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Inhalt

Vorwort des Herausgebers

Innerhalb weniger Wochen sind im Herbst 2015 Dr. Gundolf Precht und Dr. Hans-Joachim Schalles verstorben. Gundolf Precht hat als ehemaliger Dienststellenleiter mehr als 25 Jahre lang Aufbau und Entwicklung des Archäologischen Parks Xanten maßgeblich geprägt. Hans-Joachim Schalles war für den Archäologischen Park Xanten als langjähriger Leiter des Regionalmuseums Xanten und des LVR-RömerMuseums in besonderem Maße für die museale Präsentation verantwortlich. Beide haben im LVR-Archäologischen Park Xanten / LVR-RömerMuseum bleibende Spuren hinterlassen.

Der vorliegende Sammelband hätte dem Bauforscher ebenso wie dem Archäologen sicherlich gefallen, bietet er doch ein breites Spektrum Xantener Themen.

Hans-Joachim Schalles selbst hat noch einen ausführlichen Beitrag zu einem ganz besonderen Fingerring beigesteuert.

Die wissenschaftliche Bearbeitung der Gemmen aus Xanten lag Hans-Joachim Schalles stets besonders am Herzen. Dr. Gertrud Platz-Horster hat Xanten als einen herausragenden Fundplatz antiker Gemmen in der Forschung bekannt gemacht. Es ist uns eine besondere Freude, dass sie sich nunmehr mit Teil IV wiederum der Vorlage der Xantener Gemmen widmet.

Besonders hervorzuheben ist auch der Beitrag von Dr. Dr. Günter E. Thüry, der mit detektivischem Spürsinn einen längst verloren geglaubten Fund wieder ‚entdeckt' und für die Forschung erschlossen hat.

Technikgeschichtlich von großem Interesse ist der Beitrag von Dr. Daniela König über die Gussformen aus der Colonia Ulpia Traiana, der sich einer in Xanten bisher wenig beachteten Fundgruppe widmet. Auch die Wetzsteine, die Holzgefäße und die Lavezgefäße zählen nicht zu den bisher in der Xantener Forschung bevorzugten Fundgruppen. Es ist umso erfreulicher, dass hier grundlegende Beiträge dazu vorgelegt werden können.

Allen Autorinnen und Autoren sei für ihre Mitwirkung an diesem Band und für die gute Zusammenarbeit während seiner Entstehung ganz herzlich gedankt.

Die Redaktion lag bei Ingo Martell M. A. und Dr. Hans-Joachim Schalles (†), der noch vom Krankenbett aus an der Fertigstelllung dieses Bandes mitwirkte. Nach seinem Tod wurde die Redaktion von Priv.-Doz. Dr. Werner Oenbrink übernommen.

Dr. Joachim von Freeden (Frankfurt am Main) übernahm Satz und Layout.

Allen, die am Entstehen dieses Xantener Berichtes beteiligt waren, möchten wir unseren herzlichen Dank aussprechen.

Dr. Martin Müller
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BARBARA BORGERS, ROOS WIJNEN-JACKSON and MARTIJN BINK

The Roman Pottery Kiln at Halder, North-Brabant (the Netherlands), revisited

Introduction

The Roman site at Halder was explored by archaeological work around fifty years ago; this revealed a Roman pottery kiln, several wells and clay pits. This work began when a hoard of late Roman coins was found near the Essche River southwest of Halder, and when building activities in the modern village at Halder revealed a large number of sherds. During the 1960s, several Roman wells and two clay pits were discovered. During the 1970s, Friar Celestinus Vencken from the 'Instituut voor Doven' (now Kentalis) discovered a Roman pottery kiln, which contained numerous pottery wasters and clay pieces. Further excavation and examination of the finds was carried out under the supervision of archaeologists at the Rijksdienst voor het Oudheidkundig Bodemonderzoek (ROB).

Willem Willems examined the kiln and associated finds in detail, and published his results[1]. Having developed a typo-chronology of the pottery wasters, he found that the kiln was in operation during the Flavian period, i. e. between 65 and 80 AD. Taking all the evidence for pottery production at the site into account, Willems believed that one of the clay pits comprised the raw materials used for potting activities. As a result, he concluded that the excavations represented only a small part of what would have been a fairly extensive pottery industry.

Following on from this, the authors of this article re-examined the pottery assemblage, which is currently stored at the Oudheidkundig Museum Sint-Michielsgestel. Using a detailed compositional approach to ceramics, which combines thin section petrography and geochemistry, it is suggested that three more types of vessels can be assigned to Willems' typo-chronological study. In addition, it was found that the clay from the clay pit did not match the clay used for Roman potting activities.

The structure of the paper is as follows: first is the description of the site, followed by the kiln structure and the method used. The main part is dedicated to the characterisation of the pottery produced at the site of Halder and the revision of the typo-morphological study. The last part focuses on the discussion of the review and the interpretation of the data.

The Site

Halder is situated in the province of North-Brabant, the Netherlands, and located at the confluence of the Dommel and Essche Rivers. Both rivers were important transportation routes during the Roman era[2]. The site may have been located at an important junction of waterways and roads, since it is thought that there was a direct route from the *castella* of Rossum (Grinnes) and Vechten (Fectione) in the north, to Tongres, the capital of the *civitas Tungrorum*, in the south[3].

Since the discovery of the Roman kiln, wells and clay pits, the site has received little attention, in spite of its potential (Fig. 1)[4]. Therefore the pottery from these contexts is the main source for the reconstruc-

[1] Willems 1977.

[2] The banks of the Dommel River were densely populated in the Roman era (Kortlang 1987), and the Essche River was navigable as far as Oisterwijk (De Hingh 2010, 31–32).

[3] Mennen 2003.

[4] Bink 2012; Niemeijer 2012.

