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Experimental Archaeology in Dakhleh Oasis, South Central Egypt: New Insights on the Prehistoric Pottery Industry

Introduction

A recent focus of research in the study of prehistoric pottery from Dakhleh Oasis (Fig. 1) has centred on the 'life history' of the pot: that is, on the processes involved in pottery manufacture, use, reuse and discard. An improved understanding of these processes, and of the pottery industry in general, is beginning to shed light on the overall adaptive and behavioural patterns of the mid-Holocene oasis groups, in particular the Sheikh Muftah Cultural Unit (5200–4000 bp) which remains poorly understood (McDonald 1998; 2001; McDonald et al. 2001). Initial attempts to investigate these processes were frustrated by the limited amount of information that could be gleaned from the ceramic record. One way of countering this was to incorporate experiments into the research program: the experiment enables us to observe past processes in their operational state (Skibo 1992: 11-30; 2000), and is therefore a potentially significant source of data that can supplement the ceramic record when it comes to addressing such issues as prehistoric pottery manufacture and use.

This point is illustrated in the following study which reports briefly on a field experiment that took place in Dakhleh over the course of nine days in December 2002. The experiment was essentially a pilot study that set out to gather data on prehistoric pottery manufacture by replicating each stage of the manufac-

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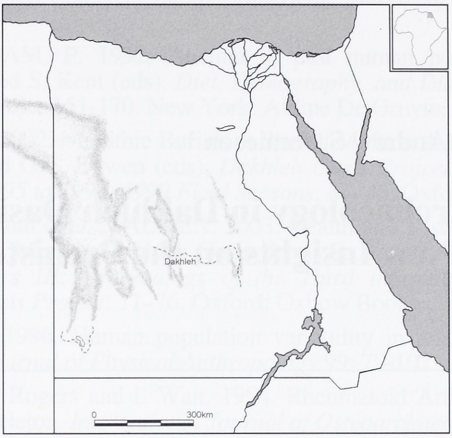

Fig. 1. Map of Egypt showing location of Dakhleh.

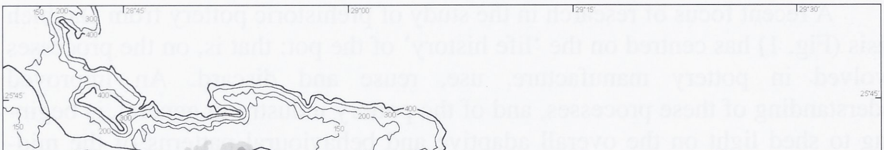

Fig. 2. Map of Dakhleh showing location of Sheikh Muftah sites and modern impact on oasis.

turing process using materials and methods that were available to the Sheikh Muftah. This enabled us to observe, in real terms, the time and labour costs involved in the production of pottery. Although our expectation was to acquire sufficient data for future experiments [3], the results were more instructive than anticipated and offer a number of insights on this process. These are discussed below for what they tell us about Sheikh Muftah pottery manufacture and how this technology could have been integrated into the organisational patterns of these oasis inhabitants. The latter point is of particular interest as the Sheikh Muftah were highly mobile which, as a rule, is not wholly conducive with pottery-production.

A brief overview of the Sheikh Muftah pottery industry

Over 70 Sheikh Muftah sites have been recorded in and around the oasis (Fig. 2).[4] Pottery has been recovered from the majority of these, and in most cases the sherd collections represent somewhere between five and 30 vessels.[5] The material is not unlike that reported for 'Late Neolithic' industries in this part of northeast Africa (Kuper 1995; Gehlen et al. 2002; Nelson 2002), only it appears to be cruder in its manufacture. The original vessels were often open or slightly restricted and preserved simple or inflected contours. Most of these appear to have been quite large (≤30cm in height and width), with walls generally in the range 4–9 mm before thickening towards the base. There is nothing by way of embellishment in the form of appendages (feet, spouts, handles, etc) and decoration is infrequent, occurring mainly in the form of rim-top incisions. Surfaces often preserve a thin self-slip and are generally quite rough, though some particularly smooth examples have been recorded. Occasionally surfaces are deliberately textured by way of finger rills applied during the leather-hard state (Fig. 3). Virtually all Sheikh Muftah fabrics are produced from iron-rich clays, which produce a range of reddish-brown (2.5YR 4/4-5/6; 5YR 4/3-6/6) and/or grey-brown (7.5YR 5/2-5/4; 10YR 5/2-5/4) fired colours, and it is common to find fire-clouds preserved on both exterior and

