drain 318	111-1-1, 111-1-4, 111-1-5	35
Baths		
Baths 404/room 1-5?	1953/2.20	3
Well 314	114-1-3, 114-2-9	13
Pit 762	114-1-12	2
Pit 763	114-1-14	65
Pit 783	114-1-6	4
Unknown	1953/2.xx	2
Total		**162**

35.1.3 Description

The majority of painted mortar fragments are not very helpful when it comes to reconstructing decorations; they are either entirely white and/or red. This applies, for instance, to nearly 60 fragments (almost 40% of the total number) from drain 318, basin 319 and pit/basin 336. Only a few have lines (or bands) in white/light grey, blue and/or green (Fig. 35.3).

3086 Two fragments on loan to the Limburgs Museum, Venlo, where they were documented. It is remarkable that no wall painting fragments were found in 1892/93, because Habets collected finds belonging to all kinds of other categories.

3087 Moormann 1984/85.

3088 Braat 1953, 57; 71; no. 1953/2.4.

3089 Braat 1953, 58; 72; no. 1953/2.6.

3090 Inventory RMO, no. 1953/2.20.

3091 Cf. Chapter 41.

3092 See Chapter 41 (well 314) and 46 (pits).

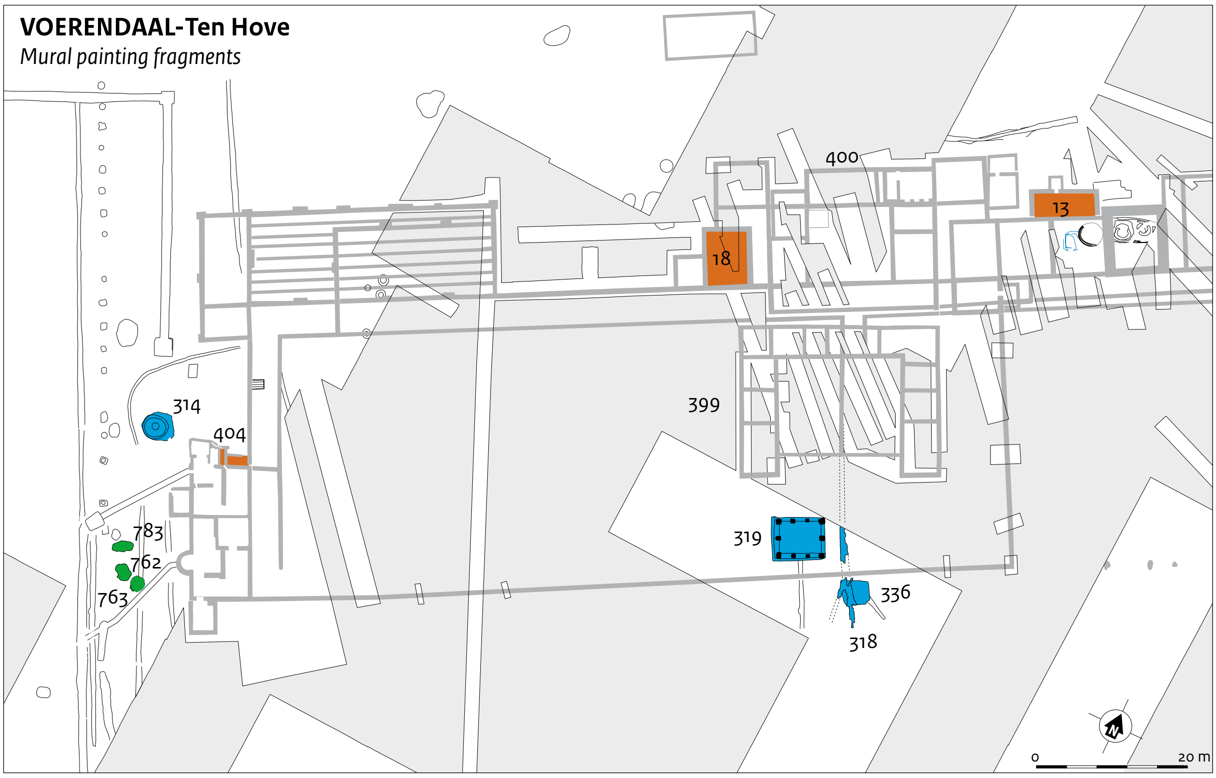


Fig. 35.1 Voerendaal-Ten Hove. Features with fragments of wall-paintings.

The pieces collected by Braat near the northeast part of the baths are also white and/or red. Item 404-3 suggests a decoration of broader bands or panels (Fig. 35.4), an impression also gained from the pieces from the pits at the west side of the building (although they could represent multiple decorations or decoration phases). Some white fragments from pit 763 have a thin red line, combined with greyish and orange/light brown lines or band (Fig. 35.4). Item 763 is decorated with a red bow. On the basis of its cross-section, large fragment 763-2 must have been a moulding at the bottom of the wall near the floor.

Of the fragments from the second main building, the two from room 13 are quite small and green, one with the pointed end of two small yellow lines (points of a bird's beak, vines? Fig. 35.2). The material from room 18 is varied and therefore the most promising for reconstructing the decoration. Fragment 400-13 is burned and the green-grey part could have been white originally, similar to 400-16 (Fig. 35.2). Item 400-15 is quite intriguing because it seems to be part of an image of 'something' (Fig. 35.2). Half of it is a purplish colour, the other pink and both have small yellow streaks. Either the motif is floral or an imaginary figure like a sea creature.[3093] Fragments 400-10 and 14 appear to contain parts of (concentric) circles in varied colours. Moormann, who wrote about the wall paintings from Voerendaal held at the RMO, believed that the latter fragment of a blue-grey circle between red lines was part of a common type of dado decoration (Fig. 35.5A-B).[3094] However, our drawing differs slightly from this and the question remains as to what the diameter of the circle was, if it was a circle. According to Moormann, the diameter was 23 cm, but in his illustration the border of the blue is too far from the red line and the circle would project from the lower (or upper!) border of the field.[3095]

The most interesting wall painting fragments from room 18, or the whole site for that matter, are those in white with two concentric red circles and small green flowers (400-4, 11, 12; Fig. 35.2). Moormann used the two

[3093] See e.g. in Xanten Jansen *et al.* 2001, fig. 126a, cat. 7.28 (floral); fig. 71-72, cat. 5.2 and fig. 176, cat. 9.1 (sea creatures and various figures). Thanks to Lara Laken for these references.

[3094] Moormann 1984/85, 67, fig. 12. A dado is the 'socle' in a mural painting, between the floor and e.g. an upper zone consisting of panels. An example with differing size and colours e.g. from Aardenburg (Van Dierendonck & Swinkels 1983, fig. 11-12).

[3095] The blue present does not seem to represent a smaller circle, however, because the border is relatively straight.

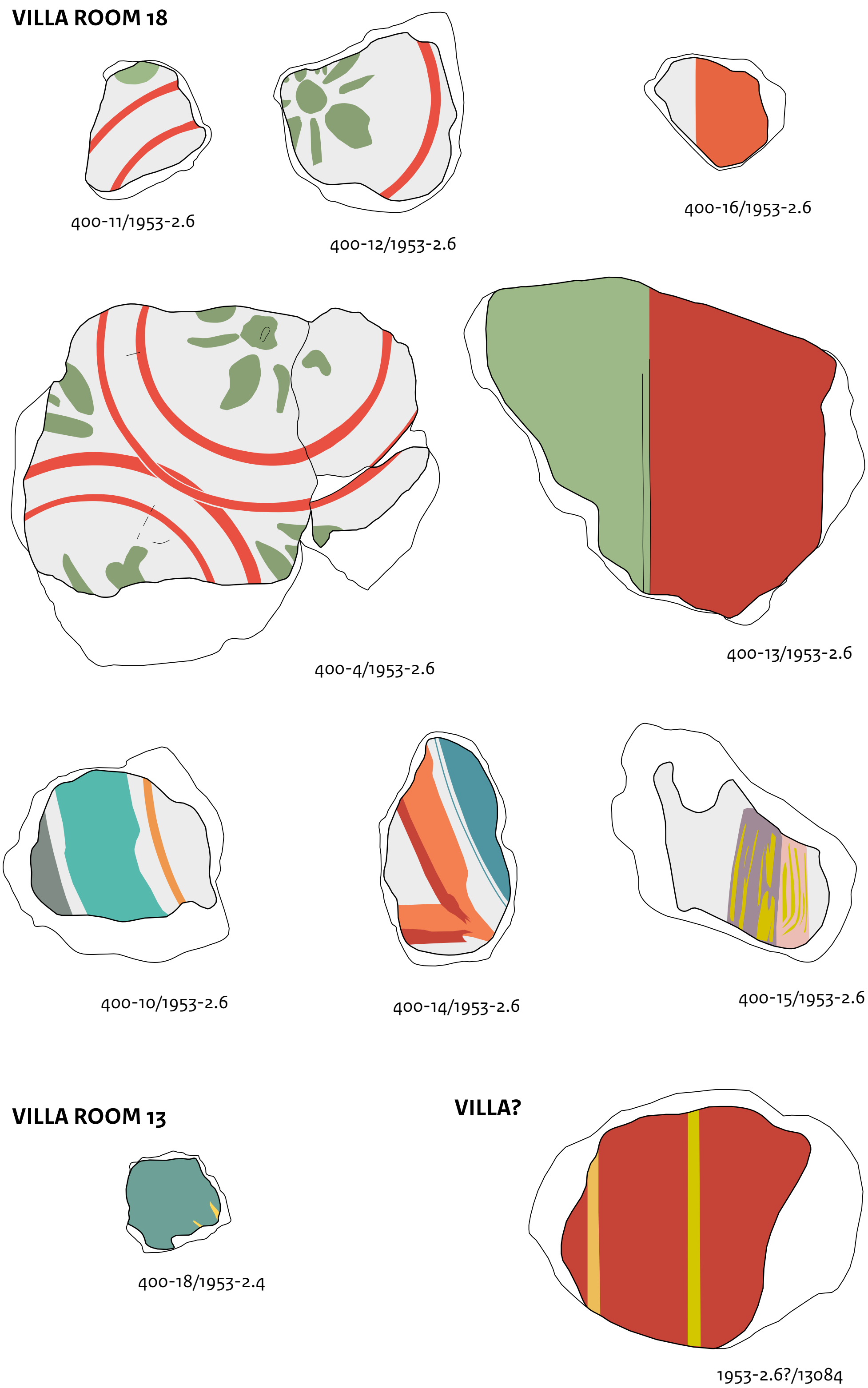


Fig. 35.2 Voerendaal-Ten Hove. Wall-painting fragments. Scale 1:2.

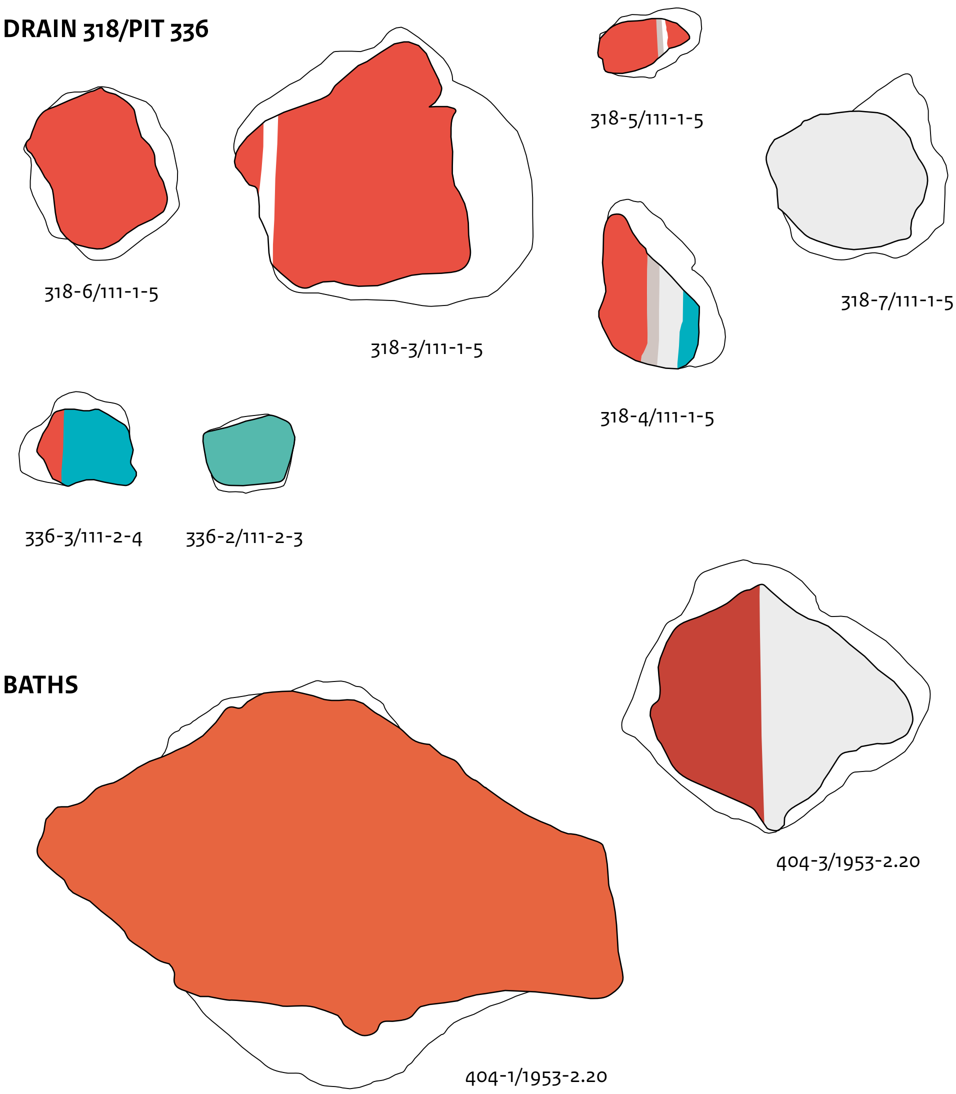


Fig. 35.3 Voerendaal-Ten Hove. Wall-painting fragments, cont. Scale 1:2.

largest fragments to reconstruct – in his own words – a kind of 'wallpaper' design, extending in several directions (Fig. 35.5C).[3096] However, in reality none of the fragments allow for more than a band of circles in one direction only (Fig. 35.5D).[3097] Decorations with circles were often used at the borders of ceilings or vaults.[3098] The same holds true for circular elements in a 'wallpaper' style, which actually do exist, although here circles are mostly small and not placed against each other, but at the crossings of lines of small flowers or leaves.[3099]

35.1.4 Conclusions

The fragments of wall painting collected at Voerendaal-Ten Hove do not allow for substantial reconstructions or precise decoration dates. A few pieces possibly did belong to the first main building (drain 318/basin 336), but the find locations suggest that the majority were part of wall decorations in the second main building and its baths. Therefore, they must have been painted between c. AD 125/150-250/275. An estimate of the surface area covered by the collected fragments, about 0.5 m², implies that they represent (much) less than 0.05% of the

[3096] Moormann 1984/85, 67-68, fig. 13.

[3097] Thanks to Lara Laken for sharing some ideas on the reconstruction of this decoration.

[3098] Barbet 2008, 315ff.; Gogräfe 1999, 115, fig. 84 (Mainz). An example of a decoration of double circles – original location unknown – in Limburg was found at Mook-Plasmolen (Braat 1934, 12, fig. 8).

[3099] E.g. at Aardenburg (Zeeland): Van Dierendonck & Swinkels 1983, fig. 16; 18j and Orléans (Barbet 2008, 319, fig. 387). Barbet illustrated only one example similar to Moormann's reconstruction (2008, 322, fig. 491).

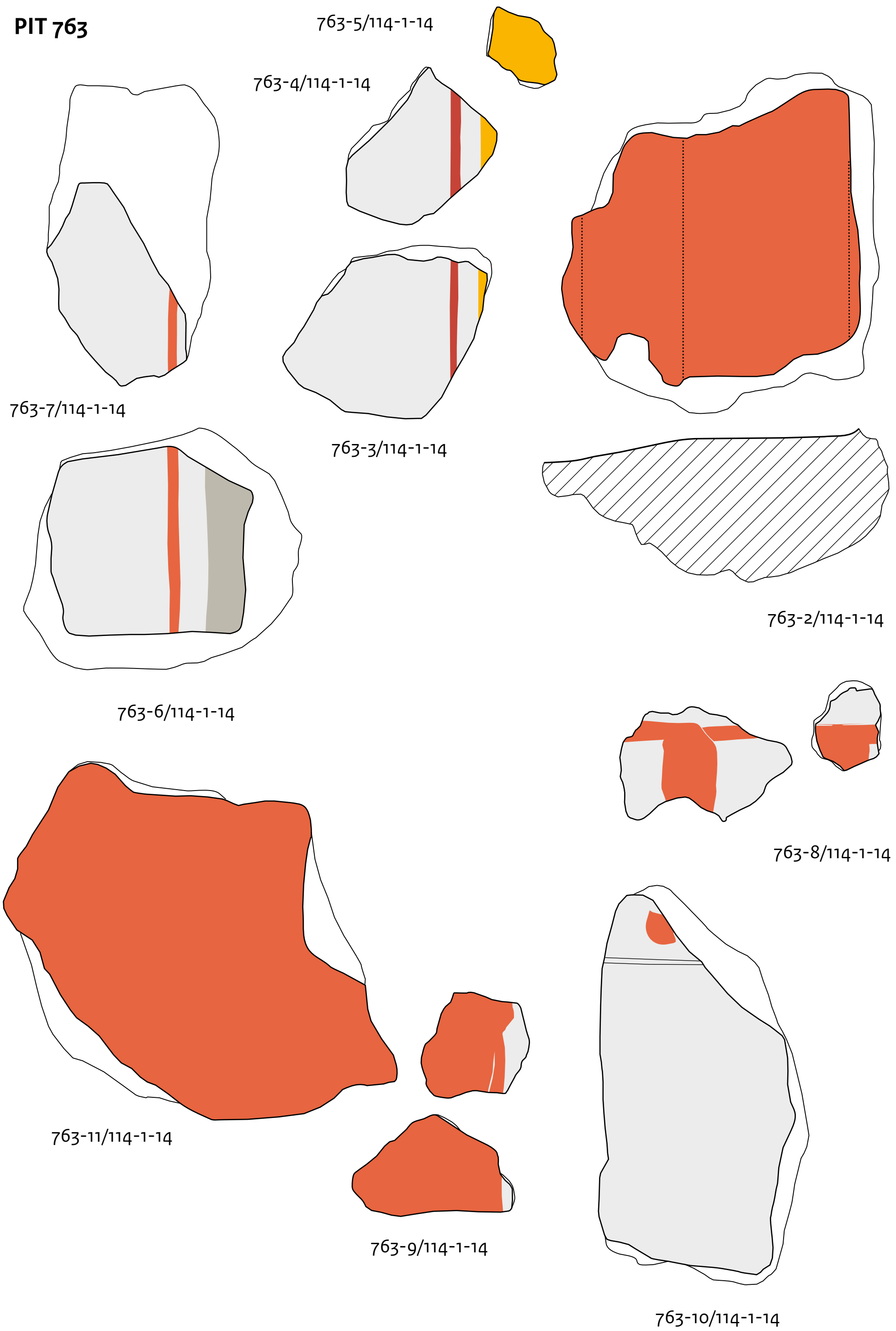


Fig. 35.4 Voerendaal-Ten Hove. Wall-painting fragments, cont. Scale 1:2.

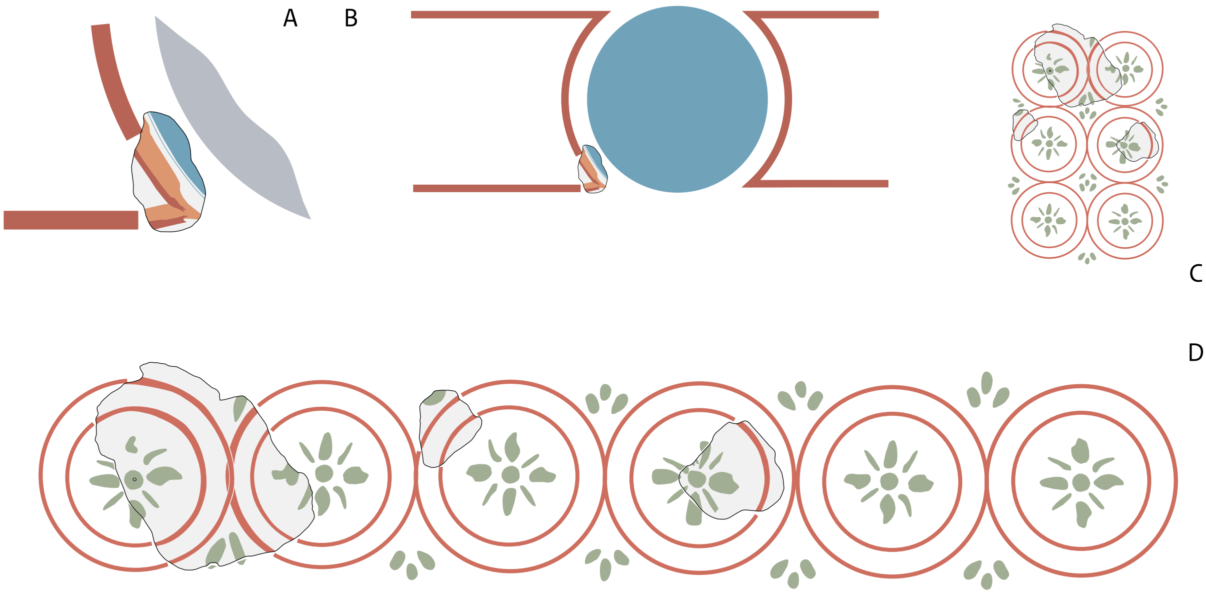


Fig. 35.5 Voerendaal-Ten Hove. Reconstructions two decorations; A and D scale 1:4, B and C 1:10. (source: B and C modified after Moormann 1984/1985, fig. 12-13) A actual position of red lines and border of blue circle; B reconstruction by Moormann; C reconstruction of 'wall-paper' decoration by Moormann; D alternative reconstruction: a band rather than a field of circles.

total surface area of walls and ceilings that must have been decorated, at least some 1000 m^2.[3100] That the material collected is only a minute portion of the original quantity largely explains why the decorations at Ten Hove seem at first sight to be rather modest. It is possible that the villa had beautiful, intricate wall paintings – at least in some rooms – consisting of both abstract and figurative motifs. The fact that the latter are known in fairly large numbers from the rather modest villa of Maasbracht-Steenakker is largely the result of specific favourable formation processes, with the material ending up in the infill of the cellar.[3101]

35.2 Pigments and painting methods

Luc Megens

To identify the pigments used to paint the walls (and possibly ceilings) of the villa at Voerendaal, first the surfaces of all plaster fragments with a paint layer were analysed non-invasively using X-ray fluorescence spectrometry (XRF).
This detected the chemical elements in the paint layers and the layers just underneath.[3102] This is not always enough to clearly identify the pigments. Therefore, some surfaces were also analysed non-invasively using X-Ray Diffraction analysis (XRD).[3103] This method can give a certain identification of the crystalline components if they are present in a sufficient concentration. Some fragments were also observed under raking light and UV radiation to observe the painting technique.[3104]

An approximately 1 mm large sample of the painted surface from some fragments was embedded, ground and polished to create cross-sections of the paint layers. These were analysed using optical microscopy and Scanning Electron Microscopy with Energy-Dispersive X-ray analysis (SEM-EDX) to identify individual pigment grains and determine the layer build-up and structure.[3105]

These analyses showed a basic pigment palette of lime wash for white paint, red and yellow ochres, green earth and probably lamp black, expanded to include the more expensive Egyptian blue. This investigation also showed that the decorations of some of the fragments had partly or largely eroded.

35.2.1 The fragments with white paint

The XRF analyses of white surfaces all show calcium (Ca) as the only major element present,

[3100] A rough estimate of the wall surface of the second villa and the baths (400 m of wall decorated up to 2.5 m high). The surface of ceilings should in fact be added and there would have been several phases of (re) decorations, lowering the known percentage even more. This is compensated, however, by the large surfaces that would have been plain white.

[3101] Swinkels 2017. Cf. section 15.5.3.

[3102] Only elements heavier than magnesium (thus not e.g. carbon, nitrogen, oxygen) can be detected in this way. The instrument used was a Bruker Tracer 5i portable XRF spectrometer with an X-ray tube with a 'thin layer' rhodium anode. It was set in 'mudrock dual' mode, in which two measurements are performed automatically, one with a tube voltage of 40 kV, a tube current of 22.3 µA and a Ti/Al filter in the primary beam, the other with a tube voltage of 15 kV, a indicating that the white paint is a white lime paint, possibly mixed with chalk or marble powder (Table *35.2). Besides calcium, trace amounts of strontium (Sr) were also detected. Due to the chemical and physical similarities between these two elements, strontium is present in calcium-containing materials as a natural trace element. When comparing the ratios of the levels of strontium to calcium (Sr:Ca) in the measurements of the white surfaces,[3106] two groups could be distinguished (Fig. 35.6), one with a relatively high Sr:Ca ($2.4 \pm 0.5 \cdot 10^{-3}$) and one with a low Sr:Ca ($0.5 \pm 0.2 \cdot 10^{-3}$). In nature, the amount of strontium varies between different calcium-based materials. In general, shells have a higher strontium content than limestone or marble.[3107] Both shells and limestone or marble can be burnt to lime. Vitruvius only mentions harder and softer stones for the preparation of lime,[3108] the former for structural applications, the latter for plastering. However, it could be possible, as in the Middle Ages and later, that lime was also produced from shells in the Roman era.

The white fragments in the group with a high Sr:Ca ratio have a finish of a white lime layer of almost pure lime, approximately half a millimetre thick, on a light yellow plaster. This white lime layer is covered with a thin limewash layer approximately 0.01 to 0.02 mm thick (Fig. 35.7). The fragments with a low Sr:Ca ratio appear to be finished with a white (very lightly pink) layer approximately one millimetre thick, consisting of lime with some calcium carbonate particles from ground limestone or marble (Fig. 35.8).

35.2.2 The red paints

The pXRF analyses showed that all red paints consist of an red pigment containing iron, generically named red ochre (Table *35.2). No obvious groups can be observed in the pXRF data for the red paints. The XRD analysis of some fragments showed the presence of hematite.

