Re-assessing Middle Nubian cultural constructs through ceramic petrography

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Abstract This study employs ceramic petrography to establish if the existing typology-based divisions for the so-called Middle Nubian cultures can be related to variations in Nubian ceramic technologies during the mid-second millennium BC (c. 1800–1550 BC). Raw materials, paste recipes, and firing technology are analyzed to identify similarities and differences between the C-Group, Pan-Grave, and Kerma ceramic traditions. Three distinct fabric groups could be identified. Each corresponds, suggestively, to one of the existing cultural units. It is proposed that these variations reflect different approaches to resource acquisition and processing as well as distinct firing processes. Although these technological groups may relate to chronology and subsistence strategies, more evidence is needed before directly linking ceramic technologies to cultural units.

Résumé Cette étude utilise la pétrographie céramique pour déterminer si les distinctions établies entre les cultures dites «Middle Nubian», principalement basées sur la typologie céramique, correspondent aussi à des variations technologiques dans la fabrication des poteries nubiennes du milieu du deuxième millénaire avant notre ère (vers 1800-1550 avant notre ère). Les matières premières, les recettes de pâtes et les méthodes de cuisson sont analysées pour identifier les similarités et les différences entre les traditions céramiques des cultures Groupe C, «Pan-Grave» et Kerma. Trois groupes de pâtes distincts ont pu être identifiés. Chaque groupe correspond, potentiellement, à l’un des groupes culturels établis. Il est proposé que ces variations reflètent différentes approches quant à l’acquisition et au traitement des ressources ainsi qu’à des méthodes de cuisson distinctes. Quoique ces groupes technologiques peuvent être rattachées à la chronologie et à différentes stratégies de subsistance, plus de recherche est nécessaire avant d’établir un lien direct entre les technologies céramiques et les unités culturelles.

Introduction

According to traditional scholarship, during the mid-second millennium BC (c. 1800–1500 BC), ancient Nubia was inhabited by several archaeological cultures: namely the C-Group, Kerma, and Pan-Grave cultures (Childe, 1929, v-vi). These labels, collectively known as the Middle Nubian cultures, were defined by archaeologists during the first half of the twentieth century. The term “Nubia” itself is anachronistic, but it is the most widely used name for the region extending from the First Nile Cataract to as far as the Sixth Nile Cataract as well as the desert regions on either side of the river (Fig. 1). The first of the documented cultures was the Pan-Grave,
Fig. 1 Map of the region, showing the location of sites from which petrographic samples were taken (A. de Souza)
which W. M. F. Petrie described based on graves excavated at Diospolis Parva in modern Egypt (Petrie, 1901, p. 45–49). The material culture associated with the Pan-Grave tradition is the most widespread of the three Middle Nubian groups and is attested along the length of the Nile Valley and in the surrounding desert regions (Bietak, 1966, p. 70–78; de Souza, 2019, p. 83–96; Liszka & de Souza, 2021, 2021; Säve-Söderbergh, 1989, p. 15–19). Following the first Archaeological Survey of Nubia, George Reisner defined the C-Group (Reisner, 1910, p. 332–342), which is most densely attested in the region commonly known as “Lower Nubia,” between the First and Second Nile Cataracts. Reisner’s definition of the C-Group has undergone revisions over the past decades. However, apart from being divided into a series of internal chronological phases, the material attributes of the culture remain stable (Bietak, 1968; Hafsaas, 2021; Säve-Söderbergh, 1989, p. 6–14). Reisner (1923) also defined the Kerma culture, a major African political power that controlled a vast region of Nubia from its center at Kerma, near the Third Cataract (Bonnet, 2019, 2021; Emberling & Williams, 2010; Emberling et al., 2014). Coinciding with the late Second Intermediate Period in Egypt (c. 1650–1550 BC), Kerma’s control extended northward to the First Cataract (Davies, 2003; de Souza, 2020, p. 330–331).

The validity and relevance of the Middle Nubian cultural groups have been subjected to increasing scrutiny in recent years, and the century-old image of bounded and clearly defined cultural groups is being challenged. All three groups overlap chronologically. According to the existing framework, the Classic Kerma period, C-Group Phase IIB, and the Pan-Grave are synchronous and broadly contemporaneous with the Second Intermediate Period of Pharaonic Egypt (Fig. 2). The groups also overlap spatially. Material culture attributed to each is attested in the Nile Valley from at least the Fourth Cataract northward into modern Egypt, with scattered archaeological attestations in the surrounding desert regions (Edwards, 2004, p. 75–111; Raue, 2019a, b). In certain cases, the material culture that would be attributed to different Nubian groups occurs together at the same site and even in single burial contexts. For example, objects attributed to the Pan-Grave, Kerma, and Egyptian material culture traditions appear together at Debeira East (Säve-Söderbergh, 1989, p. 192–194, 251–254; de Souza, 2021, p. 233–236). These temporal, spatial, and cultural interconnections between cultural units (which have long been portrayed as bounded groups) have

![Fig. 2 Relative chronological timeline](image-url)
become increasingly evident in new studies (e.g., Budka et al., 2019; Manzo, 2017, p. 33–54; Raue, 2018, p. 208–262). More attention is also being given to cultural activity in the so-called marginal areas, in the deserts on both sides of the Nile. These include the Handessi Horizon to the west in the Wadi Howar (Jesse, 2006; Jesse et al., 2004) and the Gash Group and Jebel Mokram Group to the east at sites around Kassala (Manzo, 2017, p. 33–54). Renewed considerations of the Nubian presence in Egypt add a further layer of complexity to the interconnections between the various Nubian cultures active at the time (de Souza, 2020; Forstner-Müller & Rose, 2012; Raue, 2018, 2019b). Similarities between the material culture of the early C-Group and Kerma traditions suggest that these two groups may share a common heritage (Edwards, 2004, p. 110–111). Moreover, the high variability in the archaeological remains attributed to the Pan-Grave culture has led to its re-definition as a broader cultural horizon rather than a single homogenous tradition (de Souza, 2019, p. 150–154). Morphological and stylistic consistencies between the material traditions of all three groups make it clear that the existing culture-historical framework of bounded cultural entities can no longer be sustained. Instead, it is now widely acknowledged that the sociocultural landscape of ancient Nubia during all periods was characterized by diverse and fluid populations spread across a vast geographic expanse and that those populations were interconnected via complex networks of inter- and intra-cultural contacts and exchanges. Therefore, conceptual and theoretical frameworks that better reflect the archaeological reality must be explored.