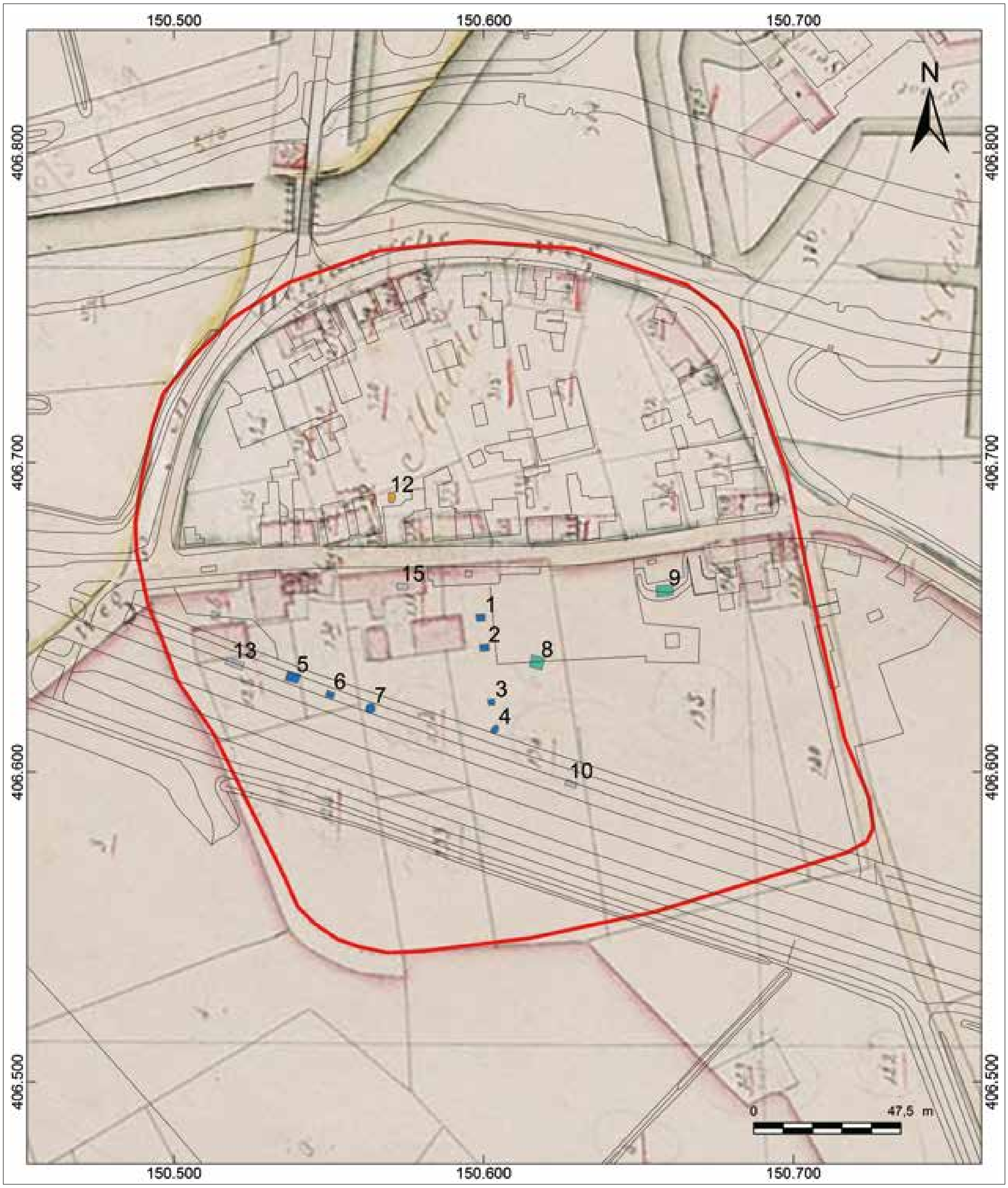


Fig. 1 Halder, North-Brabant. Probable extent of the vicus and the excavated remains.
1–7 wells; 8, 9 clay pits; 10, 13 refuse pits; 12 Roman pottery kiln; probable extent of the vicus.

tion of activities at the site during the Roman era[5]. The spectrum of the pottery wares and their dating point to the presence of a Roman settlement between the Flavian period and the first half of the third century AD[6].

The Kiln

Publication of details by Willems[7] included considerable focus on the pottery kiln, and as a consequence, it has been possible to reconstruct the nature of the kiln. It is visible on the original site plans, and it also appears in numerous photos in Willems' publication (Fig. 2). The site plans and photos show that the kiln had been rebuilt once. The kiln was a single-chambered sunken kiln cut into the natural soil. It was round in shape, its width measuring 1.20 m. The stoke-hole was oriented in northern direction. The total length of the kiln, including the flue, measured 2.6 m. The walls and floor of the kiln-chamber were clay-lined, and the westernmost wall comprised broken sherds bonded with clay. Remains of supports for a raised oven-floor included six lateral wedge-shaped piers and a central tongue, which extended into the kiln-chamber from the back. Remains of the superstructure, or dome, survived in the form of numerous fragments of burnt clay; remains of the oven-plate did not survive, however.

Willems inferred from this that the kiln would have had a removable oven-floor, consisting of plates [8]. However, there is no evidence to support this hypothesis, and it should be noted that most Roman pottery kilns are found without their oven-floors intact, suggesting that they were destroyed in ancient times. Moreover, other such kilns with wedge-shaped piers in the region appear to have had solid raised oven-floors, consisting of a clay platform perforated with vent-holes[9].

Fig. 2 Halder, North-Brabant. The Roman pottery kiln was a vertical up-draught kiln, and the associated waster vessels were dated to the Flavian period.

Method

The authors selected a total of 24 diagnostic pottery wasters, two clay samples and one clay piece for detailed compositional analysis. Small sub-samples of the chosen artefacts were taken, using a pair of carpenter's pliers, and all information on their form was recorded (Table 1). All 27 samples were prepared as

[5] The pottery from the wells, clay pits and kiln has been inserted in a database, and can be consulted on the website of the Museum at Sint-Michielsgestel (<www.romeinshalder.nl>; Niemeijer 2004; Niemeijer 2012).

[6] For more details on the different wares of pottery see Niemeijer 2012.

[7] Willems 1977.

[8] Therefore Friar Celestinus Vencken reconstructed a kiln with a removable oven-floor, consisting of six wedge-shaped plates with vent-holes. This reconstruction can be seen at the museum of Sint-Michielsgestel, or viewed on the website (<www. romeinshalder. nl>).

[9] Examples of Roman pottery kilns with wedge-shaped piers and a permanent raised oven-floor have been found at the sites of Rumst (Borgers 2014a) and Cologne (Carroll 2004).

Sample	Na_2O (%)	MgO (%)	Al_2O_3 (%)	SiO_2 (%)	P (PPM)	K2O (%)	CaO (%)	TiO2 (%)	V (PPM)	Cr (PPM)	Mn (PPM)	Fe_2O_3 (%)	Co (PPM)	Ni (PPM)
Halder_01	0,55	0,73	13,53	71,99	7747	1,77	1,10	0,95	98	111	136	3,85	7	40
Halder_03	0,68	1,32	15,58	68,07	3947	2,64	1,18	0,82	110	122	542	6,36	17	66
Halder_04	0,41	0,81	14,45	74,10	388	1,83	0,42	0,97	105	116	122	3,98	9	36
Halder_08	0,39	0,70	14,19	74,41	3474	1,80	0,65	0,97	102	112	109	3,85	9	34
Halder_09	0,66	1,53	16,20	69,45	1483	2,74	1,19	0,81	124	151	837	6,79	21	134
Halder_10	0,55	0,60	12,39	73,23	9668	1,67	1,19	0,91	94	105	103	3,54	7	32
Halder_14	0,59	0,59	12,95	76,61	3125	1,70	0,74	0,94	84	110	102	2,92	8	27
Halder_15	0,41	0,87	15,19	67,52	10948	1,90	1,11	0,97	120	119	268	4,46	12	47
Halder_18	0,46	0,79	15,39	69,39	6096	1,93	1,02	0,99	115	125	139	4,45	9	43
Halder_19	0,51	1,38	15,63	71,21	1587	2,91	0,40	1,01	164	140	127	5,75	16	46
Halder_20	0,58	0,70	9,00	46,53	5626	1,21	2,07	0,45	51	114	491	3,12	16	47
Halder_21	0,53	0,71	9,31	46,35	5279	1,16	2,36	0,43	53	68	297	3,02	12	28
Halder_22	0,42	0,70	12,98	69,90	13055	1,83	1,42	0,89	102	106	274	3,70	9	33
Halder_23	0,52	0,85	15,28	68,86	6227	1,89	1,03	0,98	116	122	93	4,36	10	40
Halder_25	0,50	0,85	20,37	65,18	4585	2,65	0,89	1,12	119	133	197	3,01	42	102
Halder_26	0,78	1,64	17,09	67,12	1140	2,94	1,36	0,85	138	134	736	7,00	20	68
Halder_27	0,37	0,76	14,09	76,17	1104	1,83	0,51	0,97	107	118	141	3,82	8	29