An example of a cross-section of red paint from a red surface is given in Fig. 35.9. In this case, a double, bright orange-red paint layer of red ochre in lime seems to be present.[3109] The red paint of the red line on the fragment with a yellow and red line, find number 763-4/114-1-14, also consists of red ochre but was applied as a much thinner layer. It seems to have been applied on a dried surface (Fig. 35.10). In both

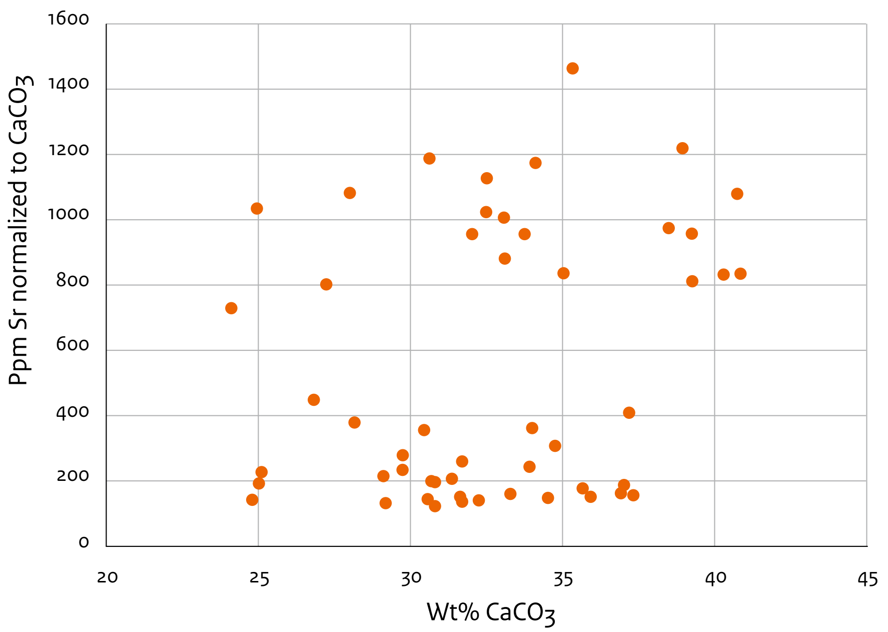


Fig. 35.6 Voerendaal-Ten Hove. Graph of the measured concentrations by XRF of strontium corrected for the measured amount of calcium carbonate versus the measured amount of calcium carbonate.

tube current of 19.1 μA and without a filter, to detect the lighter elements.

3103 A Bruker Discover D8 microdiffractometer with copper anode X-ray tube and a 2D VÅNTEC 500 detector was used for this analysis. Plaster fragments were placed in the X-ray beam without sample preparation. The resulting diffractograms were matched against database patterns from the COD database or the ICDD-PDF database to identify the individual components.

3104 A Foster and Freeman VSC8000 was used for this purpose. Infrared luminescence was also observed with this instrument.

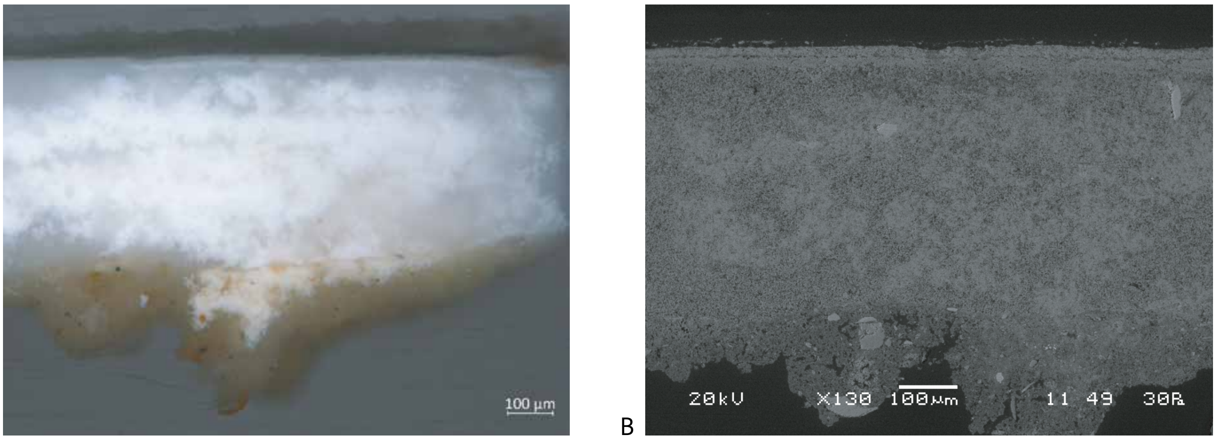
3105 Samples were observed with a Zeiss Axioplan 2 imaging optical microscope and a JEOL 5910LV SEM with a Thermo Noran EDX detector.

3106 The concentrations as reported by the instrument may not be entirely accurate because of the material being not homogeneous in the measurement volume or unevenness of the surface. However, the difference between the two groups is bigger than the uncertainty in the measurements.

3107 Ferraz *et al.* 2019.

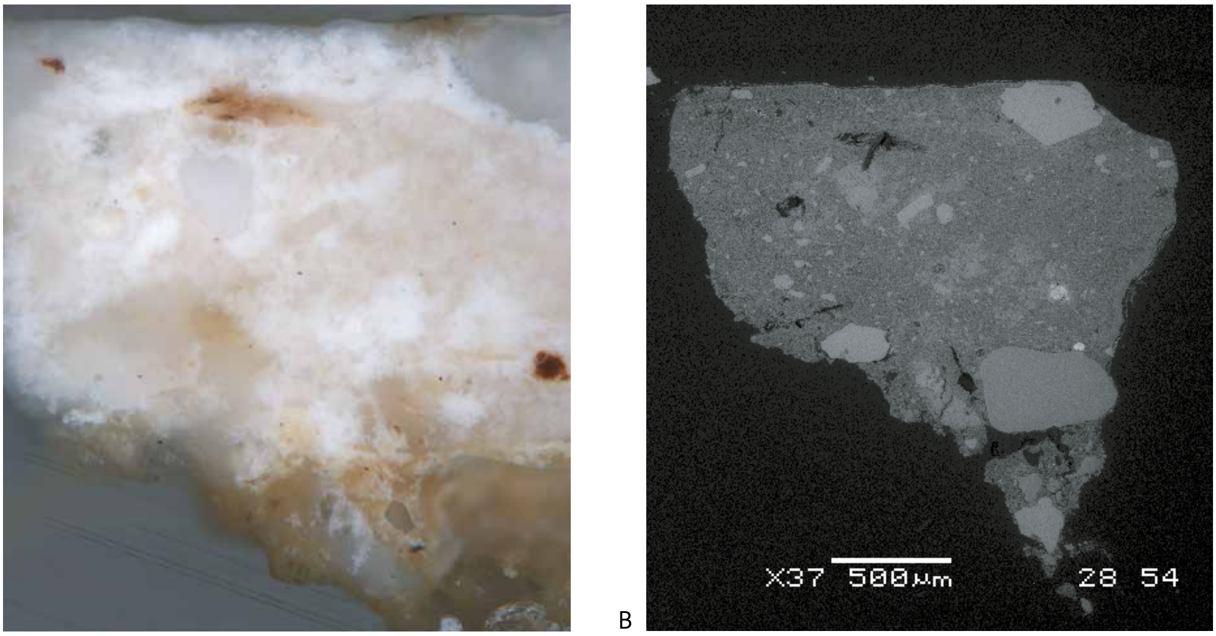
3108 Vitr.*arch.* 2.5.1.

3109 The colour in the microphotograph appears quite different from that observed at the surface of the fragment. This is due to the high magnification and different lighting conditions under the microscope.



A B

Fig. 35.7 Voerendaal-Ten Hove. Paint cross section of the white finish on one of the fragments with a high Sr content in the surface, with find number 314-3 or 5/114-1-3 (sample 20-106-2). A microphotograph in incident polarized light; B backscattered electron image (BEI) of the cross section.



A B

Fig. 35.8 Voerendaal-Ten Hove. Paint cross section of the white finish on one of the fragments with a high Sr content in the surface, with find number 314-4/114-2-9 (fragment 3, sample number 20-106-10). A microphotograph in incident polarized light; B backscattered electron image (BEI) of the cross section.

samples the red pigment particles contain the elements iron, silicon and aluminium, showing that these are hematite-containing clay minerals.

Red ochre is the generic term for a wide range of red earth pigments, from pure hematite to clay minerals containing hematite, with colours varying from bright orange to dull brown-red. It is the red pigment most found in Roman wall paintings and also described by Vitruvius and Plinius as the main red pigment. While Vitruvius only uses the generic term *rubrica* and mentions a number of origins for the best varieties, such as *Sinope*, Plinius describes *sinopis* as a separate pigment, but acknowledges that it is similar to other types of *rubrica*.[3110] Red ochre was also the main red pigment in the nearby villas at Kerkrade and Maasbracht, but the much more expensive bright red pigment cinnabar, called *minium* in antiquity,[3111] was also found at these two sites.[3112]

3110 Vitr.*arch*. 7.7.2; Plin.*nat.hist*. 35.31-36.
3111 Vitr.*arch*. 7.8.1-9.5.
3112 Megens *et al.* 2007.

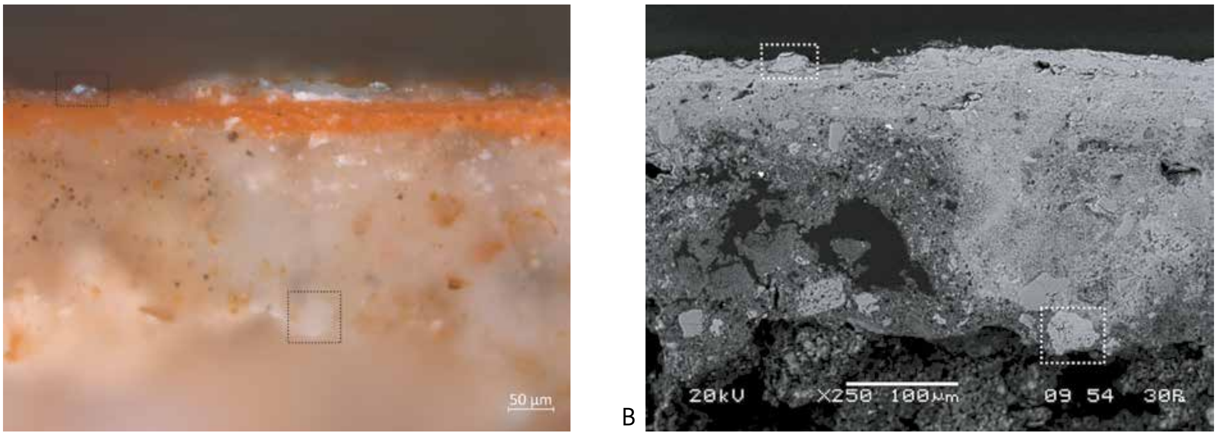
A B


Fig. 35.9 Voerendaal-Ten Hove. Paint cross section of the red finish on one of the fragments with find number 763/114-1-14 (sample number 20-106-9). A microphotograph in incident polarized light; B backscattered electron image (BEI) of the cross section.

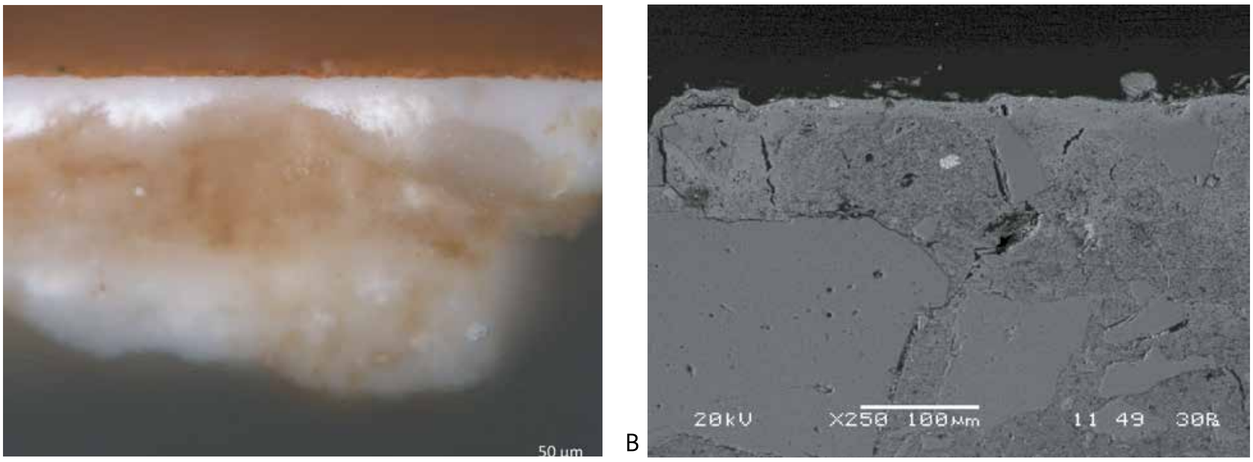
A B


Fig. 35.10 Voerendaal-Ten Hove. Paint cross section of the red line on the fragment with a yellow and red line, with find number 763-4/114-1-14 (sample number 20-106-8). A microphotograph in incident polarized light; B backscattered electron image (BEI) of the cross section.

35.2.3 Yellow paints

There is only one yellow fragment found at Voerendaal (763-5/114-1-14) and some with a yellow line (763-3/114-1-14 and 763-4/114-1-14; Fig. 35.4) or a small yellow detail (400-18/1953.2-4; Fig. 35.2). XRF (Table *35.2) and microscopic and SEM-EDX analysis of a cross-section of the yellow fragment (Fig. 35.11) show that the pigment is a yellow ochre. The paint on the yellow fragment was applied in a rather thin layer, probably on the dry plaster, which consists of lime and sand. The yellow ochre particles are surrounded by carbonated lime, indicating that the paint was prepared by mixing the pigment with lime water or a limewash.

Yellow ochre is almost the only yellow pigment found in Roman wall painting.[3113] It is the pigment described by Vitruvius as *sil* (or ὤχρα in Greek).[3114] It was found in many places in the ancient world in different qualities and tones. According to both Vitruvius and Plinius the best yellow ochre came from Attica and was twenty times more expensive than the yellow ochre from Gaul.[3115]

35.2.4 The fragments with green paint

Three fragments with green paint have been found at Voerendaal (400-10/1953-2.6; 400-13/1953.2-6; 336-2/111-2-3; Fig. 35.2-3).

[3113] Except for a rare find of massicot (yellow lead oxide) in a wall painting fragment from Metz (Dooryhée *et al.* 2005).

[3114] Vitr.*arch*. 7.7.1.

[3115] Plin.*nat.hist*. 33.158-160.

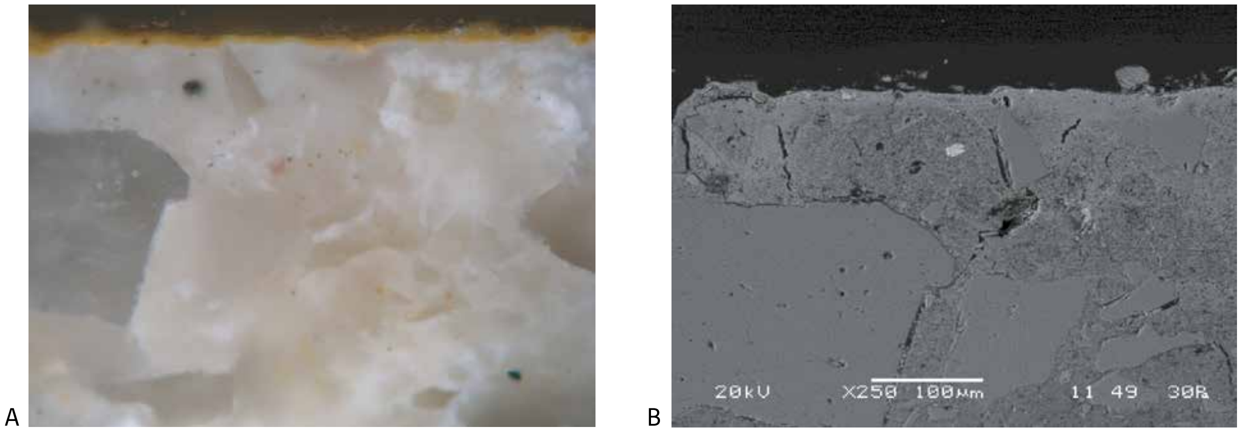


Fig. 35.11 Voerendaal-Ten Hove. Paint cross section of the yellow fragment with find number 763-5/114-1-14 (sample number 20-106-4). A microphotograph in incident polarized light. B backscattered electron image (BEI) of the cross section.

Relatively high levels of iron and potassium in the pXRF results (Table *35.2) suggest the presence of the pigment green earth, which is confirmed by XRD analysis, showing diffraction patterns of celadonite or glauconite (Fig. 35.12). Both minerals are used as green earth pigment, but celadonite and glauconite cannot be distinguished by XRD analysis. However, the chemical composition as determined by SEM-EDX analysis of individual pigment grains in cross-sections is similar to that of glauconite (Fig. 35.13).[3116] Celadonite occurs in rocks of volcanic origin, while glauconite is a green mineral found in sedimentary layers of marine origin.

Both Vitruvius and Plinius mention *creta viridis.* Even though both authors also describe the preparation of verdigris (*aerugo or aeruca*; copper acetate) and green copper minerals (*chrysocolla*) and these pigments have been analysed in paint pots,[3117] green earth is almost the only green pigment actually found in wall paintings.[3118]

The green on the fragment in the RMO collection (400-13/1953-2.6) and the green fragment found in later excavations (336-2/111-2-3), on which the green is partially painted over with red, also contain Egyptian blue. pXRF measurements show the presence of the element copper. Figure 35.14 shows the presence of particles in the surface that emit infrared radiation when illuminated with visible light, which is a typical behaviour of Egyptian blue.[3119] Both the copper content measured with pXRF and the luminescence images show that the green paint on fragment 336-2/111-2-3 contains much more Egyptian blue than that on the fragment in the RMO collection. The Egyptian blue particles are also clearly visible in the microphotograph of the paint cross-section of the former (Fig. 35.15). The sample for the cross-section was taken where the green paint covered red paint, consisting of red ochre. The plaster under the red paint has a denser structure just below the red layer as can be seen in the electron microscope image (BEI), indicating that it had dried before the red paint was applied. The green may have been applied over the red paint while it was still not fully dried. Green and blue pigment particles from the green paint seem to be semi-embedded in the red paint.

Data assembled by Delamare in 1990 showed that the green paint in Roman wall paintings from France was in most cases a mixture of green earth and Egyptian blue until c. AD 80, but after that the addition of Egyptian blue was much less frequent.[3120] Over the last 30 years, however, many examples of the admixture of Egyptian blue to green earth in later wall paintings have been attested, including those in the nearby villas at Kerkrade and Maasbracht, and in the villa of Hoogeloon.[3121] These villas, however, are dated to the second century AD.

On the fragment with part of a green circle surrounded by a grey circle (400-10/1953.2-6), only green earth had been used in the green paint. One of the greenish-grey flowers on the

3116 The data were compared with analytical data from Hradil *et al.* 2003.

3117 Augusti 1967; Varrone & Bearat 1997.

3118 A rare exception was the occurrence of verdigris in Léro, reported by Delamare *et al.* 1990.

3119 Verri *et al.* 2008; Verri 2009.

3120 Delamare *et al.* 1990.

3121 Maasbracht and Kerkrade: Megens *et al.* 2007. Various examples from Austria and southern Germany: Welter 2008. Examples from Xanten: Daskiewicz *et al.* 2001.

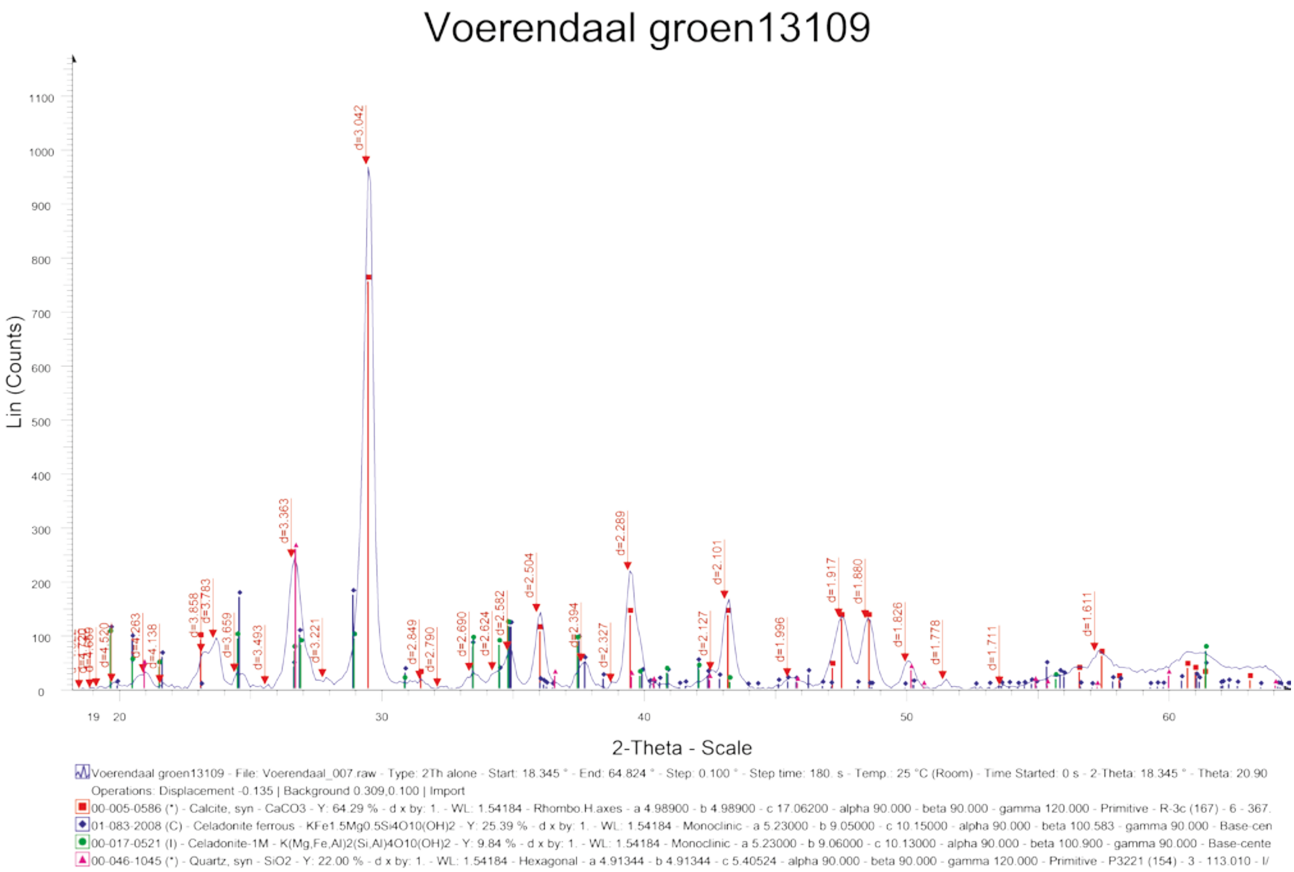


Fig. 35.12 Voerendaal-Ten Hove. X-ray diffractogram of the green surface of fragment 336-2/111-2-3 (blue line). The diffractogram matches with a combination of database patterns of calcite (red bars), two database entries of celadonite (blue and green bars) and quartz (pink bars).

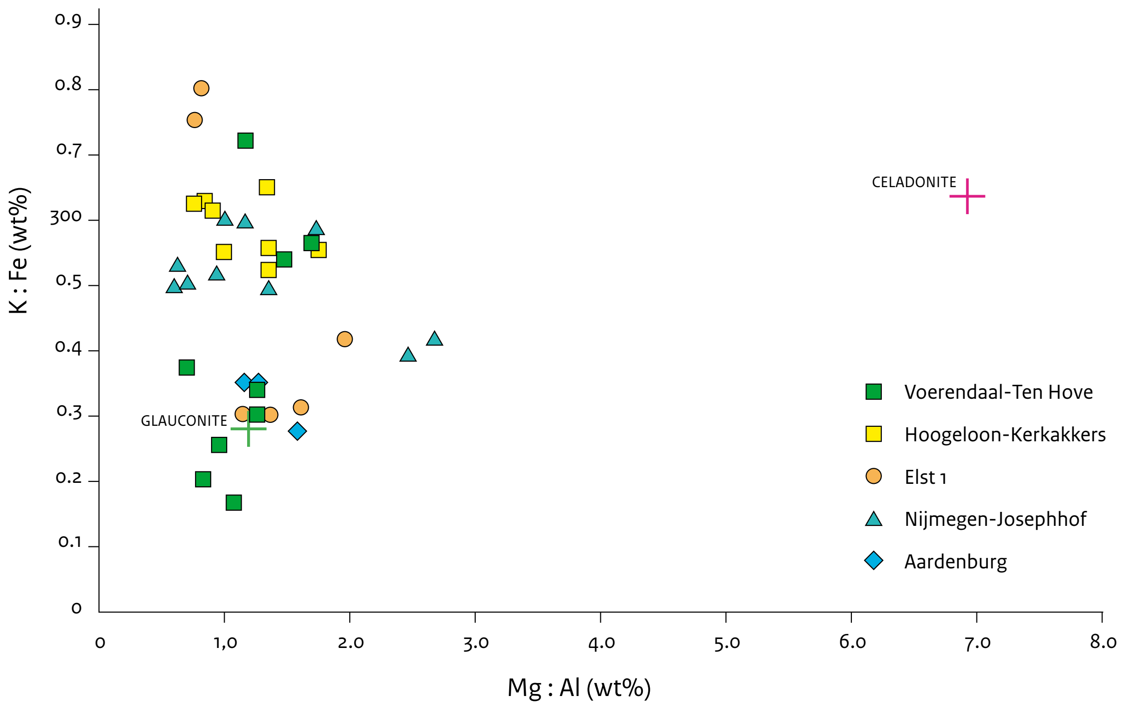


Fig. 35.13 Voerendaal-Ten Hove. Graph of ratios of elemental weight percentages (as measured by SEM-EDX on individual green pigment particles in paint cross sections) of potassium over iron (K:Fe) versus magnesium over aluminium (Mg:Al) of green pigments from Voerendaal, compared to those from other sites in the Netherlands, and to those of glauconite and celadonite (values based on data from Hradil et al. 2003).Ut odis eossit od quis assequos quaes velia dolorep

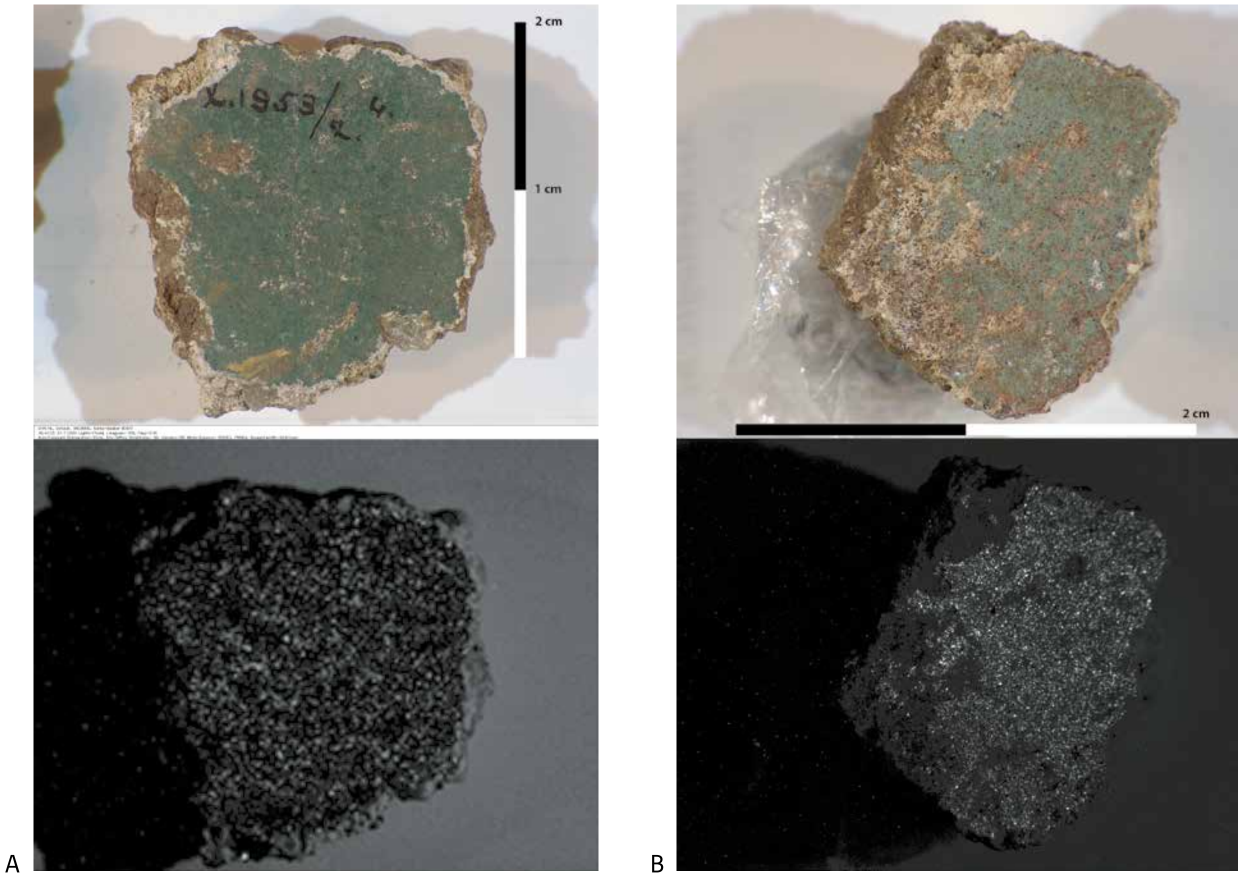


Fig. 35.14 Voerendaal-Ten Hove. Macrophotographs of fragments (top) and images of the infrared luminescence caused by particles of Egyptian blue (bottom). A 400-18/1953-2.4; B 336-2/111-2-3.

