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New data from the ceramic workshop in courtyard 224 of the Great Enclosure in Musawwarat es Sufra

In 1997, parts of a substantial ceramic deposit identified as the dump from a potter's workshop were excavated in courtyard 224 of the Great Enclosure.[1] They were investigated in trench 224.12, comprising an area of 5 x 5 m in the northeastern corner of the courtyard. This trench enlarged an architectural sondage, 224.9, of an earlier season, 1995/96, which had alerted attention to the deposit and resulted in the 1997 investigations.[2] The same deposit allegedly also showed in sondage 224.8 abutting the central part of the courtyard's northern wall, also excavated in 1995/96.[3] Contrary to the assumption of Steffen Wenig (in Edwards 1999, 4-6), the deposit could not be detected in trenches 2241 and 2242 in the southeastern part of courtyard 224, which had first been excavated by Fritz Hintze (1967/68, 289: plan IV, 1968, plan IV) in his sixth field season in 1965/66 and were reinvestigated and enlarged into trench 224.10 by Hans-Ulrich Onasch (2001, 52-53, Abb. 1) in 1999. Data from these minor locations remain to be integrated with the main excavation of trench 224.12.

From the 1997 excavations of trench 224.12 some 24,200 sherds were recorded and subjected to a first analysis by David Edwards.[4] Edwards also produced a preliminary fabric series, which partly relies on earlier work undertaken by Anne Seiler on the finds from the 1995/96 sondages 224.8 and 224.9 (Seiler 1998) and the pottery corpus from the Small Enclosure (Seiler 1999). While Edwards adopts Seiler's fabric groups A (Nile silt), B (mixed clay) and C (kaolin), he also introduces fabric group H, which according to him represents pottery "manufactured from locally-dug wadi silts" (Edwards 1999, 18, 27). Generally, Edwards (1999, 16) notes the "unusual nature of the assemblage as a whole, which includes a relatively limited number of different wares or fabric types, while being quantitatively dominated by a single (local) range of products".

The ceramics from courtyard 224 have now become the focus of a project under the auspices of the Berlin Cluster of Excellence TOPOI, whose aim it is to take up the unfinished analyses of the materials excavated in 1995/96 and 1997, continue investigations on the site and shed further light on pottery production and consumption in Musawwarat.[5] One first step in this endeavour was a reconnaissance of the finds of the 1997 field season in the storerooms of the Musawwarat mission in July 2013. In the course of this work, a first limited number of samples was selected (Claudia Näser), exported to Berlin and later to Warsaw, and subsequently analysed (Malgorzata Daszkiewicz).[6] In all, 44 samples were taken. They comprised 39 samples from sherd material from trench 224.12 and one melted ball (sample 2013.224.32) from the same location, as well as four comparative samples from other contexts.

Abridged MGR analysis and chemical analysis by WD-XRF was conducted on all 44 samples. Physical ceramic properties (open porosity, water absorption and apparent density) were measured for 25 selected samples. The first of the analytical procedures to be carried out was abridged MGR analysis. In defining different MGR groups, the thermal behaviour of each sample when refired at three temperatures (1100 °C, 1150 °C and 1200 °C) is taken into consideration. Definitive classification is based on thermal

1 Wenig and Wolf 1998c, 29-33; Edwards 1998, 1999.

2 Wenig and Wolf 1998a, 29, map 6, 1998b, 44; Seiler 1998, giving a wrong position („Südwestecke") for the sondage. Cf. Edwards 1999, 67: fig. 4.

3 Wenig and Wolf 1998a, 29, map 6, 1998c, 29.

4 Wenig and Wolf 1998c, 30; Edwards 1998, 1999.

5 For the project in question, „Meroitische Feinkeramik: Produktion, Distribution, Nutzung", see http://www.topoi.org/project/a-6-5/. The financial and logistic support of TOPOI towards conducting this project and undertaking the analysis presented in this paper is gratefully acknowledged.

6 The authors would like to express their gratitude towards the National Corporation for Antiquities and Museums of Sudan, in particular towards Dr. Abdelrahman Ali and el-Hassan Ahmed Mohammed, for granting an export permission and assisting in the necessary logistic procedures at short notice.

