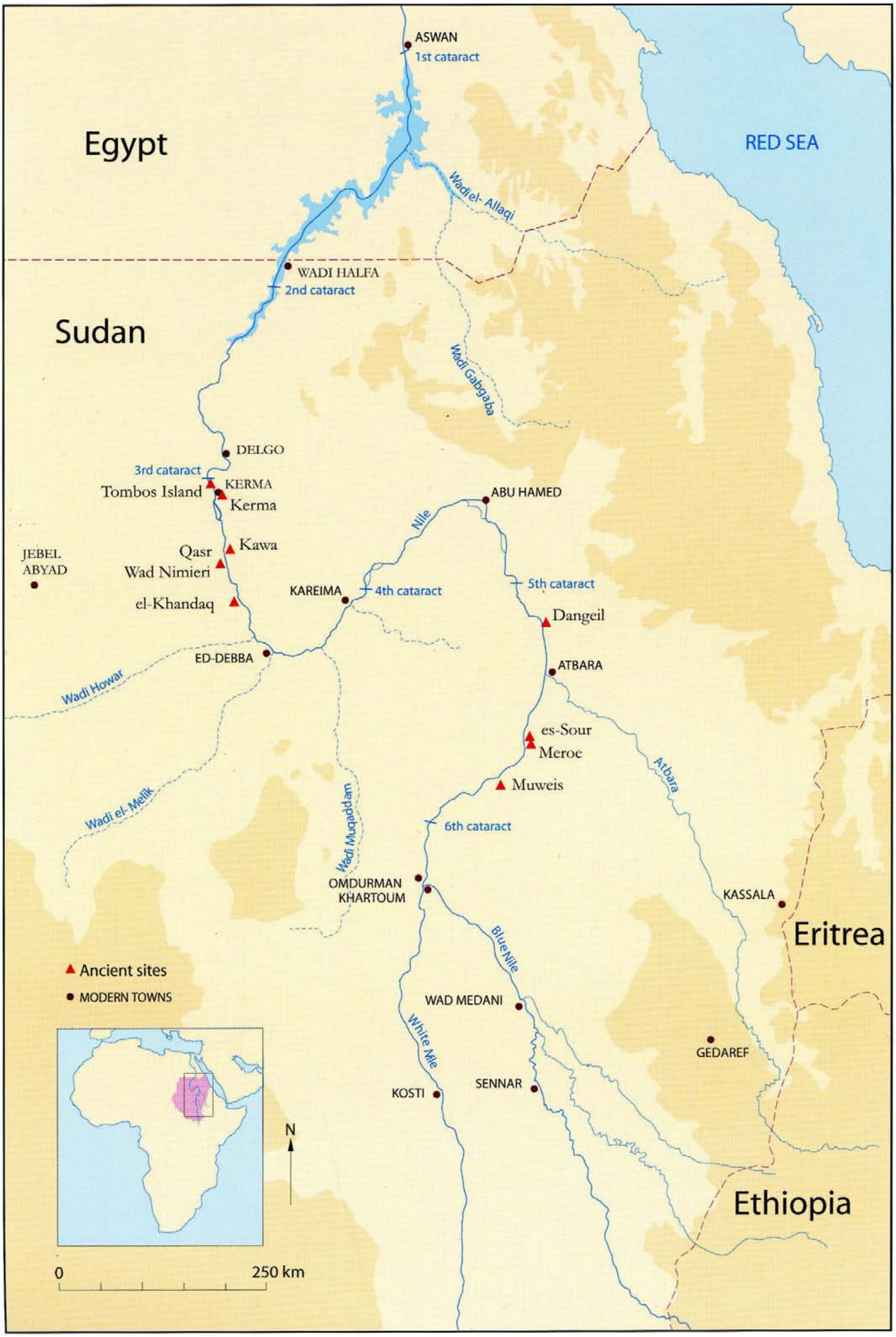
SUDAN & NUBIA

The Sudan Archaeological Research Society

Bulletin No. 12 2008



Egypt
Sudan
RED SEA
Eritrea
Ethiopia
ASWAN
1st cataract
Wadi el- Allaqi
WADI HALFA
2nd cataract
Wadi Gabgaba
DELGO
3rd cataract
KERMA
Tombos Island
Kerma
ABU HAMED
Nile
Kawa
Qasr
Wad Nimieri
JEBEL
ABYAD
KAREIMA
4th cataract
5th cataract
el-Khandaq
Dangeil
ED-DEBBA
ATBARA
Wadi Howar
es-Sour
Meroe
Atbara
Muweis
Wadi el- Melik
6th cataract
Wadi Mugaddam
OMDURMAN
KHARTOUM
KASSALA
Blue Nile
Ancient sites
MODERN TOWNS
WAD MEDANI
GEDAREF
White Nile
SENNAR
KOSTI
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250 km

SUDAN & NUBIA

The Sudan Archaeological Research Society *Bulletin No. 12* *2008*

Contents

Front cover: Rescuing rock art from the Sudan Archaeological Research Society's concession at the Fourth Nile Cataract. This collaborative project between the British Museum, Iveco and New Holland was undertaken in November 2007 and resulted in the removal, from the SARS concession, of over 50 boulders bearing rock art or used as rock gongs. The pyramid, offering chapel and enclosure wall from site 4-F-71 were also relocated. Here the work is being filmed by a cameraman from the Italian TV news channel Rei Due (photo D. A. Welsby).