[3] Since presenting this paper in July 2003, two additional field experiments have been conducted based on the results of the current study. A comprehensive report on the design, procedure and interpretations relating to all three experiments can be found in Warfe (in press). A photo essay has also been published on the first experiment (Jamieson and Warfe 2005).

[4] Most of these sites are found on the oasis floor in the modern cultivation zone (<110m a.s.l.), on the edges of this zone (approx. 130m a.s.l.), or further upslope (<136m a.s.l.) towards the desert border (McDonald 1998, 135). A few sites are located atop the plateau to the north (Fig. 2), or well beyond the oasis proper – members of the ACACIA team have reportedly come across a number of sites in the surrounding region that have yielded 'Sheikh Muftah-like' pottery (H. Riemer pers. comm., December 2004).

[5] Localities 136 and 404 (Fig. 2) are exceptional in this regard as these sites have yielded several thousand sherds that represent some 550 vessels between the sites.

interior surfaces. Fabrics are mostly medium-bodied in texture and can comprise a range of non-plastic inclusions: the most common example is known for its frequent sand-and-shale inclusions (Hope 2002), while other fabrics are shale-rich, sand-rich, vegetal-tempered, or comprise distinct clay aggregates.[6]

Our understanding of the manufacturing process prior to this experiment can be summed up in a few points. The ceramic record indicates that manufacture involved the use of local clays (Eccleston 2002), non-plastic tempering agents (Eccleston 2002; Hope 2002), non-radial construction techniques (Tangri 1992, 117; Hope 2002, 48), and firing by way of open and/or pits fires (Edwards and Hope 1987, 4). There is no clear evidence for centres of production and the distribution of pottery indicates that manufacture probably took place on a site-


Fig. 3. A typical Sheikh Muftah vessel with a textured surface.

by-site basis. The essentially egalitarian nature of Sheikh Muftah groups (McDonald et al. 2001, 9) gives the impression that manufacture took place at the most basic 'household' level (i.e. van der Leeuw 1977; Costin 1991), presumably for replacement/consumption purposes.

Experiment design

The selection of both raw materials and manufacturing techniques was guided by the principle that the field experiment should seek to place the

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[6] At the time of the experiment these aggregates or 'clumps' were tentatively identified as grog inclusions (Jamieson pers. observ., December 2002). Further analysis has revealed these inclusions are, in fact, clay pellets (Warfe pers. observ., January 2003).

analyst/s in an environment that closely resembles the archaeological context under investigation (Skibo 1992, 22-23). This was achieved largely by conducting the experiment at the DOP dig house, which is situated in the middle of Sheikh Muftah territory (Fig. 2). From here, we were able to assess the time and labour costs involved in materials collection with the view that Sheikh Muftah potters would have expended similar costs operating from sites in the region.

This approach rests on the assumption that the same materials were present during Sheikh Muftah times which, despite shifts in the local geomorphology and ecology (Kleindienst et al.1999), was probably the case.[7] The clay and non-plastic inclusions collected for the experiment along with the key fuel sources, tamarix and acacia, are widespread throughout the oasis today and have been since the beginning of the Holocene period (Kleindienst et al. 1999). While donkey dung, palm matting and straw were also sourced for fuel, it is not clear whether these were available to the Sheikh Muftah (U. Thanheiser pers. comm., July 2003; C. Churcher pers. comm., February 2004). If not, other materials with similar combustible properties – i.e. plants and animal dung – were known to exist in the oasis during the fifth millennium bp (McDonald et al. 2001).