Table 2 (left part) Halder, North-Brabant. Analytical data of 17 ceramic and geological samples.

Table 1 Halder, North-Brabant. 27 ceramic and geological samples.

Nr.	Provenance	Typology	Fabric	Chemistry
1	Halder	Gallo-Belgic bowl (Willems 1977, 1; Deru 1996, B22; Holwerda 1941, 55c)	Fabric 1	Group 1
2	Halder	Gallo-Belgic bowl (Willems 1977, 1; Deru 1996, B22; Holwerda 1941, 55c)	Fabric 1	–
3	Halder	Gallo-Belgic bowl (Willems 1977, 2)	Fabric 3	Group 2
4	Halder	Gallo-Belgic beaker (Willems 1977, 3a, 3b; Deru 1996, P11; Holwerda 1941, 31)	Fabric 1	Group 1
5	Halder	Gallo-Belgic beaker (Willems 1977, 3a, 3b; Deru 1996, P11; Holwerda 1941, 31)	Fabric 1	–
6	Halder	Gallo-Belgic beaker (Willems 1977, 3a, 3b; Deru 1996, P11; Holwerda 1941, 31)	Fabric 1	–
7	Halder	Dolium (Willems 1977, 6; Stuart 1977, 147)	Fabric 1	–
8	Halder	Dolium (Willems 1977, 6; Stuart 1977, 147)	Fabric 1	Group 1
9	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 3	Group 2
10	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 1	Group 1
11	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 3	–
12	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 2	–
13	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 1	–
14	Halder	Cork-urn (Willems 1977, 4a; Holwerda 1941, 94)	Fabric 1	Group 1
15	Halder	Bowl (Willems 1977, 9)	Fabric 2	Group 1
16	Halder	Cork-urn (Willems 1977, 4a; Holwerda 1941, 94)	Fabric 2	–
17	Halder	Cork-urn (Willems 1977, 4a; Holwerda 1941, 94)	Fabric 2	–
18	Halder	Bowl (Willems 1977, 9)	Fabric 2	Group 1
19	Halder	Bowl/plate (Holwerda 1941, 81)	Fabric 3	Group 2
20	Halder	Clay fragment from clay pit 2	X	X
21	Halder	Clay fragment from clay pit 2	X	X
22	Halder	Clay Piece	X	X
23	Halder	Dolium (Willems 1977, 6; Stuart 1977, 147)	Fabric 1	Group 1
24	Halder	Dolium (Gose 1950, 357–358)	Fabric 4	–
25	Halder	Dolium with graffito (Gose 1950, 357–358)	Fabric 4	Group 3
26	Halder	Gallo-Belgic beaker (Deru 1996, P46/49; Holwerda 1941, 27c	Fabric 3	Group 2
27	Halder	Jar (Willems 1977, 7; Stuart 1977, 201a)	Fabric 1	Group 1

Cu (PPM)	Zn (PPM)	Rb (PPM)	Sr (PPM)	Y (PPM)	Zr (PPM)	Ba (PPM)	La (PPM)	Ce (PPM)	Nd (PPM)	Pb (PPM)	Th (PPM)	LOI (%)	Sum (%)
19	91	114	134	33	431	613	34	72	30	28	16	3,97	99,42
23	177	139	125	42	282	581	42	91	45	37	15	2,71	100,00
8	52	116	67	31	419	352	33	74	29	31	16	0,71	97,89
21	62	110	93	33	434	426	37	70	35	30	15	2,03	99,52
26	174	143	98	40	257	548	49	85	49	33	13	0,44	100,23
19	103	95	117	33	469	508	37	60	31	24	10	3,87	99,11
18	66	92	70	30	509	328	31	69	31	21	13	2,16	99,67
25	114	125	156	30	311	497	38	86	37	37	16	4,68	98,41
25	72	126	105	31	311	524	31	70	34	21	13	4,08	99,29
40	106	125	93	35	273	416	35	75	33	28	11	0,84	99,97
96	257	95	176	16	148	525	22	47	19	39	9	35,28	99,72
104	291	95	170	15	116	525	20	42	17	38	8	34,30	98,88
29	154	122	175	29	404	429	34	75	35	39	13	5,14	98,49
21	66	127	97	29	314	508	32	86	34	29	15	4,65	99,20
19	94	150	149	26	182	442	44	84	39	39	14	3,65	98,88
21	183	152	109	41	253	545	44	95	46	46	19	0,64	99,80
12	60	115	75	32	465	356	37	84	39	29	15	0,78	99,59

Table 2 (right part) Halder, North-Brabant. Analytical data of 17 ceramic and geological samples.

standard 30 µm thin sections, and analysed chemically by WD-XRF at the Fitch Laboratory of the British School at Athens. The underlying objective of this integrated compositional approach is to reconstruct aspects of pottery technology, comprising the preparation of raw materials (clay and temper), forming and firing[10].

The petrographic analysis was conducted with a polarising microscope. The ceramic thin sections were grouped in fabrics based upon the nature of their inclusions, clay matrix and voids[11]. Attention was focused on the presence of specific technological practices, such as the deliberate addition of sand and grog inclusions[12].

Geochemical analysis offers an independent means of investigating compositional variability within the ceramic assemblage, and it generates complementary information to that obtained through petrographic analysis[13]. Geochemical compositional variability was assessed for a smaller set of samples, comprising 14 ceramic samples, two clay samples and one clay piece, for a total of 17. Eleven elements were chosen for analysis, comprising aluminium (Al_2O_3), barium (Ba), calcium (CaO), iron (Fe_2O_3), potassium (K_2O), magnesium (MgO), sodium (Na_2O), silica (SiO_2), strontium (Sr), titanium (TiO_2) and zirconium (Zr). The logarithmic transformed elemental dataset was evaluated, using bivariate plots and principal component analysis[14].

Results

The results section comprises the fabric analysis according to the evidence seen in thin section petrography and geochemistry, followed by the revision of the typo-morphology of the local pottery at the site of Halder.

