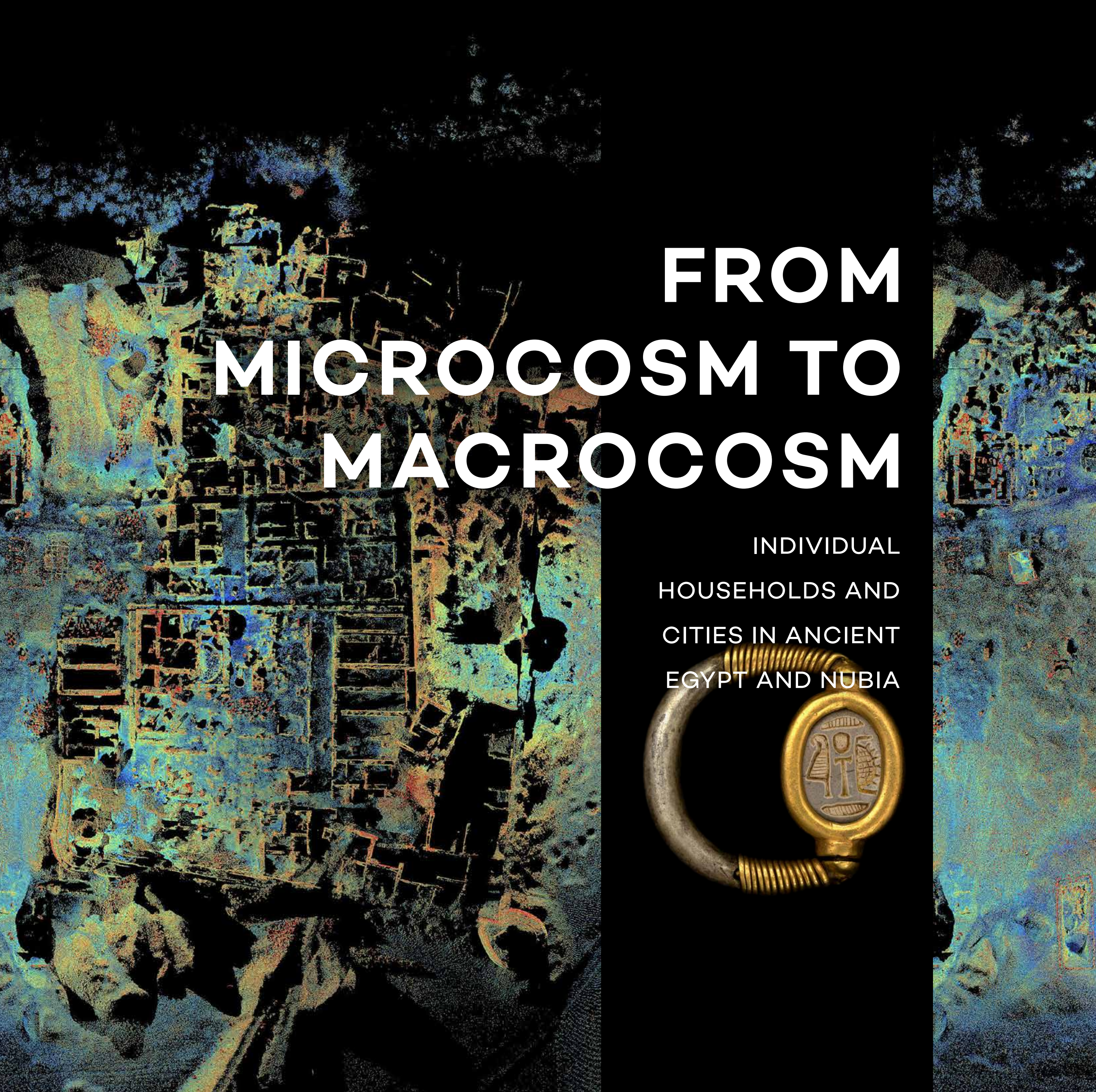

FROM MICROCOSM TO MACROCOSM

INDIVIDUAL HOUSEHOLDS AND CITIES IN ANCIENT EGYPT AND NUBIA

edited by

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Contents

From Macro Wares to Micro Fabrics and INAA Compositional Groups

The pottery corpus of the New Kingdom town on Sai Island (Northern Sudan)

Giulia D'Ercole[*] *and Johannes H. Sterba*[**]

Abstract

Between 2013 and 2016, within the framework of the European Research Council Across-Borders project, 344 samples including sherds, unfired bricks and natural soils have been submitted to petrological and chemical analysis. Of these, over 100 were Nile clay ware ceramics from the New Kingdom town on Sai Island (northern Sudan).

Instrumental Neutron Activation Analysis (INAA), with the application of the multivariate statistical filter proposed by Mommsen, succeeded in separating the samples in different compositional groups, whose largest is Group 1 including almost all of the Nile clay wares. Within the remainder of the samples, 16 additional groups were identified that correspond to and supplement the macroscopic identification. Within Group 1, which is chemically very homogeneous, specific elements allowed a separation between "Nubian-Local", "Egyptian-Local" and authentic Egyptian samples in Nile clay wares, although a certain amount of overlap was found.

Observations on thin sections with optical microscopy (OM) were consistent with the chemical results and confirmed that the largest group of Nile clay wares is strongly homogeneous also in its petrography. In spite of this, different micro fabrics were recognised within the Nubian and the Egyptian (local and not) samples. These petrographic fabrics well mirror the macro-wares identified on the field and point at a technological variability and at a compresence of different recipes in the use of Nile silt clays.

Keywords: *Nile clay wares, Instrumental Neutron Activation Analysis (INAA), Optical Microscopy (OM), Sudan, Sai Island*

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Introduction

The Pharaonic pottery corpus of the New Kingdom town on Sai Island (Northern Sudan) consists of thousands of sherds and vessels made of different fabrics and manufactured according to different traditions and recipes (Budka 2011; 2014; Budka and Doyen 2013; see also Budka Pottery in this volume).