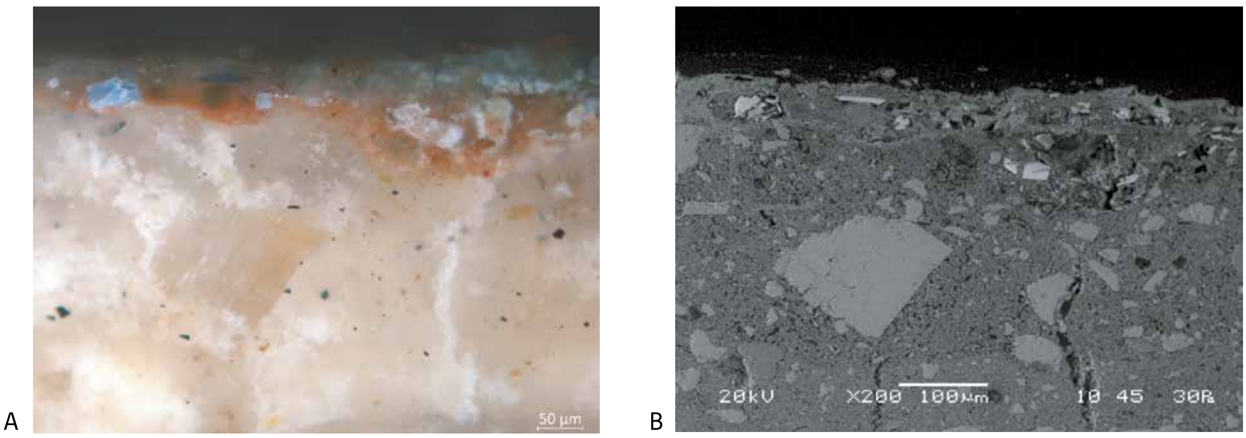


Fig. 35.15 Voerendaal-Ten Hove. Paint cross section of the green fragment 336-2/111-2-3 (sample number 20-106-4). A microphotograph in incident polarized light. B backscattered electron image (BEI) of the cross section. The brightest particles in BEI in the top layer are the Egyptian blue particles. Under the long dark blue particle a rounded green earth particle is visible partly embedded in the red paint layer.

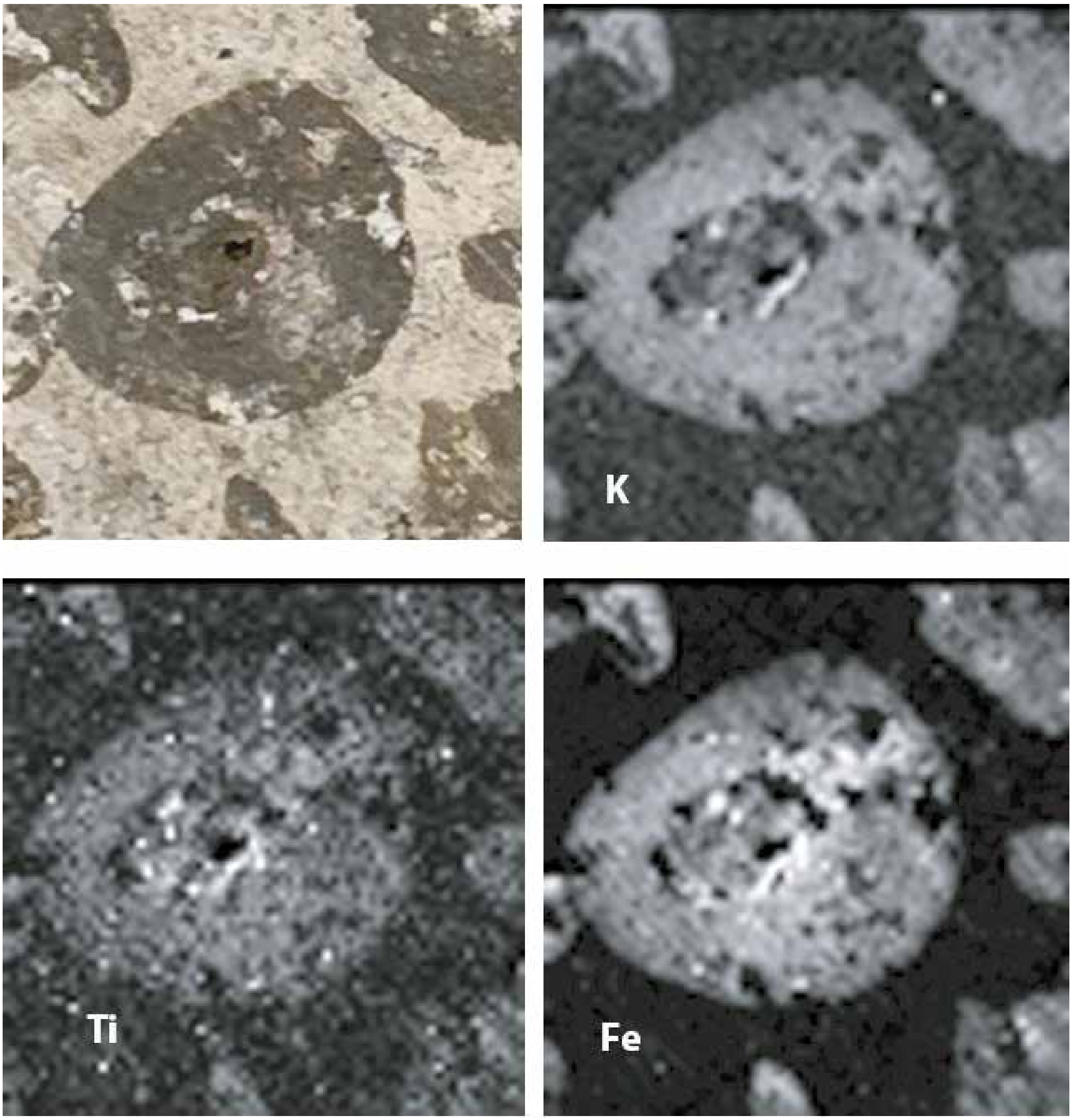


Fig. 35.16 Voerendaal-Ten Hove. XRF scans of the centre of the gray flower on fragment 400-12/1953-2.6. Clockwise from the top left are the macrophotograph of the scanned area and the element maps of potassium (K), iron (Fe) and titanium (Ti). The simultaneous presence of potassium and iron suggest the presence of green earth, which is potassium iron magnesium aluminium silicate. Titanium is a common trace element in iron rich clay minerals.

fragments with red circles (400-12/1953.2-6) was also painted with green earth, as a scan with the micro-XRF (Fig. 35.16) and an XRD analysis have shown. It is not clear why the flower is more grey than green. It might have been caused by exposure to fire. On the fragment with a double red circle, the flower and leaves or petals are very pale and mostly yellowish, which is a known effect of heat on green earth. Microscopically, the surface shows considerable crackling, which can also be related to exposure to fire. Scant remains of a similar flower seem to be present on an almost white fragment (314-3/114-1-3). Again, remains of green earth are detected using micro-XRF.

A B

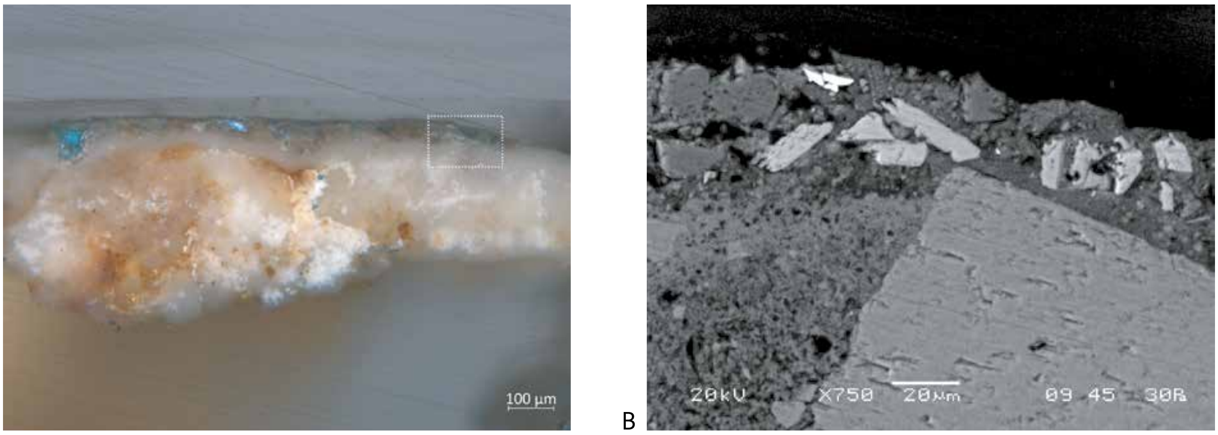


Fig. 35.17 Voerendaal-Ten Hove. Paint cross section of the blue fragment 336-3/111-2-4 (sample number 20-106-12). A microphotograph in incident polarized light; B backscattered electron image (BEI) of a close up indicated by the rectancle drawn on the polarized light microphotograph. The brightest particles in BEI are particles of tin oxide, the little less bright particles are Egyptian blue particles.

A B C

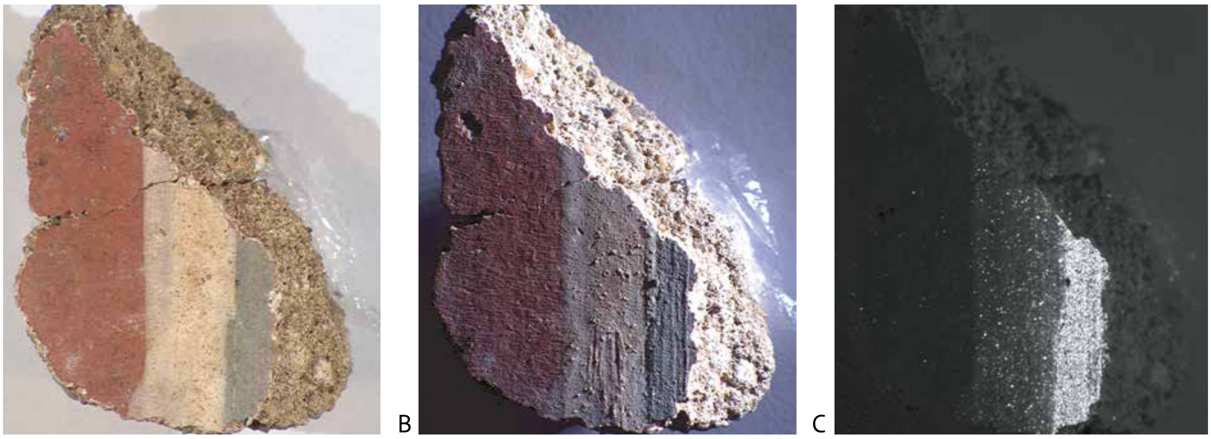


Fig. 35.18 Voerendaal-Ten Hove. Macrophotograph of fragment 318-4/111-1-5. A the fragment in normal light; B in raking light from the right; C the infrared luminescence caused by Egyptian blue particles.

35.2.5 Blue paints

As well as being mixed with green earth, Egyptian blue is the pigment in the blue paints on fragments 336-3/111-2-4; 318-4/111-1-5 and 318-5/111-1-5 (Fig. 35.3). Vitruvius describes the production of this pigment, named *caeruleum*: sand, copper filings and *flos nitri* – natron or sodium salt from the salt lakes in Egypt – were mixed together, formed into balls and then fired in earthenware pots in a kiln.[3122] The SEM-EDX analysis of a cross-section of fragment 336-3 revealed the presence of a grain of tin oxide among the Egyptian blue particles (Fig. 35.17). The presence of tin in Egyptian blue shows that not only copper, but also scrap bronze was used in the production of the pigment. This was also attested in some wall painting fragments from Maasbracht and Kerkrade and in one of three Egyptian blue balls found in Heerlen.[3123]

On fragment 336-3, the blue was applied on a white layer (partly) covering a red paint layer. The blue has partly eroded away, because the coarse pigment particles make the paint surface less even and easier to abrade.

On fragment 318-4, the blue paint was applied on a red surface with a brush stroke perpendicular to the smoothing direction of the red underlayer (Fig. 35.18, middle).

The approximately 1 cm wide white line between

[3122] Vitr.*arch*. 7.11.1.

[3123] E.g. Megens *et al*. 2007.

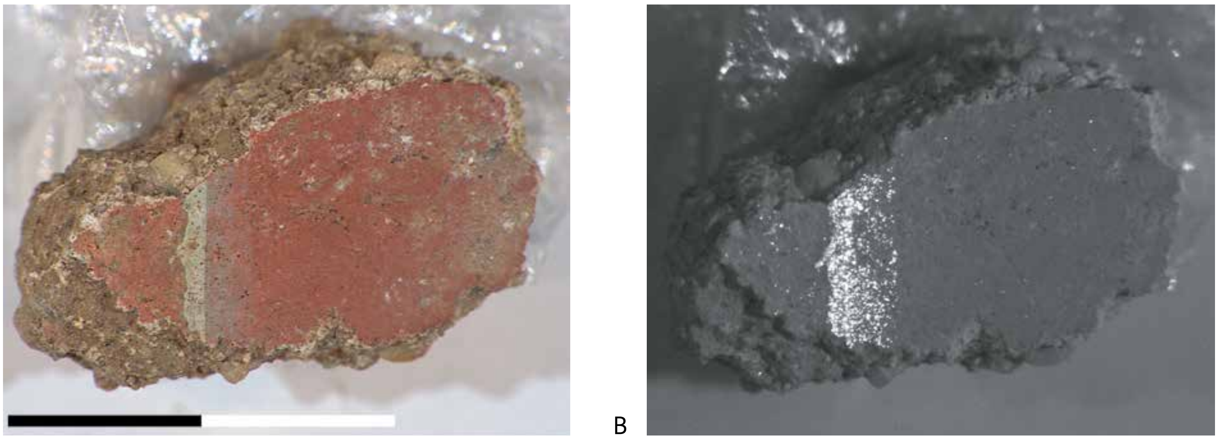


Fig. 35.19 Voerendaal-Ten Hove. Macrophotograph of fragment 318-5/111-1-6. A in normal light; B the infrared luminescence caused by Egyptian blue particles.

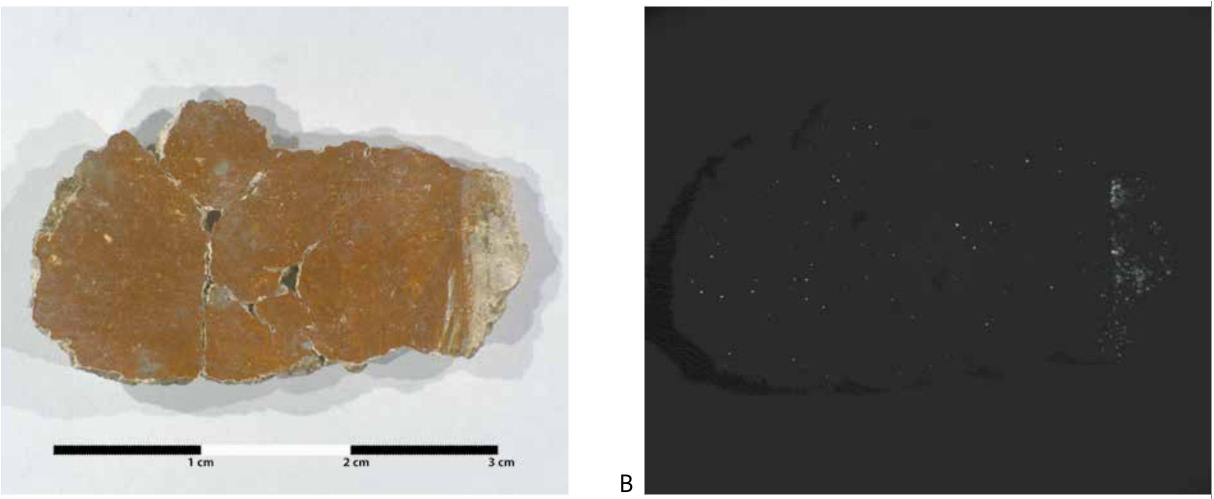


Fig. 35.20 Voerendaal-Ten Hove. Macrophotograph of fragment 763-9/114-1-14. A in normal light; B the infrared luminescence caused by Egyptian blue particles.

the red and blue area was painted with white lime paint, after the blue, with a small overlap. Infrared luminescence (Fig. 35.18C) showed that the white contains some Egyptian blue, either intentionally mixed with the white or picked up by the brush from the blue paint if the blue paint had not completely dried when the white line was painted.

On fragment 318-5, Egyptian blue is present in a thin transparent layer on top of a largely flaked-off white lime paint layer and the adjacent underlying red surface (Fig. 35.19). A thin Egyptian blue layer is also observed on fragment 763-9/114-1-14 over a white paint and partly over the adjacent red paint (Fig. 35.20).

Egyptian blue seems to have been applied thinly over the grey on two fragments with a partly grey surface, one with a red line (763-6/114-1-14), the other with a red ribbon with loops (763-8/114-1-14; Fig. 35.4) on a white background. In both cases, a fluorescent layer, in which Egyptian blue particles are concentrated, is visible in addition to the grey (Fig. 35.21-22). It could not be determined whether this fluorescence is related to an organic binder or inorganic material. No pigment could be identified in the grey paint layer by means of XRF, SEM-EDX of the cross-section (Fig. 35.23) and HPLC analysis.[3124] To obtain the grey colour, lime was probably mixed with lamp black (*atramentum*).[3125]

3124 High Performance Liquid Chromatography, a method to analyse natural and synthetic organic colourants.

3125 Vitr.*arch*. 7.10.1-4.

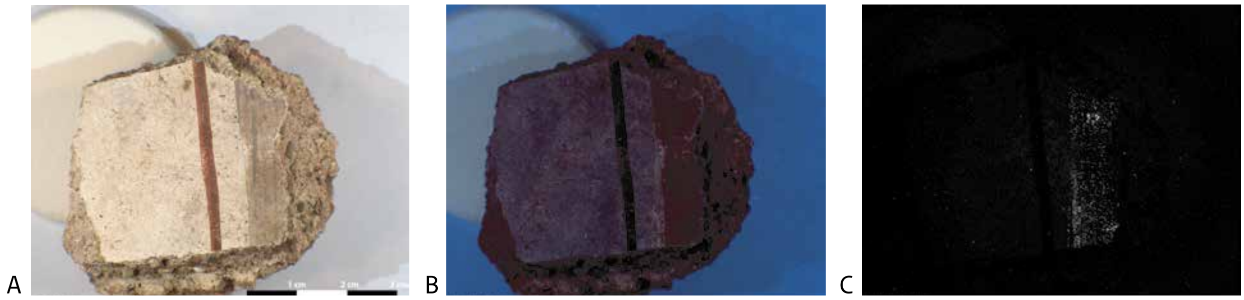


Fig. 35.21 Voerendaal-Ten Hove. Macrophotograph of fragment 763-6/114-1-14. A in normal light; B fluorescence in UV radiation (365 nm); C the infrared luminescence caused by Egyptian blue particles.

Fig. 35.22 Voerendaal-Ten Hove. Macrophotograph of fragment 763-8/114-1-14. A in normal light; B fluorescence in UV radiation (365 nm); C the infrared luminescence caused by Egyptian blue particles.

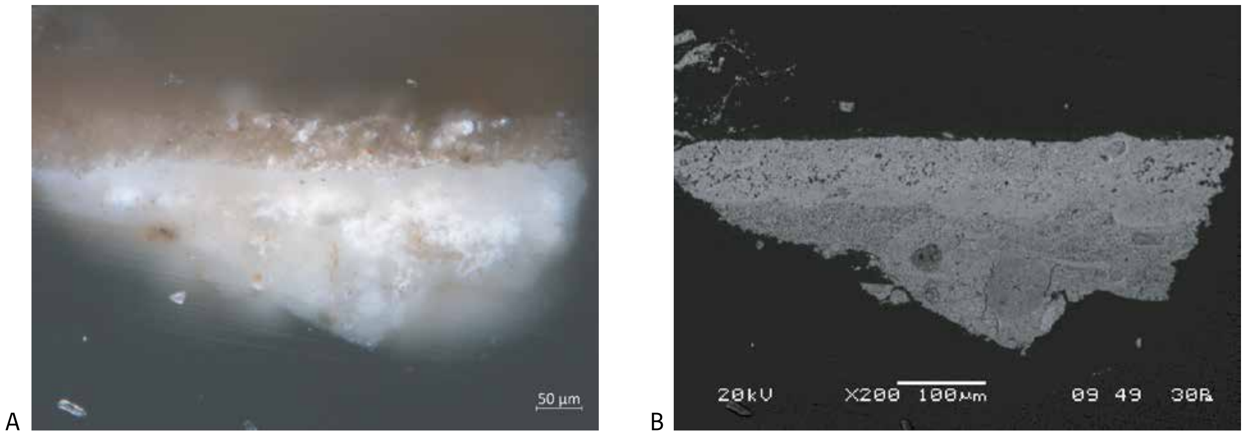


Fig. 35.23 Voerendaal-Ten Hove. Paint cross section of the green fragment 763-6/114-1-14 (sample number 20-106-5). A microphotograph in incident polarized light; B backscattered electron image (BEI) of the cross section.

36 Worked bone and antler

Henk Hiddink

During the investigations by Habets, Braat and the ROB, 19 objects of worked bone and antler were found (Fig. 36.1-2). Habets' excavations brought nine hair pins to light, of which one is apparently lost. Three pins have a 'stamp-shaped' head (*Stempelkopf*) and could date to the Middle or Late Roman period (1895-12.69, 70 and 72).[3126] Two have a round or oval head, the most common form (1895-12.71, 73). These needles were made throughout the Roman period, especially in the second and third century AD.[3127] The head of 1895-12.74 or 76 is flat like that of a nail; this form was also used from the first-fourth century AD.[3128] Two needles collected by Habets and two by the ROB are incomplete, probably all from hair pins, except for 20-1-63/3023, the point of a very thin needle (diameter 1.5-2 mm). Item 319-15 is a large sewing or darning needle, with an original length of some 13 cm and a diameter of 4 mm.

Item 20-2-36/3368 is half of a small disc, decorated with small grooves. It was listed in the database as a spindle whorl, but its weight (c. 3-4 g) seems too low for that use. There is a small 'ridge' on the underside, which suggests that it was fitted onto a another, cylindrical object. Our disc may have formed part of a bone distaff (*spinrokken*).[3129] A small disc from Braat's excavation was most likely used as a gaming piece (1953-2.5/11421).

The function of the remaining finds is unknown. Item 95-2-9/11013, part of a metapodium of horse or cattle, has a number of flattened surfaces. It is not clear whether it had a function in its own right, whether it was a half-finished product or just waste. Four objects are made of antler. The largest, 304-2, has a hole running through the whole length. It was most likely used as a handle for a knife or other tool. Item 727-1 is the tip of a red deer antler.
A function as an awl was suggested, but the tip is rather thick and blunt. Perhaps it was kept as piece of raw material for later use or simply regarded as waste. Find no. 10-1-38 is a 'polished' fragment of of bone or antler. It seems to be lost or was not recognized among the unworked animal bone. A find from Braat's investigations, probably of antler, is also highly polished on one side (1953-2.5/13039). It has four holes and is perhaps an unfinished part of an Early Medieval comb, not yet decorated with incised lines. Strongly curved combs are classified as 'hogbacked' or 'winged combs' and are rather late: seventh century and Carolingian period (and later).[3130] However, the identification is not certain because of the strong curve and rather large holes. although our piece is more curved than expected.

Two plastic objects were collected in 1987; for the sake of convenience, they were listed as worked bone. The first object is the mouthpiece of a tobacco pipe, probably of Bakelite (106-3-16/9322). Maybe it was transported down to feature 106.075 by animals. The second object is a large piece of a grey hair comb with the caption 'LUXOR MADE IN HOLLAND' (102-1-16/408; Fig. 36.1). Because it was found on top of/above the foundations of the *horreum*, it was jokingly listed as 'The comb of Braat'. This could actually be right because Luxor was an Amsterdam-based manufacturer of plastic tableware, toys, combs and other objects, active in the post-war years.[3131]

3126 Riha 1990, 106, table 136, type 17.

3127 Riha 1990, 104-106, table 134, type 16.

3128 Riha 1990, 108, table 142, type 20.

3129 Cf. Verhagen 1993, 343-345, fig. 5-6, no. 1-15. Distaffs of amber were found in some rich graves e.g. Esch V (Van den Hurk 1977, 112, no. 32) and Stein I (De Grooth & Mater 1997, 57, pl. 12). Apart from being a female attribute, these distaffs probably referred to the Parcae, who spun, measured and cut the thread of life. For references and other suggested functions of bone discs (parts of hinges, *pyxides*), see Hiddink 2005d, 21 and (including papyrus scroll holders) Greep & Rijkelijkhuizen 2019 (apparently not familiar with most finds from the southern Netherlands).