A Chemical and Mineralogical Comparison of Nubian and Egyptian Style Ceramics and the Implications for Culture Contact: Preliminary Report

Julia Carrano, Jeffrey R. Ferguson, Gary H. Girty, Stuart T. Smith and Carl J. Carrano

While in recent years there has been considerable progress in the analysis of Nubian ceramics, detailed compositional analysis, including petrography and chemical characterisation, has not kept pace with the new developments. The problems that stem from this lack of good compositional data are compounded for archaeologists working in areas and time periods in which imperial Egypt had a substantial influence on ancient Nubia. An example would be the region downstream of the Fourth Cataract from the Middle Kingdom to the Napatan/Late Period. At many sites, Egyptian-style Nile silt vessels form a prominent percentage of the overall ceramic assemblage and while Egyptian and Nubian-style wares are usually distinct in surface decoration, as well as manufacturing technique (use of the wheel, firing temperatures, etc.), many important questions remain difficult to answer because the fabrics themselves are often inadequately characterised (Adams 1986, 38-39, 44-45; Arnold and Bourriau 1993; Bourriau 1998; Bourriau *et al.* 2006, 277; Robertson and Hill 1999, 321-22). For instance, at a given site, are the Egyptian-style vessels imported, or made locally? What influence did the Egyptian wheel-made ceramic industry have on native Nubian pottery? Is this reflected in change through time of the provenance or manufacturing technique of vessels in Nubia?

Methodologies and sample selection

To help address these questions, the authors are developing a comprehensive, compositional, characterisation of pottery found in Nubia, concentrating particularly upon a comparison of Egyptian and Nubian-style vessels found together in archaeological contexts. We began by focusing on sites within the region of the Second and Third Cataracts (hoping to eventually include samples from the Merowe Dam Archaeological Salvage campaign) which date between the Kerma and Napatan periods (Figure 1, Table 1). All ceramic characterization methods have inherent difficulties, and there is no simple rule for which is the most appropriate for a specific region, or research question. For instance, petrographic analysis, such as point counting, is detailed and informative, but often too expensive and time-consuming for statistical comparisons. On the other hand, chemical characterisation of ceramics, whilst popular in certain areas of the world (such as the American Southwest), or when comparing regions with very different geochemistry, is notoriously ambiguous in large river systems such as the Nile Valley. Since compositional analysis is still relatively underdeveloped in Nubia, our research approach is to explore and combine methodologies. Thus, our primary technique is Instrumental Neutron Activation Analysis (INAA), a common chemical characterization technique. However, INAA must be supplemented with traditional petrography, as well as an alternative and more widely accessible chemical method, X-ray diffraction (XRF).

While eventually our project will include over 300 sherds, as well as raw clay samples, for the initial stage reported here, 90 samples have already been submitted for INAA, and 32 for both XRF and petrographic analysis (a total of

Figure 1. Map of Egypt and the Sudan.

Table 1. Relevant chronology (after Buzon 2004).

Date	Egypt	Lower Nubia	Upper Nubia
2050-1650 BC	Middle Kingdom (Dynasties 11-13)	C-Group	*Kerma Moyen*
1650-1550 BC	Second Intermediate Period (Dynasties 14-17)	C-Group	*Kerma Classique*
1550-1050 BC	New Kingdom (Dynasties 18-20)	C-Group	*Kerma Recent*
1050-750 BC	Third Intermediate Period	Uncertain	Pre-Napata
750-332 BC	Late Period (Dynasties 25-30)	Uncertain	Napata

18 sherds have already been analysed via all three techniques; Tables 2 and 3). The INAA samples were submitted to the University of Missouri Research Reactor (MURR) Archaeometry Laboratory for testing, using standard procedures developed at the laboratory (Glascock 1992; Neff 2000). Thirty-three elements were measured, 32 of which were used in the subsequent statistical analysis (Ni was excluded since it generally fell below normal detection limits; Ferguson and Glascock 2006, 3). Concentrations were transformed to base-10 logarithms to compensate for the differences in magnitude between elements.

XRF (including Loss on Ignition, or LOI) and petrographic analyses were conducted at San Diego State University. XRF was used to measure 10 major elements (measured as compounds and expressed as percentages of total weight) and 23 trace elements (expressed in parts per million). Petrographic work involved creating thin-sections and counting 400 points in each sample spaced at intervals of ~0.6 by ~0.6 mm. Material falling under the cross hairs of the microscope was identified and assigned to one of the categories listed in Tables 4 and 5.

Pottery samples were selected from three sites, Askut, Tombos, and Hannek. The communities at both Askut, an Egyptian fort, and Tombos, an imperial bureaucratic outpost, were affiliated with Egyptian as well as native Nubian culture, a mixture reflected in the ceramic assemblages (Smith 1995, 137-174; 2003, 97-140). Hannek, almost directly across the river from Tombos, was by contrast, a native Nubian town showing only scattered Egyptian influence, but was probably contemporary with Tombos and Askut (Smith 2003, 136-166).

Samples from the sites were selected to include variability in time (between Kerma and the Napatan/Late Period) and style (Nubian and Egyptian). It was impossible to select vessels of entirely the same type, or shape, due to the paucity of archaeological material available from Tombos and Hannek, the small size of many of the sherds, which made them impossible to classify with any certainty and the fact that ceramic types are not equivalent between Egyptian and Nubian-style vessels. Nevertheless, when possible, open-mouthed bowls and cups of fabrics that correspond to Nile Silt B2 and C (Vienna System; Arnold and Bourriau 1993, 171-174) or Nordström's (1972) IIB and IIE were chosen (Figure 2, a and b). Occasionally, restricted jars or cooking pots of the same fabrics were also included (Figure 2, c).