The selection of manufacturing techniques was based on the ceramic record (see above). Where this information was not available, we adopted techniques based on the ethnographic record of modern-day 'pre-industrial' potters (Rye 1981; Arnold 1985). In such cases, the techniques were used only if we felt they were within the technical 'know-how' of the Sheikh Muftah potters. In selecting our methods we were mindful that the Sheikh Muftah potters could have employed any combination of techniques from a wide pool of choices depending on personal preferences, communal demands, the availability and reliability of resources, levels of output and so on (for instance, Schiffer and Skibo 1997). This experiment must therefore be seen as one in which only a select range of technical choices were tested: some or all of which *could* have been those used by the Sheikh Muftah potters.

Experiment procedure

The collection and preparation of materials took place over two days. All resources, including the fuel, were collected from within a 150m radius of the dig house with minimal effort. The only exception to this were the shale inclusions (see below) which were collected from the closest known outcrop some 8km east of the dig house.

[7] Reconstructions of the palaeoenvironmental record for the sixth and fifth millennium bp indicate that this part of northeast Africa was subject to similar conditions as today, including minimal or nil seasonal rainfall, high temperatures and formidable northerly winds (Hassan 1997; McDonald 1998; Wendorf and Schild 2001; Nicoll 2004).

Approximately 11kg of a relatively fine-grained grey-green (5Y6/3; 5Y7/3; 5Y7/6) clay was taken from the base of the dig house mound – the same clay can be found exposed in patches across the oasis lowlands (Warfe pers. observ., January 2003; 2004). This was ground by hand for over an hour to the point that most particles could be sieved through a 1mm screen.[8] All largish non-plastic inclusions were removed in order to produce a finer mix and roughly 5500ml of water was added to the clay until it reached a workable state of plasticity. This was then kneaded for roughly 30 minutes and divided into six batches – labelled I to VI – each of which would receive a different temper (Fig. 4), except for batch VI which was intended to remain untempered as a control. The tempers produced for this study – fine shale, coarse shale, chaff, sand and grog – were based on Sheikh Muftah fabrics (see above).

The preparation of these inclusions was costly in both time and effort. Roughly half an hour was spent crushing shale to produce fine (≤2mm) and coarse (2–8mm) particles, and a similar amount of time was spent crushing modern pottery sherds to acquire a sufficient quantity of grog (≤8mm in size). Vegetal temper was collected by sieving the straw collected for fuel. This again was a fairly lengthy process. Each of these was then added to individual clay batches in quantities consistent with Sheikh Muftah material: in the case of Fabrics I, II, IV and V this meant somewhere between 300–400gm of fine shale, coarse shale, sand and grog, respectively. Approximately 35gm of chaff was added to Fabric III. After adding the inclusions, we found that Fabrics II, III and V were not as malleable as we had hoped and around 300gm of sand was added to all fabrics, including Fabric VI.

The construction and drying phase took place over four days. Nineteen vessels and one perforated disc [9] were produced, along with 12 briquettes on which a 10cm scale was incised to measure shrinkage rates (Fig. 5). The construction of each vessel was a relatively protracted process and one that was complicated by the morning coldness and the afternoon winds which fatigued the clay and accelerated the drying process, sometimes resulting in failure during this stage. It is interesting to note that the chaff-tempered Fabric III seemed to fatigue faster than the other fabrics, which made it particularly difficult to form.

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[8] It is assumed that the Sheikh Muftah potters would have used hides or woven materials if they chose to separate their clays

[9] Eighteen perforated discs have been found on Sheikh Muftah sites. The function of these remains unclear, though they tend to be found in association with truncated cones, or 'Clayton rings' (Riemer and Kuper 2000; Gatto 2002; Hope 2002, 46). Interestingly, all but one of the examples have been worked from existing pottery vessels, presumably after use-failure. To do this would take some time and we were curious why discs were not made anew with vessels. We still cannot explain this as the disc only took around ten minutes to form and survived the firing process.

Fig. 4. Clay batches with respective inclusions piled to the side.