3130 Miedema 1983, 226-228, type 6.1.1.1.2.6; MacGregor 1985, 87, fig. 49d-4; Ashby 2011, type 2b.

3131 Established in warehouse 'De Arend', Prinsengracht 211. See https://geheugenvanwest.amsterdam/page/13222/plastic-speelgoed-luxor/ https://www.maritiemdigitaal.nl/index.cfm?event=search.getdetail&id=101095289 (consulted 11-07-2019).

Fig. 36.1. Voerendaal-Ten Hove. Fragment of a plastic hair comb found on top of the foundations of the horreum.

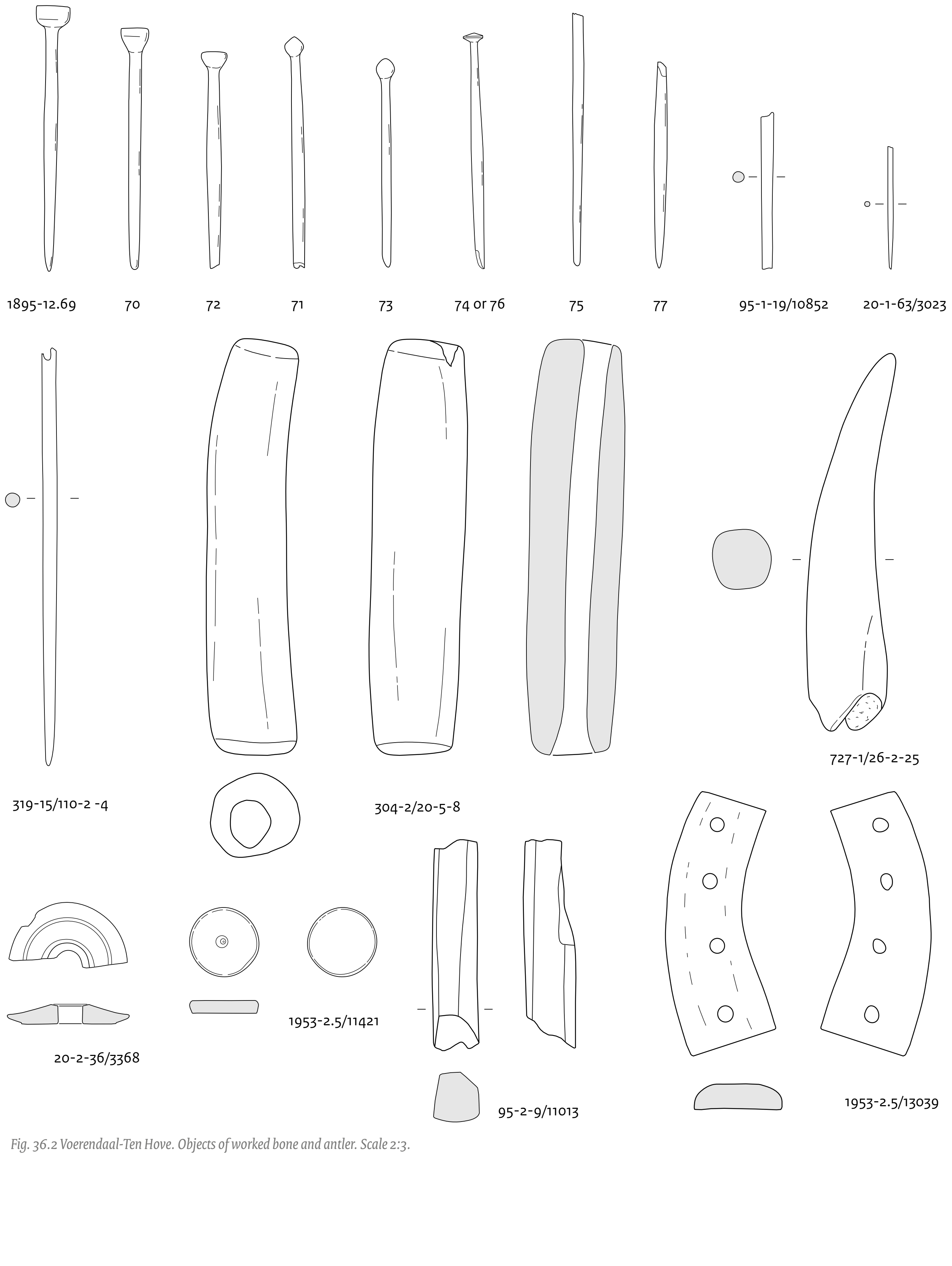


Fig. 36.2 Voerendaal-Ten Hove. Objects of worked bone and antler. Scale 2:3.

37 A Late Mesolithic lithic cluster and other flint artefacts

Erik Drenth

37.1 Introduction

The 'by-catch' of the excavation of the Roman villa and traces of other periods at Voerendaal-Ten Hove includes flint artefacts and one artefact of Wommersom-quartzite (a material that is related to flint because of its splitting properties, among other things).[3132] Figure 37.1 shows their overall distribution. The present contribution takes a closer look at these lithic finds, focusing on their typology, various intrinsic characteristics, the raw materials used and their dating. It also tries to answer the question of which human activities are reflected in the material evidence provided by the flint. The final chapter focuses on the future. As a result of the present study several themes are proposed for the research agenda.[3133]

37.2 General results

A total of 698 lithic finds were macroscopically examined. Together they weigh more than 45.8 kg. Some flint artefacts were not examined by the author. These are three flint artefacts from the Early Medieval grave 382 (Fig. 42.9), as well as a blade and three flints of unknown nature and type, which could not be located among the mass of natural stone from the site.[3134] The flint of some 81 records in the original database is entirely missing; it was discarded or got lost somewhere along the way before 2019.

All finds show some degree of surface and weathering phenomena.[3135] First and foremost, this concerns the infiltration of iron (hydr)oxides. This gives stones a brownish tinge or even makes them distinctly brown. This strong discolouration

3132 For the sake of convenience, this blade has been considered a flint artefact. The flint used as a building material in the Roman period has not been considered here. This material is discussed briefly in Chapter 33.

3133 For this contribution, thanks are due firstly to Henk Hiddink for providing information and all manner of help and assistance, as well for writing addenda about the horizontal distribution of the flints in relation to both the landscape and the soil traces. Further thanks are due to N.M.A. Arts, J.R. Beuker, F.T.S. Brounen, X. van Dijk, J. Hendriks, E. Mols and P.A.C. Schut.

3134 Find nos 94-4-7/12035, 108-2-5/12036, 181-1-3/11919 and 182-1-7/11918.

3135 See in this respect Rottländer 1989; Stapert 1976.

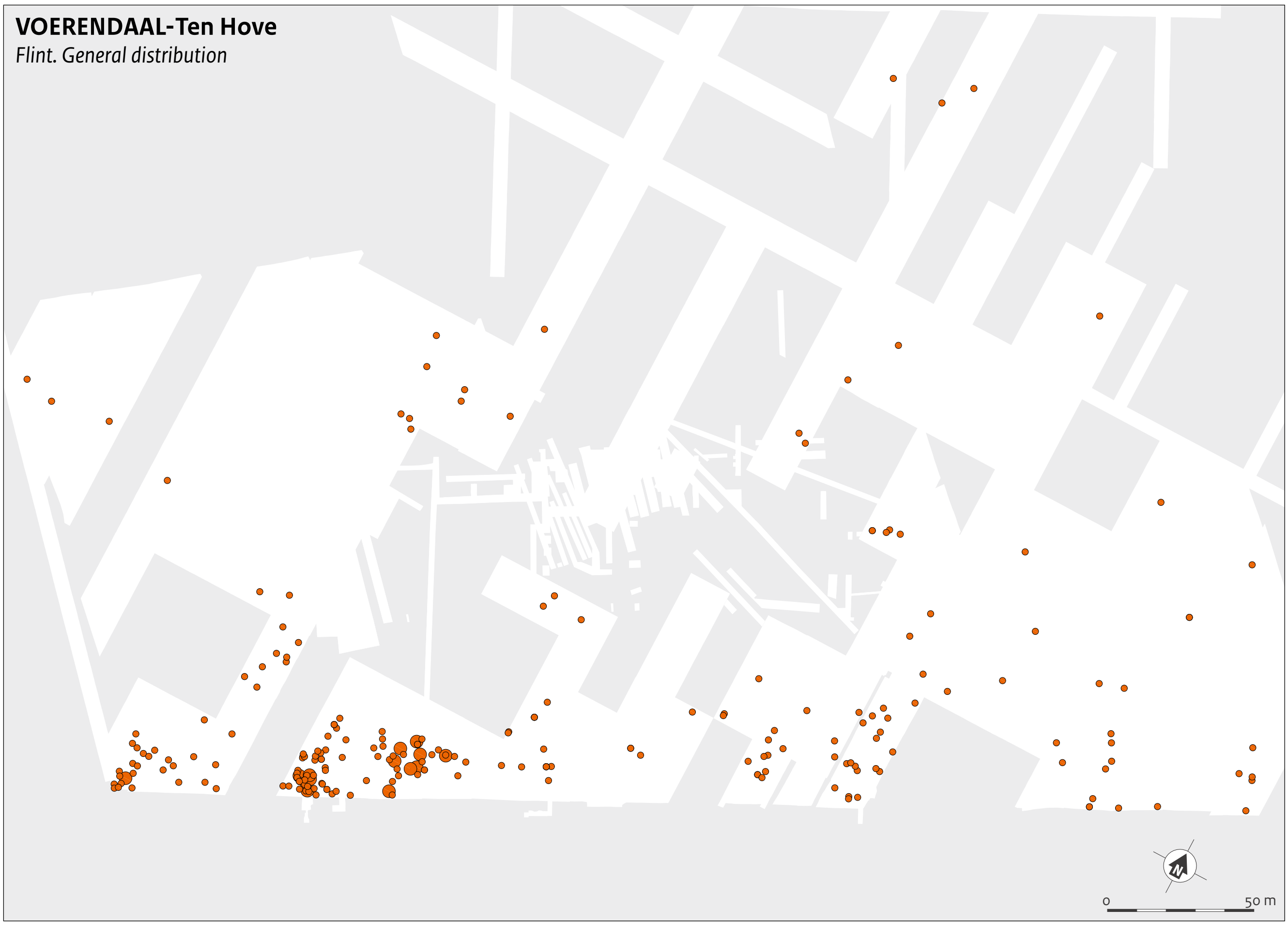


Fig. 37.1 Voerendaal-Ten Hove. Horizontal distribution of all flint artefacts.

was observed in 35 to 36 flints. Although this issue is of minor importance in the present contribution, it is not always clear whether this 'browning' occurred after the formation of the artefacts. In addition, the find complex contains eight artefacts with a bluish-white patina, which was caused by partial dissolution of the flint. In one case, this process has progressed so far that white patina has formed. Special mention should be made of a retouched piece which, judging from the differences in patina, was made from a piece split off by frost from an older artefact with blue-white patina.[3136] Finally, two (possible) artefacts are strongly rounded off (Fig. 37.2).[3137] They both exhibit windgloss, which gives the surface a macroscopic 'greasy' appearance and makes small pits visible under a microscope. These features are all the result of the objects being exposed to a sand and/or silt laden wind.

The find complex is divided into three categories: 1) unmodified/unretouched artefacts; 2) modified/retouched artefacts; 3) other flints. The artefacts of the second group are frequently referred to in the literature as tools. Microwear analysis, however, shows that unmodified artefacts may also have served as tools.[3138] That is why the term 'tools' was not

[3136] Find no. 13-3-19/1955.
[3137] Photographs of all artefacts illustrated by drawings in this chapter can be found in Appendix XIX.
[3138] See Van Gijn (2010) for several examples.

Fig. 37.2 Voerendaal-Ten Hove. Two possible Middle Paleolithic artefacts; a flake (516-5/29-1-18) and blade (21-1-5/14503). Scale c. 1:1. (source: H.A. Hiddink & D.S. Habermehl)

chosen here for the general classification. It must be emphasised, by the way, that microscopic traces of use have not been investigated in the present framework. The same applies to refitting, i.e. the fitting together of flints. The category 'other' is a heterogeneous group, consisting of artefacts of which it is not clear whether they belong to group 1 or 2, as well as nodules (see Table 37.4). Table 37.1 shows the numerical distribution of the flints over the above categories. The ratio of c. 5.2:1 between unretouched artefacts and retouched artefacts is striking, as the latter category is relatively well represented. In general, the proportion of retouched artefacts is significantly lower at surveyed flint sites. The site Haelen-Broekweg, where the ratio is about 80 : 1, serves as an example.[3139] There, sifting was used (mesh size 3 x 3 mm), which resulted in the collection of numerous chips created during flint working. During the Voerendaal-Ten Hove excavation, sieving was not used to collect flint and all other groups of finds, which may be the main reason for the difference.[3140] Table 37.1 also shows that only about 3.3% of the total shows traces of heating; tables 37.2 to 37.4 show which group of objects and types are involved. About the frequency of burnt flints it can be reported that there is no statistically significant difference between unretouched and retouched artefacts.[3141] Nor is there any such difference between the two populations as regards the proportion of broken artefacts.[3142]

37.3 Typology and intrinsic properties

Within the group of unmodified artefacts, flakes dominate numerically, as shown in table 37.2.[3143] The ratio between this type and another form of debitage, the blades, is approximately 4.4:1. Separately, two specific variants of flakes are included: a flake of a hammerstone and one of a ground axe. The latter probably testifies to recycling, whereby a broken axe served as a starting material for flint working. In trench 94 such a core was found, which in this case included a broken *spitznackiges Flint-Ovalbeil* (42-1-3/5763; for this axe type see below). While the flake can be seen as a deliberate product, this may be doubted for the flake of the hammerstone (94-0-0/10469). Such a flake will most likely have been created when a hammerstone was struck too hard and/or wrongly. Accordingly, this form of flake should not be regarded as a formal type.

It is noteworthy that among the unretouched artefacts there are relatively many cores, a fact that makes it possible to make informed statements about the nature of the site (see Section 37.6 below). These cores are typologically divided into 17 to 18 cores with incipient debitage/nodule testing, 40 blades with a single direction of impact, 10 cores with two crossing directions of impact, 27 cores with two opposing directions of impact, 3 cores with several (≥ 3) directions of impact, 2 bipolar cores and one core of an unidentifiable type. Most of the cores can be characterised as blade cores. The bipolar cores are a special type of core resulting from the hammer-and-anvil technique. This involves placing a piece of flint on an anvil and working it with a hammerstone. This results in the core splintering off the short ends.

Not only cores are widely represented, but also flakes and blades indicative of the preparation and rejuvenation of cores. The category of core repair and maintenance forms c. 10.7-11.3% of the unmodified artefacts. Indeterminate pieces have been included among

Table 37.1. Voerendaal-Ten Hove. General classification of the flint.

Category	N	N broken	N burnt
Unmodified/unretouched artefacts	577	183(185)	16
Modified/retouched artefacts	111	40 (42)	5
Other	10	6 (0)	2
Total	**698**	**229(233)**	**23**

[3139] Bats *et al.* 2010.
[3140] See, for example, Spikins *et al.* 1995 on the effects of the collection method in the case of flint artefacts.
[3141] A two-tailed Fisher exact probability test results in p = 0.3568. The statistical tests in this contribution were carried out using VassarStats and PAST, both of which can be found on the internet. The significance level (α) is always 0.05.
[3142] A non-directional chi-square test results in p = 0.9203 (excluding uncertain cases) and p = 0.6629 (including uncertain cases).
[3143] The terminology in this chapter is based on Ballin 2021.

Table 37.2. Voerendaal-Ten Hove. Typological quantitative summary of the unretouched artefacts.

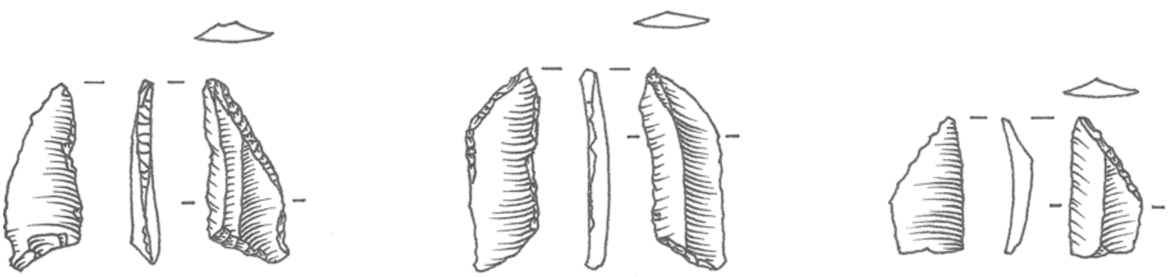
Type	N	N broken	N burnt
Flake	283	90(91)	2
Flake?	4	1	-
Flake from ground axe	1	1	-
Flake from hammerstone	1	-	-
(Micro)blade	64	41	5
(Micro)blade?	1	1	-
Core preparation piece	3	2	1
Core rejuvenation piece	72	2	-
Core rejuvenation piece?	4	1(2)	-
Core	100	4	2
Core?	1	-	-
Indeterminate piece (brok)	43	40	6
Total	**577**	**183(185)**	**16**

the unretouched artefacts, although their artificial character is not always clear. Presumably, several fracture surfaces were created during processing, whereby flint was split along pre-existing cracks resulting from frost action.

The typological range of variation within the modified artefacts can be called large (Table 37.3). There are all kinds of retouched, notched and denticulated flakes, blades, core preparation and maintenance pieces, as well as various types of points, scrapers and burins. In addition, there are notched and retouched pieces. The repertoire also includes a ground axe, some hammerstones and two strike-a-lights. As the typological nomenclature already shows, the basic forms of these artefacts are diverse: flakes, blades, core preparation and rejuvenation pieces, cores and nodules. Special mention should be made of two artefacts, each made from a flake of a ground axe: a notched flake and an end-scraper (78-5-2/7874; 95-2-19/11042).

Some modified artefacts are discussed at greater length, starting with the trapeze points. The assembly has three to four examples of trapezes (Fig. 37.3). By all appearances, they are all made on blades. Two of these points are of the rhombic type, while the other two appear to be representatives of rectangular trapezes.[3144] Because of the remarkable retouch, the two first-mentioned points merit a closer look. One of the rhombic trapezes stands out because of the flat retouch on the ventral side of the base, which in publications is called ‘retouch inverse

[3144] See in this respect Deeben & Niekus 2016; Drenth 2018.



0-0-0/14491 302-16/19-1-19 312-3/69-6-4

Fig. 37.3 Voerendaal-Ten Hove. Three trapezes. Scale 1:1. (source: R. Timmermans)

Table 37.3. Voerendaal-Ten Hove. Typological summary of the retouched artefacts.

Type	n	N broken	N burnt
Retouched flake	17	4(5)	-
Retouched flake?	1	-	-
Notched flake	13	-	-
Notched flake?	1	1	-
Notched and truncated flake	1	-	-
Denticulated flake	4	-	-
Retouched blade	5	4	-
Bilaterally retouched blade	5	5	-
Notched blade	4	3	-
Notched blade?	1	1	-
Denticulate blade	2	2	-
Truncated crested blade	1	-	-
Notched crested blade	1	1	-
Denticulate crested piece	1	-	-
Retouched core rejuvenation piece	5	-	-
Notched core rejuvenation piece	1	-	-
Retouched core	1	-	-
Retouched piece	6	1	-
Notched piece	4	-	-
End-scraper	4	3	2
End- and side-scraper	5	1	1
Double side-scraper	1	1	-
Scraper retouched all around	1	-	-
Scraper, type indet.	1	1	1
Scraper (racloir)	1	-	-
Borer/awl	3	1	-
Borer/awl?	1	-	-
Leaf-shaped arrowh., bifacial retouch	1	1	1
Rectangular trapeze	1	1	-
Rectangular trapeze?	1	1	-
Rhombic trapeze	2	2	-
Burin on a break *(A-steker)*	1	-	-
Dihedral burin? *(AA-steker)*	1	-	-
Burin on a truncation? *(RA-steker)*	1	-	-
Hammerstone	2	-	-
Hammerstone?	1	-	-
Ground axe *(spitzn. Flint-Ovalbeil)*	1	-	-
Strike-a-light	2	(1)	-
Tool, type indet.	6	6	-
Total	**111**	**40(42)**	**5**

plate' (RIP) (0-0-0/14491; Fig. 37.3).[3145] A review of the professional literature did not reveal any examples of such retouched rhombic trapezes in the north and central Netherlands.[3146] Searching literature on the south of the country yielded only one to a few examples discovered at Wintelre-Houtven.[3147] Inspection of publications on the neighbouring German area did not yield any positive results.[3148] However, several rhombic trapezes have been found for Belgium and Northern France.[3149] Belgian sites where this subtype has been found include Brecht-Moordenaarsven 2, Brecht-Thomas Heyveld, Dilsen-Dilserheide III and Opglabbeek-Ruiterskuil. According to a monograph on the Somme basin by Ducrocq, the northern French sites with such trapezes include at least Ognolles-l'Abbaye-aux-Bois and Le Mesnil-Saint-Firmin.

Based on the above literature review, the conclusion is that rhombic trapezes with RIP do not occur everywhere in the Low Countries and neighbouring regions, but are concentrated in Belgium and northern France. This conclusion corresponds well with a geographically broader study by Kozłowkski.[3150] His distribution maps for the various forms of trapezes within Europe show that the present variant is limited to Belgium, the southern Netherlands and northern France. He gives more examples of southern Dutch sites than the above overview, although the names of the sites are not given.

On the second rhombic trapeze from Voerendaal-Ten Hove not only the short sides were retouched, as is usual, but also the long sides (302-16/19-1-19; Fig. 37.3). According to the professional literature just cited, this appears to be exceptional.

The find complex also contains one leaf-shaped arrowhead, which has been completely retouched bifacially (301-1/70-3-4; Fig. 37.4).[3151] This characteristic makes it impossible to determine the basic shape. The tip of the object is broken off. It was probably destroyed by heat, as the object is moderately to heavily burnt.

The only ground flint axe in the group can be considered complete (317-21/13-3-34; Fig. 37.5). The shape of its neck and its cross-section justify its characterisation as an 'axe with an oval cross-section and a pointed neck', for which often the German designation *spitznackiges Flint-Ovalbeil* is used.[3152] The object is largely ground, although deeper flake negatives have not completely disappeared. On the neck and especially on the edge, there are several unpolished negatives.

Two artefacts are partly strongly rounded, presumably due to their use in making fire (69-6-11/14571 and 743-3/95-4-11; Fig. 37.6).[3153] Therefore, they are characterised as strike-a-light.

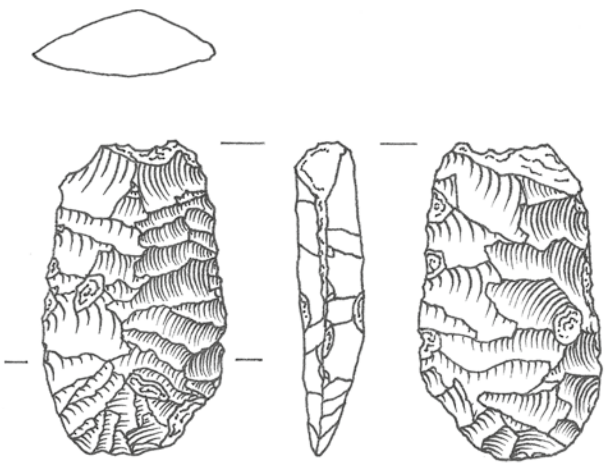


Fig. 37.4 Voerendaal-Ten Hove. Leaf-shaped, fully bifacially retouched arrowhead (point missing). Scale 1:1. (source: R. Timmermans)

[3145] De Grooth 2008, 222, with further references. Sometimes reference is made to *retouche plate inverse* (RPI).

[3146] See Beuker 1989; Devriendt 2014; Geerts *et al.* 2019; Noens 2012.

[3147] Arora 1995, fig. 17: nos. 2, 3, 5 and 6. Furthermore, the following works with regard to the southern Netherlands were also consulted: Arts 1981; 1987; 1998; Bats *et al.* 2010; Van Dijk 1996; Löhr 1994; Müller *et al.* 2018; Narr 1968; Peeters 1971; Rozoy 1978; Verhart 2000.

[3148] The following works were reviewed: Arora 1976; 1979; 1995; Baales *et al.* 2013; Brandt 1940; Gehlen 2009; Mahlstedt 2015; Narr 1968.

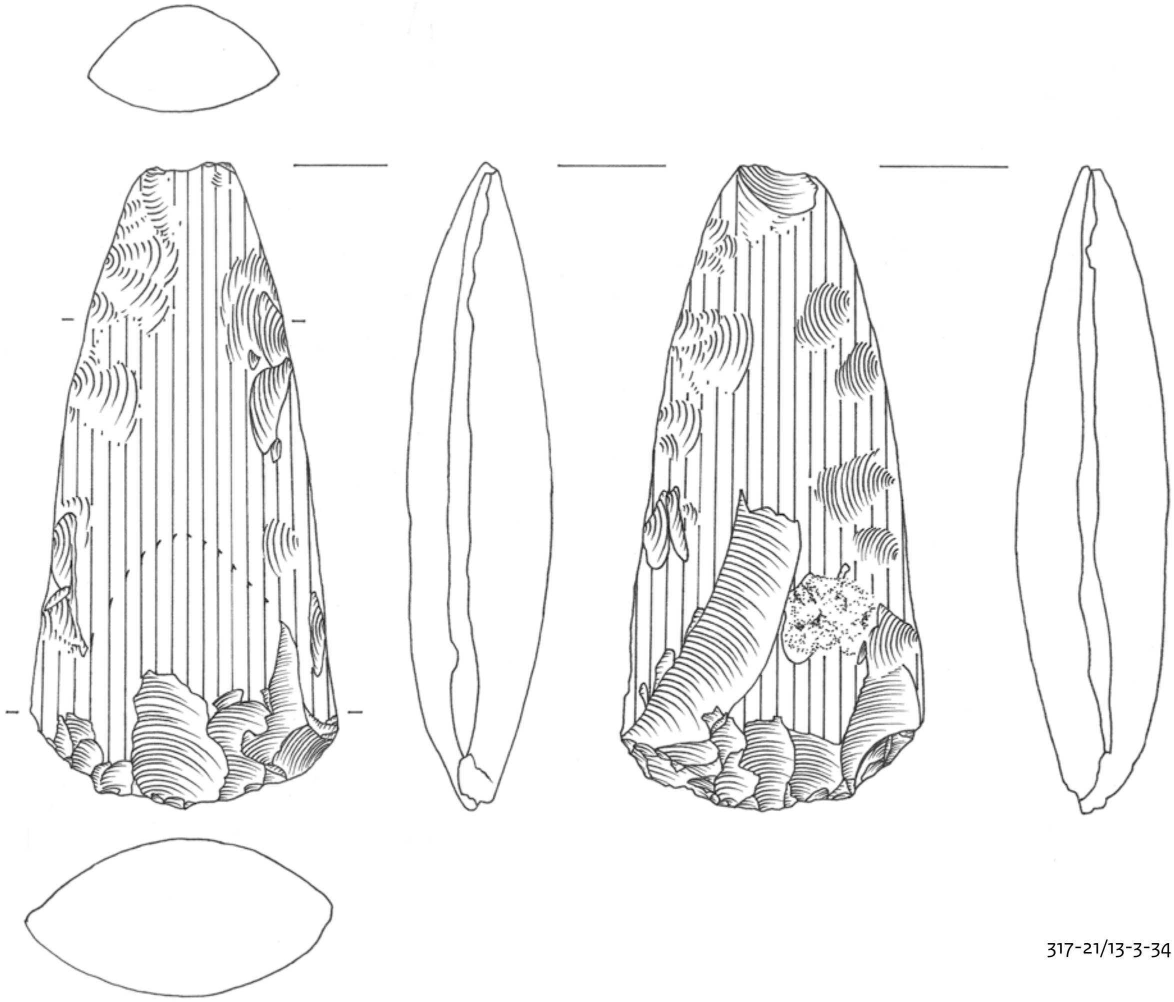
[3149] The following publications were consulted: Creemers & Vermeersch 1986; Crombé 1996; Ducrocq 2009; 2001; G.E.E.M. 1969; Huyge & Vermeersch 1982; Lauwers & Vermeersch 1982; Luypaert *et al.* 1993; Miller *et al.* 2012; Robinson 2008; Robinson *et al.* 2011; Rozoy 1978; Vermeersch 1984; Vermeersch *et al.* 1974; 1992.