Musawwarat sample ID	ZN	Lab. No.	Fabric by Edwards	Ware	Physical ceramic properties Po [%]	N [%]	dv [g/cm³]	MGR-analysis thermal behaviour at 1200°C Matrix type	Matrix colour	MGR group (SDB)
2013.224.4	none	MD862	none	fineware	27.65	15.23	1.82	SN	dark beige-greenish	95
2013.224.28	916	MD886	none	fineware	31.57	18.36	1.72	SN	beige-greenish	95
2013.224.30	324B	MD888	none	fineware	29.50	16.92	1.74	SN	beige-greenish	95
2013.224.33	905 / 911	MD891	none	fineware	35.53	21.27	1.67	ovF	grayish-greenish	96
2013.224.40	938	MD898	none	fineware	33.26	19.62	1.70	ovF	grayish-greenish	96
2013.224.35	none	MD893	none	fineware	30.33	17.50	1.73	ovF	pale grayish-greenish	96.01
2013.224.23	322B	MD881	none	fineware	34.46	19.86	1.74	SN	beige	97
2013.224.25	861	MD883	none	fineware	33.41	19.48	1.72	SN	beige	97
2013.224.27	903	MD885	none	fineware	32.59	18.80	1.73	SN	beige	97
2013.224.2	879	MD860	none	fineware	27.13	15.43	1.76	SN	dark beige	98
2013.224.3	300	MD861	none	fineware	31.13	18.04	1.73	SN	dark beige	98
2013.224.22	324	MD880	none	fineware	30.08	17.01	1.77	SN	pale brownish-beige	99
2013.224.24	853	MD882	none	fineware	30.87	17.39	1.78	SN	pale brownish-beige	99
2013.224.26	876	MD884	none	fineware	30.97	17.77	1.74	SN	pale brownish-beige	99
2013.224.29	918	MD887	none	fineware	31.30	17.62	1.78	SN	pale brownish-beige	99
2013.224.1	837	MD859	none	fineware (red slipped bowls)	34.22	20.75	1.65	SN	grayish-beige	100
2013.224.13	794	MD871	none	fineware (red slipped bowls)	35.67	21.72	1.64	SN	grayish-beige	100
2013.224.31	836	MD889	none	coarse ware (jar)	-	-	-	SN	brownish-beige	101
2013.224.5	792	MD863	none	coarse ware	39.33	24.68	1.59	SN	reddish-brownish	102
2013.224.7	788	MD865	H3	coarse ware	-	-	-	SN	reddish-brownish	102
2013.224.14	782	MD872	H1	coarse ware	-	-	-	SN	reddish-brownish	102
2013.224.15	726	MD873	B1	coarse ware	38.34	24.49	1.57	SN	reddish-brownish	102
2013.224.16	735	MD874	B1	coarse ware	41.09	27.08	1.52	SN	reddish-brownish	102
2013.224.17	737	MD875	B1	coarse ware	39.00	24.89	1.57	SN	reddish-brownish	102
2013.224.18	719	MD876	none	coarse ware	41.75	27.04	1.54	SN	reddish-brownish	102
2013.224.20	820	MD878	H1?	coarse ware	30.72	17.17	1.79	SN	reddish-brownish	102
2013.224.38	777	MD896	none	coarse ware	-	-	-	SN	reddish-brownish	102
2013.224.8	772	MD866	B1	coarse ware	-	-	-	SN	darker than 102	102.01
2013.224.9	773	MD867	B1	coarse ware	-	-	-	SN	darker than 102	102.01
2013.224.19	718	MD877	H1	coarse ware	35.75	21.31	1.68	SN	darker than 102	102.01
2013.224.21	712, joins 616	MD879	H3?	coarse ware	39.36	24.99	1.57	SN	darker than 102	102.01
2013.224.34	716	MD892	H3?	coarse ware	-	-	-	SN	darker than 102	102.01
2013.224.39	785	MD897	none	coarse ware	-	-	-	SN	darker than 102	102.01
2013.224.6	789	MD864	H3	coarse ware	-	-	-	SN	paler than 102	102.02
2013.224.10	774	MD868	H3	coarse ware	-	-	-	SN	paler than 102	102.02
2013.224.12	344, joins 771	MD870	B1	coarse ware	43.03	28.47	1.51	SN	paler than 102	102.02
2013.224.36	none	MD894	none	fineware	25.70	13.60	1.89	SN	red-brownish	103
2013.224.37	821	MD895	none	fineware (carinated bowl)	26.45	14.73	1.80	SN	gray-brown	104
2013.224.11	778	MD869	none	coarse ware (offering stand)	-	-	-	SN	gray-brown	104

Table 1: Musawwarat. List of analysed samples. Concordance of sample numbers, 'Zeichennummer' for identification in the Musawwarat recording system (Wenig in Edwards 1999, 1), fabric according to Edwards 1999 and laboratory number (identification number in the Daszkiewicz-Schneider database). Values of physical ceramic properties: P = open porosity, N = water absorption, dv = apparent density, - = analysis was not done.

behaviour at 1200 °C.[7] When samples exhibit the same appearance, colour and shade after refiring at 1200 °C this indicates that they were made from the same plastic raw material. All pottery samples belonging to the same MGR group[8] were made of the same clay or of the same ceramic body in those instances where intentional temper was not added. When MGR analysis and chemical analysis have been completed, each of the analysed samples is added to a database of pottery from Sudan (SDB[9]). Thus, pottery from Musawwarat has been grouped in keeping with a uniform system used for classifying archaeological pottery from Sudan.[10] This system relies on the four-stage attribution of a given ceramic sample to an MGR group/reference group/production region/clay type. In the following, first results

7 This description is a standardised one which is used for describing all analysed ceramic fragments.

8 The term 'group' is used even when the group in question is represented by one single sample only. It is unlikely that only a solitary vessel was made from one ceramic body, therefore it is assumed that the sample submitted for analysis represents a group of vessels made from the same material.

9 Malgorzata Daszkiewicz has been analysing archaeological pottery from Sudan since 1991; since 1997 all chemical analyses have been undertaken in cooperation with Gerwulf Schneider. The database currently encompasses 1150 ceramic fragments.

10 The principles of this classification system are described in an article on pottery from Meroe and Hamadab (Daszkiewicz and Schneider 2012).

of the analysis of the 39 pottery samples from trench 224.12 are discussed (tab. 1).