This study employs ceramic petrography to establish if the existing typology-based cultural divisions can be related to ceramic technologies. Pottery, being the most abundant class of artifacts, is an invaluable tool for addressing questions relating to the sociocultural landscape of ancient Nubia. The underlying question is the extent to which technological differences between the various ceramic traditions might correspond to cultural differences, with specific attention given to the selection and processing of raw materials, including materials added as temper. This preliminary but detailed analysis of the most basic elements of ceramic production—the raw materials—has the potential to identify technological patterns among the various chaînes opératoires and offers fresh insights into Nubian pottery making processes, ceramic ecologies, and sociocultural interconnections (Gosselain, 2012; Roux, 2016; for Nubia specifically, see D’Ercole et al., 2017a). Petrography also has the potential to inform explorations of new avenues for reconfiguring existing ceramic typologies by shifting the focus from morphological and stylistic differences to material practices and technologies.

| Table 1 | Summary of existing fabric classification systems for Middle Nubian pottery |
|----------|--------------------------------------------------------------------------------|
| **Nordström 1972** | **Gatto 2014** | **Raue 2018** | **De Souza, 2019** |
| Fabric Group I | PGI | ELN1 | PG.1 |
| Sand-tempered ferruginous fabric | Dung tempered fabric | Fein | No visible temper |
| • IA: High-grade fabric with fine sandy paste | • PGIa: fine | • ELN2 | • PG.2 | Dung temper |
| • IB: High-grade fabric with a micaceous paste | • PGIb: coarse | • ELN5 | • PG.3 | Chaff temper |
| • IC: Medium or low-grade fabric with a sandy paste | • PGI: Straw tempered fabric | • Sehr viel Häcksel | • PG.4 | Straw temper |
| • ID: Low- to medium-grade fabric of coarse, sandy paste | • PGI: Sand tempered fabric | • | • PG.5 | Sand temper |
| • IE: Medium-grade fabric of fine sandy paste | | | |
| Fabric Group II | | | |
| Ferruginous fabrics with organic temper | | | |
| • IIA: Low- to medium-grade fabric with ash-tempered paste | | | |
| • IIB: Low- to medium-grade fabric with dung-tempered paste | | | |
| • IIC: Low- to medium-grade fabric with dung-tempered brown paste | | | |
| • IID: Medium- to high-grade fabric with variegated dung-tempered paste | | | |
| • IIE: Low- to medium-grade fabric with chaff-tempered paste | | | |
Another motivation was to test how existing fabric classification systems that are based on macro-analysis (i.e., 10× magnification) correspond to paste recipes observed through microanalysis using ceramic petrography. These existing classification systems are summarized in Table 1. The most widely referenced fabric classification system for Nubian pottery is that devised by Hans-Åke Nordström for the Scandinavian Joint Expedition (SJE) survey in the region of the Second Cataract, which was applied to Early and Middle Nubian pottery (Nordström, 1972, p. 48–56; Säve-Söderbergh, 1989, p. 25–30). The SJE classification comprised five main fabric groups based on the clay type and the non-plastic materials, the first two of which cover the macro-fabric types observed in the Nubian ceramic assemblage in the SJE survey area. Those groups are: (I) sand-tempered ferruginous fabrics and (II) ferruginous fabrics with organic temper. Group III comprises shell-tempered fabrics, which do not occur in the Middle Nubian assemblages, and the remaining two groups, IV and V, cover pottery of Egyptian-style production. All groups are further divided into subgroups based on the character of the tempering material. At Elephantine, the Nubian pottery from contexts dating to the early and mid-second millennium BC have all been assigned to variants of three main fabric groups—ELN1, ELN2, and ELN5—each of which is defined by its overall coarseness (Raue, 2018, p. 227–229, 412–413). As this pottery comes from a settlement context, it cannot always be directly correlated with pottery from mortuary contexts. More simplified classification systems have recently been proposed for pottery attributed to the Pan-Grave culture. Gatto’s study of the Pan-Grave pottery from the Aswan–Kom Ombo region identified three fabrics based on added temper, namely dung, straw, and sand (Gatto, 2014, p. 23). The system devised by de Souza for Pan-Grave ceramics throughout the Nile Valley comprises five macro-fabric groups that are based on the type and size of tempering material. Those five groups are: PG.1—no visible temper; PG.2—dung temper; PG.3—chaff temper; PG.4—straw temper; PG.5—sand temper (for characterization of each group, see de Souza, 2019, p. 29–32).

The results of the petrographic analysis will be linked to the typology developed by de Souza, which is largely based on the SJE assemblages and is now being applied to Nubian-style pottery more generally (e.g., the ongoing fieldwork at Tell Edfu, Egypt). Other site-specific fabric classifications were also presented as part of a workshop on Nubian-style pottery in Egyptian cultural contexts (see various contributions in: Forstner-Müller & Rose, 2012).

Samples and Sites

The sherds examined in this study were excavated in 1961–1964 by the Scandinavian Joint Expedition to Sudanese Nubia (SJE) within the framework of the UNESCO mission to rescue and document the monuments in the region that would be lost following the construction of the Aswan High Dam (Säve-Söderbergh, 1970, p. 13–23; UNESCO, 1980, p. 41). The SJE’s survey area covered some 150 km² along the east bank of the Nile between Faras and Gemai, just south of the modern Sudanese-Egyptian border (Fig. 1). More than 490 previously unknown sites were recorded in the area, spanning the Neolithic through the Middle Ages, among which approximately 4200 burials were excavated and recorded. All of the finds were divided between Sudan and the four participating Nordic countries (Denmark, Finland, Norway, and Sweden) in accordance with legal agreements in place at the time. Materials from the Early and Middle Nubian Period sites were sent to Uppsala University, Sweden, from where the samples in this study were obtained with permission from the Museum Gustavianum.