Petrography of Ceramic Samples

A total of 24 ceramic samples from the site at Halder were divided into four petrographic groups (Table 1). It appears that a fine micaceous clay was used

10 Borgers 2014a; Borgers 2015.
11 Quinn 2013, 73–79.
12 Cuomo di Caprio / Vaughan 1993.
13 Orton / Hughes 2013, 168–182.
14 Glascock et al. 2004.

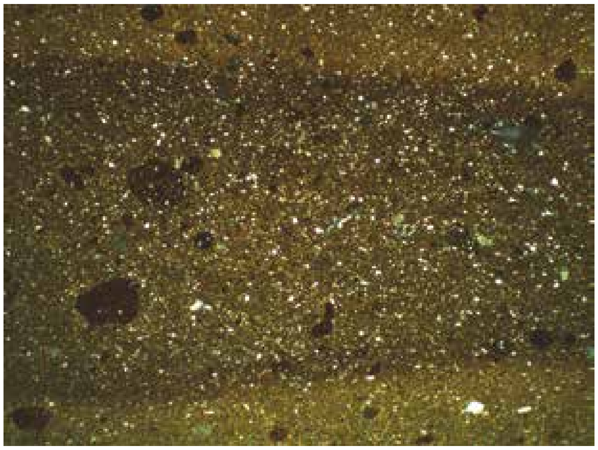


Fig. 3 Halder, North-Brabant. Micrograph of the 'Fine Micaceous' Fabric, used for the manufacture of tableware. Image taken in cross polarized light. Image width = 5.8 mm.

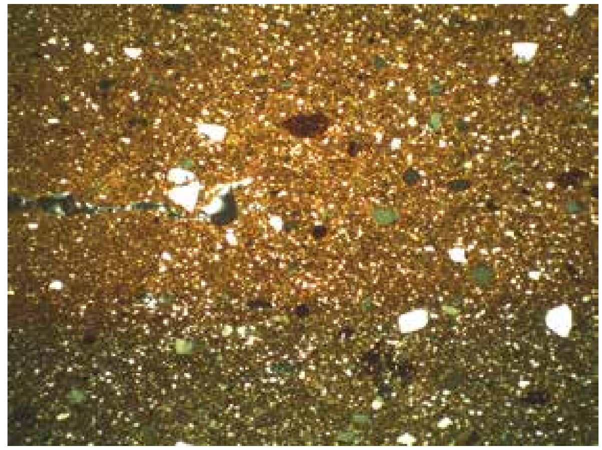


Fig. 4 Halder, North-Brabant. Micrograph of the 'Coarse Quartz' tempered variant of the 'Fine Micaceous' Fabric, used for the manufacture of coarse ware. Image taken in cross polarized light. Image width = 5.8 mm.

for pottery production at the site. This fine, red firing clay was used for the manufacture of tableware and coarse ware. However, some coarse ware vessels appear to be tempered with quartz sand or organic material, whereas large storage vessels *(dolia)* were tempered with grog. A summary of the fabrics is given below, and the detailed fabric descriptions can be found elsewhere[15].

Fabric 1: 'Fine Micaceous'

Halder 2014/1, 2, 4–8, 10, 13, 14, 25, 29

The samples of Fabric Group 1 are characterised by a red matrix with fine mica and quartz (0.5 mm). Occasionally, rounded quartz inclusions, alkaline feldspar, chalcedony and opaque inclusions can be identified among the coarse inclusions (1.5 mm). Textural elements result in a heterogeneous matrix: pyrite, iron-rich concretions and streaks, which may form a cap around inclusions. These textural elements can be associated with humid soils, and they are naturally present in the clay[16]. Both the coarse and fine fraction of inclusions are orientated parallel to the rim of the thin sections, indicating that the vessels were wheel thrown. The colour of the matrix varies from light reddish to red and grey, indicating that the vessels were fired in respectively oxidising and reducing atmosphere. Some vessels were fired at a low temperature, whereas others at a high temperature, confirming that the vessels were exposed to different firing temperatures (Fig. 3).

Fabric 2: 'Micaceous with Coarse Quartz'

Halder 2014/12, 15–18

Fabric Group 2 is characterised by coarse rounded mono-crystalline quartz inclusions and alkaline feldspar (< 2–1.5 mm) in a red matrix with fine mica, quartz and opaque inclusions. Occasionally, opaque inclusions occur in variable size (< 1.5 mm) and shape (concentric nodules, pyrite or iron-rich captions around minerals and voids). The coarse inclusions comprise 20 to 25 % of the matrix, suggesting that they may have been added deliberately. The colour of the matrix varies from light to deep red, as the result of an oxidising firing atmosphere, and grey, as the result of a reducing atmosphere. The coarse inclusions and voids are fine and channel-shaped, and orientated parallel to the rim of the thin sections, indicating that the vessels were wheel thrown (Fig. 4).

15 Borgers 2014b.

16 Bullock et al. 1985.

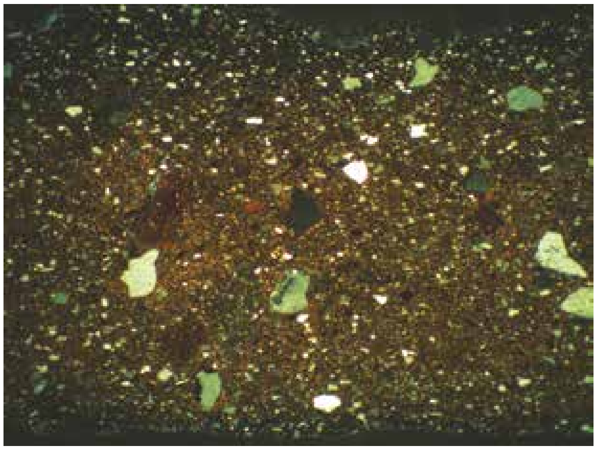


Fig. 5 Halder, North-Brabant. Micrograph of the 'Coarse Organic Material and Quartz' tempered variant, used for the manufacture of coarse ware. Organic material can be identified at the centre and centre left of the image. Image taken in cross polarized light. Image width = 5.8 mm.

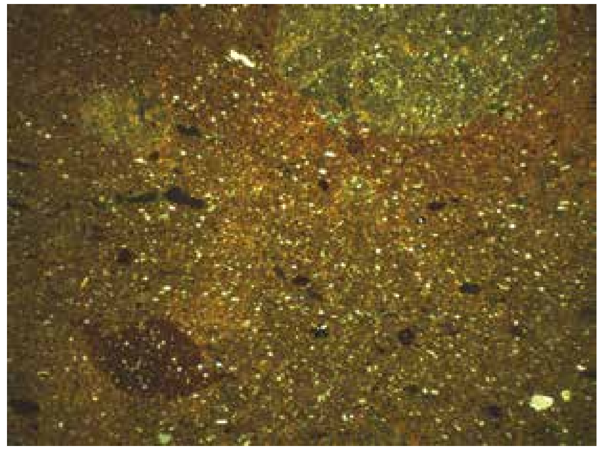


Fig. 6 Micrograph of the clay fragment, found in a clay pit near the Roman pottery kiln. Image taken in cross polarized light. Image width = 5.8 mm.