[3150] Kozłowski 2009, fig. 4.4q.

[3151] Vermeersch (1987-1988, 6 and fig. 7) was followed for the typological determination. In Schreurs' (2016, 161) classification system, the arrowhead in question falls under the triangles, as its greatest width is near the base and not the centre. As noted earlier, the English terminology is based in particular on Ballin 2021.

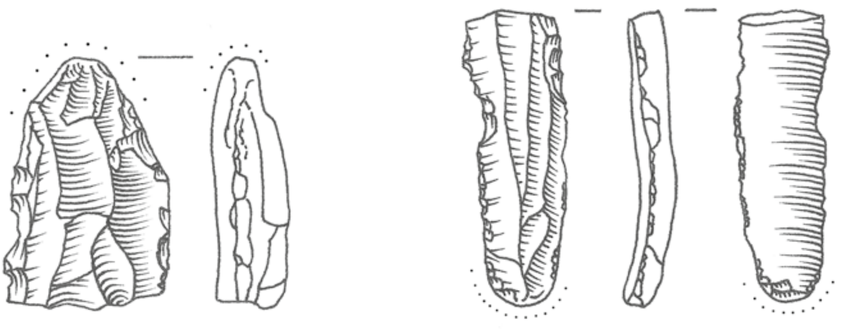
[3152] Schut 1991, chapter 4. In Hoof's typology (1970, chapter 3), this artefact represents the *S1a-Beile*.

[3153] Devriendt 2008; Stapert & Johansen 1999; Woltinge *et al.* 2008; See, however, the critical note that Van Gijn (2008) makes with regard to alleged strike-a-lights from Swifterbant.



317-21/13-3-34

Fig. 37.5 Voerendaal-Ten Hove. Ground spitznackiges Flint-Ovalbeil in Lanaye-flint. Scale 2:3. (source: R. Timmermans)



743-3/95-4-11

69-6-11/14571

Fig. 37.6 Voerendaal-Ten Hove. Two artefacts interpreted as strike-a-lights, with photographs of the blunt tips. Drawing scale 1:1; photographs not to scale. (source: R. Timmermans & D.S. Habermehl)

Table 37.4. Voerendaal-Ten Hove. Typological summery of flint pieces other than either unretouched or retouched artefacts.

Type	N	N broken	N burnt
Artefact type indet.	4	3	-
Potlid	2	2	2
Splintered piece	1	-	-
Natural piece	2	-	-
Frost flake	1	1	-
Total	**10**	**6**	**2**

As for the third main group, the 'other flints', the first thing to consider is the 'splintered piece' (German: *ausgesplittertes Stück*; French: *pièce esquillée*) uncovered in Trench 93 (302-17/93-1-1). There has been a long-standing debate as to whether this type of artefact represents a (deliberately created) tool or a waste product (the remainder of a core) created during the hammer-and-anvil technique.[3154] An unequivocal general answer cannot be given and the issue must be considered on a case-by-case basis, yet it does appear that microwear analysis is able to shed light on the matter.[3155] However, as noted above, the flint from Voerendaal-Ten Hove has not been subjected to such an analysis. Therefore, the splintered piece in question has been assigned to the typological residual group. The heterogeneous composition of this category has already been pointed out. Natural pieces or flints without macroscopic traces of human processing and/or use belong to this group; presumably, these flints were brought in by humans and can be considered *manuports*. A variant within this category that has been distinguished here is that of frost flake.

Tables *37.5 to *37.7 give the minimum, maximum and average length, width and thickness for each type of find. To further illustrate the dimensions, figures 37.7-10 present the greatest length and width of various artefacts. Comparing these data with data elsewhere in the Netherlands, it is clear that the flint artefacts from Voerendaal-Ten Hove are generally relatively large.[3156] This is undoubtedly related to the fact that the flint workers had access to raw material of considerable dimensions. The next chapter looks in more detail at the use of raw materials.

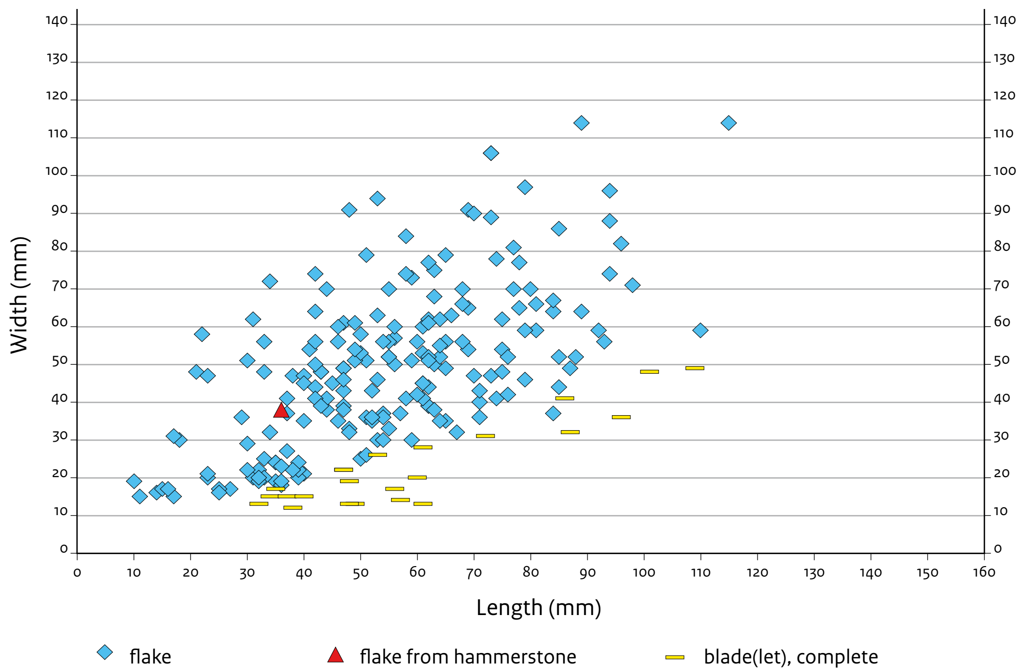


Fig. 37.7 Voerendaal-Ten Hove. Largest length and width of complete flakes and blades.

[3154] For more information see Le Brun-Ricalens 2013.
[3155] For example Van Gijn & Niekus 2001, 313 and fig. 10.
[3156] See, for example, the literature cited above.

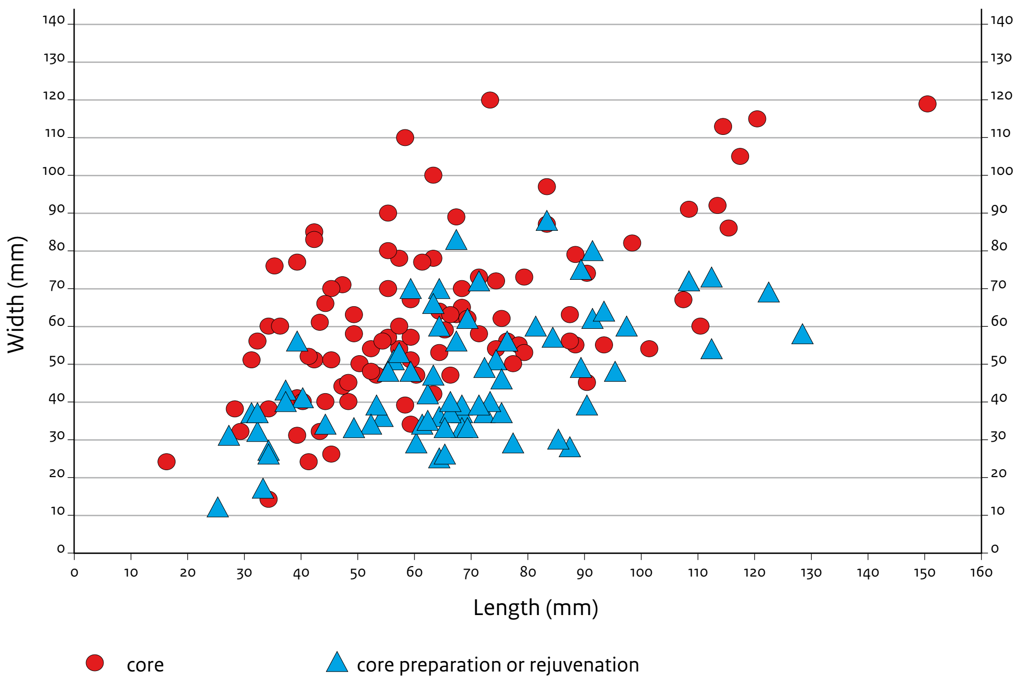


Fig. 37.8 Voerendaal-Ten Hove. Largest length and width of complete cores and core preparation or rejuvenation pieces.

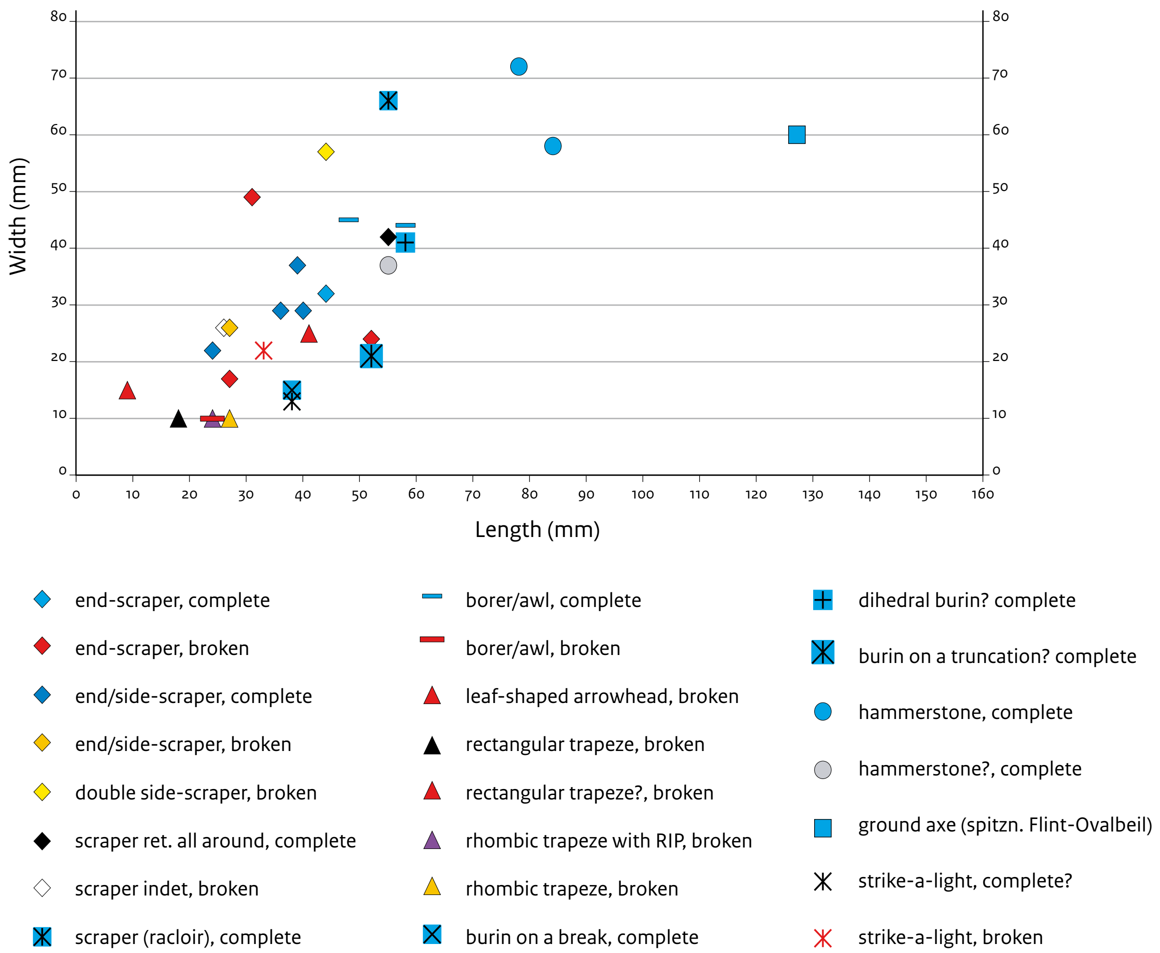


Fig. 37.9 Voerendaal-Ten Hove. Largest length and width of various retouched artefacts.

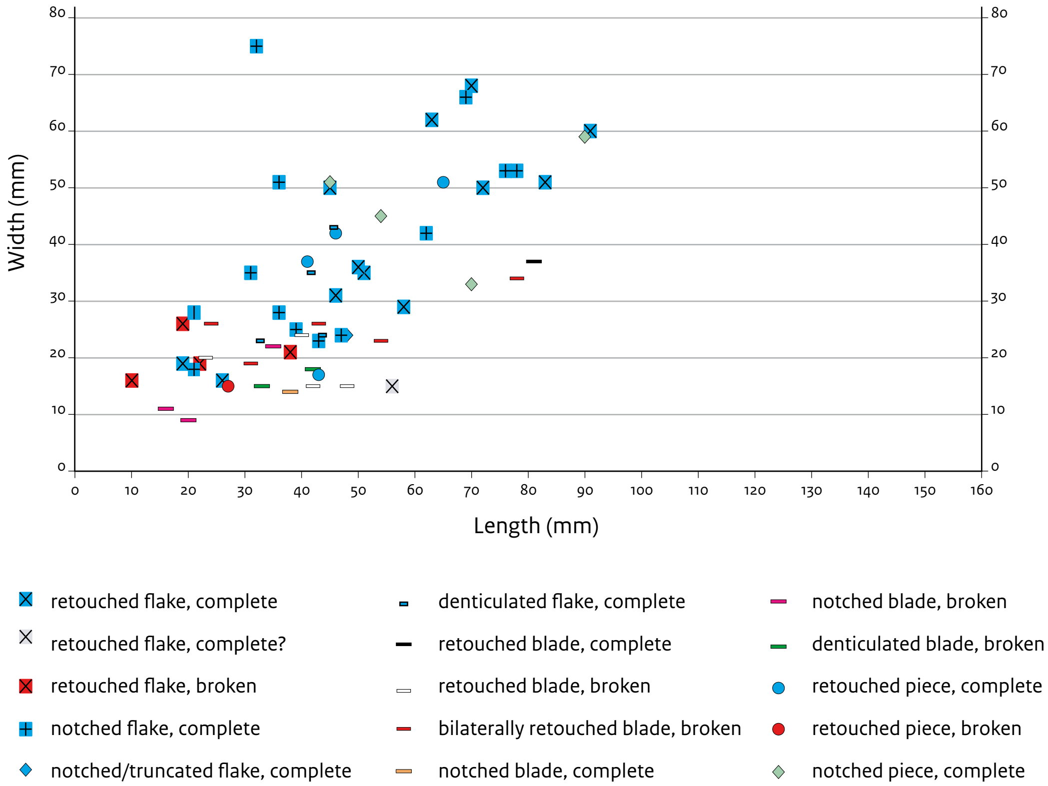


Fig. 37.10 Voerendaal-Ten Hove. Largest length and width of various retouched, notched and denticulate flakes, blades and pieces.

37.4 Raw materials

The use of raw materials was examined by means of the author's lithic reference collection and studies by Arora, Brounen and in particular a publication by De Grooth.[3157] Although this provides a general insight, a sharply delineated picture with exact absolute and relative frequencies cannot be presented here. For that purpose, the number of 'raw material units' should be determined, preferably by means of refitting, which was not feasible within the current framework. In addition, in the style of De Grooth, more research has to be done into the variation width within the various types of flint from Zuid-Limburg and surroundings, which also requires searching and collecting raw material in the field. The aim of all this is to minimise the chance of errors in raw material determinations due to similarities between flint types. For these similarities do exist, such as between Lixhe and Orsbach flint and between Simpelveld and Vetschau flint.[3158] In addition, with smaller pieces, to give another example, there is a chance that the Lousberg and Vetschau flint types may have been interchanged.[3159]

Although in 20.8% of the cases the type of flint could not be determined, the general picture is clear. For the artefacts from Voerendaal-Ten Hove it appears that flint was used which occurs naturally in the eastern part of Zuid-Limburg and the adjacent part of Germany (Fig. 37.11).[3160]

Especially Simpelveld flint, which is known for its laminated appearance, is well represented (95-2-9/14911; Fig. 37.12). On the basis of the present analysis, this is approximately 28 to 44%. Furthermore, a modest component (c. 3-4%) of Orsbach flint is identifiable (70-3-21/7619; Fig. 37.12). Also Lousberg and Vetschau flint seems to be present, but its share is negligible (<1%). It seems that Lanaye flint is significantly more abundant (about 20-25% of the finds). This is usually material referred to as Rijckholt flint, although a few Rullen flint artefacts have also been discovered at

[3157] Arora 1995; Arora & Franzen 1997; Brounen 1998; De Grooth 2011. In addition, several finds were submitted to F.T.S. Brounen for a second opinion.
[3158] De Grooth 2011.
[3159] Compare Schyle 2010, 4.
[3160] For more information on the characteristics of this flint and its distribution, see De Grooth 2011.

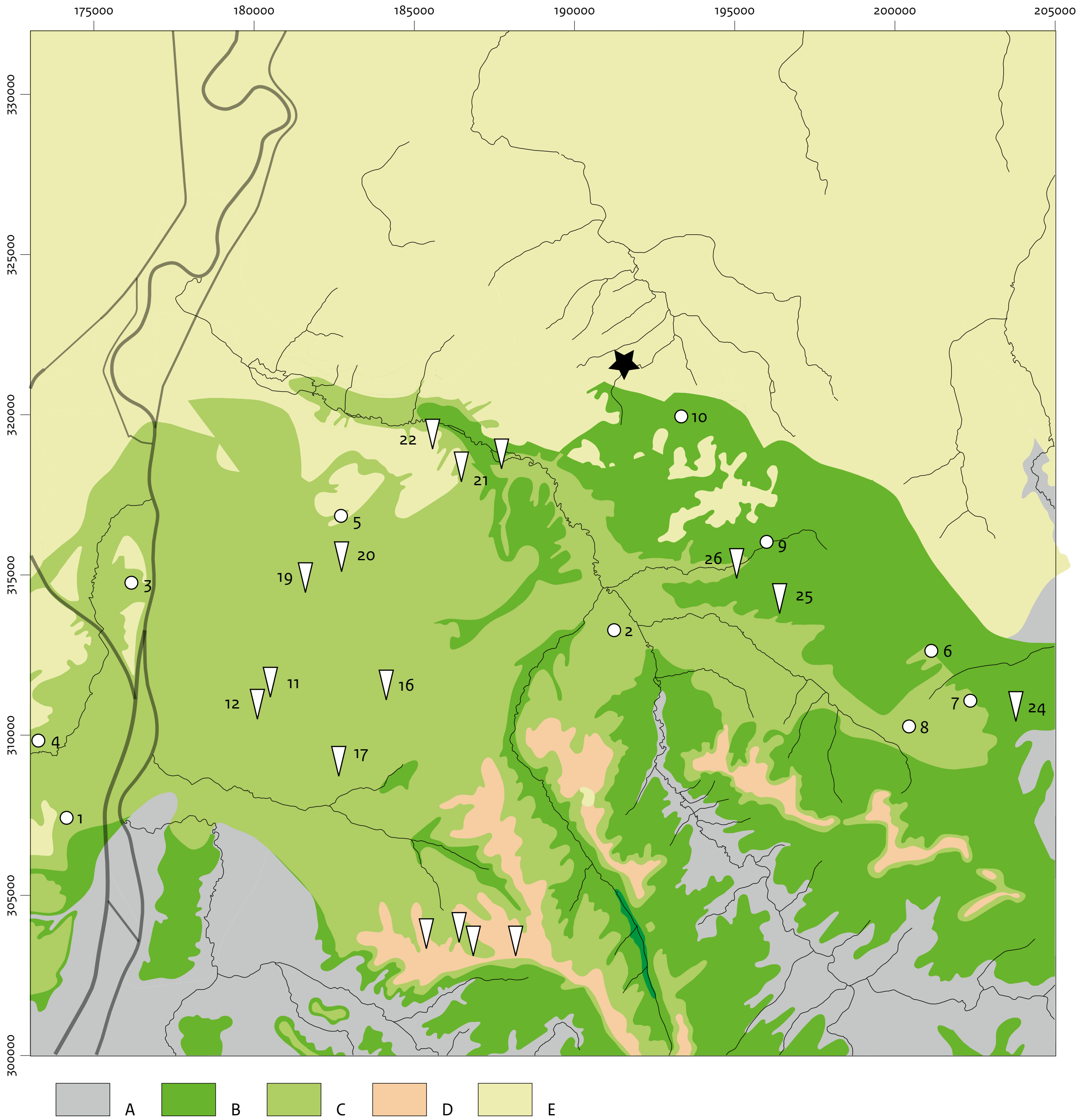


Fig. 37.11 Simplified pre-Quarternary geology of South Limburg and adjacent parts of Belgium and Germany with outcrops of flint and Neolithic extraction points. (source: H.A. Hiddink, after Geologische kaart 1984; De Grooth 2013, fig. 2)
A Carboniferous and Devonian; B Upper Cretaceous, non-flint bearing formations (Aachen, Vaals, Kunrade); C idem, flint bearing formations (Gulpen, Maastricht); D major areas with clay-with-flint (eluvium); E Tertiary clays, sands and gravels;
1 quarry CBR Lixhe; 2 Gulperberg; 3 quarry ENCI Maastricht; 4 Eben; 5 quarry 't Rooth, Margraten; 6 Vetschauerberg; 7 Wilkensberg; 8 Schneeberg; 9 Eyserbeek; 10 Bergerweg; 11 Rijckholt St. Geertruid; 12 De Kaap; 13 Rullen; 14 Vrouwenbos; 15 Sparrenbos; 16 Banholt; 17 Hoogbos; 18 Rode Bos; 19 Keerderbos; 20 Schiepersberg; 21 Biebos; 22 Plenkertstraat; 23 Schaelsberg; 24 Lousberg; 25 Bahneheide; 26 Overeys.

Fig. 37.12 Voerendaal-Ten Hove. Two cores, one of Simpelveld (95-2-9/14911) and the other of Orsbach flint (70-3-21/7619). (source: D.S. Habermehl)

Voerendaal-Ten Hove. The spectrum further counts 4-5 artefacts of light grey Belgian flint and 6-7 examples of Valkenburg flint. On one occasion, the material has been tentatively identified as Zevenwegen flint.

About half of the artefacts can be assumed to have been made from raw material collected from a primary geological context: slopes with outcrops of limestone with flint, (eroded) slope deposits and flint eluvia (Fig. 37.11).[3161] It is the (relatively) fresh cortex on various artefacts that justifies this assumption. The actual proportion is higher, but the exact percentage could not be determined. It has been observed that several artefacts (probably) originate from the same raw material unit, but for reasons of time and money, this could not be recorded sufficiently.
The assemblage also includes some examples of Valkenburg flint which, judging from the cortex, originate from a primary geological context or another flint occurrence southwest of Voerendaal-Ten Hove.

Apart from flint with no or hardly worn cortex, the find complex contains material with a rounded and sometimes even highly polished natural surface; the percentage is c. 19.7-31.8%. These characteristics are indicative of horizontal transport by natural processes. The term 'terrace flint' is frequently used for such worn material from the southern Netherlands, because an origin from gravels/stone-bearing fluviatile deposits, especially of the Meuse, is more than likely. The terrace flint that served as a raw material for the artefacts from Voerendaal-Ten Hove is a variegated variety, and with the exception of the Lousberg and Vetschau types, all of the above flint varieties seem to be represented. Also a 'Meuse egg' (Dutch: *Maasei*), the only one of its kind in the find complex studied, belongs to this group.

A blade from trench 69, the raw material of which has been identified as Wommersom quartzite, deserves special mention (69-7-4/14626). As the crow flies, the presumed source area lies approx. 75 km from Voerendaal-Ten Hove. The present find is special because on a recent general distribution map of Wommersom quartzite, the east of Zuid-Limburg is a white area, apart from one border case.

To summarise, the raw material use points first and foremost to the exploitation of local sources in the east of Zuid-Limburg and the neighbouring German area. In addition, there is a hint that flint from the neighbouring area in the west of the Zuid-Limburg region was also used, albeit to a lesser extent. This picture of raw material use seems to be based mainly on Late Mesolithic finds at Voerendaal-Ten Hove, as will be shown below. In doing so, the site ties in with observations made for Mesolithic sites in the vicinity, such as Liège-Place Saint-Lambert and the west of Germany.[3162] There, too, local sources of raw materials primarily seem to have been exploited at the time.

[3161] Compare Arora & Franzen 1987, 23; Brounen 1998; De Grooth 2011, Schyle 2010, 3-4.
[3162] Arora 1979; De Grooth 2008, 219-220 (with further references).

37.5 Chronology of the flint material

37.5.1 Contexts

It should be noted that no ^{14}C-dating or other types of absolute age measurements are available for the chronological positioning of the lithic finds discussed here. This means that placement in time has been done on typological grounds and/or on the basis of secondary finds. With the exception of the three pieces of flint from grave 382, soil traces play no role in this contribution. There are no indications that the material from Iron Age, Roman or Early Medieval pits, ditches, sunken-floored huts etc. ended up in them intentionally, although for a single piece this can certainly not be ruled out.[3163] Reuse of older artefacts in later periods, as has undeniably been observed elsewhere in the Netherlands, is therefore also theoretically possible.[3164] Although erosion can have caused some transport of flint material downslope, there are no indications that this occurred at a large scale over larger distances.[3165] One has to bear the low gradient of the slope in mind, with a gradient of only 4-5%. The majority of the flint was probably found more or less in situ, albeit original clusters were disturbed by activities (digging, trampling, agriculture) from at least the (Late) Iron Age onwards, causing some vertical and horizontal movement of flint.