This petrographic study is based on the analysis of 23 ceramic samples drawn from five mortuary sites (Table 2), which will now be briefly described from north to south. SJE Site 47 is the second largest site attributed to the Pan-Grave culture with 159 individual burials, most of which had been plundered in ancient times (Säve-Söderbergh, 1989, p. 166–174; de Souza, 2019, p. 78, 123). SJE Site 170 is a cemetery of 48 graves that yielded material culture attributed to the Pan-Grave and Kerma cultures. In certain cases, objects from both are found together in single burial contexts (Säve-Söderbergh, 1989, p. 192–199; de Souza, 2019, p. 77). SJE Site 65 is attributed predominantly to the C-Group, but some graves interspersed near the central and western parts of the site display Pan-Grave characteristics (Säve-Söderbergh, 1989, p. 174–180; de Souza, 2019, p. 78). SJE Site 95 is culturally and chronologically mixed with burials attributed to the A-Group (dated to the fourth millennium BC, see Gatto, 2021), C-Group, and Pan-Grave cultures, indicating that the site was used over a long period (Säve-Söderbergh, 1989, p. 181–185; de Souza, 2019, p. 79–80). SJE Site 97 is a large C-Group cemetery with 132 burials and 27...
offering deposits (Säve-Söderbergh, 1989, p. 185–189), and SJE Site 410 is a small but mixed site with 30 graves attributed to the Pan-Grave and Kerma cultures (Säve-Söderbergh, 1989, p. 251–254). The intensively multicultural character of the region is clearly illustrated in the northern group of sites (SJE Sites 47, 170, and 65), among which all three of the Middle Nubian traditions are attested, together with Egyptian-style material culture. Chronologically, the samples in the analysis span a period from c. 1800–1550 BC, corresponding to Dynastic Egypt’s late Middle Kingdom through the late Second Intermediate Period.

Samples were selected in consultation with the curatorial and conservation staff at Museum Gustavianum to ensure the preservation and integrity of the sherds and the collection more broadly. A number of factors guided the selection process. Firstly, the selection was made to ensure that all three of the Middle Nubian cultures as they are currently defined were represented, specifically within the context of the SJE survey area. Secondly, samples were selected to capture the full variety of ware types in order to observe the fullest possible range of material and technological variations in Middle Nubian pottery traditions represented in the SJE assemblage as a whole. The sample includes coated and uncoated wares, black-topped wares, decorated and undecorated wares, as well as coarse and fine wares. For reasons of consistency, all but one of the samples come from open bowl forms, which are common to all three of the Middle Nubian traditions (Table 2). The only exception is a rim sherd from a small closed vessel currently attributed to the C-Group (SJE 65/3:5). Thirdly, the samples were selected to capture as wide a range as possible of the different macroscopically identifiable fabric groups in the assemblage following de Souza’s classification system (de Souza, 2019, p. 29–32). Other practical parameters were that only existing sherds could be taken; sherds could only be taken if there was at least one other diagnostic piece from the same vessel; and, as much as possible, only the smallest sherd could be

Table 2  List of all samples in order by sample number with notes on fabric (de Souza system), ware, shape, and initial cultural attribution

| Sample No | Tradition      | de Souza fabric | Ware                          | Shape                |
|-----------|----------------|-----------------|-------------------------------|----------------------|
| SJE 47/0:6(f) | Pan-Grave | PG.1            | Black-top uncoated, decorated | Restricted bowl, rounded form |
| SJE 47/0:6(g) | Pan-Grave | PG.5            | Red-and-black ware, uncoated, decorated | Horned-bowl |
| SJE 47/76:2(c) | Pan-Grave | PG.4            | Uncoated, decorated          | Slightly restricted large bowl |
| SJE 47/119:3(b) | Pan-Grave | PG.1            | Black-top red, coated, burnished | Unrestricted simple cup |
| SJE 47/127:1(c) | Pan-Grave | PG.2            | Black-top red, coated, burnished | Restricted simple bowl |
| SJE 65/3:4 | C-Group?   | PG.2            | Black-top, coated, burnished  | Unrestricted bowl |
| SJE 65/3:5 | C-Group?   | PG.4            | Uncoated                      | Necked bottle |
| SJE 65/4:3 (1) | C-Group | PG.1            | Black-top, coated, burnished  | Restricted bowl |
| SJE 65/21:1 | Pan-Grave | PG.1            | Black-top red, coated, burnished | Restricted inflected bowl |
| SJE 65/76:5 | Pan-Grave | PG.1            | Black-top red, coated, burnished | Restricted bowl |
| SJE 65/107:2 (1) | C-Group | PG.1            | Black-top red, coated, burnished | Unrestricted shallow bowl |
| SJE 65/111:2 | C-Group | PG.3            | Black-top red, coated, burnished | Unrestricted simple bowl |
| SJE 65/208:2 | Pan-Grave/ C-Group | PG.1 | Black-top red, coated, burnished | Slightly restricted bowl |
| SJE 65/246:1 | Pan-Grave? | PG.1            | Uncoated, burnished           | Slightly restricted bowl |
| SJE 95/156:1(a) | Pan-Grave | PG.1            | Black-top red, coated, burnished | Restricted round-based bowl |
| SJE 97/0:120 | C-Group?  | PG.1            | Black-top, coated? lightly burnished | Restricted bowl |
| SJE 97/2:2 | C-Group?   | PG.3            | Uncoated, coarse ware, decorated | Uncertain, cooking-pot? |
| SJE 97/3:4 | C-Group   | PG.2            | Black incised ware, uncoated  | Rounded bowl |
| SJE 97/115:1 | C-Group | PG.2            | Black incised ware            | Rounded bowl |
| SJE 170/30:6 | Pan-Grave? | PG.3            | Uncoated coarse ware, decorated | Large restricted bowl |
| SJE 410/2 (5) | Kerma?    | PG.4            | Uncoated mat-impressed ware   | Large restricted bowl |
| SJE 410/21:2 | Pan-Grave | PG.2            | Black top red, coated, burnished | Restricted bag-shaped bowl |
| SJE 410/23? | Classic Kerma | PG.1       | Kerma beaker ware             | Classic Kerma beaker |
taken. Though small in number, the sample size provides valuable information for re-assessing the cultural definitions of the three groups by focusing on characteristic forms and paste differences that may indicate technological traditions among and between these cultural units. The results presented below also offer a starting point for future analyses that incorporate other methodologies.