Table 2. Description of samples analyzed via INAA.

Sample	Site	Form	Cultural style	Period	Quantity
STS059	Tombos	cup	Nubian	Napatan	1
STS060	Tombos	frag	Nubian	Napatan	3
STS061	Tombos	cup	Nubian	Napatan	5
STS062	Tombos	jar	Egyptian	Napatan	3
STS063	Tombos	large bowl?	Egyptian	Napatan	5
STS064	Tombos	cup	Nubian	Napatan	1
STS065	Tombos	cup	Egyptian	Napatan	3
STS066	Tombos	bowl	Egyptian	Napatan	U
STS067	Tombos	small bowl	Egyptian	Napatan	4
STS068	Tombos	bowl/cup	Nubian	Napatan	3
STS069	Askut	floor tile	n/a	?	3
STS070	Askut	pot	Egyptian	Napatan	U
STS071	Askut	bowl	Egyptian	Napatan	3
STS072	Askut	lid handle	Egyptian	Middle Kingdom	3
STS073*	Tombos	amphora	Egyptian	New Kingdom	5
STS074*	Askut	pot	Nubian	New Kingdom	U
STS075*	Tombos	base of jar/pot	Egyptian	New Kingdom	5
STS076*	Askut	plate	Egyptian	New Kingdom	5
STS077*	Askut	base of cup/small bowl	Egyptian	New Kingdom	3
STS078*	Tombos	pot/bowl	Egyptian	New Kingdom	3
STS079*	Tombos	bowl	Egyptian	New Kingdom	U
STS080*	Tombos	cup	Egyptian	Napatan	3
STS081*	Askut	small jar	Egyptian	New Kingdom	3
STS082*	Askut	bowl	Egyptian	New Kingdom	5
STS083*	Tombos	(flower)pot	Egyptian	New Kingdom	5
STS084*	Askut	pot	Nubian	New Kingdom	U
STS085*	Tombos	cup/small jar	Egyptian	Napatan	5
STS086*	Tombos	bowl	Egyptian	New Kingdom	3
STS087*	Tombos	large cup/open jar	Egyptian	Napatan	4
STS088*	Tombos	jar	Egyptian	New Kingdom	5
STS089*	Tombos	cup	Egyptian	New Kingdom	5
STS090*	Askut	cup	Egyptian	New Kingdom	3

Results of the chemical analysis

A variety of methods were used to interpret the INAA chemical data, including standard bivariate plots of individual elements and hierarchical cluster analysis (Baxter 1994; Harbottle 1976; Leese and Main 1994; Neff 2002). Principal component analysis

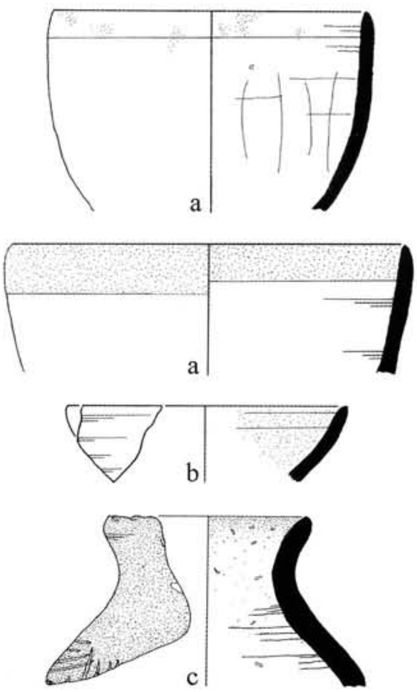

Figure 2. (a) Two drinking vessels from Tombos, Napatan period: (above) handmade Nubian-style, STS061; (below) wheel-made Egyptian-style, STS067 (b) Egyptian-style wheel-made drinking vessel, Askut, New Kingdom, sample 2042 (c) handmade Nubian-style jar with incising, Askut, New Kingdom, sample 1202b.

Table 3. Description of samples analyzed via XRF and petrographic point-counting.

Sample	Site	Form	Cultural Style	Period
ES-00-13	Tombos	jar	Egyptian	New Kingdom
ES-00-132A	Tombos	base of jar/pot	Egyptian	New Kingdom
ES-00-132B	Tombos	base of jar/pot	Egyptian	New Kingdom
ES-00-134	Tombos	amphora	Egyptian	New Kingdom
ES-1391A	Askut	base of cup/small bowl	Egyptian	New Kingdom
ES-00-174	Tombos	bowl	Egyptian	New Kingdom
ES-00-30	Tombos	bowl	Egyptian	New Kingdom
ES-00-47A	Tombos	cup	Egyptian	New Kingdom
ES-00-47B	Tombos	pot/bowl	Egyptian	New Kingdom
ES-00-73	Tombos	(flower)pot	Egyptian	New Kingdom
ES-05-131A	Tombos	large cup/open jar	Egyptian	Napatan
ES-05-131B	Tombos	cup/small jar	Egyptian	Napatan
ES-05-387A	Tombos	cup	Egyptian	Napatan
ES-05-387B	Tombos	cup	Egyptian	Napatan
ES-1189A	Askut	pot	Nubian	New Kingdom
ES-1189B	Askut	pot	Nubian	New Kingdom
ES-1391B	Askut	small jar	Egyptian	New Kingdom
ES-2042	Askut	cup	Egyptian	New Kingdom
ES-2049	Askut	bowl	Egyptian	New Kingdom
ES-2063	Askut	plate	Egyptian	New Kingdom
ES-194	Hannek	pot	Nubian	Kerma?
ES-449	Hannek	pot	Nubian	Kerma?
ES-1202A	Askut	small pot	Nubian	New Kingdom
ES-439	Hannek	pot	Nubian	Kerma?
ES-462	Hannek	pot/bowl	Nubian	Kerma?
ES-1202B	Askut	jar	Nubian	New Kingdom
ES-434C	Hannek	pot/bowl	Nubian	Kerma
ES-1423A	Askut	bowl	Nubian	New Kingdom
ES-434A	Hannek	pot/bowl	Nubian	Kerma?
ES-1423B	Askut	pot	Nubian	New Kingdom
ES-434B	Hannek	pot	Nubian	Kerma?
ES-438	Hannek	pot	Nubian	Kerma?