Between 2013 and 2016, within the framework of the project AcrossBorders, 344 samples were submitted to archaeometric laboratory analyses. This number included:

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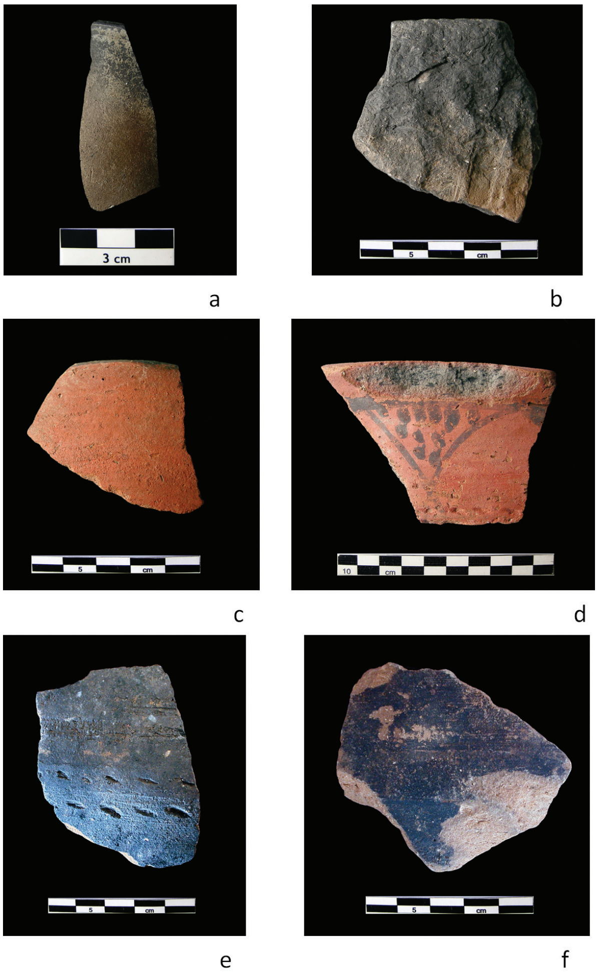

Figure 1. Macrophotographs of examples from Nubian-Local (a-b), Egyptian-Local (c-d) and Egyptian Import Nile clays (e-f) samples (photos G. D'Ercole).

- 308 ceramic samples (mostly from the New Kingdom town but also from four different prehistoric sites on Sai Island,[1] and three modern potsherds from the nearby village of Abri);
- 30 soil samples;
- two oven fragments;
- four unfired bricks.

Among the New Kingdom pottery corpus, most of the samples belong to the large macro group of the so-called "Nile clay wares". These are: "Nubian-Local" types hand-made with typical Nubian decorations and technological features, "Egyptian-Local" types wheel-made after the Egyptian fashion and technological style, and imported, authentic Egyptian wares manufactured in Nile clay wares. These samples show from a macroscopic point of view clear stylistic and morphological differences. The Nubian pottery is always hand-shaped and consists of different wares and macroscopic fabrics, such as the very fine Kerma style vessels (beakers and bowls) with red burnished and black topped surfaces, the traditional coarse Nubian cooking pots with basketry impressions or incised decorations, and the large thick-walled storage jars (Budka 2014; 2017a; cf. also D'Ercole *et al.* 2017) (figs. 1a-b).

The Egyptian-Local pottery is wheel-thrown and often undecorated. It is in most cases very similar to the same vessels manufactured contemporaneously in Egypt (cf. Carrano *et al.* 2009) and is made of different Nile fabrics classified as local variations (Budka 2017c, 120-123) of the Vienna System (Nordström and Bourriau 1993; Bourriau *et al.* 2000) (figs. 1c-d). Finally, imported, authentic Egyptian cooking pots in Nile clay wares coexist and were used side by side with local Nubian and Egyptian cooking pots (cf. Budka 2017a, 440). These vessels are of particular interest and were most likely imported to Sai Island from Upper Egypt (Budka 2016) (figs. 1e-f).

Samples, other than the Nile clay wares, included: Marl clays and Oasis clays as well as imported wares from the outside of Egypt (*i.e.*, Levantine wares). These samples are not discussed in this paper.

Research aims

Following a number of previous technological and compositional studies on ancient Nubian and Egyptian ceramic assemblages (*e.g.* Nordstöm 1972; De Paepe *et al.* 1992; Bourriau 1998; Bourriau *et al.* 2006; Carrano *et al.* 2009; D'Ercole *et al.* 2015; 2017; Spataro *et al.* 2015), this paper presents a geochemical and petrographic analysis of the New Kingdom pottery corpus of Sai Island, with a focus on the largest group of the Nile clay wares.[2]

The three principal aims of this study were:

- to discriminate between local productions and possible imports made in Nile clay fabrics;
- to identify distinct groupings and, particularly, distinct clay sources for the Nile clay fabrics;
- to recognise different technological formulas/recipes in the use of clay raw materials and tempers by the ancient Nubian and Egyptian potters;

Finally, a more general purpose consisted of finding a correlation between INAA compositional groups, "macro" (recognised on the fieldwork) and "micro" (recognised at the microscope) fabrics and to evaluate the

1 A study on the "Longue durée" of the Nubian pottery from Sai Island from prehistoric times until the New Kingdom period has been recently published (D'Ercole *et al.* 2017).

2 The complete set of data will be published elsewhere (Budka, J. ed., *AcrossBorders III*, forthcoming).

efficiency and the limits of the analytical methods we used. Do the compositional and petrographic groupings fit with the macroscopic classification? What more did we learn? What are the advantages and the possible limits of geochemistry and petrography?

Sampling

The New Kingdom ceramic samples were collected during four field seasons (from 2013 until 2016) from three sectors of the Pharaonic town: SAV1 North, the sector situated along the northern enclosure wall which was excavated between 2008 and 2012 by the Sai Island Archaeological Mission (SIAM) of the University Charles-de-Gaulle-Lille 3 (Doyen 2009; 2014; Budka and Doyen 2013; Budka 2017c), and SAV1 East and SAV1 West, the two new sectors opened in the town since 2013, within the European Research Council AcrossBorders project directed by Julia Budka (2013; 2015; 2017a; 2017b; see also Budka SAV1 in this volume) (fig. 2). For each of these sectors, the samples were chosen from different stratigraphic levels and from the different macroscopic fabrics visually identified in the field (tab. 1).

Before being analysed, each sample was first entered into the FileMaker database used also for the macroscopic classification of the ceramics, given an identification label (the acronym SAV/S = "Sai Island New Kingdom Town (Ville)/Sample" followed by numbers starting from 01), registered and photographed. Two main layouts were created on the database, of which one reported the stratigraphic provenance and the general macroscopic characteristics of the sample; the other was specifically projected for recording the microscopic petrographic features and the chemical compositional grouping.

Samples	SAV1 North	SAV1 East	SAV1 West	Total
Egyptian Import	6	7	29	**42**
Egyptian-Local	28	10	17	**55**
Nubian-Local	38	10	8	**56**
Egyptian?	4	6	14	**24**
Mix clays?	9	3	1	**13**
Marl clays	16	1	6	**23**
Oasis clays	12	1	2	**15**
Other imports	22	3	0	**25**
Unfired	1	1	2	**4**
Oven fragments	0	0	2	**2**
Total	**136**	**42**	**81**	**259**

Table 1. Ceramics and unfired samples analysed from the New Kingdom town.