Based on current definitions of the Middle Nubian cultures, the majority of the samples can be attributed to the Pan-Grave and C-Group traditions, which are most abundant in the SJE collection. Only two samples could be attributed to the Kerma ceramic tradition owing to the rarity of Kerma materials in the Second Cataract region. Most of the Kerma-style vessels in the collection were either intact or had been reconstructed and could not be broken down for sampling purposes. An important caveat is that both Kerma samples included in the analysis were surface finds without a clear context, but their attribution to the Kerma tradition is well supported based on the presence of their form and decoration in stratified contexts from other regions. For example, Sample 410/23 belongs to the well-known Classic Kerma beaker type (Gratien, 1986, p. 431–433). The mat-impressed sherd, sample 410/2(5), has close parallels from known Kerma-related contexts in Upper Nubia (Budka, 2017, fig. 67; Rose, 2012, p. 18–21, fig. 4–5; Ruffieux, 2012, Fig. 28). Similar sherds have also been found in settlement contexts in Egypt that are roughly contemporaneous with the beginning of the Eighteenth Dynasty (de Souza, 2020, p. 324, fig. 10–11; de Souza & Trognitz, 2021, p. 30–32; Raue, 2018, p. 256–259).

Among the 23 samples are six sherds of uncertain attribution. The goal in selecting these sherds was to test how far petrography can assist in identifying a sherd’s possible technological tradition and link to a cultural group. These sherds came mostly from the culturally mixed Site 65, and they have been tentatively assigned to either the Pan-Grave or C-Group tradition based on their morphology. This uncertain attribution is denoted by a question mark (?) in Table 2.

Methodology

While sample selection was guided by existing definitions of the Middle Nubian cultures, the petrographic analysis did not consider those attributions. Instead, the analysis examined all sherds as “unknowns” to first identify any patterns or trends in paste recipes and then establish how closely these patterns align with the existing cultural groups. The analysis of the thin sections (30 microns in thickness) with a petrographic microscope at 100× magnification followed standard procedures (Reedy, 2008). The colors in plane-polarized light (PPL) and cross-polarized light (XPL) were noted for each thin section. An estimate was made for the frequency of inclusions relative to the clay matrix, and the sorting of the inclusions was specified. The general shape and size range of the inclusions were noted. The minerals identified in the thin section were listed by those representing the main inclusions and the less common ones. Due to the absence of comparative raw materials, the specification of clay type and associated technological processes is based on an extensive body of previously published petrographic analyses of Egyptian and Nubian pottery (D’Ercole et al., 2015, 2017b; Khabir, 1987, 2005, 2008, 2014; Smith, 1991a, 1991b, 1997. See also Ownby & Brand, 2019 for Egypt references). Although these existing studies were useful for comparative purposes, it is important to acknowledge that they were conducted on materials from different regions and periods, being either much earlier or much later than the sherds in this analysis. To the authors’ knowledge, the present study is the first comparative analysis of ceramic materials from all three Middle Nubian cultures. While the sample size is small, the results will serve as a starting point for future study of analogous materials.

Firing temperatures were estimated based on the optical activity of the paste, which is typically optically inactive when fired at temperatures of 850 °C and above (Rice, 1987, p. 92, 431). Decomposition of calcareous material is also an indicator of firing temperature, as calcium carbonate is mostly decomposed at around 850 °C (Rice, 1987, p. 98, 103). The presence of silica from plant remains can be a factor in calculating likely firing temperatures and remains present in the paste, up to at least 800 °C (Rice, 1987, p. 88, 103.).

All the samples are made with Nile clay, and a specific provenance for the raw material could not be considered. Therefore, the primary focus was on paste recipes and processing techniques and their relationship to the existing cultural divisions. Clays from the
Nile typically show only minor mineralogical variation along the river’s length, which limits the possibility of linking vessels to a specific source of raw materials (Ownby & Brand, 2019). This is because the river receives materials from geologically varied upstream sources. Hence, it has a relatively homogeneous mineralogical composition along large sections of its course (Carrano et al., 2009; D’Ercole & Sterba, 2018). Extensive petrographic and chemical analyses of clay samples from the length of the Nile could suggest if any of the samples are likely to have originated in Nubia (see initial work by Maritan et al., 2021, but no samples from the Second Cata-ract). Unfortunately, such a study would be limited in scope as the region of the SJE concession is now fully submerged under Lake Nasser/Lake Nubia. The current analysis, however, builds upon existing petrographic studies of ceramics from Sudan. It adds historical perspectives to ceramic technologies and raw material choices (see especially de Paepe et al., 1992 for Kerma, but also Brand, 2013; Carrano et al., 2009; Chlodnicki, 1989; D’Ercole et al., 2015, 2017; Francaviglia & Palmieri, 1988; Hays & Hasan, 1974; Khabir, 1987, 2005, 2008, 20,014; Mason & Grzymski, 2009; Smith, 1991a, 1991b, 1997; Spataro et al., 2015; Thomas, 2008). Cumulatively, these studies suggest the use of Nile clay, often with plant material, from the Neolithic to the modern era (see D’Ercole, 2021, p. 356–362 with additional references). However, they also highlight other raw materials, particularly for sites in southern Sudan.

### Results

The use of the Nile River clay was consistent across all the samples examined irrespective of cultural attribution, and it was possible to discern three petrofabric

| Sample No | Petrofabric Group | Voids | % of OPL | Plant material | Estimated Firing Temp. (ºC) |
|-----------|-------------------|-------|----------|----------------|-----------------------------|
| SJE 47/0:6(f) | 2 | Long and medium planar | 20 | Straw | 750—800 |
| SJE 47/0:6(g) | 2 | Short planar and subcircular | 10 | Chaff? | 750—800 |
| SJE 47/119:3(b) | 2 | Short planar and subcircular | 10 | Chaff? | 800—850 |
| SJE 47/127:1(c) | 2 | Short planar and subcircular | 30 | Chaff | 750—800 |
| SJE 65/3:4 | 1 | Short planar, subcircular, acicular | 10 | Unknown | 800—850 |
| SJE 65/3:5 | 1 | Short planar and subcircular | 30 | Chaff | 800—850 |
| SJE 65/4:3 (1) | 1 | Short planar and subcircular | 10 | Chaff? | 800—850 |
| SJE 65/21:1 | 2 | Short planar and subcircular | 20 | Chaff | 750—800 |
| SJE 65/76:5 | 2 | Short planar and subcircular | 20 | Chaff | 800—850 |
| SJE 65/107:2 (1) | 1 | Short planar and subcircular | 20 | Chaff | 800—850 |
| SJE 65/111:2 | 1 | Short planar and subcircular | 20 | Chaff | 800—850 |
| SJE 65/208:2 | 1 | Short planar and subcircular | 20 | Chaff | 750—800 |
| SJE 65/246:1 | 1 | Short planar and subcircular | 10 | Chaff? | 750—800 |
| SJE 95/156:1(a) | 2 | Short planar and subcircular | 20 | Chaff | 750—800 |
| SJE 97/0:120 | 1 | Subcircular and acicular | 10 | Unknown | 750—800 |
| SJE 97/2:2 | 1 | Long and medium planar | 20 | Straw | 750—800 |
| SJE 97/3:4 | 1 | Short planar and acicular | 10 | Unknown | 750—800 |
| SJE 97/115:1 | 1 | Short planar and subcircular | 30 | Chaff | 750—800 |
| SJE 170/30:6 | 2 | Short planar and subcircular | 20 | Chaff | 750—800 |
| SJE 410/2 (5) | 3 | Long and medium planar | 20 | Straw | 750—800 |
| SJE 410/21:2 | 2 | Short planar and subcircular | 30 | Chaff | 750—800 |
| SJE 410/23? | 1 | Short planar and subcircular | 10 | Chaff? | 750—800 |
groups within the sample set. Each group had noticeable variations in the character of the paste. The three fabric groups are described below and summarized in Table 3, and full petrographic details are provided in Ownby (2020).