Results of the analysis

MGR analysis revealed that 36 pottery samples are characterised by a sintered matrix type;[11] these samples included all coarse ware sherds and 16 fragments of fineware pottery. Only three fragments of fineware have an over-fired matrix type[12] (tab. 1). Ten MGR groups were distinguished taking into consideration thermal behaviour, i.e. the colour of the matrix and the matrix type (colour fig. 4). Fineware is the only type of pottery belonging to MGR groups 95–100 and 103, whilst MGR groups 101–102 are represented solely by coarse ware (numbering of MGR groups corresponds to SDB numbers). MGR group 104 is represented by only two sherds, one of which is a fineware (carinated bowl), while the other is a coarse ware (offering stand). Fineware with an over-fired matrix type was made from a ceramic body which fired greyish-greenish at 1200 °C. All fineware pottery with a sintered matrix type was made using ceramic bodies which fired various shades of beige at 1200 °C (beige, beige-greenish, dark beige, pale brownish-beige, greyish-beige). Pottery belonging to MGR groups 97–99 was made from very similar ceramic bodies, slight colour variations stemming from differences in the way the raw materials were mixed together (one pale-firing raw material and one coloured by iron compounds). Only one fragment of coarse ware (jar, MGR group 101) was made from a ceramic body which fired brownish-beige at 1200 °C. The remaining 18 coarse ware sherds take on shades of reddish-brown (MGR group 102). The fineware sherd representing MGR group 103 (MD894) was made using a ceramic body with a temper which is almost invisible macroscopically. Coarse ware pottery fragments representing MGR groups 101 and 102 were made from the same plastic raw material as sample MD894 with the addition of a coarse temper. MD876 has clearly visible clay lumps that exhibit the same thermal behaviour as the matrix of sample MD894 (colour fig. 4).

Measurements of physical ceramic properties (open porosity, water absorption and apparent density) showed that all fineware sherds are characterised by high open porosity values (26.45–35.67 %), even though distinct differences are observable in the way that fineware and coarse ware pottery was made (table 1, fig. 1). Coarse ware sherds have much higher open porosity values (up to 43 % in the case of a beer jar). Only two coarse ware sherds (2013.224.19, 20) have physical ceramic properties with the same range of values as fineware pottery. A fineware bowl (sample MD894 – fragment almost devoid of macroscopically visible temper) was found to have the best parameters – an open porosity 25.7 %.

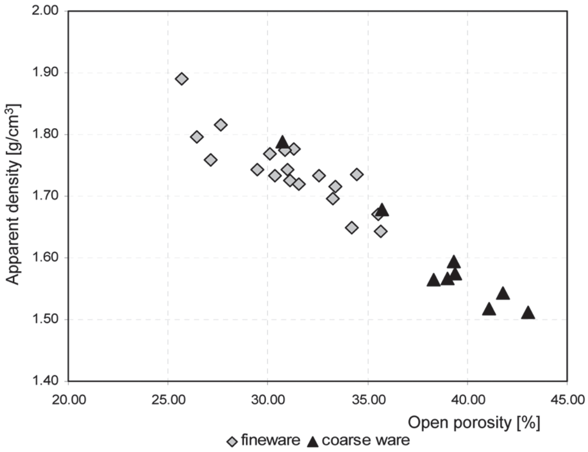

Fig. 1: Musawwarat. Open porosity versus apparent density.

The results obtained from the analysis of the sherds' chemical composition allowed the identification of eight chemical groups. Multivariate cluster analysis[13] results are presented in the form of a dendrogram (fig. 2). The results of chemical analysis by WD-XRF, which formed the basis for the grouping analysis outlined above, are presented in table 2; the sequence of samples in this table corresponds to the groups revised using MGR analysis and shown in the dendrogram (multivariate cluster analysis is based on the content of elements within a given sample regardless of what phase they occur in).[14] High levels of Al_2O_3 point to the presence of kaolinite in the ceramic body. The content of iron compounds has a major effect on the colour

11 Sintered (SN) = the sherd is well compacted, it may or may not become smaller in size in comparison to the original sample, whilst its edges remain sharp.

12 Over-fired (ovF) = the sample changes in shape, bloating, however, does not occur nor does the surface of the sample become over-melted.

13 Brookhaven Data Handling Programs: Euclidean Distance, Average Linkage, logged date, elements used: Si, Ti, Al., Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Zn, Rb, Y, Sr, Zr, Ce, La.

14 Chemical analysis allows to establish the quantity of major and trace elements in the body, although the phases in which individual elements occur cannot be ascertained; giving the major elements as oxides is standard procedure in geochemistry when presenting the results of chemical analysis (CaO content identified by chemical analysis may be attributable to, for example, inclusions of calcite or dolomite or anorthite, or may occur exclusively in clay fraction in the matrix).

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Euclidean  MGR    Lab.
Distance   group  No.