Analytical methods

Two analytical methods were used: Instrumental Neutron Activation Analysis (INAA) and Optical Microscopy (OM). INAA analysis was used to determinate the elemental composition (or "chemical fingerprint") of the archaeological artefacts and to establish, by comparison, their provenance. This analytical method is based on the irradiation of a small aliquot of the sample with neutrons in a nuclear reactor. After irradiation, the radiation emitted from the induced radionuclides in the sample is measured and from this qualitative and quantitative information on the elemental composition is gained (Minc and Sterba 2017).

The preparation procedure required that a tiny portion of the sherd be ground up in an agate mortar or sampled by drilling (about 100mg of powder). All samples were then dried for circa 12h in the oven at 95°C, weighed and sealed into Suprasil™ glass vials for irradiation in the TRIGA Mk II reactor of the Atominstitut in Vienna, Austria. After irradiation, the outer surfaces of the vials were decontaminated and packed into capsules. The samples were measured for 1800s after a decay time of four days (activity of the medium-lived radionuclides) and again for 10.000s after four weeks (long-lived radionuclides). The concentration of a total of 28 chemical elements was determined. The final data were statistically processed by the multivariate statistical filter method developed by Mommsen (Beier and Mommsen 1994; for further details on the analytical procedure, see also Sterba *et al.* 2009).

OM was used in combination with INAA, as a complementary technique, on 83 samples.[3] This analysis has mainly a technological importance as it allows examining in greater detail the different ware groups and fabrics, elucidating particular technological aspects of the pottery manufacturing sequence which cannot be otherwise detected with the naked eye. A standard procedure has been followed for the preparation of the thin sections. The samples were impregnated in Araldite and ground down to a thickness of 30 microns. Petrographic observations were carried out with a Nikon Eclipse E600 POL microscope at the laboratories of the Department of Lithospheric Research and the Department of Geodynamics and Sedimentology of the University of Vienna.

3 In this paper, we discuss exclusively the petrography of the Nile clay wares.

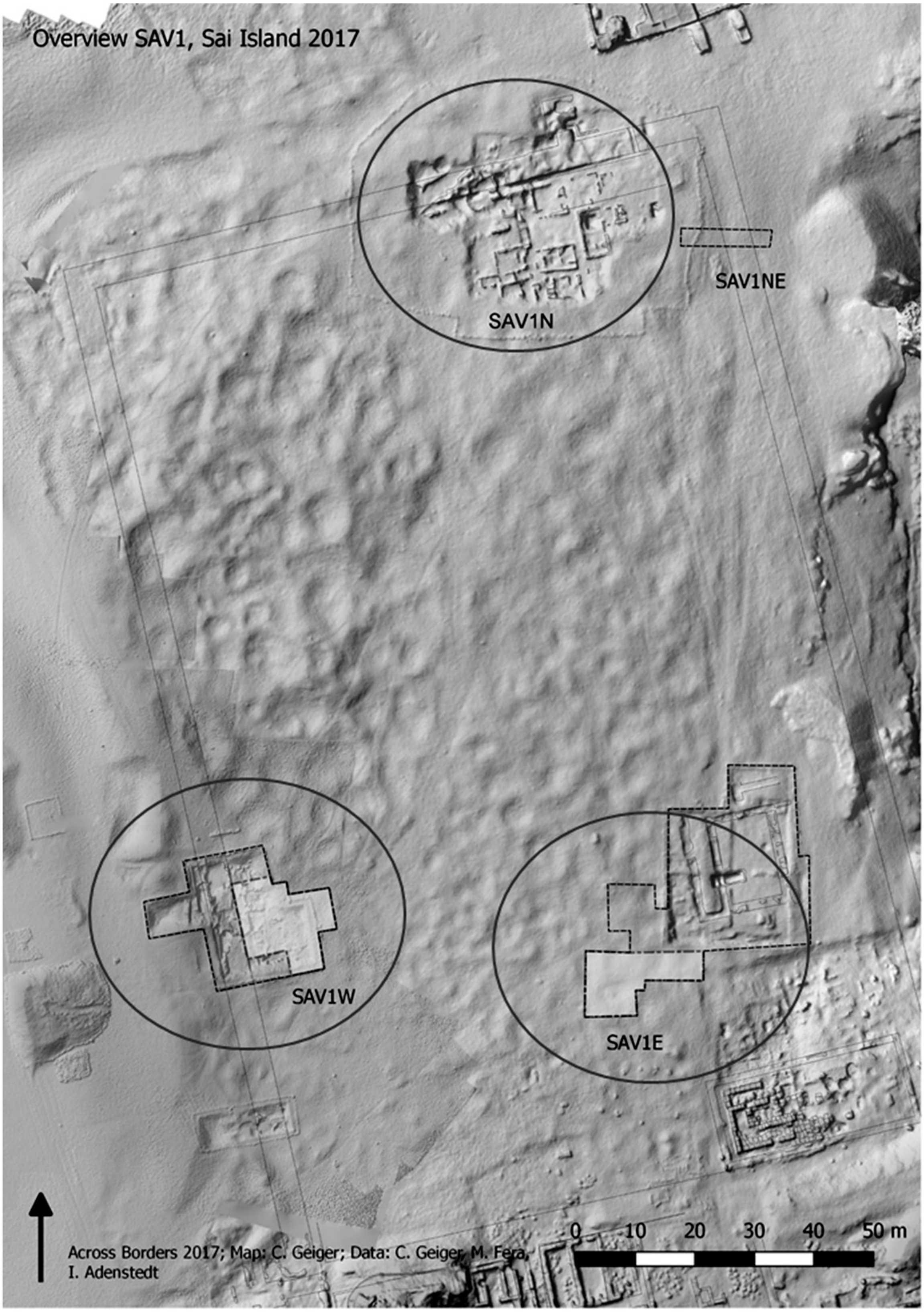

Figure 2. Location of AcrossBorders excavation sectors in the New Kingdom town of Sai from where the analysed samples originate (map modified after Budka 2017b).

Results

Instrumental Neutron Activation Analysis (INAA)

From the statistical analysis of the INAA data, the New Kingdom samples, together with all other samples collected in this project, were grouped into 17 chemically distinct groups, where the group of Nile clay wares was clearly the largest with 183 samples, including most of the New Kingdom Egyptian-Local, Nubian-Local and Egyptian Import Nile clay wares as well as a few samples classified on the field as possible mixed clay and one marl clay. Some of the unfired samples, the oven fragments and the natural soils were also part of this group, together with one modern ceramic from the nearby village of Abri (fig. 3).[4] All other groups were much smaller, on the range of two to nine samples each. A total of 84 samples could not yet be assigned to a specific group by multivariate statistical analysis. Of the 28 elemental concentrations measured for each sample (As, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, K, La, Lu, Na, Nd, Ni, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, U, W, Yb, Zn and Zr), only 22 were used for the grouping. The elements As, Na, W, Ba, Nd, Sr were not used due to their relatively high natural variation in the samples. Table 2 presents the mean composition of the group of the Nile clay defined in mg/kg. Looking more closely at the data of the Nile clay group, a Principal Component Analysis (PCA, see fig. 4) shows that while the most probably locally produced samples (Egyptian-Local and Nubian-Local) form an equally distributed point cloud, a few samples from the archaeological group of Egyptian Imports are slightly separated. All those samples are cooking pots (see discussion).