Petrofabric Group 1

Samples in this petrofabric group are composed of Nile clay with some silty inclusions, rare medium-sized grains, and some plant remains. The typical Nile clay inclusions of quartz, potassium feldspar, plagioclase, iron oxides, and opaques are present. Pyroxene is somewhat common, as is biotite. Quartzite and volcanic rock fragments are rare. A mostly black paste color indicates a completely or incompletely reduced firing atmosphere. Where present, an exterior slip appeared as a thin hematite coating without inclusions rather than a clay-based slip characterized by fine mineral grains. Nine samples could be securely attributed to this petrofabric group. Each displays slight variations, but there is noticeable consistency overall. Fabrics in this group correspond de Souza’s types PG.1, PG.2, and PG.3.

Sample SJE 65/3:4 is from an unrestricted bowl made in the fabric described above (Fig. 3b). SJE 65/4:3(1), a restricted bowl, is made from a similar but slightly coarser paste (Fig. 3e). The unrestricted bowls SJE 65/107:2(1) (Fig. 3g) and SJE 65/111:2 (Figs. 3a & 4) are both related to SJE 65/4:3(1) but with mostly fine plant remains. All of these samples were most likely fired between 800 °C and 850 °C. Two decorated samples come from rounded bowls, and both are made of fine Nile clay with some fine plant remains. SJE 97/3:4 (Fig. 5) is uncoated, fired at a low temperature between 750 °C and 800 °C, and has very rare quartzite and volcanic rock fragments in the paste. The firing temperature and atmosphere for SJE 97/115:1 (Fig. 6b) are analogous to the previous sample, and the paste is similar but with more and coarser plant remains. SJE 97/115:1 may also have a dark slip on the exterior side, but this is difficult to determine using only visual analysis owing to the dark color of the vessel fabric. Samples SJE 65/208:2 (Fig. 6a) and SJE 97/0:120 (Fig. 3c), both restricted bowls, are also within this group, but their firing temperature was likely around 800 °C or slightly below.

Three samples that started with uncertain attributions belong to this petrofabric group. SJE 65/3:5 (Fig. 3d) is fine Nile clay with coarse plant remains and some medium to coarse grains. Rare quartzite and volcanic rock fragments are also identified, and the firing temperature was likely above 800 °C. SJE 65/246:1 (Fig. 3h) has finer plant remains with some quartzite and volcanic rock fragments, but the firing temperature was probably lower, between 750 °C and 800 °C. SJE 97/2:2 (Fig. 3f) is a decorated sherd of similar fine Nile clay but contains a lower quantity of quartzite and volcanic rock fragments. Instead, it has more and coarser plant remains than the other samples. This pot was also fired between 750 °C and 800 °C. All three samples were from uncoated vessels, and only SJE 65/246:1 is burnished. Sample SJE 410/23 (Fig. 7), from a beaker of the Classic Kerma style, is made with a fine Nile clay similar to Petrofabric Group 1 but with fewer plant remains. Rare quartzite and volcanic rock fragments are also present. The firing temperature was probably between 750 °C and 800 °C with an even, slightly unoxidized atmosphere.

Petrofabric Group 2

Samples in Petrofabric Group 2 are also Nile clay with mostly carbonized plant remains but with a higher proportion of very fine quartz grains resulting in an overall siltier paste. As with Group 1, occasional medium- to coarse-sized grains could be present along with some variation in the size and amount of plant remains, though the latter is generally more common than in Petrofabric Group 1. Biotite is common and may derive from granite, a few fragments of which were noted in a sample. On the other hand, muscovite and pyroxene are rare. Rock fragments are also rare, occurring mostly as quartzite and occasionally volcanic materials. The paste is typically brownish, indicating an incomplete oxidizing atmosphere. Those sherds with a surface coating appear as a hematite slip that likely derived from earthy hematite with added water rather than clay with natural fine inclusions. A total of ten samples could be assigned to this fabric group. The fabrics in this group mostly correspond to de Souza’s type PG.5 but with organic inclusions.
Fig. 3 Line drawings of vessels made in Petrofabric Group 1. (a) SJE 65/111:2; (b) SJE 65/3:4; (c) SJE 97/0:120; (d) SJE 65/3:5; (e) SJE 65/4:3(1); (f) SJE 97/2:2; (g) SJE 65/107:2; (h) SJE 65/246:1. (All images: A. de Souza)
Of the undecorated samples, SJE 47/119:3b from an unrestricted simple cup has some rare sand-sized quartz and rarer plant remains (Fig. 8e). SJE 47/127:1c (Fig. 8b), a restricted simple bowl, is notable for having some micritic limestone in the paste that was likely natural to the clay deposit. This may indicate a clay source slightly different from that utilized for the other vessels. Sample SJE 65/21:1 (Figs. 8a & 9), from a restricted inflected bowl, was made in a somewhat coarser variant of this fabric, having more notable volcanic rock fragments. SJE 65/76:5 (Fig. 8c), a restricted bowl, has more sand-sized quartz grains and a few volcanic rock fragments. SJE 95/156:1a (Fig. 8d), a restricted round-based bowl, also contains some sand-sized quartz grains and one very coarse-sized quartzite fragment. Some plant remains and a few volcanic rock fragments were noted. SJE 410/21:2 (Fig. 8f) is similar to SJE 65/21:1, but with a slightly coarser Nile clay, some plant remains, and more notable volcanic rock fragments, some of which are likely mafic and possibly basalt. The estimated firing temperatures for these undecorated samples varied from slightly below 800 °C to closer to 850 °C.