was also attempted, but, as is common with small sample sizes, the groups did not define well based on the principal components. In general, the goal is to identify distinct compositional groups of ceramics, e.g. "centers of mass in the compositional hyperspace described by measured elemental data" (Ferguson and Glascock 2006, 3). These groups are then "inferred to be representative of geographically differentiable [clay] resources" (Bishop and Blackman 2002, 604). In our study, five chemical compositional groups were detected, with a substantial portion of the samples (26.7%) not assigned to any group (Table 6). Groups 1 and 2 only contained two or three sherds in total, and we do not discuss them further here, since at this point it is impossible to determine if these groups represent distinct clay sources, or are simply outliers.

Group 3 is the largest group with 31 members, as well as the most chemically variable (Figure 3). Because of its size, it was possible to calculate a probability of group membership, based on Mahalanbois distance; this calculation resulted in an acceptable 10% or better probability for each member. With a bias towards Egyptian (73%), rather than Nubian-style (27%) vessels, this group includes sherds from every site, time period and style. Two of the member sherds are particularly significant. One of these is a floor tile from Askut (STS069), which is probably of local manufacture. The other is an Egyptian-style handle lid (STS072), also from Askut, which has a particular gilded appearance, created by flecks of mica. Such "gilded" pottery is only known to come from Nubia.

Given that these two samples are members of Group 3, it is probable that the group is local to the Askut area (Ferguson and Glascock 2006, 8). Excavations at Askut have provided evidence for Egyptian-style pottery manufacture and it would be unsurprising, given the amount of Nubian-style pottery found at the site, if local production of Nubian vessels also occured during the New Kingdom and Late/Napatan Periods (Smith 1995, 137-174). Therefore, sherds of both styles found at Askut, falling into Group 3, have a high likelihood of being local. Whether or not the existence of Group 3 sherds at Tombos and Hannek means that vessels made at Askut were transported to these sites is hard to assess, however. It may be that the chemical signatures of some clay deposits in the Third Cataract are extremely similar to those at Askut. The next step in our ongoing study, necessary to resolve this question, will be analysis of clay samples from each location.

Group 4 is an unusual cluster, containing Nubian-style sherds (n=6) from Hannek and Egyptian-style sherds (n=4) from Tombos. Lack of sherds from Askut is probably significant, leading one to surmise that Group 4 may repre-