Nile Clays (183 Samples)			
As	2.29 +/- 0.47	Ni	74.4 +/- 5.1
Ba	429 +/- 52	Rb	44.5 +/- 4.5
Ce	64 +/- 2.1	Sb	0.233 +/- 0.037
Co	32.4 +/- 2.1	Sc	21.4 +/- 0.75
Cr	152 +/- 11	Sm	6.92 +/- 0.28
Cs	1.28 +/- 0.12	Sr	270 +/- 63
Eu	1.9 +/- 0.06	Ta	1.38 +/- 0.055
Fe	67000 +/- 2400	Tb	1.08 +/- 0.091
Hf	7.08 +/- 0.59	Th	6.22 +/- 0.37
K	14700 +/- 3600	U	1.5 +/- 0.23
La	31.5 +/- 1.3	W	1.26 +/- 0.52
Lu	0.46 +/- 0.032	Yb	3.19 +/- 0.2
Na	12400 +/- 2500	Zn	109 +/- 7.3
Nd	29.4 +/- 4.8	Zr	239 +/- 24

Table 2. Mean values and errors found in the Nile clay chemical group. All values in mg/kg.

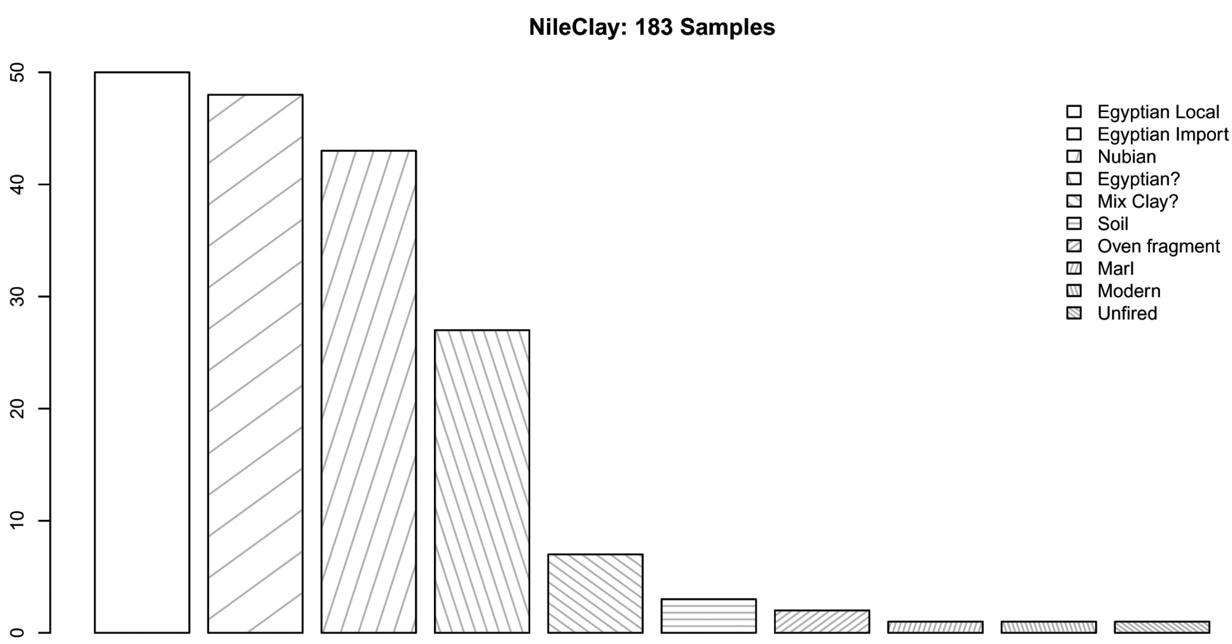

Figure 3. Distribution of archaeological groups in the chemical group of Nile clays. The height of the bar represents the number of samples in the archaeological group.

4 This chemical group also includes three prehistoric Nubian ceramic samples from Sai Island and nine New Kingdom Nile clay ceramics from the site of Dokki Gel (Kerma) (courtesy Philippe Ruffieux; excavation by Charles Bonnet). These samples are not discussed in this paper.