The decorated samples are all from uncoated vessels. SJE 47/0:6f (Figs. 8h & 10) is a restricted bowl with a rounded form. Its fabric contains some medium- to coarse-sized grains and includes a sandstone rock fragment and some plant remains. SJE 47/0:6 g (Fig. 11) came from a so-called horned-bowl (de Souza 2019, p. 24–25) and was made of silty Nile clay with sand-sized quartz and some plant remains that are characteristic of this fabric group. The vessel was low-fired, between 750 °C and 800 °C, as was the
previous sample. The slightly restricted large bowl SJE 47/76:2c (Fig. 8g) was made of silty Nile clay with rare sand-sized quartz, and some plant remains, and the firing temperature was higher, probably closer to 850 °C. Another large restricted bowl, SJE 170/30:6 (Fig. 8i), is less silty than the other samples but has a higher proportion of fine to medium inclusions, along with common plant remains and some micritic limestone that could have naturally occurred in the clay deposit. A few coarse-sized quartzite rock fragments were also observed. The vessel was low-fired from approximately 750 °C to 800°C.

Petrofabric Group 3

Only one sherd in the sample belongs to this petrofabric. Its paste is unique in the sample set. The petrofabric comprises a very fine Nile clay with some silty inclusions, a few sand-sized grains, and common plant remains (Fig. 12). The firing temperature was likely in the range of 750–800 °C. While the core is dark gray to black, the edges are light brown, suggesting exposure to oxygen, probably during a short firing. The single sherd in this group, SJE 410/2(5), is from a large, uncoated, mat-impressed ware vessel.
This type of fabric corresponds to de Souza's type PG.4.

**Discussion: From Technology to Tradition**

**Technological Aspects**

The results indicate subtle differences between the raw materials in Petrofabric Groups 1 and 2. Overall, the samples in Petrofabric Group 1 were produced of a fine Nile clay with a high occurrence of very fine-sized inclusions and rare larger grains, along with the addition of plant remains as temper. The characteristics of the Nile clay suggest it may have come from regions south of the First Nile Cataract due to the higher proportion of biotite compared to muscovite, amphibole, and volcanic rock fragments typical for Nile clays from further north. In terms of ware, the eleven samples in Fabric Group 1 comprise coated, uncoated, and decorated sherds, displaying stylistic affinities with the C-Group ceramic tradition as currently defined.

The Nile clay utilized for Petrofabric Group 2 displays many of the same features as Group 1 but has more naturally occurring very fine-, fine-, medium-, and coarse-sized grains and contains slightly more plant remains. Further, the Nile clay for this group has more biotite and fewer volcanic rock fragments. The ten samples in this group include decorated, coated, and uncoated wares that mostly display affinities with the Pan-Grave ceramic tradition as currently defined.
The overall characteristics of the clay and inclusions in Petrofabric Group 2 are also consistent with the Nile clay derived from south of the First Cataract, based on the geology of that region. Although Petrofabric Group 3 contains only one sample, the paste is distinct and may also have derived from a location.
between the First and Second Cataracts (see Maritan et al., 2021, Fig. 4 for thin-section images of Nile clayey sediments collected between the Third and Second Cataracts that are somewhat similar to the Nile clay pastes of the analyzed samples).

Due to the nature of the Nile River, it is difficult to determine precisely if the paste differences reflect disparate locations of production. Although the clay varies texturally across and along the river (Ownby & Brand, 2019), seasonal factors such as annual inundation and rainfall could lead to variations in inclusion sizes within a limited area. The results show that specific raw materials were utilized but it remains challenging to determine if this reflects different locations of production. Some of the mineralogical differences between the groups could indicate different sources of raw materials and distinct locations of production, but this remains difficult to determine.

The general lack of medium- to coarse-sized inclusions in Petrofabric Group 1 suggests that potters utilizing that paste preferred naturally levigated sources, such as canals and irrigation channels. Conversely, potters working with the slightly coarser Petrofabric Group 2 seem to have collected clay closer to the riverbanks with more natural inclusions. However, the frequency of the medium- to coarse-sized grains is still relatively low and does not suggest sand temper was added to the clay (i.e., there is no bimodal sorting of inclusions). At the same time, the petrographic consistencies within each fabric group also suggest that the raw materials were exploited and processed following a specific chaîne opératoire, which might further reflect technological distinctions. It is worth noting at this point that both Petrofabric Groups 1
and 2 are present among the samples from site SJE 65, which suggests that vessels of more than one pottery tradition were deposited in burials at this site. Finally, all but one of the samples analyzed were bowls, and raw materials for other utilitarian vessels could be distinctly different. The subtle variation in pastes within the petrofabric groups could reflect slightly different raw materials for coated, decorated, or uncoated vessels.
There is no known archaeological evidence of pottery firing sites or processes for the Middle Nubian cultures in the SJE survey area. Hence, any observations relating to firing can only be conjectural. Nevertheless, differences in firing technology could be observed in the samples. The samples in Petrofabric Group 1 tend to derive from completely or incompletely reduced firing atmosphere. They are black in cross section with only slight oxidation at the exterior surface. In contrast, the sherds in Petrofabric Group 2 are partially oxidized, with most samples being browner in cross section. Such variations could indicate different firing technologies or processes (Rye, 1981). Based on optical activity, the vessels were likely fired at temperatures ranging from 750 °C to 850 °C, most probably in open fires rather than enclosed kilns. To achieve a reducing atmosphere, the fuel and vessels may have been covered with potsherds, wood, or dung during firing (Rye, 1981, p. 114–118).

Plant remains added to the clay paste, usually in quantities between 10 and 30 percent, would have
created a more workable and less sticky paste suitable for hand-building techniques associated with Nubian traditions (see below). The majority of the plant remains in Petrofabric groups 1 and 2 were mostly carbonized, and their presence is indicated by short and wide rectangular and subcircular voids. Based on a comparison to published thin-section images of test tiles with various plant materials, the characteristics of the voids suggest they are from chaff temper (van Doosselaere et al., 2014). Four uncoated samples (one from Group 1, two from Group 2, and one from Group 3) likely had straw added as temper based on the long, rectangular, and wide voids that suggest that the plant materials comprised unprocessed stems of a grassy species. None of the samples likely contained dung. If present, they would have left behind acicular (needle-like) voids that are sometimes volute (spiral-like) after firing (Amicone et al., 2020).