          102.01 MD866  -.
1.379E-1  102.01 MD867a -'---.
1.768E-1  102.01 MD897      -'---.
2.038E-1  102.01 MD867b         -'-.
2.227E-1  102    MD874            -'-.
2.460E-1  102    MD875              -'-----.
2.943E-1  102.01 MD879                    -'---------.
3.719E-1  103    MD894                              -'-.
4.018E-1  102    MD872      -.                         I-----------------.
1.694E-1  102.01 MD877      -'-----.                   I                 I
2.190E-1  102    MD878            -'-----.             I                 I
2.803E-1  102    MD863        -.         I-------------'                 I
1.941E-1  102.02 MD868        -'-.       I                               I
2.090E-1  102    MD876          -'---.   I                               I
2.379E-1  102.02 MD870              -'-. I                               I
2.629E-1  102    MD873                -'-'                               I
5.441E-1  102.02 MD864                -.                                 I-.
2.526E-1  102    MD896                -'---------------------------------' I
5.701E-1   98    MD860    -.                                               I-----.
1.584E-1   98    MD861    -'---------.                                     I     I
2.380E-1  100    MD871              -'-----.                               I     I
2.927E-1  101    MD889                    -'---------.                     I     I
3.856E-1  100    MD859                              -'-----.               I     I
4.272E-1   99    MD882      -.                             I-----------.   I     I
1.788E-1   97    MD883      -'-----.                       I           I   I     I
2.230E-1   99    MD880          -. I---------.             I           I   I     I
2.073E-1   99    MD884          -'-'         I             I           I   I     I
3.165E-1   99    MD887                      -'-----.       I           I   I     I
3.532E-1   97    MD885                            -'-------'           I   I     I
5.398E-1   97    MD881                                              -'---'     I
6.248E-1  102    MD865                    -.                                     I-----.
2.999E-1  102.01 MD892                    -'-------------------------------------'     I
6.627E-1   95    MD886          -.                                                     I----------------.
2.033E-1   96    MD898          -'-----------.                                         I                I
3.053E-1  104    MD869                      -'-----.                                   I                I
3.643E-1   95    MD888                        -.   I---------.                         I                I
3.209E-1   96    MD891                        -'---'         I                         I                I
4.498E-1   95    MD862                                      -'-----------------.       I                I
6.026E-1   96.01 MD893                                                        -'-------'                I
8.234E-1  104    MD895                                                                                 -'-
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Fig. 2: Musawwarat. Dendrogram of cluster analysis using Euclidean Distance and aggregative clustering of distance using average linkage with the following elements: Si, Ti, Al, Fe, Mg, Na, Ca, K, V, Cr, Ni, Rb, Sr, Y, Zr, Ce and La, data logged (Brookhaven Data Handling Programs, kindly provided by E. Sayre).

of ceramics. Both in the dendrogram (fig. 2) and the two-component diagram showing Na_2O content versus SiO_2 content (fig. 3), samples made from ceramic bodies representing MGR groups 95, 96 and 104 are clearly differentiated. But the geochemi-

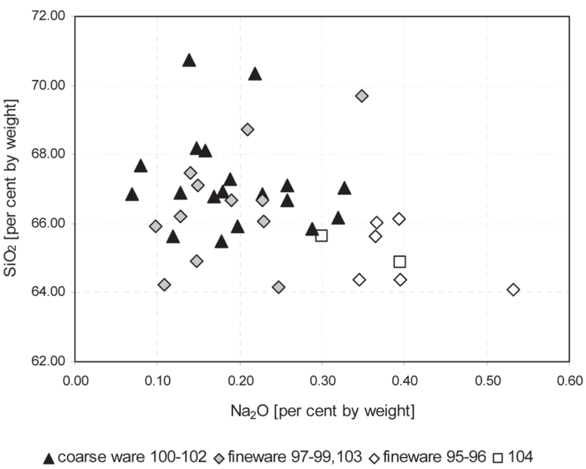

Fig. 3: Musawwarat. Content of sodium (as Na2O in per cent by weight) versus silicon (as SiO2 in per cent by weight).

cal parameters determined in the chemical analysis indicate that all analysed samples were made of raw materials sourced from the same geological region. Comparison with the SDB revealed that all samples of the present series represent a raw material group which does not occur at other sites. This group also includes ceramic sherds from Musawwarat analysed in previous studies (Gerullat 2001; Daszkiewicz and Schneider 2001: chemical group GI; dito unpublished samples submitted for analysis by Claudia Näser and Ulrike Nowotnick). A collation of all MGR groups (and subgroups) is presented in table 3, detailing the count of individual groups with division into reference groups. In keeping with the established conventions of classification, reference groups are identified by alphanumerical codes. In this instance, because the provenance is known, the reference groups have been named Mus 1–4 (abbreviation derived from Musawwarat). Three reference groups are associated exclusively with fineware (Mus 1–3). Reference group Mus 4 is represented by a raw material which was mainly used for making coarse