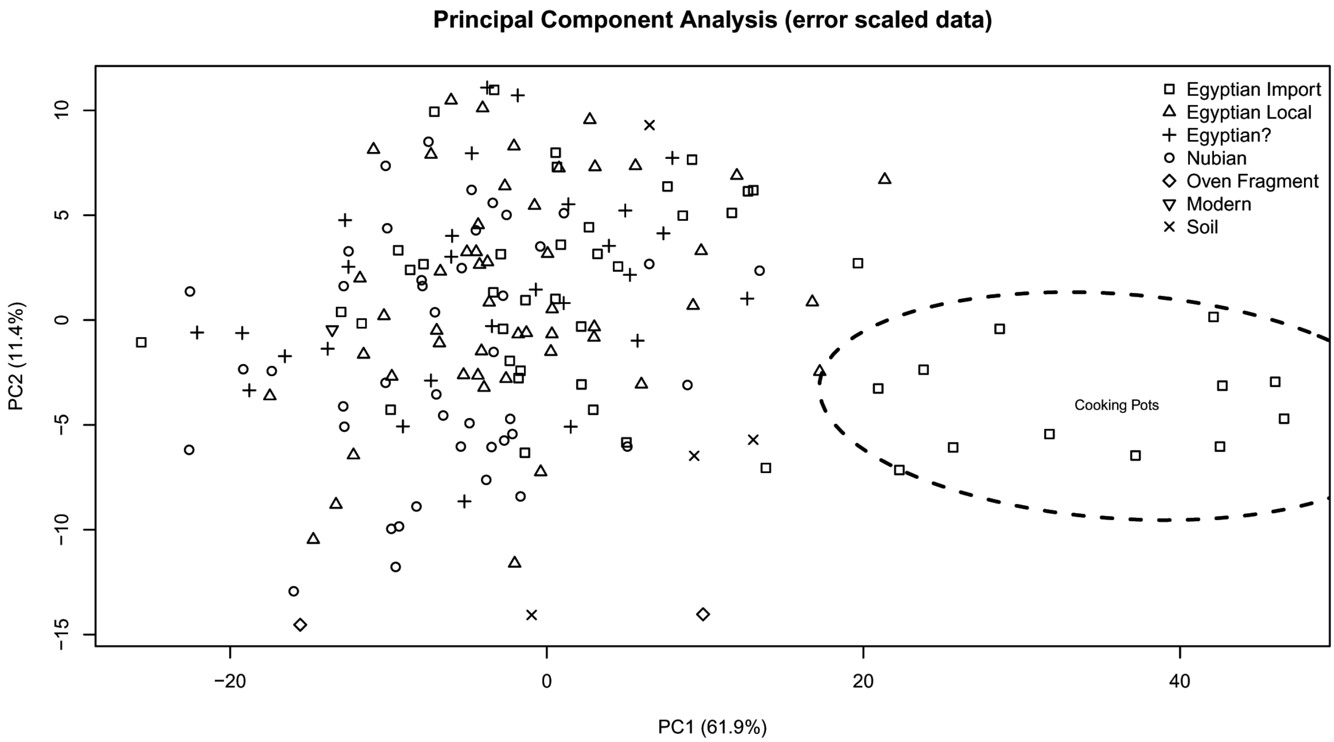

Figure 4. Plot of the two major principal components of all samples in the Nile clay group. Symbols represent the archaeological grouping. The group of cooking pots clearly has a slightly different chemical composition.

Optical Microscopy (OM)

Looking at their petrography, Nubian-Local, Egyptian-Local and Egyptian Import Nile clay wares are all made of a non-calcareous clay matrix, rich in mica and iron oxides, and containing a similar suite of non-plastic inclusions: mainly silicate minerals such as quartz and feldspar (either plagioclase and alkali feldspar). Among other mineral phases, present are: chert, biotite and muscovite micas, chlorite, iron oxides, as well as traces of clinopyroxene (*i.e.* augite), epidote, amphibole (*i.e.* green hornblende), olivine and iron-titanium oxides (*i.e.* ilmenite, ulvospinel). Rock fragments derived from metamorphic, granitoid and volcanic rocks are also common together with pieces of carbonate rocks, classifiable as nodules of microcrystalline calcite (micrite).

Taken together, these characteristics point to the use of an alluvial silt clay as common source of raw material for making these vessels (D'Ercole 2018).

As stressed in previous studies (cf. Carrano *et al.* 2009, 788; Spataro *et al.* 2015), the composition of the Nile alluvia is homogeneous along the river, even several kilometres apart, and samples gained from different Nile clay deposits can show a very similar petrography. However, differences in textural features (grain size) and in the type and proportion of the inclusions (mineral and organic), allowed to discriminate among different petrographic groups. These differences refer to the concept of "fabric" which comprises the raw material plus the potter's treatment, adapted for specific purpose to produce different types of ceramics (Quinn 2013; Rice 2015) (fig. 5).

Nubian-Local samples

Among the Nubian-Local samples, three main petrographic groups or micro fabrics were recognised (figs. 6a-c):

Micro Fabric 1: This is a characteristic sandy fabric, consisting mainly of a large amount of monocrystalline quartz of eolian and/or fluvial origin. The distribution of the silicate minerals is unimodal with a dominant grain size in the class of the fine-grained sand (~ 0.125 to 0.25mm). These samples do not contain or contain only in small amounts organic inclusions. The two samples attributed to this micro fabric are fine black-topped wares, Kerma beakers (tab. 3; fig. 6a).

Micro Fabric 2: Samples from this group have a micaceous texture, with a very fine unimodal grain size (~ 0.062 to 0.125mm) and contain common small organic inclusions. These organics are thin and tubular and seem to consist either of selected/chopped vegetable remains or of an organic component of animal origin (herbivore dung) (cf. D'Ercole *et al.* 2015; 2017; see also Livingstone Smith 2001). Macroscopically, these samples are medium-fine to medium open wares: black-topped and black-topped red slipped wares, bowls with burnished or wet

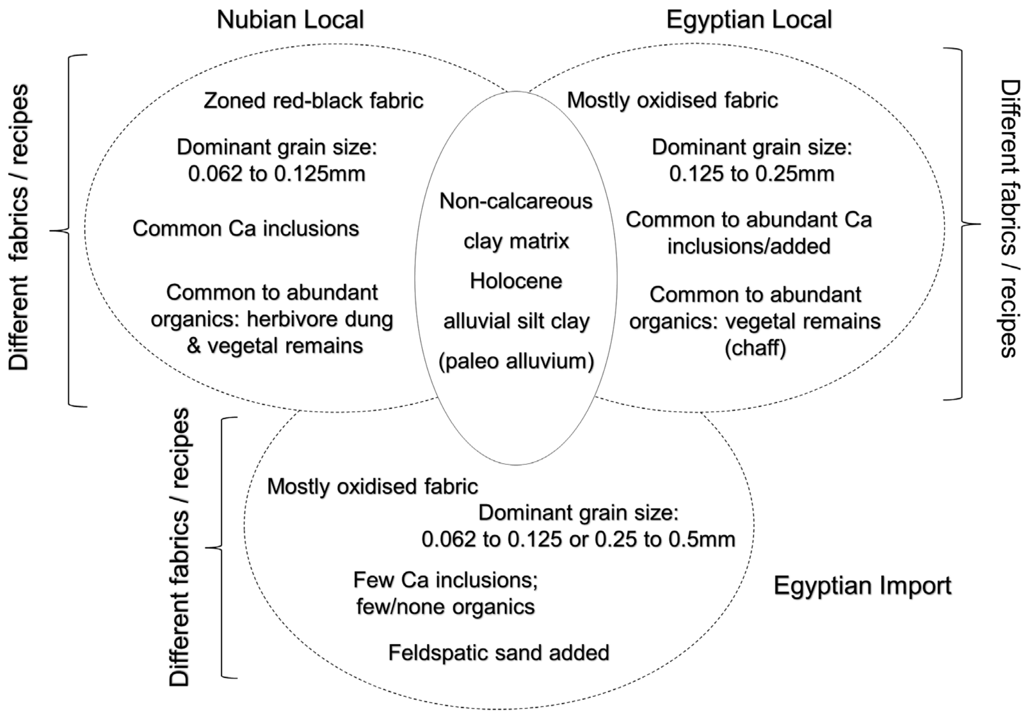

Figure 5. Schematic representation of the main petrographic features recognised in thin section. The circle in the middle includes the features that the groups have in common. The dashed circles refer to the features peculiar to each group.

smoothed surfaces decorated with incised or impressed patterns (tab. 3; fig. 6b).

Micro Fabric 3: This fabric has the same suite of non-plastic inclusions of fabric 2, however, it can be distinguished from it because of the significant presence of large organic matter added to the paste as a temper. The organics are either elongated pieces of straw and grass or other vegetable matter such as glumes, seeds, fruit or berries. In a few samples, the presence of calcium carbonate spherulites from herbivore dung was recognised (cf. Canti 1998, 435). Samples from this group mainly refer to bowls or globular vessels and cooking pots with typical basketry or matting impressions (tab. 3; fig. 6c).