Only a single concentration of material was indicated on a field drawing, as two patches in a 2 x 2 m area inside trench 107. The flint was collected under find number 107-2-8, containing 55 pieces with a weight of 7 kg (see below). These finds were collected from a spotted layer (caused by bioturbation), with the contours of nearby post holes – belonging to Late Iron Age-building 223 – starting to appear. Therefore it is obvious that the flint was found near the 'original' ground surface.

Another indication for flint being near the original ground level is that 26 artefacts from trench 68 and 69 were found in the top of the 'virgin' loess and another 19 in the '(light)grey layer' which is also part of the subsoil.[3166] It is interesting that 28 artefacts were found in 5 'tree throws', each with one sherd of handmade, Iron Age-pottery (and not a single speck of Roman material). This suggests that flint was lying at the late prehistoric ground level. No less than 55 pieces of flint were recovered from ditch 312 (period 2), probably filled in with soil from its immediate vicinity. Nearly 40 finds were collected from other Roman features and layers, the latter all from below the Middle Roman ground level. Although all this is no absolute proof against artefact displacement downslope, it suggests it was not significant and influenced the excavated material long before the more extensive Medieval erosion. In the lower levels of the Medieval colluvium covering the foundations of building 403, only 4 pieces of flint were found.

The above-mentioned problems with the identification of the raw materials and the lack of possibilities for a detailed technological analysis, for determining the number of raw materials units and for refitting make dating very difficult. Exact frequencies of Late Mesolithic and Neolithic artefacts can therefore not be given on the basis of the present analysis and the distribution maps of both groups (Fig. 37.13-14) have no more than an indicative character.

37.5.2 Middle Palaeolithic

The earliest artefacts are a complete flake and a broken blade from trench 29 and trench 21 respectively, although the artificial character of both objects is not fully established (21-1-5/14503 and 516-5/29-1-18; Fig. 37.2). They differ from the other flint artefacts from Voerendaal-Ten Hove by their strong rounding and windgloss. On the basis of these characteristics and the geological find conditions of at least the first piece (loess, deposited after c. 240,000 BC), an allocation of the two objects to the Middle Palaeolithic is justified. In other words, they can be attributed to the material culture of the Neanderthal man. This (sub)species of man disappeared around 40,000 years ago.

37.5.3 Late Mesolithic

In all probability, the majority of the lithic finds date to the Late Mesolithic. In trench 68, 69, 95, 96, 101 and 107 with numerical highlights in trench 69 and 107 a total of 453 finds have been uncovered, of which 403 have been assigned to

3163 One wonders, for instance, how polished axe 317-21/13-3-34 (fig. 37.5) could end up in a Roman drain.

3164 Amongst others, Verhart 2016a.

3165 Section 4.2.3-4. These trenches yielded 176 pieces of flint (7679 g). Even here, with well-documented trench wall sections at three sides, it is extremely difficult to establish the exact stratigraphic position (or context) of artefacts, because many thin layers in the trenches are not visible in the sections.

3166 *Ibidem*.

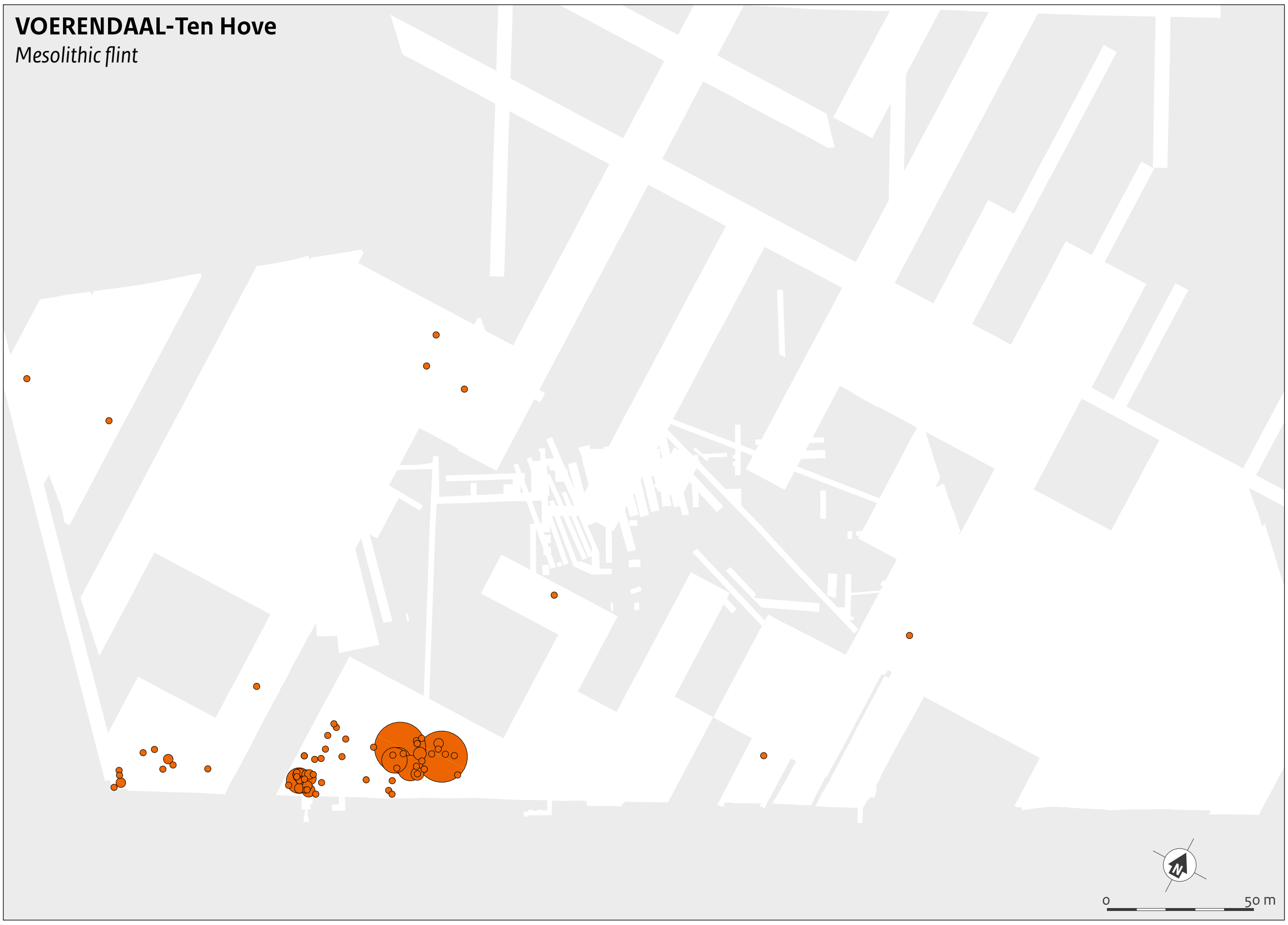


Fig. 37.13 Voerendaal-Ten Hove. Horizontal distribution of the Late Mesolithic flint artefacts.

the Late Mesolithic. Among these finds are one or two rectangular trapezes and 69 cores, which can generally be labelled as blade cores. They were accompanied by 36 blades and 51-55 core preparation and rejuvenation pieces. The above-mentioned artefacts are frequently attributed to the same raw material unit, a fact that, together with the find location, speaks for a direct relationship in time and space. This is certainly true of trench 107, where the greatest density in the horizontal distribution of finds can be discerned (Fig. 37.13). Of the 243 lithic finds made here, 111 are made of Simpelveld flint, while this is suspected for another 50 pieces.

The discovery of a Wommersom-quartzite blade in trench 69, already mentioned, supports the above chronological idea. The current general picture is that artefacts of this material in the Southern Netherlands mainly date from the Middle and Late Mesolithic.[3167]

Trapezes are generally considered to be diagnostic of the Late Mesolithic.[3168] The beginning of this period in the Southern Netherlands is generally placed around 6500/6400 BC.[3169] Opinions are more divided about the final dating.[3170] Deeben and Niekus think that the transition between Mesolithic and Neolithic took place between 5300-4900 BC, while Verhart puts the end of the Mesolithic at 4400 BC.[3171] Earlier, in his dissertation, the latter suggested that the end date in the coversand area of the southern Netherlands might even be several centuries later. The reason for this assertion are the results of an excavation at Merselo-Haag, where both Early and Late Mesolithic artefacts were discovered. They were

3167 Arts 1989, 304. See also Noens & Van Baalen 2019.
3168 See for example Arts 1989, fig. 8; Deeben & Niekus 2016, 133; Drenth 2018.
3169 Deeben & Niekus 2016, 133, 135; Verhart 2010, 172; Verhart & Arts 2005, table 1.
3170 See also Amkreutz 2013; section 5.2.3.
3171 Deeben & Niekus 2016, 135; Verhart 2010, 172 (cf. Verhart & Arts 2005, table 1).
3172 Verhart 2000, chapter 2.
3173 A 2 sigma calibration yields the following dating possibilities: 4049-3768 and 3721-3716 cal BC. The calibration was made using

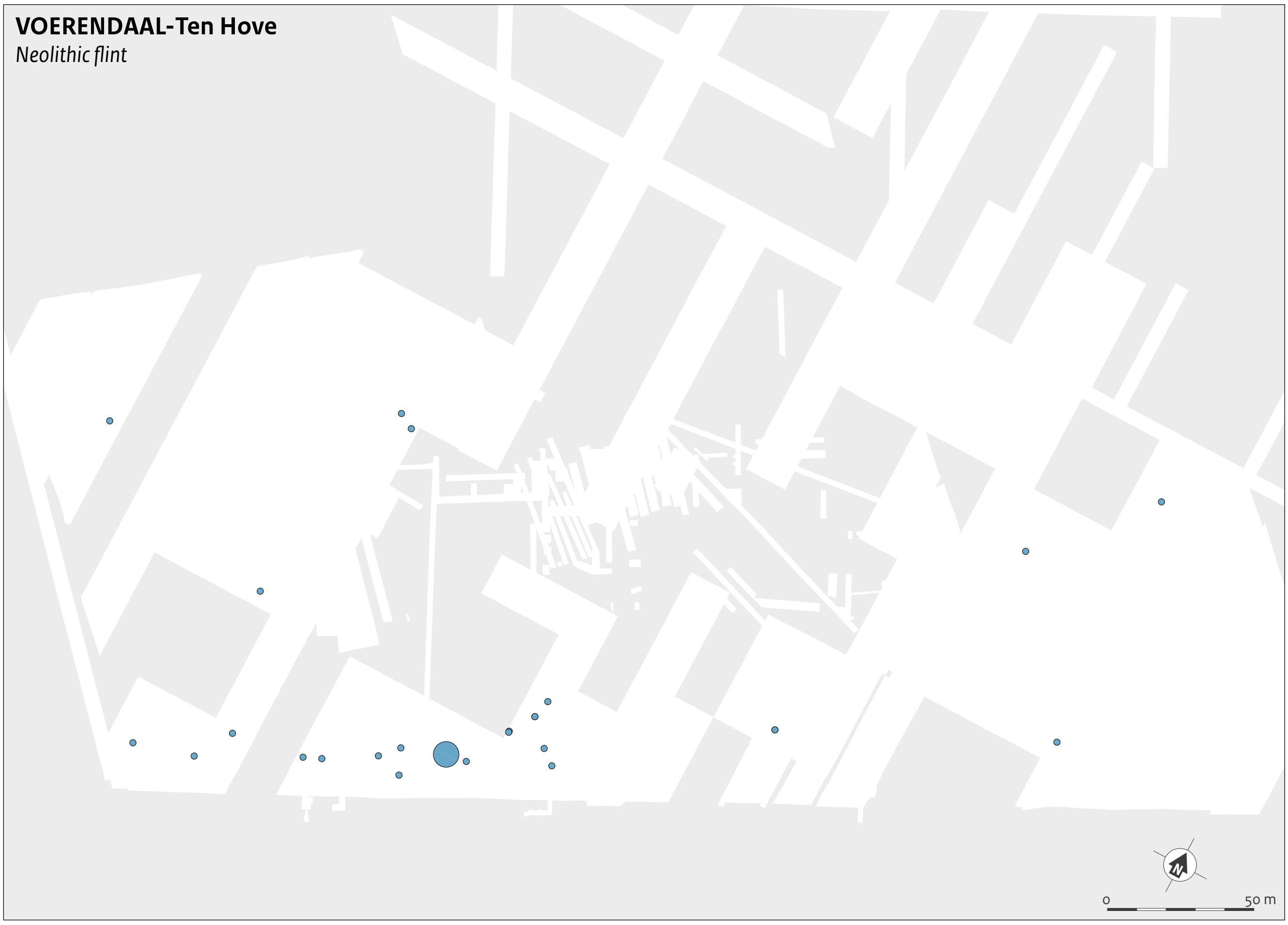


Fig. 37.14 Voerendaal-Ten Hove. Horizontal distribution of the Neolithic flint artefacts.

accompanied by some hearths.[3172] One of these is ^{14}C-dated at 5120 ± 60 BP (GrN-17407). Calibration (2 sigma) of this radiometric age determination comes out in the tail end of the fifth millennium BC and roughly the first quarter of the next millennium.[3173] Verhart associates this result with the Late Mesolithic component of the Merselo-Haag site, not so much by naming it explicitly, but rather by hinting at it between the lines.[3174] In arguing for a possible younger closing date, he points to three other Mesolithic sites that have produced ^{14}C-dates similar to those for Merselo-Haag. That is, first of all, the Hazeputten I site, for which an age determination of 5380 ± 40 BP (GrN-5998) is available.[3175] The second site referred to is Moerkuilen II with a ^{14}C-date of 5365 ± 70 BP (GrN-6371).[3176] Finally, Valkenswaard/Borkel-Achterste Brug is cited;[3177] in this case, the ^{14}C-date is 5390 ± 50 BP (GrN-12022).[3178] In addition, Verhart puts forward the Belgian Dilsen-Dilserheide III site as an argument, because amidst a concentration of Late Mesolithic artefacts a pottery vessel has been found that is attributed to the Michelsberg culture or a related cultural group (the Spiere group) (see below).

Verhart's postulate about the end-date of the Mesolithic is important in the present context, because it means that the Late Mesolithic finds from Voerendaal-Ten Hove could belong to the period 4500-4000 BC or perhaps even be of an even younger date. At Merselo-Haag several rectangular trapezes have been uncovered, while the find spectrum of Dilsen-Dilserheide III shows examples of rhombic points. When the present hypothesis is

OxCal v4.4.4 with the IntCal 20 curve. The same applies to the other calibrations in this contribution.

3174 Verhart 2000, 111-112, 114.

3175 Calibration: 4336-4219, 4204-4161, 4133-4056 cal BC (2 sigma).

3176 Calibration: 4343-4045, 4008-4001 cal BC (2 sigma). Incidentally, Lanting and Van der Plicht relate this dating to the Moerkuilen site II (1997/1998, 148).

3177 Lanting & Van der Plicht 1997/1998, 146.

3178 Calibration: 4343-4216, 4206-4159, 4136-4055 cal BC (2 sigma).

critically examined using ^{14}C-dates, doubts arise, however, as to whether Verhart's ideas can hold water.[3179]

Firstly, the reliability of the radiometric dating can be disputed. Especially for the datings with respect to the Dutch Mesolithic carried out shortly after the development of the ^{14}C-method, Lanting and Van der Plicht note several times that the pre-treatment of the dated sample was insufficient.[3180] So too in the case of Moerkuilen II.[3181] Furthermore, Verhart's claim that not only Early Mesolithic but also Late Mesolithic artefacts were found at Hazeputten 1 is open to debate. Of the finds made at the site, he refers to trapezes and backed blades ('*steil geretoucheerde klingen*'), because he considers them to be typical of the late phase of the Mesolithic.[3182] Arts has completely different thoughts about the latter type and believes that backed blades within the southern Netherlands Mesolithic are not diagnostic of a specific phase.[3183] This is also the outcome of a recent typological and chronological study by the author into microliths, especially in Belgium and the southern Netherlands.[3184]

Also the trapezes from Hazeputten should be commented on.[3185] Within the Low Countries, this type occurred not only in the Late Mesolithic but also in the Late Palaeolithic Ahrensburg culture and the Early Mesolithic, as for example already recognised by Heesters and Wouters.[3186] Arts also points in a typochronological overview to the occurrence of broad (a)symmetrical trapezes and rhombic trapezes in these cultural and chronological contexts.[3187] He does not mention rectangular trapezes in that context, but closer inspection shows that he did include this form in his typochronological scheme. He only uses a different typological label: Zonhoven-point. The trapezes at Hazeputten 1 should be seen against this background. On typological grounds they are not necessarily Late Mesolithic, because the site report shows that (in any case) two specimens of the rectangular and one of the rhombic type are involved. A dating based on other considerations, especially associations, runs up against the problem that three spatially separated lithic clusters were discovered at the site without their composition being described in detail in the site report. However, the text does reveal that trapezes were not found in the third concentration.

At the Dilser-Dilserheide III site, scepticism arises as to whether the Mesolithic artefacts, including rectangular and rhombic trapezes – some with RIP – and the Michelsberg pot are indeed contemporaneous, as Verhart assumes, following Luypaert *et al.*[3188] The former stresses that a direct association in time is plausible, as no other settlement material of the Michelsberg culture was found at the site. This may be true, but Luypaert *et al.* write that some flint artefacts have been found that can be associated with this culture: two unretouched flakes and one retouched flake coming from three different ground axes, possibly including a specimen of Spiennes flint.[3189] Could these lithic finds, together with the pottery, not point to a second, Neolithic phase of use of the site? A definitive answer to this question is not possible. Recently, Amkreutz *et al.* have also come to this conclusion, as they write about the pot, which has in their opinion the best parallels in the Spiere group: 'The horizontal and vertical distribution of the sherds suggests that they are in direct association with the Late Mesolithic artefact assemblage. This is confirmed by the presence of only very few Neolithic flint artefacts at the site, none of which are strictly contemporaneous with the Michelsberg culture horizon. The technological and typological dating of the material in the late fifth millennium cal BC, on the other hand, makes such an association remarkable and questionable at the same time. Unfortunately, the context has not been sealed after the artefact deposition and it cannot be excluded that the observed distribution and mixture resulted from bioturbation processes of at least two not contemporaneous moments of deposition.'[3190]

The results of the ^{14}C-survey of two stratified sites excavated at Hardinxveld-Giessendam (De Bruin and Polderweg) also cast doubt on Verhart's hypothesis. At both sites, asymmetrical and symmetrical trapezes were found, but no rectangular and rhombic examples.[3191] The trapezoidal arrowheads of Polderweg belong to phases 1 and 1/2, placed respectively between c. 5500-5300 BC and c. 5100 (± 50) BC.[3192] In De Bruin's case, they come from phases 2 and

[3179] The Borkel/Valkenswaard-Achterste Brug site is not included in this discussion because no trapezes were discovered there (Verhart 2000, 115). This makes this location less relevant for the dating of the trapeze-containing site Voerendaal-Ten Hove.
[3180] Lanting & Van der Plicht 1997/1998.
[3181] *Ibidem*, 148.
[3182] Verhart 2000, 163.
[3183] Arts 1989, fig. 8.
[3184] Drenth 2018.
[3185] Caution is advised with the Hazeputten I site, as it was partly published by Wouters. It has been established that for decades he regularly tampered with archaeological assemblages (Niekus *et al.* 2018). Thus, Wouters can be accused of site falsification, i.e. he used artefacts from elsewhere to expand lithic assemblages of sites.
[3186] Heesters & Wouters 1968, 105.
[3187] Arts 1989, fig. 8.
[3188] Luypaert *et al.* 1993; Verhart 2000, 115.
[3189] Luypaert *et al.* 1993, 26, 31.
[3190] Amkreutz *et al.* 2010, section 2.4.
[3191] Van Gijn *et al.* 2001a; 2001b.
[3192] Mol & Louwe Kooijmans 2001a.

3, which have an age of 5100-4800 BC and 4700-4450 BC respectively.[3193] Based on the examination of the covered and (partly) stratified sites that were recently excavated at Well-Aijen, it may well be that the above findings represent a regional or even supra-regional situation.[3194] For at this North Limburg site, the trapezes that are younger than 5000 BC belong in each case to the asymmetrical and symmetrical variants. The stratigraphy at the Liège-Place Saint-Lambert site reinforces this picture. From sector DDD comes a rectangular trapeze from a layer (phase VIIB) that, thanks to ^{14}C-analyses, can be assigned to the second half of the sixth millennium.[3195] The Belgian site Verrebroek-Aven Ackers also supports this idea about the chronological position of rectangular and rhombic trapezes.[3196] Both trapezoidal variants were excavated at the site, which can be ascribed to the second quarter of the sixth millennium BC on the basis of ^{14}C-dating.[3197]

Based on the above, it is warranted to date the Late Mesolithic finds from Voerendaal-Ten Hove to at least 4500 BC. The rhombic trapeze with RIP from this site may offer further chronological clues, although the difficulty is that the precise location of this artefact is unknown (0-0-0/14491; Fig. 37.3). The flat retouche on the ventral side, gives this trapeze a certain affinity with arrowheads of the Linear Pottery Culture (here we will use the abbreviation LBK, referring to the Dutch *Lineare Bandkeramiek* or German *Linearbandkeramische Kultur*). It has already been pointed out that this retouch inverse plate (RIP) connects certain Late Mesolithic points with several Early Neolithic arrowheads.[3198] This has led to extensive philosophising about the relationships between the earliest farmers and hunter-gatherers in (continental) Europe.[3199] Assuming that the arrowheads with RIP testify to direct contact, the rhombic trapeze and thus the entire Late Mesolithic assemblage of Voerendaal-Ten Hove could be assigned to roughly the last two or three centuries of the sixth millennium BC.[3200]

37.5.4 Neolithic

Figure 37.14 shows the distribution of artefacts which, on typological grounds, can be assigned to the Neolithic period. Most of these have already been mentioned in the typological discussion: the ground axe or *spitznackige Flint-Ovalbeil* (317-21/13-3-34; Fig. 37.5), a core from a broken ground axe (also a *spitznackiges Flint-Ovalbeil*), some flakes from ground axes, a scraper on a similar flake and a bifacially retouched leaf-shaped arrowhead (301-1/70-3-4; Fig. 37.4). Also of Neolithic signature is a fragment of a broad bilaterally retouched blade from trench 46 (46-1-6/11263; Fig. 37.15). Three other bilaterally retouched blades may also be Neolithic (317-22/13-3-37; 757-41/109-2-5; 110-1-1/10059). They stand out because of the polish on the edges of the long sides and partly because of the rounding of these edges (the result of working with silica-bearing plants?).[3201] The two more or less round to oval hammerstones probably also date from the Neolithic (68-5-9/7008 en 308-14/106-2-17).[3202]

The find complex undoubtedly contains more artefacts from the Neolithic period, but they cannot be recognised due to the lack of sufficient diagnostic features, a spatial overlap with Late Mesolithic objects and the fact that refitting was not considered in this study. This Neolithic component is probably to be sought among the artefacts of Lanaye flint (variant Rijckholt). The unambiguous Neolithic items just mentioned are mainly from this material.

At first glance it is tempting to attribute the undeniably Neolithic artefacts all to the Michelsberg culture, which for the Netherlands is dated between c. 4200-3800 BC.[3203] Both blade points, bilaterally retouched blades and *spitznackiges Flint-Ovalbeile* are known from that culture.[3204] Moreover, such a cultural attribution would fit into the general distribution picture of the Michelsberg culture.[3205] In the vicinity of Voerendaal-Ten Hove, earlier remains of this culture were excavated at Brunssum and Heerlen-Schelsberg.[3206] At the latter location, 5 km northeast of Ten Hove, there are even traces of an earthwork/enclosure (Dutch *aardwerk*, German *Erdwerk*), the only example of its kind in the Netherlands that is beyond all doubt.

However, there are some reservations about the attribution to the Michelsberg culture. The first is that it is uncertain whether the finds form a closed assemblage. That is debatable,

---

3193 Mol & Louwe Kooijmans 2001b.
3194 Müller *et al.* 2018.
3195 Van der Sloot *et al.* 2003, especially 88, table 1 and fig. 7: no. b8.
3196 Robinson *et al.* 2011.
3197 The item dated is a charred hazelnut shell, resulting in 6785 ± 40 BP (KlA-37694) or 5732-5626 cal BC (2 sigma).
3198 Including De Grooth 2008; Löhr 1994; Robinson 2008; Robinson *et al.* 2013.
3199 In this context, mention should also be made of the Haelen-Broekweg site, where – in addition to three flint points with RIP – *Begleitkeramik* have been excavated (Bats *et al.* 2010). This pottery category is contemporaneous with the LBK (Brounen 1999; Brounen & Hauzeur 2010).
3200 De Grooth 2008, section 19.2; Lanting & Van der Plicht 1999/2000, esp. section 4.1.
3201 See in this respect Schreurs 1998, section 6.7.
3202 For parallels, see for example Schreurs 1998.
3203 Lanting & Van der Plicht 1999/2000, section 2.3 and 4.5.
3204 See in this context Fiedler 1979; Lüning 1967; Scheurs 1998; 2005; 2016; Schut 1991; Vermeersch 1987-1988; Schut 1991.
3205 Schreurs 2005, 301 and fig. 1.
3206 Drenth 2019a (Brunssum); Schreurs & Brounen 1998 (Heerlen).

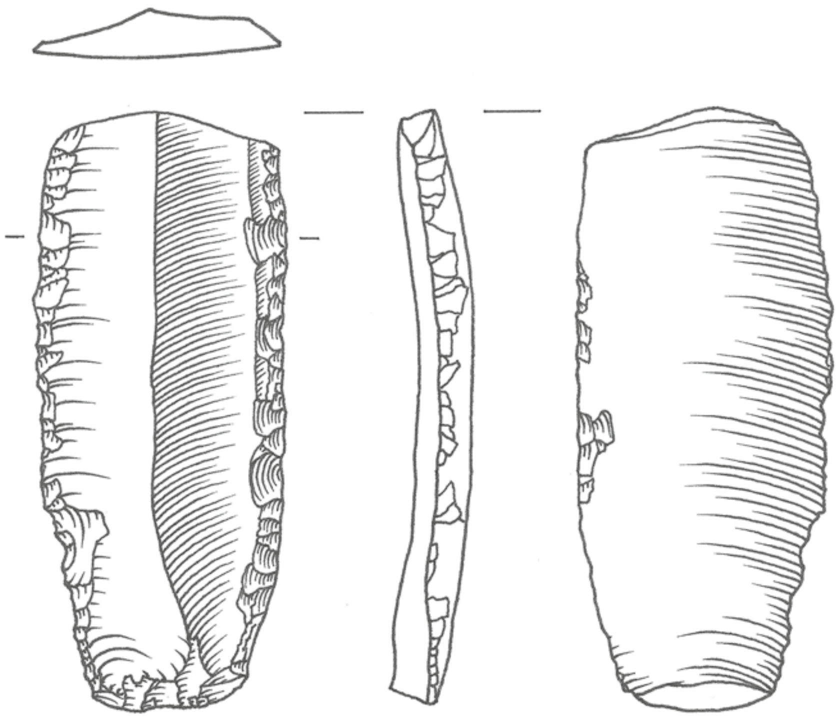


Fig. 37.15 Voerendaal-Ten Hove. Bilaterally retouched blade in Lanaye-flint. Scale 1:1. (source: R. Timmermans)

because the artefacts were not found close together. Furthermore, it can be objected that the artefacts in question belong to types that are not exclusive to the Michelsberg culture, such as the *spitznackige Flint-Ovalbeil*. Finds elsewhere from (continental) north-western Europe indicate that this type continued until c. 3000 BC. This means that the Voerendaal-Ten Hove specimens (including the core on an axe) may also belong to the material culture of another Neolithic culture in southern Limburg: the Stein-Vlaardingen complex (c. 3400-2600 BC).[3207] The same applies to the bilaterally retouched blade and the leaf-shaped arrowhead, as research by De Grooth has shown.[3208] It is worth noting that both faces of the arrowhead are completely covered by retouching, which is exceptional for the Michelsberg culture.[3209] Judging by finds from Koningsbosch, this does not seem to be substantially different in the Stein-Vlaardingen complex, so that the degree of coverage of the retouching cannot be used as a chronological and cultural criterion.[3210] Nor is it possible to give a definitive answer on the precise dating and cultural affiliation of the Neolithic artefacts on the basis of ceramic associations. No Neolithic pottery has come to light in the Voerendaal-Ten Hove excavation.[3211]

As mentioned in the introduction, 3 flint artefacts originate from the Early Medieval grave 382, which in the present context could only be studied on the basis of drawings. These drawings are included here as figure 42.9. They are recycled artefacts that were given to the dead man as strike-a-lights, given the presence of an iron axe. This type of artefact is a frequently occurring grave gift.[3212] Perhaps a piece of flint and a broken flint blade (381-42, 43) from the Early Medieval grave 381 should also be interpreted as fire strikers. However, unlike 382 there is no iron fire striker present in the grave. The location of the flint in the grave was not documented.