MGR group	Lab. No.	SiO_2 % by weight	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V ppm	Cr	Ni	(Cu)	Zn	Rb	Sr	Y	Zr	(Nb)	Ba	(La	Ce	Pb	Th)	l.o.i. %	TOTAL %
		beige-greenish fired at 1200°C																										
95	MD862	66.02	1.42	23.94	5.23	0.058	0.63	1.38	0.37	0.68	0.27	116	157	88	32	60	20	181	43	242	16	226	30	51	11	11	5.87	100.48
95	MD886	65.64	1.39	24.97	4.90	0.045	0.54	1.05	0.37	1.00	0.09	140	153	50	34	44	24	132	48	232	17	363	21	73	12	14	3.82	100.80
95	MD888	66.15	1.47	24.47	4.69	0.046	0.57	1.13	0.39	0.98	0.09	146	148	50	31	44	23	150	53	242	18	300	48	77	14	16	4.05	101.12
		grayish-greenish fired at 1200°C																										
96	MD891	64.39	1.42	26.21	4.52	0.040	0.47	1.39	0.35	1.11	0.10	143	159	53	35	47	20	156	43	221	18	166	33	50	12	14	3.61	100.88
96	MD898	64.37	1.43	26.50	4.56	0.041	0.48	1.17	0.39	0.95	0.10	140	157	54	30	47	21	117	43	223	20	169	19	53	9	15	3.25	100.25
96.01	MD893	64.08	1.36	28.01	3.63	0.021	0.37	1.05	0.53	0.89	0.06	141	157	52	41	42	15	159	52	195	16	255	41	41	12	13	7.61	100.24
		beige, dark beige or pale brownish-beige fired at 1200°C																										
97	MD881	64.23	1.45	27.23	4.73	0.043	0.51	0.87	0.11	0.71	0.10	112	164	57	23	47	19	76	44	221	17	182	19	60	11	15	1.44	100.29
97	MD883	67.45	1.53	24.59	4.18	0.041	0.56	0.79	0.14	0.62	0.09	109	147	48	22	37	20	85	57	259	20	213	42	97	13	12	1.51	99.04
97	MD885	64.92	1.44	26.77	4.61	0.042	0.49	0.72	0.15	0.75	0.10	125	163	54	26	48	20	109	42	221	17	208	38	51	11	15	1.97	100.61
98	MD860	66.07	1.42	24.82	5.00	0.044	0.50	0.86	0.23	0.95	0.10	136	149	45	26	39	22	141	51	230	18	279	39	76	15	13	2.42	100.10
98	MD861	66.69	1.47	24.37	4.71	0.047	0.56	1.01	0.23	0.80	0.11	131	155	50	33	42	21	137	55	244	18	289	44	84	11	15	2.78	100.59
99	MD880	66.20	1.49	25.06	4.74	0.049	0.56	0.97	0.13	0.69	0.11	119	165	54	27	46	22	90	57	243	19	252	43	82	13	15	1.51	100.71
99	MD882	67.11	1.46	24.65	4.72	0.051	0.54	0.64	0.15	0.59	0.11	109	148	48	26	45	21	76	55	248	19	235	45	82	12	13	1.15	100.23
99	MD884	66.69	1.48	24.63	4.74	0.049	0.56	0.85	0.19	0.70	0.11	128	150	51	31	44	21	90	55	250	17	199	38	72	13	13	2.14	99.58
99	MD887	65.93	1.49	25.19	5.14	0.055	0.67	0.63	0.10	0.66	0.13	135	156	55	38	47	23	82	56	245	19	225	57	87	17	18	1.17	101.11
		grayish-beige fired at 1200°C																										
100	MD859	69.71	1.51	22.09	3.79	0.043	0.56	0.85	0.35	1.01	0.10	97	150	38	19	34	20	107	41	305	18	215	39	72	13	11	2.38	99.80
100	MD871	68.71	1.52	22.35	4.25	0.054	0.64	1.05	0.21	1.05	0.16	113	149	43	22	38	21	152	46	297	17	322	44	80	12	11	2.32	99.71
		brownish-beige fired at 1200°C																										
101	MD889	66.92	1.45	23.47	5.33	0.058	0.67	0.83	0.18	0.96	0.13	154	152	49	26	47	25	109	50	263	17	242	54	92	14	11	1.61	100.13
		reddish-brownish fired at 1200°C																										
102	MD863	68.11	1.43	21.18	5.62	0.076	0.92	1.27	0.16	0.98	0.25	118	144	54	37	56	29	120	49	272	17	316	49	105	16	12	1.44	100.71
102	MD865	70.34	1.31	19.36	5.33	0.081	0.97	1.37	0.22	0.85	0.16	125	128	45	26	48	28	117	38	263	12	282	21	55	10	10	1.23	100.35
102	MD872	66.88	1.48	22.41	5.84	0.079	0.95	1.09	0.13	0.94	0.21	119	163	59	34	55	33	101	42	279	18	281	40	97	13	13	1.24	100.40
102	MD873	65.64	1.43	23.29	6.00	0.071	0.86	1.45	0.12	0.92	0.21	125	154	61	41	59	29	105	50	245	18	256	43	85	12	11	1.68	100.57
102	MD874	67.10	1.46	22.45	5.37	0.067	0.80	1.16	0.26	1.16	0.18	131	157	54	26	50	28	159	57	271	18	353	40	106	11	14	7.50	100.52
102	MD875	66.86	1.42	22.39	5.72	0.070	0.77	1.28	0.23	1.06	0.20	150	149	57	34	53	29	166	50	250	18	450	60	82	12	14	2.91	100.27
102	MD876	68.20	1.43	21.49	5.42	0.070	0.85	1.07	0.15	1.13	0.19	140	151	54	23	52	30	102	45	279	18	258	59	88	10	12	1.48	100.61
102	MD878	65.92	1.51	22.98	6.28	0.080	0.98	0.92	0.20	0.94	0.19	136	157	60	40	57	36	91	51	267	21	272	44	101	13	13	1.39	100.53
102	MD896	66.85	1.42	22.46	6.07	0.078	0.88	0.87	0.07	1.10	0.20	112	148	61	43	57	34	94	52	258	19	253	57	96	13	16	0.81	99.97
102.01	MD866	67.05	1.47	21.79	5.72	0.065	0.79	1.22	0.33	1.40	0.17	137	145	56	36	55	32	187	52	291	17	359	53	108	13	11	3.08	100.53
102.01	MD867	65.85	1.41	22.60	6.02	0.073	0.87	1.25	0.29	1.42	0.21	132	148	58	37	58	33	178	51	254	15	335	46	97	13	15	3.12	100.14
102.01	MD877	66.78	1.47	21.81	6.18	0.078	1.05	1.10	0.17	1.17	0.20	130	157	60	36	57	35	105	40	281	19	283	41	98	13	14	0.90	100.38
102.01	MD879	66.17	1.42	22.73	5.67	0.064	0.84	1.22	0.32	1.40	0.16	120	147	53	24	45	28	109	42	227	16	202	52	89	12	16	2.71	99.76
102.01	MD892	70.76	1.32	18.89	5.63	0.070	1.05	0.99	0.14	0.93	0.22	133	123	48	30	46	32	95	35	276	14	218	20	44	10	14	1.01	99.84
102.01	MD897	66.69	1.41	21.72	6.18	0.082	0.95	1.32	0.26	1.18	0.22	147	147	58	38	57	33	177	47	259	18	403	52	106	13	15	2.79	99.90
102.02	MD864	67.68	1.52	22.33	5.29	0.072	0.81	1.17	0.08	0.88	0.16	124	160	53	33	47	32	89	45	299	18	263	46	84	10	14	1.09	100.41
102.02	MD868	67.28	1.48	22.81	4.99	0.060	0.82	1.18	0.19	1.01	0.17	142	155	48	31	46	29	109	53	271	18	261	45	104	13	12	1.77	100.36
102.02	MD870	65.50	1.43	23.70	5.61	0.058	0.73	1.57	0.18	1.00	0.22	130	151	53	34	51	29	120	57	237	18	238	57	103	13	14	2.38	100.31
		red-brownish fired at 1200°C																										
103	MD894	64.15	1.47	22.34	7.91	0.090	1.06	1.03	0.25	1.53	0.17	133	154	70	48	67	38	113	45	254	18	309	36	89	11	15	1.25	99.96
		gray-brown fired at 1200°C																										
104	MD895	64.89	1.42	24.82	5.10	0.057	0.76	0.87	0.39	1.56	0.13	139	148	57	39	56	35	152	83	278	25	332	95	214	10	14	2.63	100.30
104	MD869	65.64	1.44	24.34	4.88	0.049	0.63	1.11	0.30	1.46	0.15	143	155	54	29	48	24	152	46	237	16	230	25	83	19	10	2.79	99.54