Egyptian-Local samples

In the same way as the Nubian-Local samples, also within the Egyptian-Local wares we distinguished three main petrographic groups or micro fabrics (D'Ercole 2018) (figs. 6d-f):

Micro Fabric 1: Samples from this fabric are characterised by a very fine and homogeneous framework (average grain size between ~ 0.062 to ~ 0.125mm) with abundant mica and iron oxides. They contain numerous clay pellets and argillaceous rock fragments. Organic inclusions are few to abundant. They are completely carbonised and seem to derive mainly from straw, chaff and other plant remains. Samples assigned to this fabric are either hand-shaped bread plates and bread moulds or wheel-made dishes made in a local variation of fabric Nile clay B_2/C_2 or C_2 of the Vienna system (tab. 3; fig. 6d).

Micro Fabric 2: These samples have a dominant grain size in the class of fine sand (~ 0.125 to ~ 0.25mm), with a coarser population of grains consisting of rounded monocrystalline quartz and carbonate rock fragments (up to 1mm and more in size), possibly added to the clay as a temper. Organics are few and they are mainly tubular-shaped and completely carbonised. Macroscopically, these samples are made in a local variation of fabric Nile B_2 (D) or Nile D of the Vienna system and used for bowls, dishes and jars (tab. 3; fig. 6e).

Micro Fabric 3: Samples from fabric 3 have about the same size distribution and suite of mineral inclusions of micro fabric 2. However, they contain a higher amount of organic tempers. The organic inclusions are for the most tubular-shaped carbonised remains of chaff and vegetal fibres and can measure as much as 2.5mm or more long. These samples are made in a local variation of fabric Nile B_2/C_2 or Nile C_2 of the Vienna system and originate from deep bowls and cooking pots (tab. 3; fig. 6f).

Egyptian Import Nile clay wares samples

The petrography of the Egyptian Import Nile clay wares is pretty much the same as the Egyptian-Local samples. Two micro fabrics were distinguished according to the grain

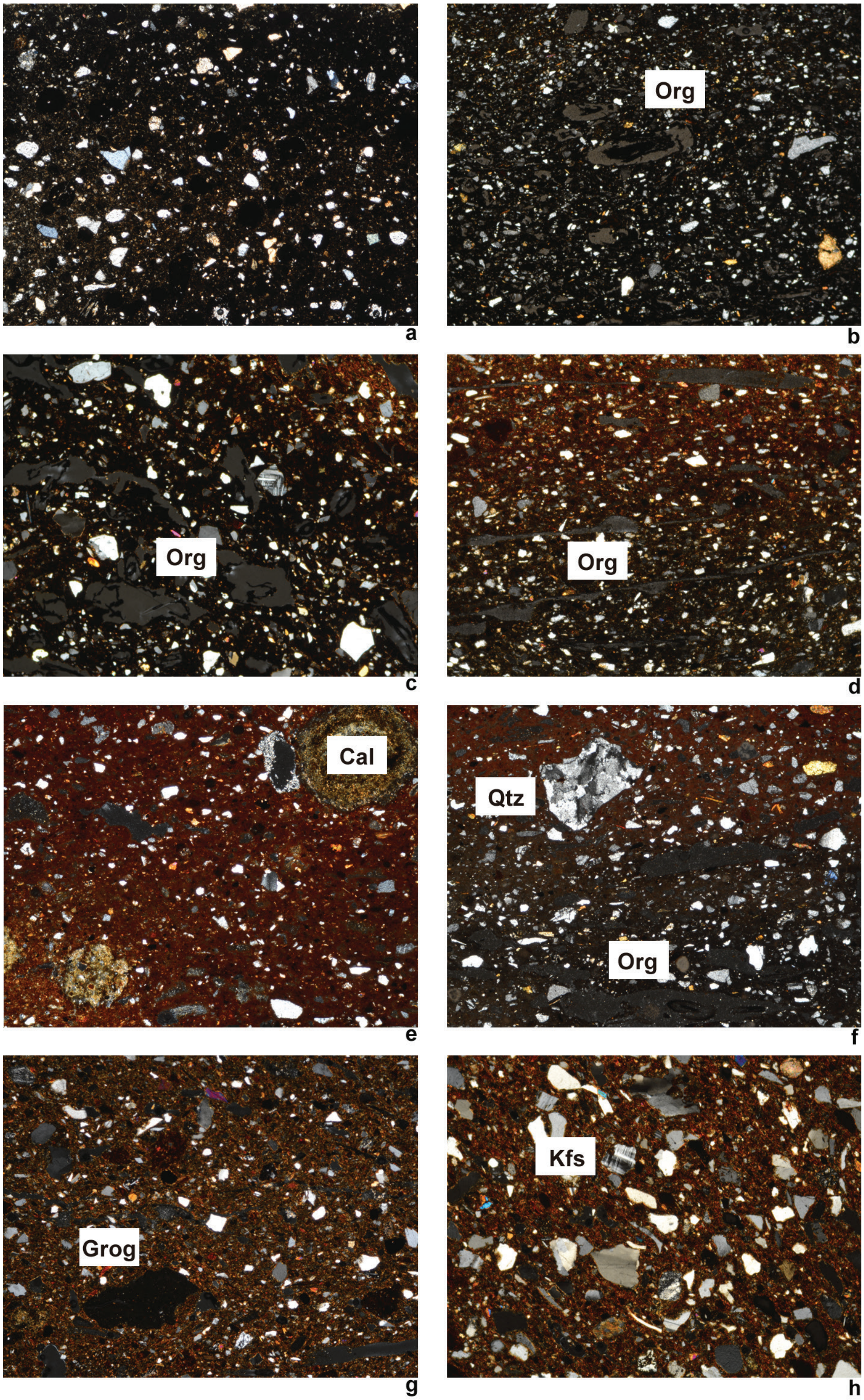

Figure 6. Microphotographs of examples from Nubian-Local (a-c); Egyptian-Local (d-f) and Egyptian Import Nile clays samples (g-h). Abbreviations Org, Cal, Qtz, and Kfs stand for: organics, calcite, quartz, K-feldspar (cross polarized light; 3.3mm field of view; photos G. D'Ercole).

size, the morphology and the type of mineral inclusions (D'Ercole 2018) (figs. 6g-h):

Micro Fabric 1: Very fine to fine sandy and micaceous samples. These samples contain common clay pellets and argillaceous rock fragments (ARF) and possibly some grog inclusions of higher fired ceramic. Organics are few and consist mainly of tubular-shaped chaff remains burned out after the firing. Their size commonly ranges from 1 to 2mm. These samples are cooking pots manufactured in a sandy version of a Nile clay B_2 of the Vienna system (tab. 3; fig. 6g).