Fabric 3: 'Grey Micaceous with Coarse Organic Material and Quartz'

Halder 2014/3, 9, 11, 19
The samples of Fabric Group 3 are characterised by coarse organic material and quartz inclusions in a grey matrix with fine mica and quartz inclusions. The organic material has been burnt out in most samples, resulting in characteristic voids with a blackened iron-rich rim. This evidence suggests that the vessels were over-fired. Another indication for this is the deep grey and inactive clay matrix. The presence of the organic material, and their prints, has resulted in a heterogeneous matrix, making a comparison with the other fabrics in this assemblage difficult. Hence, it cannot be said with certainty whether the clay used for Fabric 3 is similar to Fabric 1 and 2 (Fig. 5).

Fabric 4: 'Grey Fabric with Grog'

Halder 2014/26, 27
Fabric 4 is characterised by coarse angular grog inclusions (< 2.5–1 mm) in a matrix with fine mica and quartz inclusions. The matrix is deep grey in colour and inactive, suggesting that the vessels were overfired. In addition, small organic material has been deposited on the interior of the numerous voids. This makes it difficult to confidently compare Fabric 4 to the other fabrics in this ceramic assemblage. Nevertheless, the composition of the clay – i. e. fine mica and quartz inclusions – suggests that the clay is similar to the one identified in Fabrics 1, 2 and 3.

Petrography of Clay Piece and Clay Fragments

The evidence seen in thin section suggests that the fine, micaceous clay was not only used for the manufacture of fine tableware, but also for the clay piece, used to stack the pottery in the kiln. By contrast, the clay fragments do not appear to have been the raw materials used for Roman potting activities.

Fabric: Grey Clay Piece

Halder 2014/22
The clay piece is characterised by a grey matrix with fine mica and quartz inclusions. Hence, its composition would appear to be similar to Fabric 1 with the difference that it contains some organic material as well. If this organic material was added deliberately, the fabric of the clay piece is similar to Fabric 3.

Fabric: Clay Fragments

Halder 2014/20, 21
Both clay fragments are characterised by a homogeneous matrix, which is rich in fine quartz and some

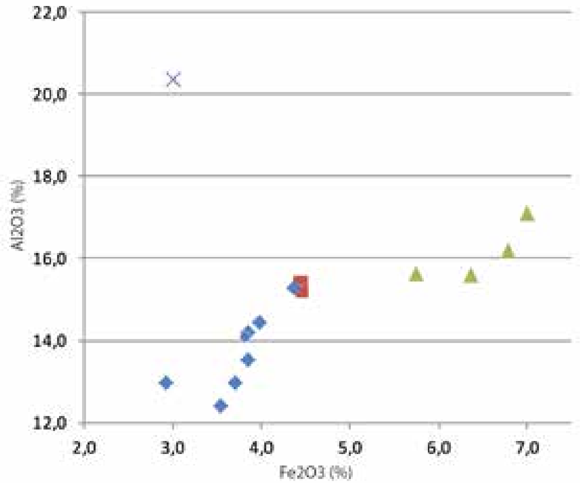


Fig. 7 Halder, North-Brabant. Bivariate plot of aluminium (Al_2O_3) and iron (Fe_2O_3) shows that the ceramic samples of Fabrics 1 and 2 are located in the lower centre of the figure and are compositionally similar. By contrast, Fabric 3 is located to the right of the figure, and characterised by a comparatively high value of iron, and Fabric 4 at the top of the figure contains the highest value of aluminium in this ceramic assemblage. – ◆ Fabric 1, ■ Fabric 2, ▲ Fabric 3, × Fabric 4.

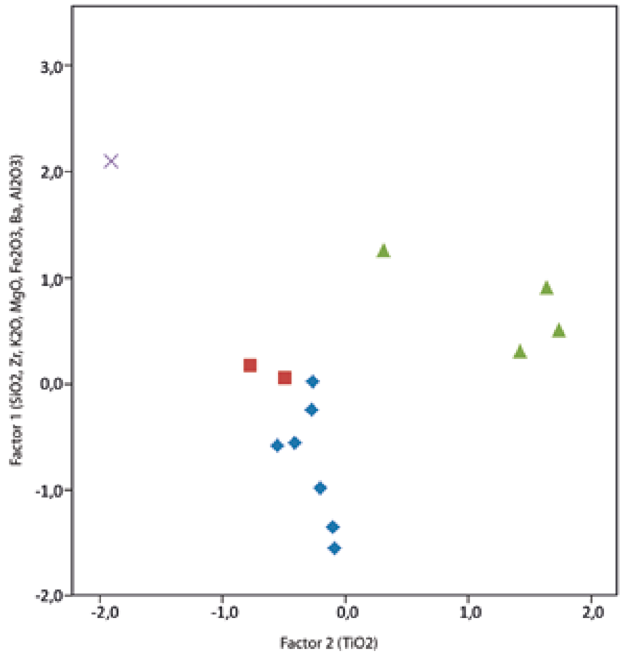


Fig. 8 Halder, North-Brabant. Principal Component Analysis of eleven elements, including Al_2O_3, Ba, CaO, Fe_2O_3, K_2O, MgO, Na_2O, SiO_2, Sr, TiO_2 and Zr, shows three main Geochemical Groups. Geochemical group 1 comprises the samples of Fabrics 1 and 2 in the lower centre, Geochemical Group 2 comprises Fabric 3 to the right, and Geochemical Group 3 comprises Fabric 4 at the top left of the figure. This evidence suggests that Fabrics 1, 2 and 3 were produced with similar raw materials, whereas Fabric 4 is characterised by comparatively high values for Al_2O_3, Ba, Fe_2O_3, K_2O and MgO. – ◆ Fabric 1, ■ Fabric 2, ▲ Fabric 3, × Fabric 4.

mica inclusions. Rounded, sand-sized quartz inclusions are packed in concentrated areas of the sections. The homogeneity of the matrix suggests that this clay was purified in one way or another. The composition of the matrix appears to differ from the ceramic fabric groups, given that it does not contain numerous mica inclusions in the fine fraction. The coarse quartz inclusions, on the other hand, appear to be similar to Fabric 2 (Fig. 6). Therefore, it might be postulated that the coarse quartz inclusions of Fabric 2 were deliberately added. However, in order to confidently match the clay fragments to the clay used for potting activities, we must turn to the results of the geochemical analysis.