Table 2: Musawwarat. Results of the chemical analysis by WD-XRF (by Gerwulf Schneider, Rudolf Naumann and Malgorzata Daszkiewicz). LOI = loss on ignition at 900 °C; TOTAL = original sum before normalization to 100 %. Values for S and Cl have not been included in this table, as they mostly amounted to less than 0.01 %. Trace elements determined with lower precision are given in brackets.

ware pottery, but is also present in one fineware sherd. In the case of MGR group 104, represented by one fragment of fineware and one fragment of coarse ware, at the present stage of research it is difficult to decide whether these samples belong to one or two different reference groups.

fineware (number of samples)	coarse ware	MGR group	Reference group	Clay type	Production region
3		95	Mus 1	coloured by iron compounds kaolinit bearing clays	Musawwarat
2		96	Mus 2		
1		96.01			
3		97	Mus 3		
2		98			
4		99			
2		100			
	1	101	Mus 4	Wadi clay with temper (conglomerats of quartz with whitish fired matrix)	
	9	102			
	6	102.01			
	3	102.02			
1		103		without temper	
1	1	104	?	mx?	

Table 3: Musawwarat. Count of individual MGR groups with divisions into fineware and coarse ware as well as reference groups.

Conclusions

Analysis revealed that 19 coarse ware samples in the present series (MGR groups 101, 102, 102.1, 102.2) were made from wadi clays, low in potassium (K_2O content 0.88–1.40 %) and tempered with varying amounts of conglomerates of quartz with a white firing matrix (reference group Mus 4 in SDB). They include sherds of fabrics B1, H1 and H3 as defined by Edwards (1999, 17-26), who however concedes that "by the conclusion of the season's work, many of the distinctions appeared increasingly arbitrary and it seems likely that these represent variations of a local fabric type, which becomes increasingly coarse in larger heavier-walled vessels" (Edwards 1999, 17). It is interesting to note that the distinction made between H-wares ("wadi clays"; see Edwards 1999, 18) and B1 ("mixed clay"; see Edwards 1999, 18) as maintained in the primary publication – "Fabric B1 is probably of mixed clays, but distinct from the local H series" (Edwards 1999, 18) – is not reflected in the MGR analysis. MGR group 102 also includes the earlier samples MD2592 (GA/372) and MD2596 (GA/273) from Musawwarat, which had been identified as H6 and B1 respectively (Daszkiewicz and Schneider 2001, 82-89, tab. 1-4; cf. Gerullat 2001, 64). These two samples come from trenches 2251 and 2022, i.e. the room tentatively identified as the potter's workshop in courtyard 224 and the main room of Temple 200.[15] The significance of this finding has to be evaluated in future analyses on larger sample series including material from other archaeological contexts in Musawwarat.