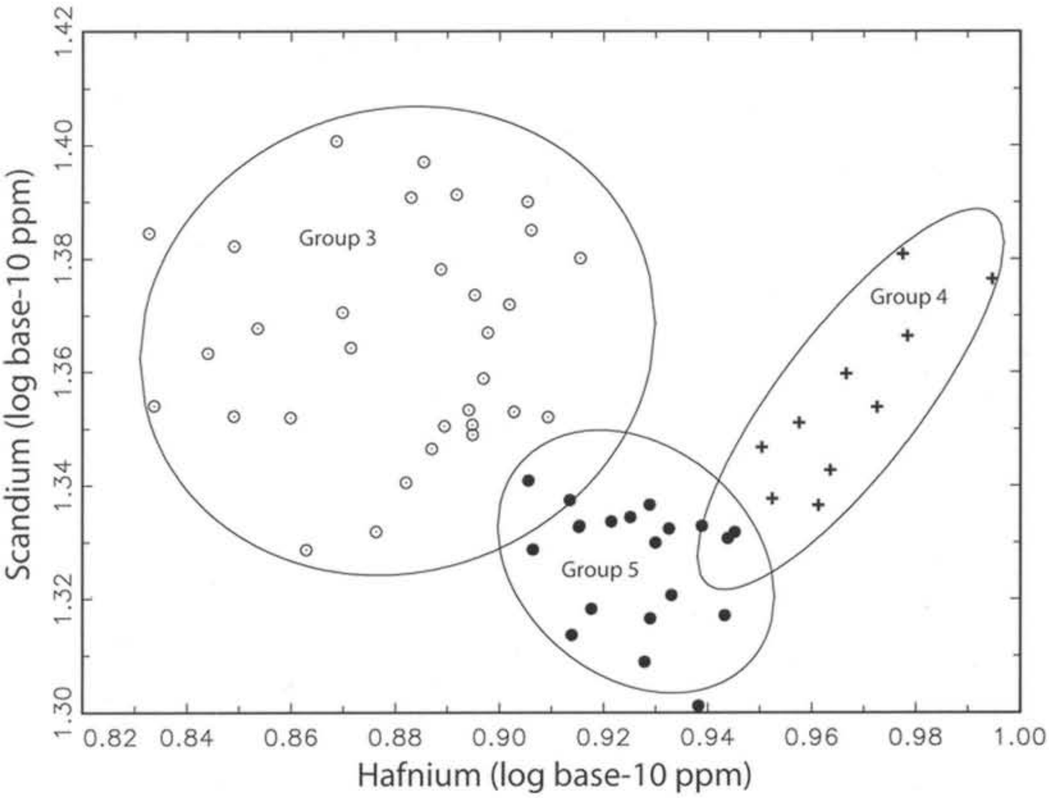

Figure 3. Bivariate plot of hafnium and scandium base-10 logged concentrations showing the separation of Groups 3, 4, and 5. Ellipses represent a 90% confidence level for membership in the group (after Ferguson and Glascock 2006).

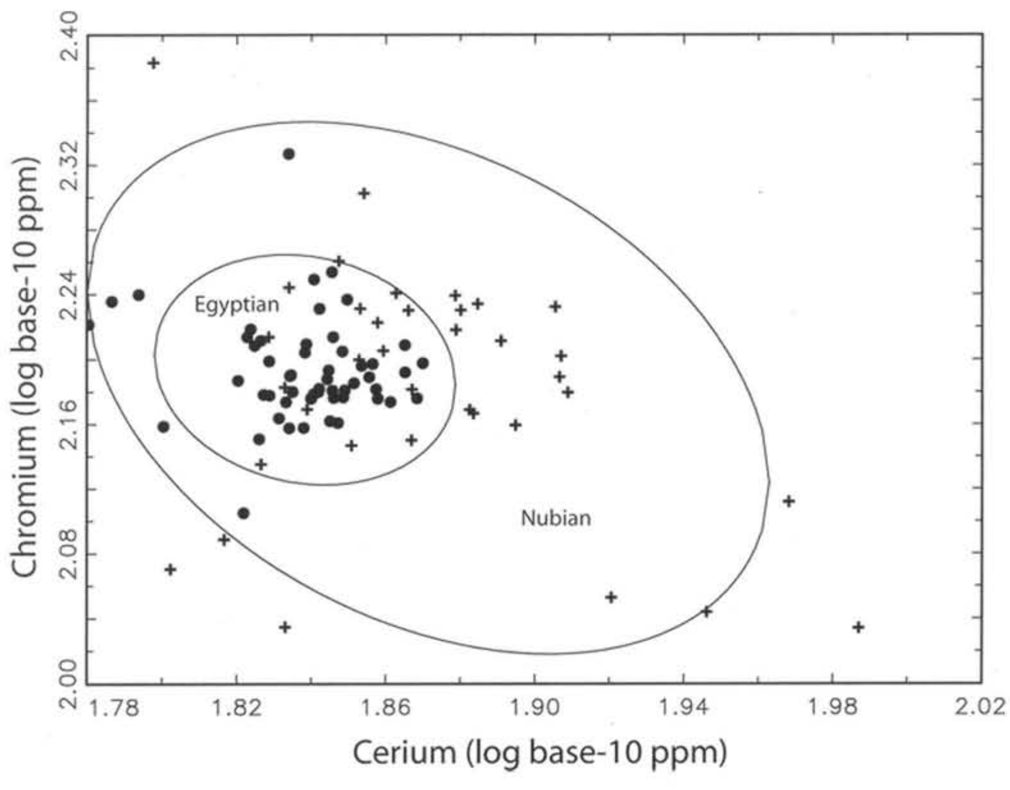

Figure 4. Bivariate plot of cerium and chromium base-10 logged concentrations showing the overlap between the Egyptian (○) and Nubian (+) pottery samples. Ellipses represent a 90% confidence level for membership in the group (after Ferguson and Glascock 2006).

Table 4. Point-count results, Egyptian style sherds.[1]

No[2]	Quartz	Feldspar	Biotite	Mica[3]	Amphibole	Epidote	Plant	Rock Fragments			Calcite	Chlorite	?[4]	Opaque	Void	Matrix
								Vol[5]	Meta[5]	Car[5]						
00-13	8.8	3.5	1.3	0	0.3	0.5	0.5	0.5	0	0	0	0	1.3	6.3	5.5	71.8
00-132	8.3	4	3.5	0.3	0.5	0	0.8	0.5	0.5	1	0	0	0.8	5.5	7.3	67.3
00-134:1[6]	6.3	4.8	0.5	0.3	0	0	3	1.8	0	0	0	0	0.8	0	6.8	76
00-134:2[6]	6.3	5	0.5	0.3	0	0.3	3	3.5	0	1.5	0	0	1.3	0.5	5.3	72.8
00-134:3[6]	6.8	3.5	1	0	0.3	0.3	4.5	0	0	1	0	0	0.5	0	5.8	76.5
1391a	3	2.3	0.3	0	0.3	0	0.3	0.5	0	0	0	0	0.8	3.5	2.8	86.5
00-174	6.8	3.3	1	0	0	0	1.8	1.8	0	0	0	0	0.5	5	3.8	76.3
00-30	8.8	3.3	1	0.5	0	0.3	0.3	0	0	0.3	0	0	0.8	4.5	2.5	78
00-47a	6.5	5.8	0	0	0.3	0	3.8	0.5	0	0	0	0	0.8	2.5	8.8	71.3
00-47b	6.3	1	0	0	0.3	0.3	1.3	0	0	1	0	0.3	1.3	3	3.8	81.8
00-73	7	4.3	0.5	0	0.3	0	1.8	0.3	0	1.8	0	0	1	2.8	6.8	73.8
05-131a:1[6]	6	5.8	0.3	0	0	0	1.8	0	0	0	0	0	0.3	0.3	8.8	77
05-131a:2[6]	7.5	3.3	0.5	0	0.3	0	2.5	0.3	0	0	0	0	0.3	1	6.8	77.8
05-131b	6.5	3.8	0.5	0	0.3	0	2.5	0.3	0	0.3	0	0.3	0.3	1.3	15.5	68.8
05-387	2	3	0.8	0.5	0	0.5	2	0	0	0	0	0	0.8	0	9.8	80.8
1391b	6	3.3	0	0	0.5	0.5	2.5	0.3	0	0	0	0	1	1.5	7.8	76.8
2063	8.8	1.8	0.8	0	0	0.8	0.5	1	0	0	0	0	2.5	3.5	4	76.5