Geochemistry of Ceramic Samples

A total of 14 ceramic samples were subjected to geochemical analysis. The analytical data of all the samples are reported in Table 2 (p. 172–173). Three main geochemical groups could be identified (p. 172 Table 1). More specifically, the results indicate that Fabric 1 and Fabric 2 are compositionally similar, whereas the composition of Fabric 3 and Fabric 4 appears to be significantly different. This can be seen in the bivariate plot of aluminium (Al_2O_3) and iron (Fe_2O_3), in which Fabric 1 and Fabric 2 are located at the lower left end of the figure. By contrast, Fabric 3 is situated at the centre right, and characterised by a comparatively high value of iron, whereas Fabric 4 at the top left of the figure contains the highest value of aluminium in the entire ceramic assemblage (Fig. 7).

Principal component analysis was performed on all the log-transformed ceramic samples, based on the elements Al_2O_3, Ba, CaO, Fe_2O_3, K_2O, MgO, Na_2O, SiO_2, Sr, TiO_2 and Zr. The first two components account for 73 % of the total variation within the dataset. Factor 1 is dominated by high values of K_2O, MgO, Fe_2O_3, Ba and Al_2O_3, and large negative

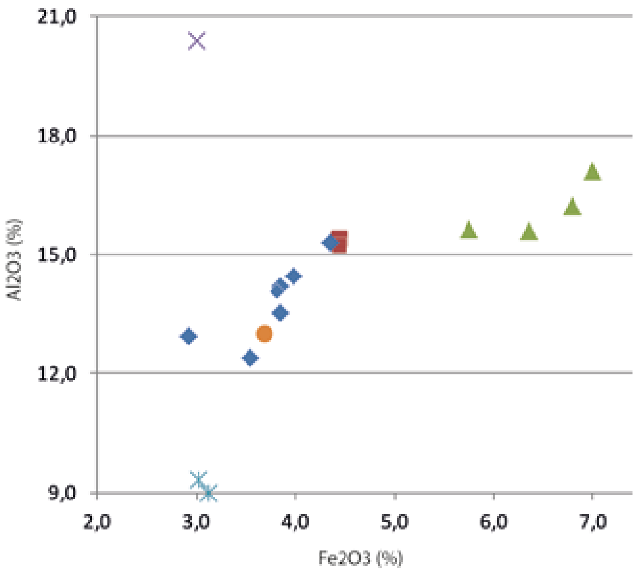


Fig. 9 Halder, North-Brabant. Bivariate plot of aluminium (Al_2O) and iron (Fe_2O_3) shows that the value for aluminium (Al_2O) and iron (Fe_2O_3) of the clay piece is similar to the samples of Fabrics 1 and 2, whereas the value for aluminium of the clay samples is comparatively low. – ◆ Fabric 1, ■ Fabric 2, ▲ Fabric 3, × Fabric 4, ⁎ Clay, ● Clay piece.

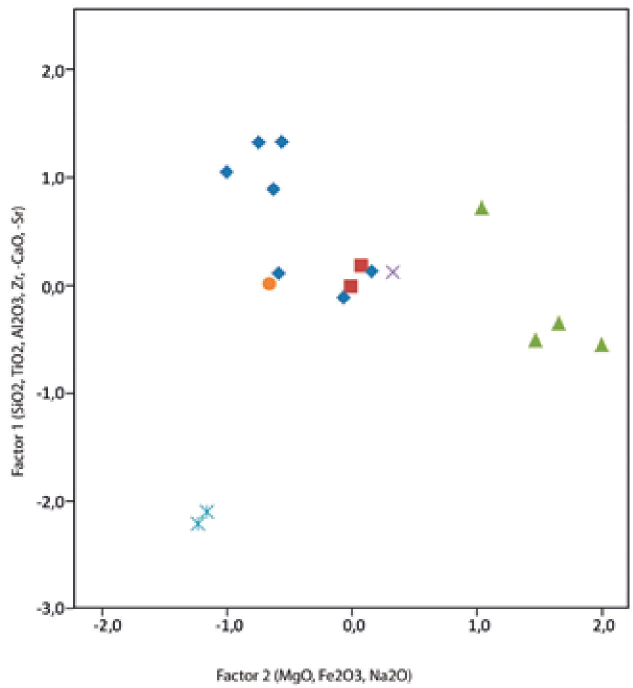


Fig. 10 Halder, North-Brabant. Principal Component Analysis of eleven elements, including Al_2O_3, Ba, CaO, Fe_2O_3, K_2O, MgO, Na_2O, SiO_2, Sr, TiO_2 and Zr, shows that the composition of the clay piece is similar to the composition of the ceramic samples of Fabrics 1 and 2, whereas the clay fragments appear to have a comparatively low value for Al_2O, suggesting that they may not have been used for Roman pottery production. – ◆ Fabric 1, ■ Fabric 2, ▲ Fabric 3, × Fabric 4, ⁎ Clay, ● Clay piece.

contributions from SiO_2 and Zr. Factor 2 is characterised by a high negative contribution from TiO_2.

The three geochemical groups, which were tentatively identified in the bivariate plot of aluminium and iron (Fig. 7), can be identified more clearly in the figure of the multivariate statistics (Fig. 8). Geochemical Group 1 comprises the samples of Fabrics 1 and 2, which are located in the lower centre of the figure. Geochemical Group 2 consists of the samples of Fabric 3. They are located at the centre right of the figure, and contain a comparatively high value of TiO_2. Geochemical Group 3 consists of Fabric 4, which is located at the top left of the figure. This group is characterised by the highest values of K_2O, MgO, Fe_2O_3, Ba and Al_2O_3 in the entire ceramic assemblage.

The results of the multivariate statistics suggest that the geochemical composition of Fabrics 1, 2 and 3 is similar, suggesting that similar raw materials were used for their manufacture. It can be confirmed, therefore, that the potters at the site of Halder used a fine micaceous clay for the manufacture of tableware, and they tempered this clay with quartz or organic material for the production of coarse ware. By contrast, Fabric 4 appears to be compositionally different from Fabrics 1, 2 and 3. It might be postulated that the presence of grog, or crushed pottery, is responsible for the comparatively high value of Al_2O_3, and the presence of organic material in the voids of the thin sections accounts for a higher contribution from MgO and Fe_2O_3.

Geochemistry of Clay Piece and Clay Fragments

The geochemical analysis of the clay piece and clay samples suggests that the composition of the clay piece is comparatively similar to the ceramic samples, whereas the composition of the clay samples is comparatively different. This is suggested by the bivariate plots of aluminium (Al_2O) and iron (Fe_2O_3) (Fig. 9). More specifically, it can be seen in Fig. 9 that the clay piece is situated near the samples of Fabrics 1 and 2, indicating that they have similar values of aluminium and iron. By contrast, the two clay samples are situated at the lower left bottom of the figure, and appear to contain a comparatively low value of aluminium.

Principal component analysis was performed on the 17 log-transformed ceramic samples, the clay fragments and the clay piece. The first two components account for 77.4 % of the total variation within the dataset. Factor 1 is dominated by high values of SiO_2, TiO_2, Al_2O_3 and Zr, and large negative contributions from CaO and Sr. Factor 2 is characterised by high values of MgO, Fe_2O_3 and Na_2O (Fig. 10).