Finewares from Musawwarat were made from ceramic bodies prepared using a variety of recipes featuring clays which contain kaolinite and are coloured by iron compounds. Nine samples of MGR groups 97–99 were of very similar ceramic bodies differing from the rest of the fineware samples by a lower content of Na_2O (average 0.16 %) and by a slightly lower content of CaO. Three fineware samples belonging to MGR groups 96 and 96.01 are characterised by the highest Al_2O_3/SiO_2-ratio. Three fineware samples from MGR group 95 have an Al_2O_3/SiO_2-ratio similar to groups 97–99, but a content of Na_2O twice as high. The two samples constituting MGR group 100 are from two red slipped fineware bowls. 2013.224.1 (= ZN837) is reported to come from context [626], a fireplace formed by an inverted jar, underlying the main deposit in trench 224.12 (Edwards 1999, 9, 36). According to Edwards, material from [626] and [628] might predate the material of the main dump. 2013.224.13 (= ZN 794) comes from context [616], a distinct layer in the upper eastern part of the main dump (Edwards 1999, 10), which displayed a conspicuous concentration of red slipped fineware sherds (Edwards 1999, 35). While Edwards (1999, 35) states that for him "it remains uncertain whether these are also local products", the present analysis indicates that indeed they are, as they consist of raw materials sourced from the same region as the other samples in the series. The chronological attributions made by Edwards will have to be re-evaluated in future. Two of the samples which represent smaller MGR groups (2013.224.13, 31) come from the same depositional context, [616] (Edwards 1999, 10). That this layer produced sherds with properties diverging from the larger groups – shapes and decoration types vary, too – suggests that the stratigraphic differentiation may reflect a true difference in the find assemblages and two distinct depositional events. Another 'diverging' sample, 2013.224.37 (= ZN821), derives from a vessel of which only this one example has been recovered from the deposit, a carinated fineware bowl of unusually fine execution, which imitates a metal vessel.

In sum, it is now possible to identify one major fabric group of coarse ware (reference group Mus 4 in SDB) manufactured from wadi clays – and thus corresponding to fabric group H in Edward's classification – as well as three fineware groups (reference groups Mus 1–3 in SDB) which seem to represent the bulk of the local pottery production present in the dump of courtyard 224. Future studies shall evaluate this result and investigate the position of the groups identified in the present study in the overall ceramic corpus from Musawwarat.

APPENDIX 1

Description of methods used

MGR analysis

Four thin slices were cut from each sample in a plane at right angles to the vessel's main axis. One of these sections was left as an indicator of the sample's original appearance, whilst the remaining three were fired in an electric laboratory chamber furnace, each one at a different temperature. Firing was carried out at the following temperatures: 1100, 1150 and 1200 °C in air, static, with a heating rate of 200 °C/h and a soaking time of 1 h at the peak temperature. The fragments were then glued on to paper.

Chemical analysis

In the present sample series chemical analysis by WD-XRF (Wavelength-dispersive X-ray fluorescence) was used to determine the content of major elements, including phosphorus and a rough estimation, after loss on ignition, of sulphur and chlorine (measurements were made by Gerwulf Schneider and Rudolf Naumann using an Axios spectrometer). All samples were prepared by pulverising fragments weighing approximately 1.5 g, having first removed their

15 For the provenancing see Gerullat 2001, 68.

surfaces and cleaned the remaining fragments with distilled water in an ultrasonic device. The resulting powders were ignited at 900 °C (heating rate 200 °C/h, soaking time 1 h), melted with a lithium-borate mixture (Merck Spectromelt A12) and cast into small discs for measurement. This data is, therefore, valid for ignited samples but, with the ignition losses given, may be recalculated to a dry basis. The precision for major elements is better than 1 %, for trace elements this rises up to 20 % depending on the concentrations. Some trace elements are determined with lower precision (Cu, La, Ce, Pb). Accuracy is tested by analysing international reference samples and by exchange of samples with other laboratories. For major elements and the most important trace elements it is between 5 and 10 %. The results of chemical analysis given in the table include major elements in per cent and trace elements in parts per million (ppm). For easier comparison the major elements are normalised to a constant sum of 100 %. Major element contents are calculated as oxides. Total iron is calculated as Fe_2O_3. Si = silicone, content recalculated as SiO_2; Ti = titanium, content recalculated as TiO_2; Al = aluminium, content recalculated as Al_2O_3; Fe = total iron content recalculated as Fe_2O_3; Mn = manganese, content recalculated as MnO; Mg = magnesium, content recalculated as MgO; Ca = calcium, content recalculated as CaO; Na = sodium, content recalculated as Na_2O; K = potassium, content recalculated as K_2O; P = phosphorous, content recalculated as P_2O_5; V = vanadium; Cr = chrome; Ni = nickel; Cu = copper; Zn = zinc; Rb = rubidium; Sr = strontium; Y = yttrium; Zr = zirconium; Nb = niobium; Sn = tin; Ba = barium; La = lanthanum; Ce = cerium; Pb = lead; Th = thorium.

Measurement of physical ceramic properties

Measurement of physical ceramic properties (open porosity, water absorption and apparent density) was carried out by hydrostatic weighing. Prior to measurement samples were boiled in distilled water for two hours in order to fully saturate all open pores with water. Next, the samples were cooled to room temperature and weighed twice, making note of the mass of the sample immersed in water (mww), and the mass of the moist sample weighed in air (mw). Samples were then weighed for a third time in air, having first been dried to a constant mass in a dryer at 105 °C and cooled to room temperature in a desiccator. This was the method used to determine the mass of the dry sample (ms).