3207 Schut 1991, 31-32. See Drenth 2019b and Lanting & Van der Plicht (1999/2000, section 3.4.2, 3.4.3, 4.9 and 4.10) for the absolute dating of the Stein-Vlaardingen complex. For the distribution area of the Stein-Vlaardingen group, see Schreurs 2005, 318.

3208 De Grooth 1991, especially 161.

3209 Schreurs 2016, 161; Vermeersch 1987-1988, 6; Compare with the illustrations in Lüning 1967.

3210 Van Haaren & Modderman 1973, fig. 12-16.

3211 All handmade pottery, almost 3000 fragments, passed through the hands of the late Jan Thijssen and – over 30 years later – of Henk Hiddink. Neither of them observed any pottery that could potentially date to the Neolithic (or Bronze Age).

3212 E.g. Langenbrink & Siegmund 1989 and Drenth in prep.

37.6 Character of the site

The two (possible) artefacts from the Middle Palaeolithic fit into the general assemblage of finds outlined in recent survey studies.[3213] They are not the first Middle Palaeolithic artefacts from Zuid-Limburg.[3214] In the light of the concentration of Late Mesolithic artefacts noted in the southwest of the excavation area, there is no reason to assume that the present artefacts were originally part of an undetected lithic cluster. In other words, they seamlessly fit into the general pattern of single finds and sparse Middle Palaeolithic find scatters known for the Dutch loess area. It is impossible to say which human activities both artefacts reflect. They have not been subjected to microscopic examination for traces of use.[3215] The find conditions also don't offer any clues. The flake was found in a Late Roman or Early Medieval sunken-floored hut, while the blade comes from a high archaeological excavation level, both secondary contexts.[3216] The find locations are c. 80 m apart and situated in the southeast part of the excavated area.

The Late Mesolithic finds mainly testify to the production of blades, which, judging from the horizontal spatial distribution and the absence of associated soil traces, took place in the open air. A substantial component of artefacts consists of (blade) cores, flakes and blades, which are associated with the preparation and maintenance of the *nuclei*. In addition, dozens of blades were found. It is quite possible that they are underrepresented compared to cores and core preparation and rejuvenation pieces. After all, blades are usually smaller and the excavation did not involve sieving – apart from archaeobotanical samples –, which in principle leads to an under-representation of smaller pieces.

The impression is that the blade production proceeded roughly as follows.[3217] By means of direct hard percussion by a hammerstone, a piece of flint was roughly trimmed when deemed necessary. This form of flint working was also frequently used for the upkeep of cores. The actual striking of the blades, on the other hand, was done with direct soft percussion or the 'punch technique'. Detailed technological research, which went beyond the scope of the present study, should show the extent to which the above scenario is correct. It should also come to light to what extent the blades were made in Coincy or Montbani style.[3218]

The trapezes indicate that not only blades were struck at the site, but in any case hunting equipment was also maintained there. In at least three cases, the damage on the first-mentioned artefacts looks like impact fractures, or fractures and damage caused by the impact of projectiles.[3219] This points to a use of the trapezes as arrowheads. This is in line with the findings of microscopic traces of use of trapezes that have come to light elsewhere, such as at Basel-Sluis and Hoge Vaart-A27.[3220] On the other hand, it cannot be denied that the microscopic traces of use on trapezes have not always been interpreted as the result of shooting with bow and arrow. The site Kampen-Reevediep can be mentioned as an example.[3221] Based on the results of microwear analysis, a part of the trapezes excavated there is related to the working of silica-bearing plants, inorganic material or a medium-hard unknown material. A microscopic use-wear analysis of the trapezes from Voerendaal-Ten Hove is therefore a desirable step. Such an analysis will also be able to shed light on the question to what extent the retouche inverse plate (RIP) on one of the rhombic trapezes from this site is functional and related to scouring.

The hypothesis about the maintenance of hunting tools needs a second comment. The Late Mesolithic assemblage of Voerendaal-Ten Hove does not contain microburins (Dutch *kerfresten*), also called pseudoburins. One possibility is that microliths, in particular trapezes, were not produced at the site after all. An alternative explanation is that they are missing because microliths were not made by the microburin technique.[3222] Finally, there is a chance that microburins may be missing as a result of the excavation method, only relatively little soil sieved for archaeobotanical sampling.

It should also be noted that flint arrowheads in the Late Mesolithic were fixed in the wooden arrow shafts by means of an adhesive, such as pitch or a similar material. When replacing broken or damaged projectile points and barbs,

3213 Rensink 2005; Verpoorte *et al.* 2016.
3214 See Rensink 2005, fig. 1; Verpoorte *et al.* 2016, 2.
3215 It is highly doubtful whether such an investigation would have been conclusive. The two artefacts have been rounded off and polished by the wind (windgloss) to such an extent that we can expect any traces of use to have disappeared.
3216 Because a substantial part of the loess cover was eroded over time, the approx. 8 m that is present is the remainder of a much thicker deposit (cf. section 4.1.1).
3217 For more information on flint working techniques, see Beuker 2010, section 2.5.
3218 See de Grooth 2008, 221-222 (with further references).
3219 Fischer *et al.* 1984.
3220 Peeters *et al.* 2001, 46-47; Tomasso *et al.* 2015.
3221 Verbaas *et al.* 2019, 149-150.
3222 See in this regard Robinson *et al.* 2013, 11-12.

this adhesive had to be softened by heating in order to fix the new microliths. It is for this reason that flint spikes are frequently found directly around a hearth at Mesolithic sites.[3223] Remnants of a Late Mesolithic hearth, however, have not come to light or been recognised at Voerendaal-Ten Hove. However, two flint strike-a-lights were discovered (see earlier) in the concentration of Late Mesolithic artefacts (Fig. 37.6).

In this context, the small percentage of artefacts with traces of heating should be pointed out again. There is a good chance that this is no coincidence. An exploratory study of Late Palaeolithic and Mesolithic sites in the southern Netherlands indicates that certain types of artefacts are burned significantly more often than others.[3224] Blades and cores belong to the category that less often show thermal traces, which indicates that these artefacts were usually handled more carefully. Considering the important place blades had in the Mesolithic, among other things as the base form for several retouched artefacts, this is understandable. An alternative explanation for the virtual absence of burnt flint is that the site was only inhabited or visited for a short period of time. In trenches, other than trapezes, thirty retouched artefacts were found in trenches 68, 69, 95, 96, 101 and 107, including (possibly) burins, a scraper, a borer or awl and especially all kinds of retouched flakes, blades and core rejuvenation pieces.

It can be concluded that a special Late Mesolithic site was discovered at Voerendaal-Ten Hove, as the author is unaware of any other Late Mesolithic 'blade production' sites in the southern Netherlands. Whether this is a site where blades were produced once or several times is not clear. However, this does not diminish the remarkable character of the site, which is in any case a welcome addition to the existing archaeological picture. The east of Zuid-Limburg has so far hardly any sites from the Late Mesolithic, as studies by Arts and Verhart, among others, have shown (Fig. 37.16).[3225] The scarcity of such sites recently tempted Verhart to make the following statement: 'The [Late Mesolithic] hunters and gatherers were active throughout the southern Netherlands in the cover sand landscape and the stream and river valleys. Fewer sites have been discovered in West Brabant and the hill country of the Zuid-Limburg loess area does not appear to have been inhabited in the Late Mesolithic and may only have been used [in other ways] occasionally.'[3226]

It is no easy task to interpret the Neolithic finds. Previously the 'chronological perils' and the uncertainty about the exact size of this ensemble have been pointed out. Attention has also been drawn to the absence of ceramic artefacts and the fact that none of the artefacts came from a Neolithic feature. If for the sake of convenience a closed assemblage is assumed, then an explanation of the artefacts as settlement remains is most plausible. The typological composition of the complex is the main argument for this.[3227]

Finally, the significance of the flint artefacts from Early Medieval graves has already been discussed in the previous section.

37.7 Conclusions

Of the lithic finds that have been made in Voerendaal-Ten Hove, it is especially those from the Late Mesolithic that are thought-provoking. They come as a total surprise and this discovery raises a number of questions:

- Was the east of Dutch Zuid-Limburg indeed not or hardly inhabited during the Late Mesolithic and only sporadically used, as is now assumed? Or does the scarcity of Late Mesolithic sites represent a *Forschunglücke*? The current study indicates that the possibility that such sites were not always recognised should be taken seriously. It should be noted that in Zuid-Limburg, and certainly in the eastern part, hardly any specific excavations for Mesolithic remains have been carried out.[3228]

Recently, Van de Velde *et al*. summarised the state of knowledge regarding Linear Pottery Culture (LBK) in the Netherlands (c. 5200-5000 BC).[3229] Among other things, they presented a distribution map, which is reproduced here as part of Figure 37.16. It is striking that LBK settlements and finds in eastern Zuid-Limburg are completely absent. This calls for an

3223 As in the case of Maastricht-Landgoederenzone (Machiels & Drenth 2015).
3224 Drenth 2015.
3225 Arts 1989, fig. 7; Verhart 2000, fig. 2.2; 2010, fig. 6.11; Verhart & Arts 2005, fig. 1.
3226 Verhart 2016, 345.
3227 Compare Maastricht-Klinkers (Schreurs 1998), which has been interpreted as a (basic) settlement.
3228 Arts 1989, fig. 6; Machiels & Drenth 2015, section 4.2.
3229 Van de Velde *et al.* 2016.

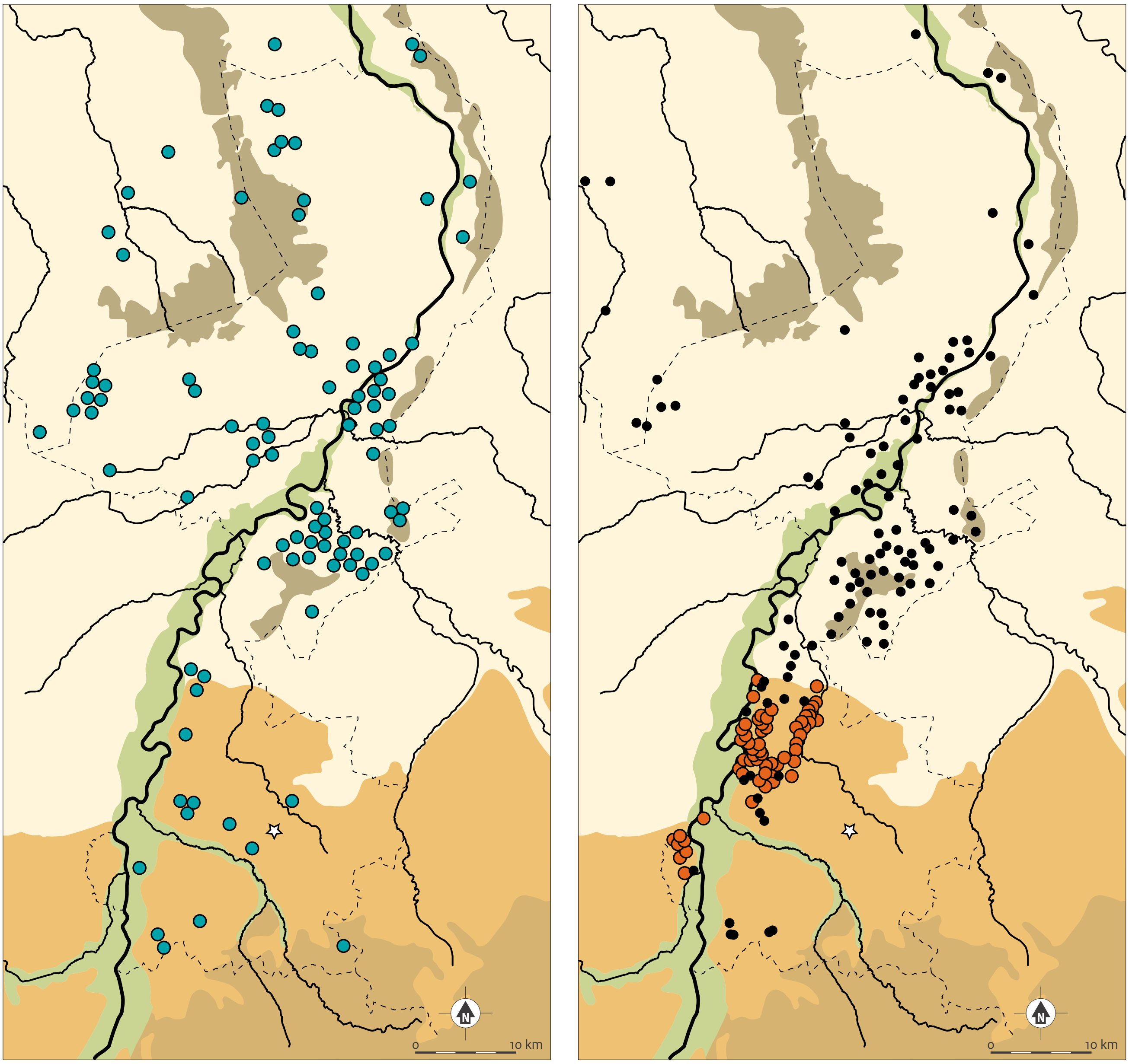


Fig. 37.16 Dutch Limburg and part of North Brabant. Late Mesolithic and Neolithic sites. (source: modified after Verhart 2000; Van de Velde et al. 2016) A Late Mesolithic sites; B Linearbandkeramik, sites with features (red dots) and finds only (black dots).

explanation and answers questions such as 'To what extent does the white area on the map reflect the original situation?'[3230] and 'What is the chronological significance of the typological variation within trapezes and to what extent is this variation related to contacts between hunter-gatherer and farmers (LBK)?' For a well-founded answer to the latter question, more ^{14}C-dated sites are needed.[3231]

Were the Late Mesolithic artefacts from Voerendaal-Ten Hove intended only for personal consumption? Judging from the composition of the entire assemblage, they were in any case struck on site for retooling the arrows, whereby blades were transformed into trapezes or had to replace broken trapezoidal points. But is that the end of the matter? Given the possible age of the ensemble, the artefacts may have been produced

[3230] Compare Amkreutz 2013, 128.

[3231] Compare De Grooth 2008, 216; Robinson *et al.* 2013, 5-7.

in part in order to be exchanged with or traded to the LBK. At this point, it can be noted that these artefacts consist mainly of Simpelveld flint and items of this raw material are hardly known from LBK contexts in Zuid-Limburg, according to De Grooth.[3232] An exploratory study suggests that the situation for the LBK in Belgium is not fundamentally different.[3233] Simpelveld flint is also not frequently found at LBK sites in the Rhineland.[3234] This is shown in table 37.8. Simpelveld and Vetschau flints have been lumped together on the basis of the observation by Hohmeyer that both types cannot be discriminated with certainty.[3235] Despite the modest contribution that Simpelveld flint appears to have made to the LBK, De Grooth believes that this type of flint, together with the flint variants Lousberg, Orsbach and Vetschau, can be important for insights into the contacts between LBK pioneers and indigenous hunter-fisher-gatherers.[3236]

A related question concerns the size of Late Mesolithic socio-economic territories. To what extent were Simpelveld and Vetschau flints an expression of identity and group feeling at the time? For an answer, of course, an extensive, and if possible exhaustive, overview is necessary.[3237] In any case, it is important that both types of raw materials are defined more sharply than before in order to keep them separate. Also, the natural occurrences and extraction points need to be better mapped. Finally, the geographical distribution of Late Mesolithic flint artefacts from Simpelveld and Vetschau must be mapped. A first, exploratory study shows that such artefacts occur at least up to c. 80 km north of Voerendaal. According to Verhart's dissertation, four examples of Simpelveld flint have been excavated in Merselo-Haag.[3238] It is possible that they also came to light in the 'in-between' area. Smeets mentions several sites in the Roer area where Simpelveld flint artefacts have been discovered (on the surface).[3239] For example, there are the Herkenbosch-295 and Posterholt 208 sites, where the finds mainly date from the Mesolithic. In addition, there are a few 'large chunks', one of which weighs 1,095 g, of this material known from the Linne-16 and Posterholt-165 sites. While at the latter site mainly Mesolithic finds and to a lesser extent Neolithic artefacts have been made, the lithic material from Linne-16 indicates that this site was popular as a place of residence in various Stone Age periods. In his overview, Smeets makes no statements about which phase within the Mesolithic to which the Simpelveld flint artefacts (may) belong. It should be emphasised that this type of flint within this period in the southern Netherlands seems not to be limited to the late phase. During an excavation of the Geldrop 3-3 site from the Early Mesolithic period, several Simpelveld flint artefacts were discovered.[3240] Yet, in addition to the present study and Verhart's thesis, the studies by Arora and Franzen suggest a chronological centre of gravity in the late Mesolithic. They mention the following Mesolithic sites with (possibly) Simpelveld flint, which are situated as the crow flies up to c. 40-45 km from Voerendaal and are surface sites: Hergenrath-Brennhaag in Belgium, Vaals-Bokkebosje and Vaals-recreatie park Vallis in the Netherlands and the German sites Erkelenz-Isengraben (also called Erkelenz 17), Niederkrüchten-Beek, Niederkrüchten 25,

Table 37.8. German Rhineland. Total number of flint artefacts and absolute/relative frequency of Simpelveld/Vetschau-flint on different LBK-sites (after Hohmeyer 1997).

Site/area	N	N Simpelveld/Vetschau	% Simpeldveld/Vetschau
Aldenhovener Platte (different sites)	22317	224	1.0
Aldenhoven 3	1457	13	0.8
Hambach 8	3041	173	5.7
Langweiler 8	10614	105	0.8
Lamersdorf 2	2193	27	1.2
Laurenzberg 7	8053	79	0.9

3232 De Grooth 2013, 37. Cf. De Grooth in Van Wijk *et al.* 2014; Van Wijk & Meurkens 2008, 83.
3233 Cahen *et al.* 1986, chapter 18-19.
3234 De Grooth in Van Wijk *et al.* 2014, 505; cf. Zimmermann 1995, 44.
3235 Hohmeyer 1997, 248. Arora and Franzen (1987, 27) had already pointed out the presence of Simpelveld flint artefacts at this site.
3236 De Grooth 2013, 36-37.
3237 Deeben (1997, 65) has already pointed out the lack of this.
3238 Verhart 2000, 82-83 and table 2.7. What types these artefacts represent, however, remains unspecified.
3239 Smeets 1998, 128.
3240 Deeben 1997. Dr N. Arts (pers. comm. June 2021) is suspicious of these finds and suspects that A. Wouters may have tinkered with the find material.

Wegberg-Elsenkämp (Wegberg 1), Wegberg 2, Wegberg 10 and Wegberg 24.[3241] Of these sites, those in German territory can be attributed to the Late Mesolithic period, if not all, given the typological composition of the find complexes. Also notable for these German sites are the frequent occurrence of microliths from Simpelveld flint and the absence of assemblages in which this type of material is numerically dominant.

Several studies of Late Mesolithic and Early Neolithic points have looked at lateralisation.[3242] It has been suggested that within these periods 'right-lateralised' points dominate in the Low Countries, which has been interpreted as an indication of continuity in a stylistic or socio-symbolic sense.[3243] Despite their small number, the trapezes from Voerendaal-Ten Hove fit seamlessly into the picture above. As far as is clear, they are all right-lateralised (3x and 1x unknown). This is considered typical for the Late Mesolithic in continental North-Western Europe north of the Paris Basin, whereas the points in the neighbouring southern area are said to be mainly 'left-lateralised'. A recent study by Robinson *et al.* (2013) into the south of the Low Countries does not contradict this hypothesis for the Late Mesolithic, but their findings with regard to the LBK correspond less well with the idea of the continuation of Late Mesolithic customs. They therefore note: '… there are high frequencies for right lateralization during the LM [Late Mesolithic] in the study area, but in the LBK dataset the relative frequencies of left-to-right lateralization are much closer to each other. This leads us to believe that armature lateralization may not have been so important for social identities during the LBK as it was during LM.'[3244] It goes without saying that further research is required here.

The recommendation is to include the above-mentioned research topics in the archaeological research agenda for the province of Limburg. As the above text clearly shows, it is advisable to include the neighbouring Belgian and German regions in future studies. More appealing and more solidly based results, in other words better results, can be achieved through such cross-border research. The late W.J.H. Willems, who played such a prominent role in the investigations at Voerendaal-Ten Hove, would undoubtedly have welcomed such an approach and endorsed its content, considering, among other things, his participation in a Belgian-German-Dutch project about archaeological monuments in the Meuse-Rhine Euroregion.[3245]

3241 Arora 1995; Arora & Franzen 1987, 26. Niederkrüchten-Beek as mentioned by Arora and Franzen is probably the same location as the Niederkrüchten 11 site described by Arora (1995, 350-353).

3242 The lateralization is determined as follows. An (asymmetric) microlith is placed on the ventral side with the tip pointing upwards. If the retouching at the tip is on the right-hand side, the object is right-lateralized or 'right-angled'. If the microlith is left-lateralized, the other side is retouched.

3243 E.g. Löhr 1994.

3244 Robinson *et al.* 2013, 10.

3245 Bauchhenß *et al.* 1992.

38 Two stone axes

Erik Drenth and Bertil van Os

38.1 Introduction

Among the lithic finds from Voerendaal-Ten Hove are two non-flint stone axes.[3246] A first axe was found in the topsoil or on the spoil heaps of trench 101 (axe 1; 101-0-0/8727; Fig. 38.1-2). The second axe comes from a pit dated in or after the Middle Roman period (752-8/102-1-2; Fig. 38.1-2). The typology, material, dating and function will be discussed below.

38.2 Typology, intrinsic characteristics and technological aspects

Axe 1 has a rectangular, somewhat asymmetrical section. It measures 6.3 x 4.2 x 2.1 cm and weighs 93.4 g. The artefact must have been larger originally, as is suggested by the irregular neck, which – like adjacent parts of the surface – shows negative flake scars and traces of splintering (Fig. 38.1; 38.3A). On both faces and sides there are many traces of hammering that are not ground over (Fig. 38.3B-C). This suggest these are

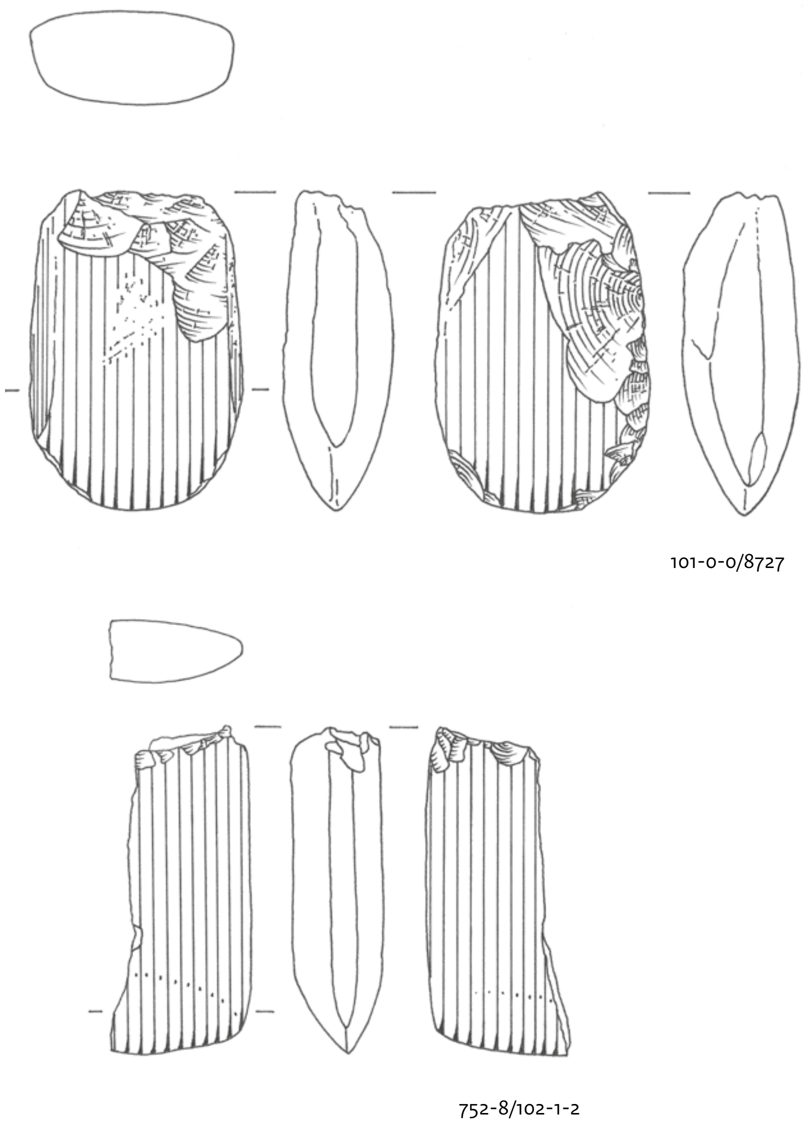


Fig. 38.1 Voerendaal-Ten Hove. Two non-flint ground axes. Scale 2:3. (source: R. Timmermans)

[3246] We wish to thank F.T.S. Brounen (RCE) for his assistance with investigating the axes.

101-0-0/8727 752-8/102-1-2

Fig. 38.2 Voerendaal- Ten Hove. Two non-flint ground axes (cf. Appendix XIX). Scale 1:1. (source: D.S. Habermehl)

secondary features, not originating from the pecking (with a hammerstone) during the shaping of the axe. Traces of original pecking are nowhere to be seen on the surface, indicating that the artefact was ground carefully. Presently some 70% of the surface is still smooth. Many grinding scratches are clearly visible, mostly in the longitudinal direction of the axe. The cutting edge is blunt and c. 1 mm wide.