No. sample	No. pottery	Sector	Description	Macro fabric	Vessel form	Micro fabric
SAV/S 01	N/C 966.1	SAV1N	Nubian-Local	2 (GDE)	Cooking pot	Nubian-Local 2
SAV/S 02	N/C 966.2	SAV1N	Nubian-Local	2? (GDE)	Cooking pot	Nubian-Local 2
SAV/S 03	N/C 966.3	SAV1N	Nubian-Local	3? (GDE)	Beaker, possibly post NK?	Nubian-Local 3
SAV/S 04	N/C 966.4	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 05	N/C 966.5	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 06	N/C 1302	SAV1 N	Nubian-Local	2 (GDE)	Cooking pot	Nubian-Local 2
SAV/S 07	N/C 1302	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 08	N/C 1302	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 09	N/C 1302	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 10	N/C 1302	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 11	N/C 1302	SAV1N	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 12	N/C 1302	SAV1N	Nubian-Local	1/2 (GDE)	-	Nubian-Local 2
SAV/S 13	N/C 1302	SAV1N	Nubian-Local	2/3 (GDE)	-	Nubian-Local 2
SAV/S 14	N/C 702.1	SAV1N	Egyptian-Local	var. B2/C2	Dish	Egyptian-Local 1
SAV/S 15	N/C 702.2	SAV1N	Egyptian-Local	var. B2 (D?)	Incense bowl	Egyptian-Local 2
SAV/S 16	N/C 702.3	SAV1N	Egyptian-Local	var. B2 (D)	Carinated dish	Egyptian-Local 2
SAV/S 17	N/C 702.10	SAV1N	Egyptian-Local	var. B2/C2	Jar	Egyptian-Local 3
SAV/S 18	N/C 1295	SAV1N	Egyptian-Local	var. B2	Base sherd	Egyptian-Local 1
SAV/S 49	SAV1E P 015.4	SAV1E	Nubian-Local	1 (GDE)	Kerma beaker	Nubian-Local 1
SAV/S 50	SAV1E P 026.11	SAV1E	Nubian-Local	3 (GDE)	Cooking pot	Nubian-Local 3
SAV/S 51	SAV1E P 015.2	SAV1E	Egyptian-Local	var. C2	Deep bowl	Egyptian-Local 3
SAV/S 52	SAV1E P 015.3	SAV1E	Egyptian-Local	var. C2	Bread plate	Egyptian-Local 1
SAV/S 53	SAV1E P 020.10	SAV1E	Egyptian-Local	var. B2 (D?)	Dish, black rim	Egyptian-Local 2
SAV/S 54	SAV1E P 020.16	SAV1E	Egyptian-Local	var. D2	Neckless jar	Egyptian-Local 2
SAV/S 55	SAV1E P 026.12	SAV1E	Egyptian-Local	var. C2	Bread mould	Egyptian-Local 1
SAV/S 56	SAV1E P 026.13	SAV1E	Egyptian-Local	var. C2	Bread mould	Egyptian-Local 1
SAV/S 70	N/C 927	SAV1N	Nubian-Local	1/2 (GDE)	-	Nubian-Local 2
SAV/S 76	N/C 801	SAV1N	Nubian-Local	1? (GDE)	-	Nubian-Local 2
SAV/S 77	N/C 801	SAV1N	Nubian-Local	1 (GDE)	-	Nubian-Local 2
SAV/S 80	N/C 1209	SAV1N	Nubian-Local	1/2 (GDE)	-	Nubian-Local 2
SAV/S 85	N/C 865	SAV1N	Nubian-Local	1 (GDE)	-	Nubian-Local 1
SAV/S 149=150	SAV1W P 2014/002	SAV1W	Egyptian Import	E var.	Cooking pot	Egyptian 2
SAV/S 151	SAV1W P 2014/003	SAV1W	Egyptian Import	B2 var.	Cooking pot	Egyptian 1
SAV/S 152	SAV1W P 012.5	SAV1W	Egyptian Import	B2	Cooking pot	Egyptian 1
SAV/S 153	SAV1W P 012.6	SAV1W	Egyptian Import	B2 (sandy)	Cooking pot	Egyptian 1
SAV/S 154	SAV1W P 012.7	SAV1W	Egyptian Import	B2 (sandy, calc.)	Cooking pot	Egyptian 1
SAV/S 155	SAV1W P 012.8	SAV1W	Egyptian-Local	var. B2 (chaffy)	Cooking pot	Egyptian-Local 3
SAV/S 156	SAV1W P 012.9	SAV1W	Egyptian Import	E var.	Cooking pot	Egyptian 2

Table 3. Provenance, macroscopic features and fabric groups defined by petrographic analysis. The acronym GDE refers to the Nubian macro fabrics identified by G. D'Ercole on the field (see AcrossBorders report 2013).

Micro Fabric 2: Medium-grained sandy Egyptian samples with abundant quartz, alkali-feldspar and biotite mica. Samples from this fabric also contain a large amount of rock fragments of both volcanic and metamorphic origin. They do not contain any organic remains. Porosity is very low, and the fabric appears macroscopically hard and gritty to the touch. These samples are cooking pots manufactured in a variant of a Nile clay E of the Vienna system (tab. 3; fig. 6h).

Discussion

The recent excavations undertaken at the New Kingdom town on Sai Island as part of the AcrossBorders project have shown that the greatest quantity of the New Kingdom vessels found at the site were made from Nile silt clay (*i.e.* Nile paleo-alluvium). This group of wares includes both locally made products (either Nubian or Egyptian types) modelled from local clays collected and manufactured on Sai Island itself, but also examples of authentic Egyptian vessels produced on the outside of Nubia, possibly from Nile clay deposits located in Upper Egypt. These latter were found in all sectors of the town, beside the local production, and mostly refer to cooking wares made from a characteristic sandy Nile clay fabric (Nile clay B_2 or a variant of a Nile clay E of the Vienna System) (Budka 2016; 2017a). There are also are many other examples of Egyptian vessels made in Nile clay wares, such as dishes and decorated jars, which are likely to be imported, although this is less visible from a chemical point of view. Further analysis could confirm or deny the archaeological interpretation.

The Nubian hand-made wares can easily be differentiated from the wheel-made Egyptian types in the field as for being made through different manufacturing techniques and eventually by distinct social groups (respectively: Nubians and Egyptians residing in Nubia). However, the Egyptian wheel-made wares are more difficult to separate, and their attribution as local or imported is sometimes uncertain and can raise questions. In any case, these three pottery types (Nubian, Egyptian-Local and Egyptian Imported) are all made from a clay raw material geochemically very homogeneous so that paradoxically it becomes even more complex to separate these wares in the laboratory, according to specific petrological and chemical features (cf. Carrano *et al.* 2009, 787).

In this study, we have compared a large sample of Nile clay vessels from the New Kingdom town on Sai Island with other wares as well as with unfired bricks and natural soils. An integrated approach was adopted for the laboratory analyses, carrying out INAA and OM.