Closer investigation of the added chaff led to the question of whether it was carbonized as a result of firing in a reducing atmosphere or if it had been added to the clay paste as ash. Ash was previously identified as a tempering material in early A-Group pottery, as designated in Nordström’s fabric type IIA, though not examined petrographically (Nordström, 1972, p. 51). To address this question, experimental test tiles of an iron-rich clay were made, fired, and examined petrographically (see Ownby, 2020 for details). A total of eight samples were analyzed, four had added straw as temper, and four had added burnt straw ash. All of the samples were fired in pits; four samples (two from each fabric type) were fired in an oxidizing atmosphere, and the other four were fired in a reducing atmosphere created by covering the pit with dung. The results show that the organic remains were highly broken down with mostly indistinct cellular wall structure and present as many thin fragments in the paste. These suggest that the tempering material in the Nubian samples was most probably added as ash; and that the plant material was already partially decomposed by burning before being added to the clay and then disintegrated further during firing. The initial burning process likely created the many thin fragmentary pieces observed in both the experimental samples and the original Nubian sherds.

Chronological Considerations

Although the present analysis is based on a few samples and is therefore only preliminary, the three petrofabric groups appear to align closely with the cultural attributions initially assigned to the samples, which may in turn be related to chronology. All but one of the sherds in Petrofabric Group 1 are associated with the C-Group ceramic tradition, and all of the sherds in Petrofabric Group 2 were attributed to the Pan-Grave ceramic tradition. Petrofabric Group 3 consists of only one sherd attributed to the Kerma tradition. This strongly suggests that the choice and manipulation of raw materials may be culturally specific. Although only a single example was available for this analysis, the Kerma beaker sherd (SJE 410/23) is a noteworthy exception in that it appears petrographically closest to Petrofabric Group 1, which is otherwise associated with pottery attributed to the C-Group.

The differences in technology might also be related to chronology, but assigning dates to Middle Nubian material culture based on ceramic attributes can be problematic. Relative sequences do exist for each of the Middle Nubian traditions (Fig. 2), but in most cases, researchers must rely on associated Egyptian objects (assuming any are present) and other characteristics such as grave shape in order to reach even an approximate relative date (de Souza, 2019, p. 143–148; also see Bourriau, 1981; Kopp, 2018). However, this approach has limitations. First and foremost, it cannot be assumed that the Egyptian-style objects are contemporary with their deposition in a Nubian grave. These objects were possibly in circulation for an undetermined period before their eventual burial. At best, Egyptian objects can only offer an approximate terminus post quem for a given assemblage. In any case, Egyptian pottery and other dateable objects are rare across all of the contexts from which the samples were taken, but some broad chronological groups could be discerned.

All samples from site SJE 65 appear to be the earliest in the analysis, roughly contemporaneous with the late Middle Kingdom to early Second Intermediate Period in Egypt (c. 1800–1700 BC). Egyptian-style pottery from the relevant contexts at SJE 65 is minimal. A body sherd from a Marl A3 biconical jar from grave SJE 65/4 can be dated to the Second Intermediate Period in Egypt, and other bodysherds
in Marl fabrics are most likely of a similar date. All the analyzed Nubian pottery samples from this site were attributed to the C-Group following existing definitions. The morphology of the samples and their distribution in the cemetery suggests a date in Bietak’s C-Group Phase IIa/b, somewhere between c. 1800–1700 BCE (Bietak, 1968, p. 98–113; also see Säve-Söderbergh, 1989, p. 7). This is supported by the oval shape of all but one of the grave pits. It is also possible that the samples from Site SJE 97 fall into this chronological range based on their C-Group character, but the absence of Egyptian objects from any of the relevant contexts limits the accuracy of even a relative date. Petrographically, all of the samples from these earlier contexts were assigned to Petrofabric Group 1.

Site SJE 47 appears to be slightly later and roughly contemporaneous with the early Second Intermediate Period on the Egyptian timeline (c. 1750–1650 BCE). The only Egyptian-style pottery in any relevant context is a heavily worn sherd from a jar stand of a wide date range found in association with sample SJE 47/127:1(c). The graves from which the samples were taken are mostly oval or rectangular in plan usually associated with later phases for the Pan-Grave tradition (de Souza, 2019, 143–150). All samples from these contexts have been assigned to Petrofabric Group 2.

Petrofabric Group 2 also includes samples from sites SJE 170 and SJE 410, dated to the end of the Middle Nubian period and roughly contemporaneous with the late Second Intermediate Period in Egypt (c. 1650–1550 BCE). The decorated sherd 170/30:6 came from an elongated oval grave that suggests a slightly later date. The single Pan-Grave-style sample from site SJE 95 most likely also fits into this chronological group based on the recessed rim profile and rectangular shape of the grave in which it was found, both of which are thought to be late features of the Pan-Grave culture (de Souza, 2019, p. 118). All of the samples in the group have been assigned to Petrofabric Groups 2 and 3. Apart from the Kerma beaker sherd (SJE 410/23), Petrofabric Group 1 sherds are absent from these contexts.

This relative sequence suggests that there may be a chronological difference between the petrofabric groups. Petrofabric Group 1, which shows affinities with the C-Group ceramic tradition, is only attested during the earliest phase and is absent from contexts assigned to later phases. It is, therefore, possible that the paste differences are the result of changes in technology over time. However, given the chronological overlap between the traditions, it is also likely that the petrographic differences resulted from cultural and technological divergence. The distinctive characters of the two principal petrofabric groups also made it possible for sherds of uncertain cultural attribution to be tentatively assigned to one or another tradition based on paste features.

Mobility and Nubian Ceramic Ecology

The petrographic consistency within each fabric group suggests that the raw materials were collected within a localized area, but, significantly, samples from across the study area were made using the same fabric type and firing technology. The Petrofabric Group 1 samples come from SJE 65 in the northern area and SJE 97 in the middle of the study area, while Petrofabric Group 2 is present at all sites. Following the hypothesis that technological differences may correspond to broader cultural differences, it is possible to surmise from the distribution that samples initially assigned to the C-Group tradition (Petrofabric Group 1) are restricted to the northern half of the concession, whereas samples originally assigned to the Pan-Grave tradition (Petrofabric Group 2) have a wider distribution. Future analyses of Nubian ceramics from other regions and periods will help to refine these preliminary observations.