[1] Data are percentages of each category in each sample and are based on counting 400 points in each specimen.
[2] For brevity the prefix ES for all sample names is not shown.
[3] White Mica
[4] Uncertain grain or fragment type.
[5] Vol = volcanic, Meta = metamorphic, Car = carbonate.
[6] Multiple thin sections of the same sherd counted.

Table 5. Point-count results, Nubian-style sherds.[1]

No[2]	Quartz	Feldspar	Biotite	W.Mica[3]	Amphibole	Epidote	Plant	Rock Fragments			Calcite	Chlorite	?[4]	Opaque	Void	Matrix
								Vol[5]	Meta[5]	Car[5]						
194	1.3	1.3	0	0.3	0	0	2	0.5	0	1	0	0	0.3	0	10.3	83.3
1202a	11.5	4.8	0.5	0.3	0	0.3	0	0	0	1	0	0	0.3	0.3	20.3	61
439	3.5	4	0.8	0.3	0.3	0.3	1	0.3	0.3	2.3	0	0	1.3	0	13	73
1202b	5.3	6	0.8	0.3	0.3	0	0	0	0	4.3	0	0	0.8	5.3	13.3	64
1423a	3.3	1.8	0.8	0	1	0.3	2.5	0.5	0	0	0	0	0.8	0	8.8	80.5
434c	4.3	5.8	1	0.3	0.8	0	3.5	0.3	0.3	0.5	0	0	0.3	1.3	14.3	67.8
1423b	2.8	1.5	0.5	0	0	0	3.5	0	0	0	0	0	0.5	0	7	84.3
438	4.8	4.3	2	0.5	1	0.5	0	0.3	0.3	1.3	0	0	0	3	15.8	66.5
1189a:1[6]	16.5	3.3	2	0.3	0	0.8	3.5	0	0	1.8	0.5	0.3	0	1.3	9.3	60.8
1189a:2[6]	13.8	2.3	0	0.3	0	0	2.3	0.3	0	0.8	0.8	0.5	0.5	1	7	70.8
1189b	11.3	1.8	2	0	0	0.3	0.3	0	0	1.3	0	0	0.3	0.5	10.8	71.8

[1] Data are percentages of each category in each sample and are based on counting 400 points in each specimen.
[2] For brevity the prefix ES for all sample names is not shown.
[3] White Mica.
[4] Uncertain grain or fragment type.
[5] Vol = volcanic, Meta = metamorphic, Car = carbonate.
[6] Multiple thin sections of the same sherd counted.

Table 6. Percentages of Nubian and Egyptian affiliated sherds by chemical group.

Chemical Group	# Egyptian	# Nubian	% Egyptian	% Nubian
1	0	3	0	100
2	0	2	0	100
3	22	8	73	27
4	4	6	40	60
5	18	2	90	10
Unassigned	9	15	38	62

sent a clay source(s) from the Third Cataract area. In this case, the Egyptian-style sherds from Tombos would have been locally manufactured from a similar, or even identical clay source to the traditional vessels from Hannek.

Group 5 is hard to define both chemically and culturally. The most noticeable feature of the group is that it consists of a far greater percentage of Egyptian (90%) versus Nubian-style (10%) vessels. Although examples come from all three sites, the majority of sherds are from Tombos. It, therefore, seems likely that this group represents either a clay source somewhere in Egypt which exported vessels to the colonial community at Tombos (which we know maintained strong political links to Egypt), or a local clay source around the Third Cataract that was exploited predominately by the colonists. In the former, the two Nubian-style sherds which clustered within this group should be considered outliers of another group. Coincidentally these fall within the range of imported Egyptian vessels; the close elemental values between clay sources along the Nile makes this possible. However, under the second hypothesis, the grouping of the Nubian-style samples from Hannek and Tombos with these Egyptian-style Third Cataract vessels would be even more probable, making this explanation the most likely.

In sum, the INAA results display no simple correlation between ceramic composition and either site provenance or style. Each of the three major compositional groups contains sherds from at least two of the three sites. It is not possible to obtain a bivariate plot of any elements that create a statistically significant differentiation between Egyptian and Nubian-style ceramics. Therefore, the Egyptian-style pottery is consistently contained within the 90% confidence level of Nubian-style pottery, indicating that it is made from similar clay sources, probably local to this area of Nubia.