Fig. 5. Briquettes with incised 10cm scales.

The method of construction was fairly straightforward and simply involved constructing base sections out of slabs and then building on these with coils, or forming the entire vessel using coils. Having said this, it was especially difficult to produce walls within the range 4–9mm without malformation at some point. It was also difficult to produce large vessels unless this was conducted in several stages allowing the lower body to dry slightly in order to hold shape for the construction of the upper body. Little effort was invested in surface treatments, and most vessels simply received a thin-slip. The briquettes, which were exposed to the sun and wind, indicated approximately 10 percent shrinkage within the first 48 hours, after which point there was no further change.

The firing process took place over three days. A pit fire, as opposed to open fire (for distinction see Nicholson 1993, 108), was chosen as the preferred apparatus for two reasons. First, pit fires can maintain relatively high temperatures and some Sheikh Muftah pottery is fired in excess of 800°C (Edwards and Hope 1987, 4-5). Secondly, pits containing charcoal have been recorded on Sheikh Muftah sites, though it is unclear whether these were used for firing pottery.

The dimensions of Sheikh Muftah pits seem to vary on an individual basis and have also been obscured by a number of post-depositional factors. The pit dug for the current purposes measured approximately 120cm in length, 95cm at its widest, 25cm at its deepest, with an opening that faced 315° north-northwest. The orientation of the pit, as well as its shape, was designed this way to maximise the amount of wind required to fan the flames – though there is no archaeological evidence to suggest the Sheikh Muftah would have done this. The clay objects were grouped in the pit, separated by layers of fuel (Fig. 6) to ensure relatively uniform exposure to heat and oxidation.

The firing began at 16.00 hr to coincide with the onset of the daily winds. Within a few minutes the estimated 4-5kg of fuel in the pit had almost completely burned away, and over the next half hour a further 30kg was added to the fire (Fig. 7). In an attempt to reduce the rate of combustion, the opening to the pit was closed off to prevent wind fanning. After 40 minutes, most of the fast-burning fuel was smouldering and had formed a canopy over the pit. At this point, the walls of the pit were pushed inwards and dung was placed on top to completely smother any remaining flames. The pottery was left in the pit for roughly 42 hours to ensure sufficient cooling before removal.

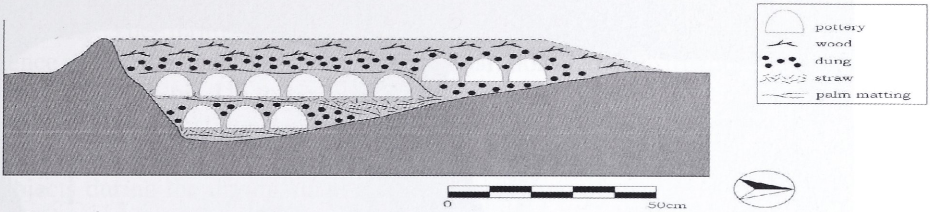

Fig. 6. Stylised cross-section of firing pit.

Fig. 7. Firing in progress (photo taken facing south).

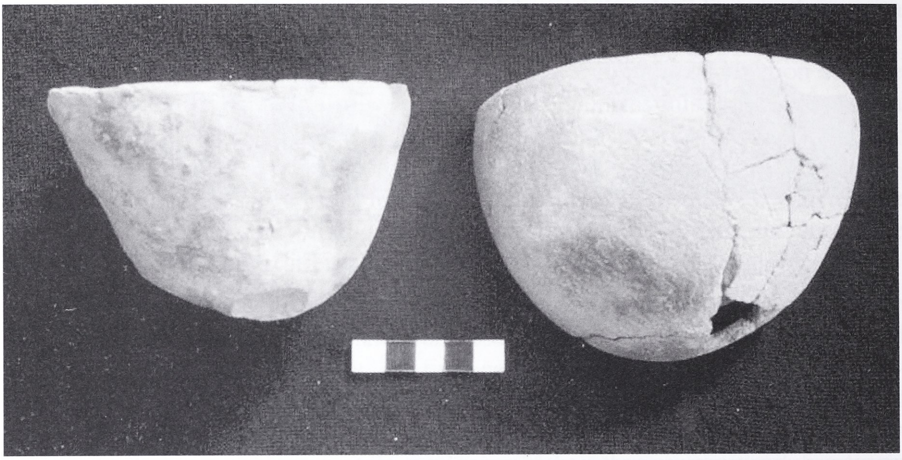

Fig. 8. A Sheikh Muftah vessel (right) and experimental vessel side-by-side.