Axe 2 measures 6.5 x 2.7 x 1.7 cm and weighs 50.5 g. The artefact was split lengthwise, after being broken in the width. Negative flake scars and splintering near the latter fracture show that some effort was made to modify the broken axe. Apart from the fractures, the surface is ground in its entirety. Grinding scratches are visible with the naked eye, mainly near the sharp edge. At one face, most run parallel to the longitudinal axis of the implement, while they form a criss-cross pattern at the other (Fig. 38.3D). The part near the edge stands out by facets on both broad sides, which are 1.6 and 1.8 cm wide. The edge itself has some rounded-off dents, which indicate re-sharpening after use. Axe 2 originally had a rectangular cross-section, as shown by the flattened side. At one of the faces a narrow facet is present at the transition to the side.

Because of their rectangular cross-section, both axes can be classified as *Fels-Rechteckbeile*. No attempt has been made at a more precise typological classification. One reason is that the original form is lost, another that the frequently used studies by Brandt and Hoof are being questioned as typological frames of reference.[3247] These publications are over 50 years old and are only suitable for general classification, not for subtypes, as is demonstrated in Schut's critical evaluation.[3248]

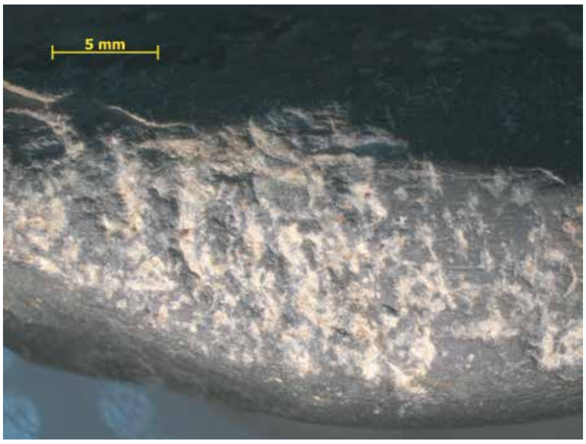
38.3 Raw material of the axes

Both axes are made of a dark-coloured rock with a fine-grained texture and inclusions barely visible to the naked eye. Another common characteristic is that the rock shows either a weakly developed lamination or schistosity. Lamination develops under changes in the depositional environment during sedimentation, while schistosity is related to the recrystallization of minerals as a result of temperature and pressure underground (metamorphosis). Sedimentary rocks can also be transformed by metamorphosis, resulting in meta-sedimentary rocks.

[3247] See Brandt 1967; Hoof 1970; Schut 1991.
[3248] Schut 1991, 19.

A

B



C

D

E

Fig. 38.3 Voerendaal-Ten Hove. Details of the stone axes.
A axe 1, neck with traces of chipped off pieces; B axe 1, side with traces of hammering cutting through grinding traces; C axe 1, one of the faces with the same kind of traces/markings; D axe 2, criss-cross pattern of grinding traces near the cutting edge; E axe 2, with spherical structures (spherulites).

Development of a direction in texture can also be found in volcanic rocks, by the flow of magma or when the still-hot rock cools. However, it is clear here that the observed direction is not caused by variations in texture. Moreover, no directionally recrystallized minerals, developed during metamorphosis, are visible at the imperfect cleavage planes.

The very fine-grained material of both Voerendaal axes is reminiscent of schist or slate.

From a functional perspective the use of these rock types makes no sense because they will split quickly (in a single direction). The identification as schist or slate is also unlikely because the main fracture in axe 2 does not follow the layering of the rock, but is perpendicular to the long axis. The shape of the fissures indicates that the material developed more or less isotropically, meaning that it splits in a similar way in all directions. Nevertheless, spherulites (spherical structures with the radial composition of crystals) are visible at the ground and broken surfaces, especially of axe 2. They are quite clear because they are accentuated by loess deposited on the interface with the matrix (Fig. 38.3E).

The material of the axes cannot be scratched with a fingernail, nor can it make scratches in metal itself. This shows that no quartz is present at the surface and its hardness lies between 5 and 7 on Mohs' scale. No mica or clay minerals were observed with a hand lens. The minerals are too small to be identified with the naked eye.

X-ray fluorescence (XRF) analysis shows that axe 1 is made of a rock mainly consisting of aluminosilicate rock with a relatively high iron content (14-16% Fe_2O_3) and a very low (<1.3%) level of potassium (Table 38.1).[3249] The material of axe 2 has a similar composition. Table 38.1 gives the chemical composition of both artefacts in more detail. The density of axe 1 is c. 2.75 g/cm³

[3249] The XRF analyses were carried out at the RCE using a Thermo Scientific Niton XL3t GOLDD + energy-dispersive p- XRF analyser, equipped with a silicon drift detector. The Cu/Zn mining mode was used, with a measuring time of 110 s, using four sequential energy settings: light range (Mg to Cl) at 8 kV 200 µA, low range (K to Ti) at20 kV 100 µA, main range (V to Ag including L-lines for Pb) and high range (Cd-Ba) both at 50 kV, 40 µA. Since factory calibrations are a

Tabel 38.1. Voerendaal-Ten Hove. Chemical composition of the two stone axes according to the XRF-analysis.

Xrf-no. RCE		83	84	85	86	88
Find number		101-0-0/8727	101-0-0/8727	752-8/102-1-7	752-8/102-1-7	752-8/102-1-77
Location	Unit	ground face	ground side	ground face	lgth.wise fracture	lgth.wise fracture
SiO_2	%	68.000	67.000	69.000	63.000	67.000
CaO	%	0.502	0.621	0.420	3.200	3.050
P_2O_5	%	0.512	0.666	0.259	2.050	1.930
K_2O	%	1.280	1.020	0.945	0.644	0.676
Al_2O_3	%	15.000	15.000	15.000	17.000	14.000
TiO_2	%	0.465	0.342	0.305	0.274	0.264
Fe_2O_3	%	14.000	16.000	14.000	14.000	14.000
MnO	%	0.070	0.086	0.082	0.107	0.092
MgO	%	3.460	3.510	3.050	4.020	3.500
Zn	mg/kg	321	351	239	247	230
Cu	mg/kg	26	21	31	25	20
Ni	mg/kg	190	224	188	219	198
Co	mg/kg	114	118	110	109	109
Sn	mg/kg	33	40	21	29	31
Pb	mg/kg	22	27	21	20	14
Cr	mg/kg	86	63	63	88	84
Zr	mg/kg	83	61	71	58	57
Sr	mg/kg	66	69	80	221	201
Rb	mg/kg	39	27	23	18	16
Ba	mg/kg	388	375	401	226	280
Y	mg/kg	15	17	21	113	108
Th	mg/kg	5	5	7	7	6

and that of axe 2 c. 2.8 g/cm^3.[3250] These densities are higher than those of sandstone or schist but lower than those of ultrabasic rocks such as gabbro or diorite.[3251] The measurements at the break of axe 2 give an even higher CaO and Sr level and lower K_2O level than on the ground surface. CaO likely disappeared through weathering; it is present in plagioclase form in this kind of rock, weathering more easily than the iron and magnesium silicates (probably pyroxenes). The softer plagioclase may also have been removed from the iron-rich matrix while the axe was ground.

The material of both axes seems to be a dyke (such as tachylite). This conclusion is based on the fine-grained character, the absence of phenocrysts in combination with the high iron and 'raised' magnesium and calcium content, the low K_2O level and the absence of quartz. A rapid cooling of the rock prevented the development of phenocrysts and other crystals from the matrix. The presence of spherulites substantiates the identification as a gangue rock, cooled very rapidly after intrusion of a basic magma (quartz-undersaturated), preventing the development of phenocrysts.[3252] The composition of both axes suggests a similar geologic origin. The dark colour is probably caused by ferrous pyroxene crystals.

An important question is whether the axes were made of stones collected locally or whether they represent imported pieces. A definitive conclusion cannot be drawn because a good lithological frame of reference is missing, as well as studies on comparable axes from Zuid-Limburg and adjacent regions, with attention to possible provenances from regions far away. Nevertheless, it can be said that the raw material of the axes does not seem to be present in gravels deposited by the Meuse or in rocks in the Ardennes or Eifel.[3253] Basic intrusive rocks do occur in the Ardennes, but were subject to the Hercynian orogeny and mostly metamorphosed.[3254] The Eifel volcanism has a calk-alkaline character,[3255] and its rocks stand out by their relatively high K_2O levels. Comparable rocks are known, for instance, from the Alpine region and the Carpathians.[3256]

38.4 Dating

Ground stone axes presumably appeared in our parts during the first half of the fifth millennium BC or Early Neolithic B. As far as we know, these early axes were round or oval in section. Examples with a rectangular section, like the two axes found at Voerendaal-Ten Hove, seem to have been introduced in the Netherlands with the Michelsberg culture (from c. 4200 BC onwards; Middle Neolithic A). Axes of this kind were used for a long period.[3257] The youngest representatives can be attributed to the end of the Neolithic (Late Neolithic B).[3258] Stone axes and hammer axes in stone were sometimes reused in the Iron Age and Roman period.[3259] Although this cannot be ruled out for the finds at Ten Hove, there are no clear indications for it; even axe 2 from pit 752 probably ended up there by chance.

38.5 Function and meaning

The general idea is that ground stone axes were used first and foremost as implements for felling trees and for woodworking. This is not merely suggested by the analogy with historic and modern axes, but is also made plausible by the results of microscopic microwear analysis.[3260] Although neither axe from Voerendaal was investigated by that method, there are no reasons to assume an alternative function for them. The blunt edge of axe 1 is an indication of its use as a woodworking tool. As remarked in the previous section, there are no compelling reasons to assume that the axes were reused in a later period. Besides, there are indications of habitation or other activities at Voerendaal-Ten Hove during the Middle and/or Late Neolithic (Chapter 37).

potentially serious source of error when using HH XRF, the machine calibration was checked and adapted using a set of 14 powdered ISE standard soil samples (www.wepal.nl). Accuracy was tested using the BAMS005B glass standard.

3250 Density was measured using Archimedes law. The axes were weighted on a Sartorius PT 600 balance. After that, a degassed water filled beaker was placed on the balance and zeroed. The axe was carefully tied with an iron wire and placed carefully in the beaker so that it did not touch the sides or bottom. The weight, equivalent to the displaced volume, was noted. The density of the axes was calculated by dividing the weight of the axe by the displaced volume.

3251 Giustetto *et al.* 2017.

3252 *Encyclopædia Britannica* volume 25 (1911), lemma 'Spherulites'.

3253 Bosch 1992.

3254 Cobert *et al.* 2018.

3255 Schmincke 2007.

3256 Christensen *et al.* 2006; Giustetto *et al.* 2017; Bernardini *et al.* 2019.

3257 On the date of *Fels-Rechtbeile* Schut 1991, 24-25.

3258 There is a possibility that axes with a rectangular section were still being used in the early stages of the Bronze Age.

3259 E.g. Verhart 2016a; cf. section 37.5.1.

3260 Amongst others Wentink 2020, section 5.5.

39 Phosphate analysis

Henk Hiddink

39.1 Introduction

Soil mapping in the Dutch river area in the 1940s revealed that high phosphate concentrations – visible in clay as greenish-yellow stains – were one of the indicators of ancient settlements, besides artefacts and dispersed charcoal.
From the late 1970s onwards the ROB used determinations of soil phosphate levels on a large scale to search for Roman-period settlements in the Kromme Rijn area.[3261]
Also inspired by research outside the Netherlands, phosphate levels were investigated at Kootwijk as early as 1971/72 to determine the length of the period in which the arable was tilled and the presence or absence of stalls within houses.[3262] Similar research was conducted at the micro level of individual house plans, for instance, in Oss-Ussen between 1976 and 1986,[3263] at Wijk-bij-Duurstede-De Horden in the same period [3264] and at Oosterhout in 1984-85.[3265]

The results of these and other studies showed that the mapping of phosphate was not without problems and that at least a large number of samples were needed, combined with reference sections including the topsoil and subsoil of the location. The sampling at Voerendaal does not meet the former precondition, nor, for most locations, the latter. Because of the methodological flaws, the results are not relevant, to put it bluntly. The results are nevertheless discussed here because it was claimed that two outbuildings were used as stalls on the basis of the phosphate analysis and to answer for spending the taxpayers' money.

39.2 General results

During the three years of the excavations, 73 phosphate samples were taken from various locations (Table *39.1; Fig. 39.1).[3266] The samples were analysed in 1988 by RAAP.[3267] It is not clear what exactly was measured, but it was probably the total of both inorganic and organic phosphate. The phosphate level ranged from 102 to 1923 ppm, with an average of 908 and a standard deviation of 408.

In some 16 samples from 'clean' loess in the subsoil at various locations, the level ranged from 297 to 1250 ppm, with an average of 604 and a standard deviation of 236. The levels that supposedly indicate the presence of a stall are in the range of 1102-1923 ppm (average 1523).
We will return to these values later. For now, it is important to say that high phosphate levels could indeed relate to animal dung and urine, but also to vegetable matter, bones, meat and modern artificial (inorganic) fertilizer. The latter component is probably of no importance here because the levels of the subsoil under an arable layer of average thickness are relatively low (see above). The same holds true for three samples in the colluvium near the Steinweg (398-610 ppm). However, the idea that not only animal excrements contribute to phosphate levels is relevant.[3268]

39.3 Phosphate levels in and around several structures

Twelve samples were taken inside building 410, and another eight north of it. Although methodologically unsound, the samples of each group were combined. The levels in both groups are very low (Table *39.1). Only one sample was analysed from the northern hallway of building 405, also resulting in quite low phosphate levels. The soil 'inside' – in reality, from beneath – and around the *horreum* was sampled nine times. Phosphate levels ranged from 381 to 1250 ppm, with the latter value the only and – inexplicably – high value (average 620 ppm).

In trench 13, samples were taken from the subsoil under granary 249 and sunken hut 508, showing a low phosphate level. The fill of hearth 633 in trench 7 showed a high level, however, with 1442 ppm. The 'sampling strategy' for building 401, one of the structures that was supposedly a stable at some time, is remarkable. Only one sample was taken from a high level (1), which contained little phosphate. The presence of visually observed phosphate is noted on the field drawings of level 4 only, in the south-eastern part of the building (layer 20.173-174).

The infill of structure 757, a large cellar-like pit in trench 108 near the Steinweg, was sampled at three levels. The phosphate levels were very high (1538-1923 ppm), also in comparison with

3261 Van der Voort *et al.* 1979; Steenbeek 1994.
3262 Kamermans 1987; on the years of the investigation, see Heidinga 1987, 12.
3263 Van de Wetering & Wansleeben 1987; the research concerns Haps house 100 (Schinkel 1998, fig. 220) and Alphen-Ekeren/Oss 8C house 118 (Wesselingh 2000, fig. 107).
3264 Steenbeek 1983; 1994, fig. 100.
3265 JROB 1985, 32-33; for the excavation results, see Verwers & Kooistra 1990.
3266 Four samples from the wall of trench 22 were not analysed.
3267 Letter 88-246 of 26-09-1988 from Ronald Wiemer. It stated (correctly) that: 'On the basis of the low number of samples it is difficult to say anything about the significance of the results. The phosphate levels in the soil can fluctuate considerably from place to place, and therefore a single sample is not representative of a whole level.'
3268 Two thin layers in the subsoil against the north wall of the *horreum* are also described as 'phosphate-rich'. In theory, animals could have been kept here, but another source is more likely.

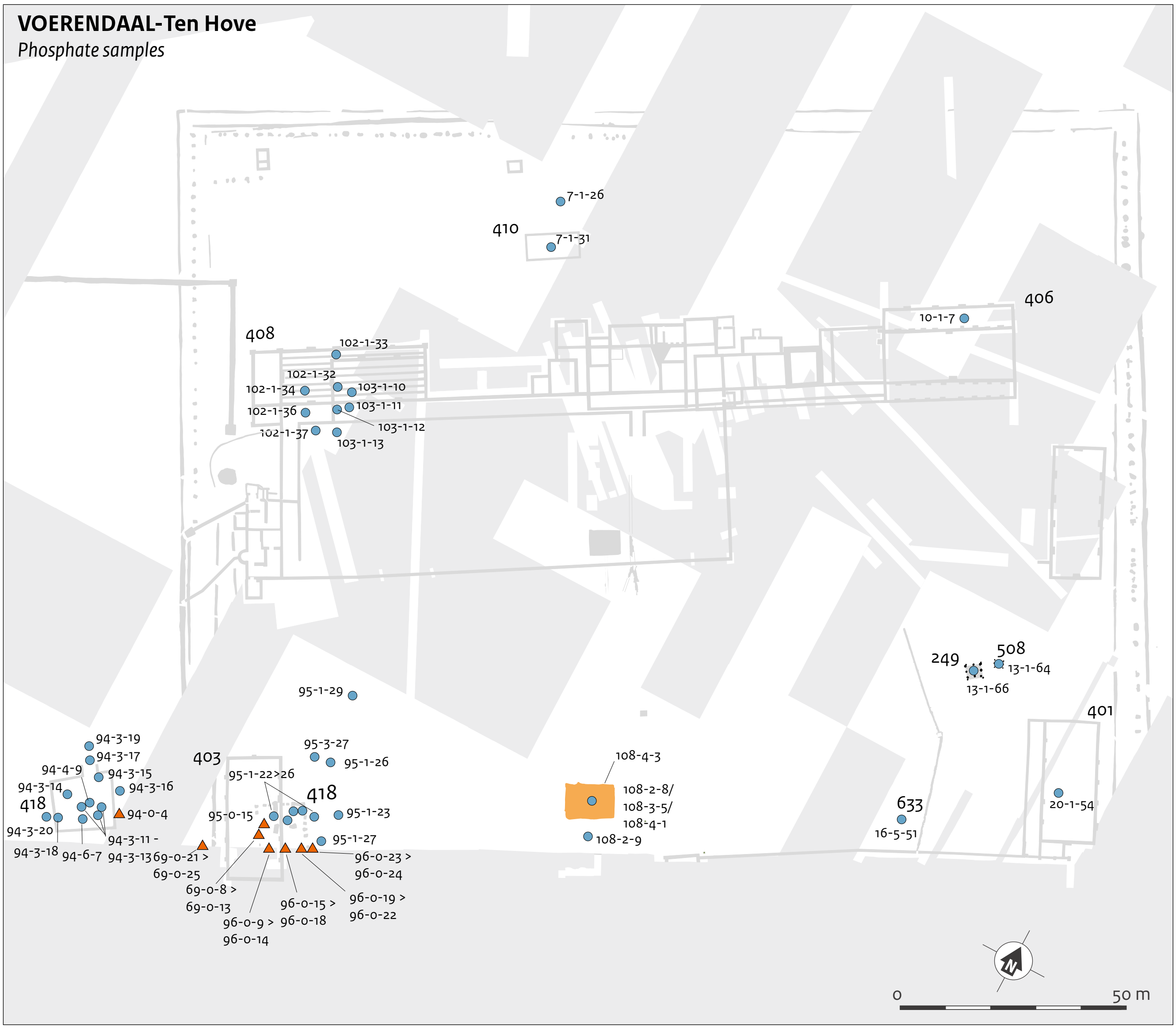


Fig. 39.1 Voerendaal-Ten Hove. Location of the phosphate samples.
Circles: samples from layers or subsoil in trenches; triangles: samples from layers in trench wall sections.

reference samples from the subsoil next to and beneath the feature (433-720 ppm). The infill was probably not 'enriched' with phosphate during the period in which the feature was used. It is likely that the soil was collected in the vicinity when the feature was backfilled. The phosphate present could result from different sources, accumulated during the Roman period and possibly even the Middle Ages.

The same probably holds true for the soil in horse pond 413 in trench 94. When in use, this feature must have been cleaned from time to time and was filled with water, not with soil. Only one sample was taken from the soil between the stone pavement at the bottom. It showed a phosphate content of 746 ppm, comparable to two samples from the subsoil around the pond (731-769 ppm). Only in one sample did the soil outside it contain more: 1154 ppm. The fill of the structure was sampled at various levels and locations, with the samples showing various phosphate levels. These ranged from (very) low, with values between 102 (lowest of all samples) and 769 ppm (average of five samples 584 ppm), to high with levels between 1250 and 1823 ppm (average of three 1473 ppm). The soil of the infill stems both from locations with quite clean soil and soil enriched by phosphate-producing activities.

39.4 Was building 418 used as a stall?

That building 418 had possibly been a stall was inferred during the excavation from phosphate stains in the soil at excavation level 4 of trench 95 (layers 159-160). Later, the visual observations seemed to be confirmed by the results of the analysis.[3269] A number of samples were taken from level 1 in trench 95, but these show 'normal', lower levels of phosphate. A single sample from level 3 contained 1102 ppm, but most relevant for the interpretation are a number of samples from the walls of trenches 69 and 96 (Fig. 39.2). In the latter trench, samples from the (light) grey subsoil just outside (no. 23) and inside building 418 (no. 20-22, 15-17) show high phosphate levels: 1186-1923 ppm (average 1767 ppm).

The question, however, should be: are we really measuring high phosphate contents associated with building 418? The light grey soil around excavation level 4 was indeed situated just below the floor of the building, as the postholes are dug into it. Somewhat further to the east, however, the floor level of building 403 is situated slightly higher. It can be identified by chalk rubble and a dark band at the level where the foundation changes into the wall proper (marked by a layer of mortar on top of the irregular stones). The floor of 418 must have been at the same level, but is no longer present and was replaced by the dirty dark layer present everywhere outside and over building 403. The phosphate content in this layer is sometimes quite low, but is high in some samples. They include 96-0-19 (and 69-0-12, 69-0-22), just above the samples mentioned earlier. Therefore, it seems possible that the high phosphate levels below building 418 are mostly or partly the result of illuviation from the dark layer, which was still in formation after building 418 was demolished.[3270]

Another argument that contradicts the stall function is provided by sample 96-0-13. This sample was also taken from the grey layer inside building 418. It should therefore show a high phosphate level, but it does not. The fact that the layer was protected against illuviation, by the roof and walls of the later building 403 and the grey raised layer inside, suggests again that the high values in the other samples are

[3269] Cf. Willems & Kooistra 1988, 140; Kooistra 1996, 131.

[3270] Sherds of 'almost stone ware' (*bijna sttengoed*; s4) and (early? Langerwehe) stoneware (s2) were found in this layer, suggesting that it was partly formed or ploughed at the beginning of the Late Middle Ages.

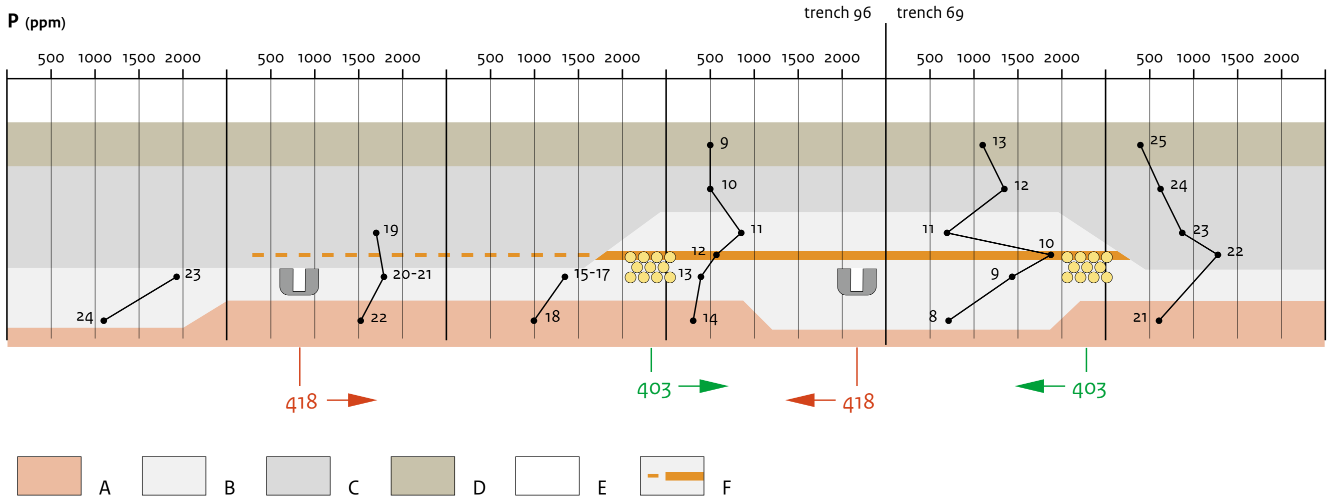


Fig. 39.2 Voerendaal-Ten Hove. Schematic trench wall section of trench 69 and 96 (looking south), with the schematized features of building 403 and 418, as well as the phosphate level of the different samples through the soil column.
A subsoil (loess); B light grey soil; C dark grey dirty soil; D older arable layer in colluvium; E modern arable layer; F rubble layer or approx. ground level.

caused (partly) by activities other than the stalling of animals in building 418.

A final argument is that the number of samples with high phosphate levels is too low and is concentrated spatially, in one thin line along the trench wall. Significant patterns could perhaps have been observed only if many samples were taken in a grid, extending to the north over both buildings 403 and 418.

39.5 Conclusion

The varying levels of phosphate in the samples suggest that this kind of analysis had a certain potential at Ten Hove. However, the sampling should have been far more extensive, with systematic sampling in a grid – both inside and outside/far outside the buildings – and at various levels, from the 'virgin' subsoil through archaeological layers and the complete colluvium/arable. Although relevant data could have been collected on the possible function of some buildings, their interpretation would still have been complicated, certainly at a multi-period site like Voerendaal. Take for example the area inside and in the immediate vicinity of building 401. If this would have showed high phosphate levels, these could be the result of a byre-function of the preceding post-built structure 254, the primary use of 401 in the Middle Roman period (although we know it had other functions during this time), and/or a secondary use of 401 in the Late Roman period and Early Middle Ages. It would be impossible to decide which explanation(s) is or are correct. Other interpretation problems would have been caused by the different conditions at the lower (buildings 401, 403) and higher (402, 405, 408) parts of the site. A complete succession of layers is present at the former parts, while the post-Roman, strongly manured arable often rests directly on the subsoil at the latter. Nevertheless, a more thorough phosphate analysis would have been desirable.

This report presents the results of the excavations at Voerendaal-Ten Hove, especially those conducted three decades ago by the State Service for Archaeological Investigations (ROB). A full publication of the Roman villa was long overdue because it represents only one of three Dutch examples investigated in its entirety. Moreover, the site is relevant for its Late Iron Age enclosure, post-built structures preceding the large villa and settlement remains and burials of the Late Roman and Merovingian period.

In this third part of the publication, the results are presented of the work by specialists on coins, metal finds, pottery, glass, building ceramics, painted wall-plaster, stone, iron slag, flint and data on the agricultural system.

This scientific report is intended for archaeologists, as well as for other professionals and amateur enthusiasts involved in archaeology.

The Cultural Heritage Agency of the Netherlands provides knowledge and advice to give the future a past.