Open porosity, i.e. the percentage of the amount of water absorbed by a given volume of sample was determined using the formula $P_o = \frac{m_w - m_s}{m_w - m_{ww}} \cdot 100$ and expressed as a percentage. Water absorption, i.e. the percentage mass gain of the sample soaked in water in relation to the mass of the dry sample, was determined using the formula $N = \frac{m_w - m_s}{m_s} \cdot 100$ and expressed as a percentage. Apparent density, i.e. mass of sample in relation to volume of sample, was determined using the formula $d_v = \frac{m_s}{m_w - m_{ww}} \cdot \rho_{H_2O}$ and expressed in g/cm^3. ρ_{H20} = bulk density of water at temperature of measurement, in this analysis temperature of measurement is room temperature[16] and $\rho_{H20} = 1 g/cm^3$.

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16 The term ‚room temperature‘ refers to a temperature of 20 °C.

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Zusammenfassung

Dieser Aufsatz präsentiert die Ergebnisse einer archäometrischen Analyse von 39 Keramikproben aus dem Keramikdeposit, das 1997 in Hof 224 der Großen Anlage in Schnitt 224.12 partiell ausgegraben wurde. 19 Proben von Gefäßen grober Ware bilden eine Gruppe, die aus Wadi-Tonen mit geringem Kaliumgehalt hergestellt wurde (Referenzgruppe Mus 4 in der SDB). Einzelne Vertreter dieser Gruppe wurden in der Erstvorlage des Keramikkorpus aus Hof 224 von David Edwards (1999, 17-26) als fabrics B1 (B = gemischte Tone), H1 und H3 (Wadi-Tone) bestimmt. Diese Unterscheidung spiegelt sich in der aktuellen Analysereihe nicht wider. Zu der genannten Gruppe gehören auch die in früheren Jahren analysierten Proben MD2592 (GA/372) und MD2596 (GA/273), die vorher ebenfalls als fabrics H6 und B1 angesprochen worden waren (Daszkiewicz und Schneider 2001, 82-88, tab. 1-4).

Die in der Probenserie erfassten Feinwaren bestehen aus keramischen Massen, die aus kaolinitischen Tonen mit hohem Eisengehalt hergestellt wurden. Variationen in der Bruchfarbe sind auf unterschiedliche Mischungen dieser Grundmaterialien zurückzuführen. Neun Proben der MGR-Gruppen 97–99 bestehen aus sehr ähnlichen keramischen Massen, die von den anderen Proben durch einen geringeren Na2O-Gehalt (Durchschnitt 0.16 %) und einen geringeren CaO-Gehalt unterschieden sind. Drei Proben der MGR-Gruppen 96 und 96.01 sind durch die höchsten Werte im Al_2O_3/SiO_2-Verhältnis charakterisiert. Drei Proben der MGR-Gruppe 95 weisen ein ähnliches Al_2O_3/SiO_2-Verhältnis wie MGR-Gruppen 97–99 auf, besitzen aber doppelt soviel Na_2O.

Die restlichen Proben können zu kleineren Gruppen geordnet werden, deren Zusammengehörigkeit in der vorgelegten Analyse partiell mit anderen Parametern – gleiche Form, gleiche Oberfächenbehandlung oder gleicher Deponierungskontext – einhergeht. Die geochemischen Parameter zeigen jedoch, dass alle in dieser Serie analysierten Proben aus Rohmaterialien gefertigt wurden, die derselben geologischen Region entstammen. Demzufolge sollten alle Gefäße der lokalen Produktion zuzuordnen sein, oder mit anderen Worten: in Musawwarat hergestellt worden sein. Zukünftige Untersuchungen im Rahmen des Projekts „Meroitische Feinkeramik: Produktion, Distribution, Nutzung“ im Berliner Exzellenzcluster TOPOI sollen die Ergebnisse dieser ersten Studie evaluieren und die Position der hier vorgestellten Gruppen im keramischen Gesamtrepertoire von Musawwarat präzisieren.

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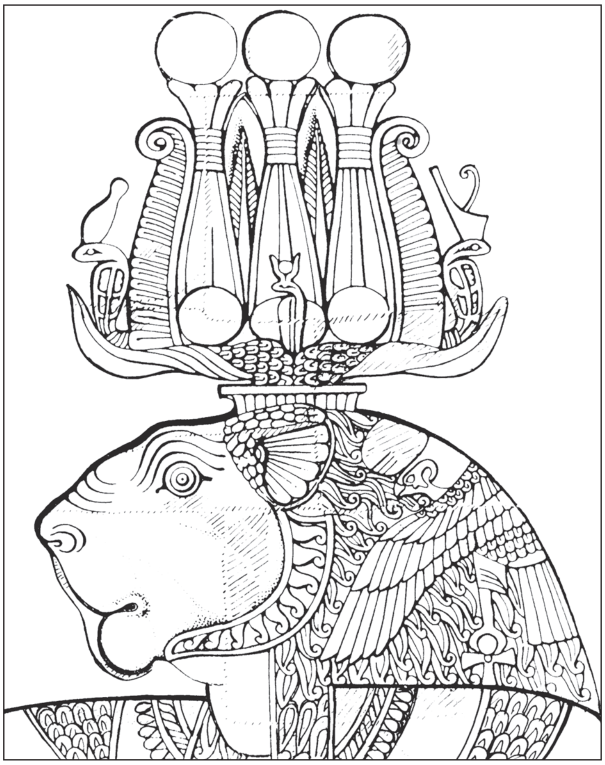

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