It could also be suggested that the pottery was produced in a single area, from which it was distributed and used before being deposited in burials, but this observation makes two significant assumptions. Firstly, it assumes that pottery was used in life before gravesite deposition (that is, not made specifically for burial), and secondly, that Nubian pottery production was centralized. The first assumption is at least partially verifiable. Repair holes on samples SJE 170/30:6 and SJE 47/76:2(c), both of which were assigned to the Pan-Grave tradition, strongly suggest that the pottery was used in life and was considered valuable enough to be repaired. Repair holes were identified on at least six other vessels from Site SJE 47, but these are not included in the petrographic analysis. For the C-Group tradition, sherds with elaborate decoration like that seen in cemetery contexts have also been found in settlement contexts at Elephantine.
(Raue, 2018, pl. 142–143), which suggests that some of the vessels used in domestic contexts were eventually deposited as mortuary goods (Gratien, 2000). As noted above, mat-impressed wares similar to sample SJE 410/2(5) are well-known utilitarian types often found at habitation sites mostly in Upper Nubia and from settlement contexts in Egypt. As the sherds are mostly from uncoated, coated, and decorated bowls, this could account for some of the subtle paste differences, though it is remarkable that the fabrics are so uniform given the range of wares examined. The second assumption that Nubian pottery production was centralized is more difficult to prove. This is unlikely for the Pan-Grave ceramic tradition, for which broad stylistic variation, even at neighboring sites, is a strong indicator that pottery production was community-based (de Souza, 2019, p. 145–146). There may have been a degree of specialized production for other Nubian potting traditions, but further cross-regional investigations are required before any conclusions can be made.

Mobility might have played a role in the distribution of ceramic vessels and the selection of raw materials. During the period in question, Nubia was a dynamically multicultural region populated by numerous communities adhering to different cultural traditions and following diverse subsistence strategies. Degrees of sedentariness also varied such that groups would have come into contact and engaged in some level of cultural and/or material exchange. Pan-Grave communities (according to existing definitions) were very likely mobile, at least seasonally, and therefore had a wide distribution across Nubia and Egypt. Things appear to have been somewhat more varied for C-Group and Kerma communities. Both had pastoral economies, but degrees of mobility would have varied between partially mobile or entirely sedentary. The latter case is demonstrated by settlements such as Wadi es Sebua, attributed to the C-Group (Sauneron & Jacquet, 2005), and the city of Kerma, from which that culture takes its name.

Recent ethnographic studies have demonstrated that mobility is not an impediment to pottery production, and pottery is a necessary item among African mobile communities (Arnold, 1985, p. 109–126; Grillo, 2013, p. 307–309; Heitz, 2017; Van Oyen, 2017). There are, however, differences in how pottery was used and perceived within a given social setting based on variations in lifestyle and subsistence strategies. Communities with a higher degree of sedentariness, such as those described as C-Group or Kerma, are likely to have had greater opportunities for producing pottery and hence for being more selective in raw materials. On the other hand, for mobile or partially mobile communities, pottery was most likely produced seasonally as conditions and resources permitted. Their higher mobility may have driven them to use whatever resources were available during sedentary periods (Arnold, 1985: 119).

These differences relating to mobility appear to be reflected in the petrographic results. Petrofabric Group 1, apparently utilized in the C-Group and Kerma pottery traditions, comprises finer clays likely collected from naturally levigated sources. This could suggest that these potters had more time to seek out and exploit such resources. By contrast, Petrofabric Group 2, utilized for Pan-Grave-style pottery, is generally coarser and thus may reflect less selective strategies for resource extraction, perhaps resulting from time restrictions in pottery production. Whatever the case, this limited study suggests that raw material collection for pottery production may have taken place in one locality, which is reflected in the similarities between the fabrics used for the Pan-Grave vessels found at several sites. The technological commonalities observed in the paste recipes, including the use of ash temper, firing processes, and employment of the same paste for various vessel forms, also suggest similar approaches to pottery production, regardless of differences in mobility. These similarities possibly resulted from interactions between the groups that led to exchanges of technological and cultural information. They could also have originated from an overarching degree of relatedness across all communities that lived and produced pottery in the region.

Conclusions

Although this petrographic analysis has observed distinct fabric groups characterized by different raw materials and technological processes, the results also revealed certain commonalities between the different pottery-making traditions. These similarities may, in turn, be linked to chronology, availability of resources, and subsistence strategies. Moreover, the petrofabric groups align with the different Middle Nubian pottery traditions, as currently defined. We
acknowledge that one should be cautious in making direct links between material traditions and cultural entities. Not only are definitions for the existing Middle Nubian cultures undergoing intense scrutiny, but drawing such direct links between objects and assumed cultures could reinforce the outdated concepts of bounded cultural entities, which is now widely accepted as a problematic approach. Nevertheless, our results, though preliminary, demonstrate these correlations.

It is important to recognize that while there are clear differences between the petrofabric groups, there are also several commonalities. All of the fabric groups utilized Nile clay and ash temper for various vessel forms, but the raw materials and the exact paste recipes were distinct. Firing technology is tentatively suggested also to have been the same or at least highly comparable among the groups. Therefore, despite some chronological and spatial differences, there is as much to relate the petrofabric groups to one another as there is to differentiate them. The same might be said of ancient Nubian cultural entities and cultural entities the world over.

It is also important to recognize that although petrography can distinguish paste recipes and choices, technological traditions do not necessarily equal culture. Hence, the petrographic observations should not be connected with culture or identity without other supporting evidence (Arnold, 2017; Bader, 2021, p. 15–40). It is almost certain that the analyzed pottery was produced in or near the Nile Valley in Lower Nubia using different sources of Nile clay, and ware types and overall morphology of the vessels are necessary considerations when addressing questions of tradition, culture, or identity. A recent analysis of ancient Nubian pottery-forming techniques has identified at least two different forming processes that may indicate different technological traditions (de Souza and Trognitz, 2021). More of such micro-analyses of ancient Nubian material culture need to be conducted and integrated with archaeological and anthropological approaches if a more accurate image of cultural diversity and interconnections is to be gained through material technology. This petrographic study of the Middle Nubian pottery traditions contributes to what promises to be an exciting subject of inquiry in the future.

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