However, there is a difference between the percentages of unclassified sherds from each site and in each style: almost half of the samples from Hannek do not fall into any of the five chemical groups and approximately one third of the sherds from Askut cannot be assigned to any group. By contrast, only four of the 38 sherds from Tombos are unassigned. This is probably linked to the fact that twice as many Nubian-style sherds are unassigned, as are assigned to one of the five compositional groups. By contrast, the Egyptian-style sherds, although from several sites and time periods, generally cluster into relatively tight groups, with 44 of the 53 samples being classified as members of one of the three main compositional groups (Table 6).

The reason for this discrepancy is that Nubian-style sherds are chemically more diverse than Egyptian-style sherds. Returning to the bivariate plots, such as that of cerium and chromium (Figure 4), we see that while the Egyptian-style pottery clearly falls within the 90% confidence group membership for Nubian-style pottery, the reverse is not the case. Some Nubian-style sherds fall within the Egyptian group ellipse, but many do not. Such chemical diversity indicates that traditional style Nubian pottery was made from a variety of raw clay sources or pastes as opposed to a relatively homogenous recipe for Egyptian-style vessels.

Using a much smaller sample size, the alternative chemical method we applied, XRF, generally supports the INAA results. Bivariate plots show a pattern similar to that produced via INAA, with Egyptian and Nubian-style sherds having overlapping chemical signatures, but with Egyptian-style samples falling into a much tighter cluster. Furthermore, use of the multivariate statistical methods of Ward's clustering, k-means, and discriminant analysis (statistical package JMP 5.1.2) reveal that style, rather than site provenance, for instance, is the most accurate predictor of chemical makeup. In addition, both of the chemical methods show little or no change in the chemical composition of ceramics of either style over time; for instance, traditional Nubian wares reveal noticeable compositional continuity from Kerma through the Napatan period (cf. Nichols *et al.* 2002).

Results of petrographic anlaysis

Petrographic point count analysis indicates that both Egyptian and Nubian-style pottery sherds consist of a coarse grained (~0.02 – ~2.30mm) framework composed mostly of the silicate minerals quartz and feldspar, a fired matrix of black to red-brown cryptocrystalline material (<~0.01-0.02mm) surrounding the framework, the scattered remains of plant fragments and voids (most of which indicate they are left by plant fragments). Silicate minerals other than quartz and feldspar identified as part of the framework include biotite, amphibole, chlorite, epidote, and white mica. Augmenting the silicate minerals in the framework is calcite, an opaque phase, and rock fragments, mostly subround to subangular pieces of volcanic, carbonate, and volcanic rock.

Despite the overall petrographic similarities between the two styles, however, some differences emerge. Nubian-style sherds tend to be composed of finer grained framework components (possibly the result of different levigation techniques), as well as more plant and void space, than Egyptian-style sherds. This reinforces our chemical characterizations by showing that, despite a similar fabric framework, the Nubian and Egyptian-style vessels are not compositionally identical, and that a more consistent mixing recipe was used in the formation of Egyptian-style vessels, in contrast to the heterogeneous mixing recipes employed in the creation of Nubian-style ceramics.

Compositional comparisons

One particular advantage of conducting chemical characterization using a technique such as INAA is that it is possible to statistically compare results with other researchers using the same laboratory. In this case, our sherds were compared to all samples in the MURR database by calculating the Euclidean distance of each new sample to the nearest match. Only 11 of our sherds have significant similarities to the more than 37,000 samples in the database and in fact they only match with two samples. These two matches are Egyptian-style Nile silt vessels found at Beth Shan in Israel and Thebes in Egypt (Ferguson and Glascock 2006, 9; McGovern, pers. comm.). The sherds that match with the sample from Israel are both Egyptian and Nubian-style, though the three samples from our study that match with the sample from Thebes are all Egyptian-style. The sherd from Israel plots well within Group 4, while the sherd from Thebes is quite close to Group 3.

However, the actual significance of these matches is hard to determine at this stage. Group 3 has a high likelihood of being locally produced in the area of Askut—does this mean that the sherd found at Thebes was imported from Nubia? This is possible, but unlikely, since the sherd is from a wine amphora; there is considerable evidence that such amphorae were produced at Thebes and there is equally no indication that this type of vessel was ever manufactured in Nubia (McGovern 1997, 95). Even more unlikely is that the vessel found in Israel was imported from the Third Cataract area where Group 4 is thought to originate. It is more likely, in fact, that the few matches that were found are a coincidental product of the similarities in geochemistry of Nile alluvium throughout the river system. In this case, the scarcity of meaningful matches between our samples and those in the database, including the great majority of Egyptian vessels, is further indication that our sherds are likely local wares produced in Nubia (McGovern 1997, 95).

Despite the lack of precise matches for our sherds, however, the compositional data from chemical characterization and petrography fit well within the normal range for Egyptian Nile silts, in contrast, for instance, to Upper Egyptian marls, the so-called mixed clays, and the Desert wares of the Sudan (Bourriau 1998; Bourriau *et al.* 2000; Bourriau *et al.* 2006; Klein *et al.* 2004, 345-47; Mallory-Greenough *et al.* 1998, 89, 93; Redmount and Morgenstein 1996, 746-747). This confirms that our samples probably come from raw clay sources that are similar to, yet distinct from, those that were used to create the vessels from Egypt which are analysed in the literature.