Figure 10 seems to confirm what the bivariate plot of aluminium (Al_2O) and iron (Fe_2O_3) already suggested (Fig. 9). The clay piece is situated near the samples of Geochemical Group 1, suggesting that it has a similar composition to the ceramic Fabrics 1 and 2. Hence, it can be tentatively suggested that the clay used for Fabrics 1 and 2 was also used for the clay piece. By contrast, the location of the clay samples at the bottom left of the figure suggests that their value of aluminium is too low for Roman potting activities at the site of Halder.

Typo-morphology

Willems identified several types of vessels among the local pottery at the site of Halder. They comprised three shapes of Gallo-Belgic ware, including bowls with everted rims (Fig. 11 types 1, 2; Fig. 13,2) and beakers (Fig. 11 types 3a–b; Fig. 13,3). In addition, he identified several types of cork-urns (Fig. 11 type 4a), jars with everted rim (Fig. 12 type 7; Fig. 13,4) and handmade bowls (Fig. 12 types 8, 9).

The results of the detailed compositional analysis above indicated that two more types of vessels in Gallo-Belgic ware can be added to the local repertoire of Halder, namely a bowl with flanged rim (Fig. 12 type 10 [= Holwerda 1941, 86c]) and a beaker (Fig. 12 type 11 [= Deru 1996, P46/49; Holwerda 1941, 27c]). In addition, a third form could be added to the local typo-morphology, namely a small wheel thrown storage jar or *dolium* (Fig. 12 type 6 [= Stuart 1977, 147]; Fig. 13,1)[17]. As for the large handmade *dolia* (Gose 1950, 357–358), the results of the petrographic analysis suggest that they were also produced locally. However, this is not confirmed by the results of the geochemical analysis, since the composition of these vessels altered considerably. This might be due to the presence of temper, and overfiring and post-depositional infiltration of organic material[18].

Discussion

In the 1970s a Roman pottery kiln was found at the site of Halder, the Netherlands, which was in use during the Flavian period. Typical local products included beakers and bowls in Gallo-Belgic fine ware, and jars with everted rim, cork-urns and handmade bowls in coarse ware. Also, small wheel thrown *dolia* were found among the waster vessels in both grey (reduced) and red (oxidised) fabric, suggesting that they were local products.

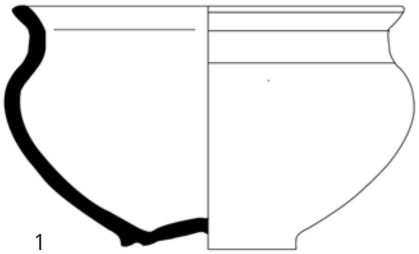
The authors of this article re-examined the pottery wasters from the site at Halder, and used an integrated compositional approach to revise the existing typo-morphological study. The results confirmed that the aforementioned ceramics were indeed local products, and suggested that three new types of vessels could be added to the typo-morphology. These are a bowl with flanged rim and a beaker in Gallo-Belgic ware as well as a small wheel thrown storage jar or *dolium*.

Furthermore, the results of the detailed study indicated that the potters at Halder used four recipes for making Roman vessels (Table 1). They used fine micaceous clay for the production of fine Gallo-Bel-

Fig. 11 Halder, North-Brabant. Typo-morphology from the site (after Willems 1977): Types 1, 2, 3a, 3b, 4a. – Scale 1 : 3. ▷

[17] Willems suspected that *mortaria* (Type 5) and small *dolia* (Type 6) were locally produced, but there were no wasters in the material to confirm this (Willems 1977, 121). The suggestion that *mortaria* (specifically those produced by Adiutor) were produced at Halder was already dismissed by Bogaers (Bogaers 1986).