INAA analysis succeeded in separating the samples into different compositional groups, whose largest is Group 1. Within the remainder of the samples, sixteen additional groups were identified. Group 1 is chemically very homogeneous and includes most of the Nile clay wares, that is: Nubian types, locally produced Egyptian types and Egyptian Imported Nile clay wares. The unfired bricks, some of the natural soils and the modern ceramic samples also fit into this group, indicating the possibility of a correlation between Nile clay ceramics and local sediments through a broad chronological frame.

Within Group 1, Principal Component Analysis allowed a separation between Egyptian-Local and Egyptian Imported Nile clay wares. In particular, the cooking pot wares formed a well isolated cluster. In contrast, the locally made types (Nubian-Local and Egyptian-Local) turned out to be chemically very similar.

Observations on thin sections were consistent with the chemical results and confirmed that the largest group of Nile clay wares is strongly homogeneous also in its petrography. The mineralogical data suggested that Nubian-Local, Egyptian-Local and Egyptian Imported Nile clay wares were all made from Nile alluvial clays typically containing fine quartz, feldspar and mica together with rock fragments of calcareous, metamorphic and volcanic origin. Based on the proportion of the mineral components, their size distribution and the type and quantity of organic matter added to the pastes, it was possible to recognise different micro groups or fabrics. Such a variability may be attributed both to the varying composition of the raw materials selected to make pots with (different deposits/sources of Nile clays) and to the technological choices made by potters during the manufacture.

Specifically, the Nubian vessels turned out to have a finer grain size in comparison with the Egyptian wares and to contain on average a larger amount of organic inclusions, which were mainly of animal origin (herbivore dung), in the fine and medium wares, and of both animal and vegetal origin, in the coarse wares and in the cooking pots (cf. also Carrano *et al.* 2009). In contrast, the Egyptian-Local vessels were in most cases tempered with an organic component of vegetal origin (chaff and other plant remains). The fine wares, either Nubian or Egyptian, always contained a lower proportion of organics, abundant mica and very fine quartz inclusions.

Some of the Egyptian cooking pots showed a unique fabric: they contained predominant quartz grains angular to sub-angular in shape associated with crystals of alkali feldspar, biotite mica and rock fragments. In these samples, the size, distribution and morphology of the non-plastic inclusions might indicate the deliberate addition of a feldspathic medium-grained sand to the clay resulting from the decomposition of granitoid and metamorphic rocks (D'Ercole 2018). These petrological features correlate well with the chemical data and suggest that these vessels, manufactured in a variant of Nile clay E of the Vienna system, were most likely produced outside of Sai Island in a geological context where alkaline granite and derived metamorphic rocks outcrop. Besides provenance, it is worth to stress the coexistence of two very distinct types of cooking wares at the New Kingdom site on Sai Island: on the one hand the Nubian cooking pots produced locally according to the Nubian tradition and recipe (D'Ercole *et al.* 2017) with pastes rich in organic tempers (see micro fabric 3 of the Nubian samples); on the other hand the authentic Egyptian cooking pots, tempered mainly or exclusively with mineral inclusions (see micro fabric 2 of the Egyptian Import samples). In addition to these two types, there are also examples of Egyptian cooking pots thrown on the wheel on Egyptian models by using a local (Upper Nubian) variant of a sandy Nile clay tempered, in different proportion, with organic inclusions (cf. Budka 2016, 287).

Such differences in the manufacturing process in the use of similar Nile clay-based ceramics might be explained according to differences in the ways of cooking (*e.g.* different ranges of temperatures, cooking procedures and eventually type of food for which the vessels were intended for).[5] Also, we must bear in mind the role played by the various standards of craftsmanship and by the local traditions and cultural identities (Budka 2016; 2017a, 440).

An experimental practical class was recently undertaken on this topic by the team of AcrossBorders (see http://acrossborders.oeaw.ac.at/tag/cooking-ware). Further research and laboratory analyses are planned in the future with the aim of elucidating this aspect of ceramic production.

Ultimately, a methodological consideration regards the benefits of combining petrological and chemical analyses with the archaeological classification of the ceramics on the field. This study showed that both methods, INAA and OM, worked in finding similar groups which correspond and supplement the macroscopic identification. INAA particularly has proven to be a valuable method for differentiating, among the Nile clay wares, the local from the non-local production, although the compositional differences were not as sharp as by the archaeological assessment. OM added useful information on the technological processes which complemented and finalised the macroscopic groupings. More detailed results derived from an efficient combined use of chemistry and petrography.

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5 In terms of technology and performance, a cooking pot should satisfy the following requisites: fracture strength, toughness, thermal shock resistance and thermal conductivity or heat transfer. These requisites depend on the ceramic manufacture and are mainly related to the firing temperatures and to the addition of tempering material (Tite *et al.* 2001). Generally, high amounts of temper material and low firing temperatures increase thermal shock resistance and toughness (Kilikoglou *et al.* 1995). On the other way around, vessels fired at high temperatures result in an increase in fracture strength (Steponaitis 1984; Kilikoglou *et al.* 1995) and thermal conductivity, the latter being beneficial for boiling activities (cf. Müller *et al.* 2013, 6). Pastes (like the Nubian cooking pots) with large and open pores have a bad thermal resistance although the heat transfer is greater. These vessels are theoretically poor cooking pots as porosity delays heating (Velde and Druc 1999, 161).

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FROM MICROCOSM TO MACROCOSM

This book illustrates the state-of-the-art in settlement archaeology in Northeast Africa.

As reflected in the title "From Microcosm to Macrocosm: Individual households and cities in Ancient Egypt and Nubia", both a micro-approach introducing microhistories of individual sites according to recent archaeological fieldwork incorporating interdisciplinary methods as well as general patterns and regional developments in Northeast Africa are discussed.

This combination of research questions on the micro-level with the macro-level provides new information about cities and households in Ancient Egypt and Nubia and makes the book unique. Architectural studies as well as analyses of material culture and the new application of microarchaeology, here especially of micromorphology and archaeometric applications, are presented as case studies from sites primarily dating to the New Kingdom (Second Millennium BC). The rich potential of well-preserved but still not completely explored sites in modern Sudan, especially as direct comparison for already excavated sites located in Egypt, is in particular emphasised in the book.

Settlement archaeology in Egypt and Nubia has recently moved away from a strong textual approach and generalised studies to a more site-specific approach and household studies. This new bottom-up approach applied by current fieldwork projects is demonstrated in the book. The volume is intended for all specialists at settlements sites in Northeast Africa, for students of Egyptology and Nubian Studies, but it will be of interest to anyone working in the field of settlement archaeology. It is the result of a conference on the same subject held in 2017 as the closing event of the European Research Council funded project AcrossBorders at Munich.

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