Conclusions

Thus, with regards to ceramic style and composition, the sourcing evidence supports several conclusions:

(1) Potters producing Egyptian and Nubian-style vessels were in many cases exploiting similar raw clay sources along the Nile and were both manufacturing the majority of their vessels locally

(2) These potters were probably not the same individuals, however, since the relatively tight chemical grouping of Egyptian-style vessels, along with the petrography, supports a model of specialised craftsmen, continually exploiting particular raw clay sources and adding consistent quantities and types of temper. By contrast, the diversity of chemical signatures from the Nubian-style pottery suggests that these vessels were being produced on a smaller scale, likely by part-time potters who were exploiting a range of clay sources (Vaughn and Van Gijseghem 2007, 819-821). In addition, the recipes for production were probably either quite flexible or consistent only within a family or other small social group

(3) There was little change over time in either the clay sources exploited for local manufacturing or in the quantity of vessels imported from long-distances into Nubia. No shift can be seen in local pottery production at the height of, or during the decline of, Egyptian power in Nubian communities.

These conclusions have a number of implications for developing a view of Egyptian imperial power in Nubia (Smith 1998, 264). Firstly, they support the idea that Egyptians were interested in developing self-sufficient colonial communities in Nubia, as well as acculturated native groups, in part through the establishment of Egyptian ceramic technologies of production in the controlled territories (Kemp 1991, 166-178, 228-230; O'Connor 1993, 67-84; Smith 1995; 2003). This points to a deep-seated "Egyptianization" of at least some members of the population in Nubia (Adams 1977; Arkell 1961; Buzon 2004, 8-9, 46-47; Morkot 2000; Simon and Maureille 1999; Török 1991; Trigger 1976). How well these "Egyptian" groups were integrated into the communities as a whole is problematic, however, if we consider that one clay source (Group 5) was almost exclusively used to form Egyptian wheel-thrown vessels. Secondly, the fact that little or no change is observed in the composition of local Nubian-style ceramics over time, and that these vessels continue to be produced in a Nubian method of manufacture and distribution, casts doubt on the ability or desire of Egypt to substantially transform certain sectors of the Nubian political economy and identity (the lasting impact of Egyptian colonialism on Nubian society as evidenced by the nature of the Napatan kingdom is debated; Edwards 1996; Robertson and Hill 1999, 325-26; Welsby 1996, 11-18, 72-98, 153-176).

If we are correct in concluding that there were two parallel ceramic technologies and styles in Nubia from the Middle Kingdom to the Late/Napatan period, it is interesting to consider why individuals may have chosen to produce and/or use one style rather than the other (Dietler and Herbich 1998; Janusek 2002; Jones 1997, 106-127; Lightfoot and

Martinez 1995, 479-488; MacEachern 1998; Sackett 1985, 155, 157-158; Santley *et al.* 1987, 86-89, 96-97; Stark 2003, 200, 204-205, 211-212; Van Dommelen 2005). For instance, producing Egyptian-style vessels required abandoning older traditions, not only of decoration, but also of local independent manufacturing with individual paste recipes. Instead, it was necessary to adopt foreign technology, such as the potter's wheel, exploit certain clay sources and sustain a relatively high level of conformity in recipes between potters. This may have appealed to many Nubians as a way to tap in to the new social and economic benefits of compliance with Egyptian rule. On the other hand, the maintenance of traditional Nubian pottery traditions may have been a tool for some communities, families and individuals to tacitly resist foreign domination and assert an alternative ethnic identity, while also retaining important social and economic networks associated with the production and trade of vessels between families of potters and non-potters. The role of women, who were probably the household potters, must be seen as highly significant in the maintenance of ethnic identity, a conclusion that is supported by other archaeological evidence, such as the increase in native Nubian cooking pots at Askut over time and funerary practices of women at Tombos (Adams 1986, 38-39, 44-45; MacEachern 1998; Stark 2003, 205; see Smith 2003, 97-166 for greater discussion of gender issues in Nubia).

While at this stage our findings should not be regarded as conclusive, we are pleased with the initial results and the potential for Nubian archaeologists of future research in ceramic compositional characterisation. In general, it appears that the petrographic and chemical analyses are compatible, altogether producing a more complete picture than either method could accomplish on its own. As for the two chemical characterization techniques, INAA will probably remain the method of choice for our project and many others, due to the well developed testing protocols which have been established and the ability of archaeologists to compare their new data with the widespread INAA databases. On the other hand, XRF is a much more easily accessible technique (most universities in Europe and North America have the necessary equipment) and the results seem to compare well with the INAA results. Most importantly, we hope to have shown that even in the Nile river valley, in which pinpointing exact clay sources is extremely difficult, useful information about provenance and manufacturing techniques can be obtained from composition studies (Carpenter and Feinman 1998). As we continue to expand our research of many more sherds, as well as raw clay samples, we trust this information will become even clearer.

Acknowledgements

Analysis of the samples was supported by an NSF grant (BCS-0504015) to the University of Missouri Research Reactor Archaeometry Laboratory and grants to Stuart Smith and Julia Carrano from the Institute of Humanities and Social Sciences and the Academic Senate, UCSB. The INAA laboratory report was authored by Michael Glascock and Jeffrey Ferguson. Cameron Campbell and Aaron Hebler helped with the XRF analysis and grain size work, and David Abraham assisted in final editing.

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