[18] Similar examples have been identified at the pottery production sites of Tienen and Vervoz, Belgium (Borgers 2014a).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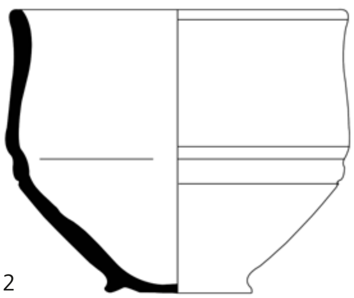
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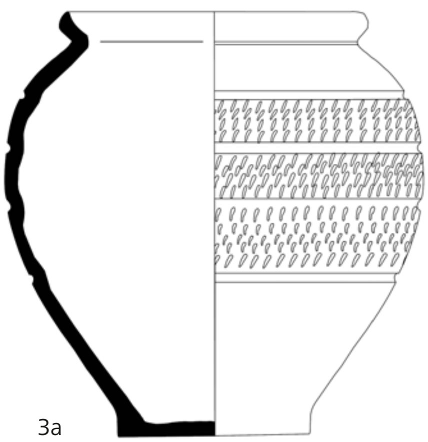
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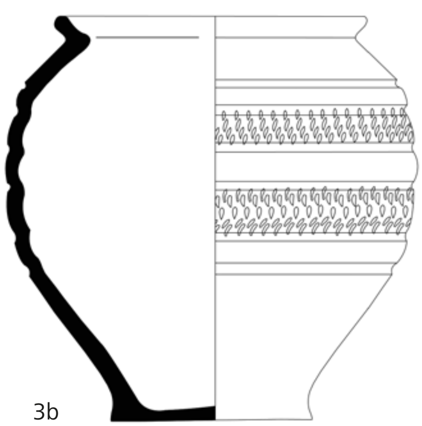
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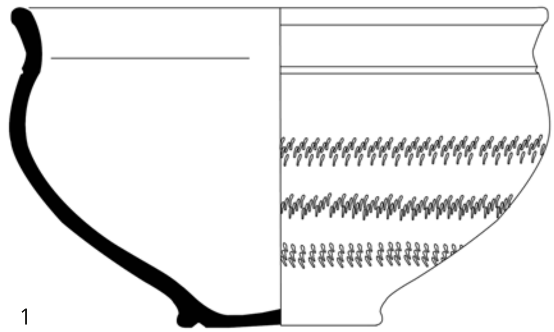
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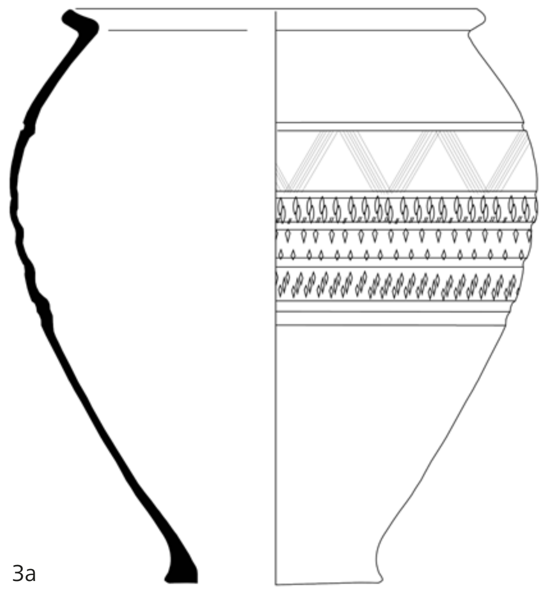
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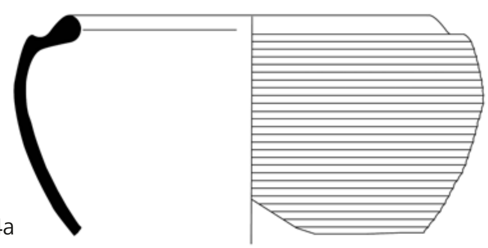
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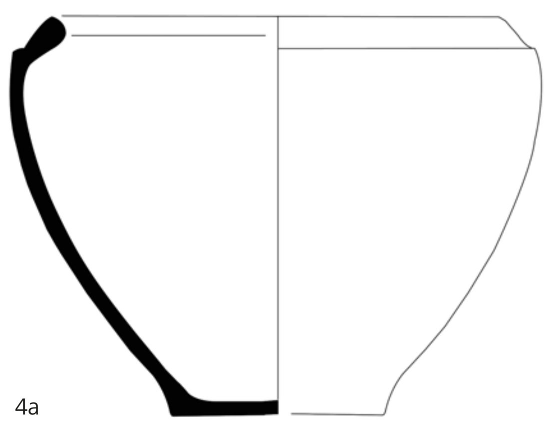
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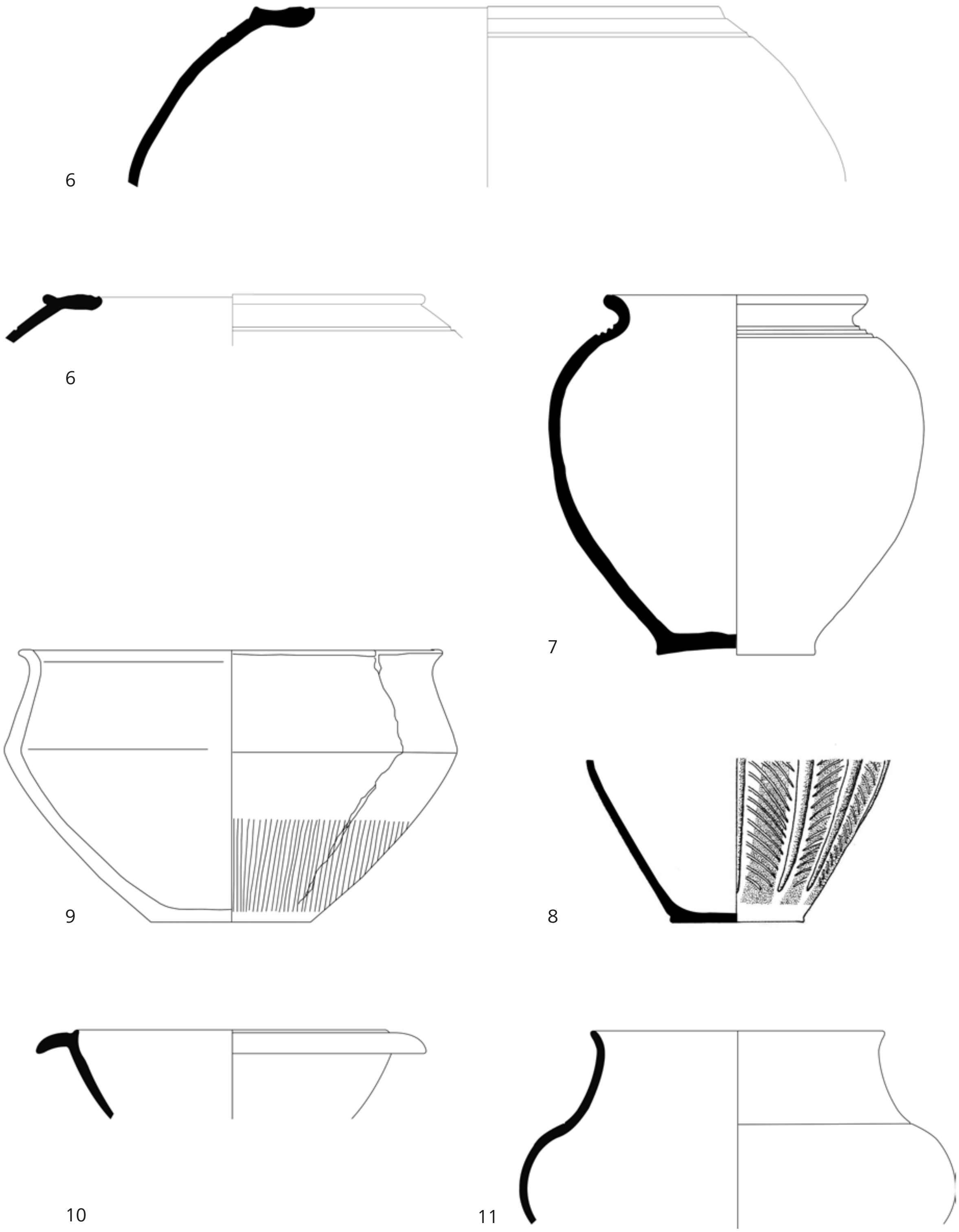

Fig. 12 Halder, North-Brabant. Revised typo-morphology from the site (after Willems 1977) with three new types of vessels: Types 6–11. — Scale 1 : 3.

Fig. 13 1 Small wheel thrown *dolia* (Stuart 1977, 147) were produced locally, and fired in oxidising and in reducing atmosphere. – 2 Gallo-Belgic bowl produced in the 'Fine Micaceous Fabric' (Deru 1996, B22). – 3 Gallo-Belgic beaker produced in the 'Fine Micaceous Fabric' (Deru 1996, P11). – 4 Jar (Stuart 1977, 201a) produced in different fabrics, namely the 'Fine Micaceous Fabric' and its tempered variants the 'Micaceous with course Quartz' and 'Grey Micaceous with course organic Material and Quartz' fabrics.

gic pottery and clay pieces to stack the pottery in the kiln, whereas they tempered the coarse ware with quartz inclusions or organic material, and tempered handmade *dolia* with grog. Moreover, it was found that jars with everted rim occurred in three different fabrics, suggesting that the potters at Halder shared raw materials for making vessels, and worked in different traditions – some of which may have been indigenous.

The composition of the local pottery was compared to the composition of clay fragments which were discovered in a clay pit near the Roman pottery kiln. The results suggest however that these raw materials were not used for potting activities during the Roman era. This would appear to be in agreement with previous research on the finds of the clay pit, which indicated that they mainly result from later activities at the site.

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Credits

Fig. 1 Martijn Bink, Map by Friar Celestinus Vencken, projected on the cadastral map. – Fig. 2 Oudheidkundig Museum Sint-Michielsgestel. – Figs. 3–10 Barbara Borgers. – Figs. 11–12 Roos Wijnen-Jackson. – Fig. 13 Laurens Mulkens.

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