Fig. 9. Collection of experimental objects after firing.

Results

The experiment took nine days and involved varying levels of labour expenditure. The more costly exercises were those that fell earlier in the sequence – i.e. the materials collection, preparation and construction, and the digging of the fire pit. Up to six people were involved in two of these exercises and we worked almost constantly during daylight hours. The labour investment dropped considerably after this point and involved only intermittent checks on the objects during the drying stage and the supervision of the firing for roughly an hour.

As for the fired objects, these were found to resemble the Sheikh Muftah material in most formal properties (Fig. 8). Analysis of sherd sections at x40 magnification revealed that the colouration and zoning of the experimental objects compare closely with Sheikh Muftah samples. The only notable difference concerns the texture, which was denser in the case of the experimental material. Analysis has also revealed that none of the experimental tempers, with the exception of sand, are comparable with Sheikh Muftah samples. The chaff we used was considerably coarser than the vegetal temper used by the Sheikh Muftah potters, and the angularity, texture and colour of both the grog and shale inclusions is nothing like that observed in the original. On the other hand, the 'bricky' ring of the experimental objects, the 2.5–3.5 scratch resistance (*Mohs*), and the relatively high transverse strength fit the profile of the Sheikh Muftah material. The reddish-brown and grey-brown surface colours are also comparable (see above), though the experimental objects preserved far more extensive fire-clouding (Fig. 9).

Discussion

The results clearly demonstrate that while a number of the materials and techniques we chose were appropriate, others were not. Beginning with clay, the similarities in groundmass indicate that the same bed was tapped by the experimenters and Sheikh Muftah potters alike. This was not unexpected as the same clay is exposed at various points in the oasis lowlands and is easy to access even when covered by Holocene sediments (Warfe pers. observ., January 2004). It is also an ideal clay for pottery manufacture: it is easily workable in its wet state, it retains plasticity for several hours, and does not require excessive inclusions – a point illustrated clearly with Fabric VI which maintained both its malleability and strength during the construction stage. The differences in texture have been ascribed to different preparation techniques, as opposed to differences in the clay. While we spent over 90 minutes grinding and wedging the clay, it is likely the Sheikh Muftah did not invest the same levels of time and effort in preparation. If the clays were extracted in their wet state – i.e. from the edges of water catchments – the removal of 'clumps' and air pockets would presumably take only a matter of minutes (Warfe in press).

In terms of the non-plastic inclusions, the results indicate we need to rethink this aspect of the study. As mentioned earlier, our decision to produce a grog temper was misguided by preliminary analysis of the ceramic record. It now appears that the Sheikh Muftah did not recycle their pottery in this manner. The presence of clay aggregates in Sheikh Muftah pottery could be the result of pellets forming naturally in a larger clay-body that has not yet been sourced in the oasis, or the mixing of clays: both hypotheses require further testing. As for the chaff, the carbon-lined pseudomorphs in the Sheikh Muftah pottery are considerably finer (≤5mm) than those preserved in the experimental sections (≤15mm). Although our method of obtaining chaff was questionable (see above), it is not clear whether this temper was ever added by Sheikh Muftah potters. The fineness of particles in the original pottery could be the result of using a dung temper (i.e. Nordström 1972, 42), or collecting clay from beds that retain vegetal matter through lacustrine formation processes. Again, further analysis is needed to test these points.

The shale we prepared appears nothing like the grey-green or dark-grey lath-like particles in the Sheikh Muftah pottery. Our immediate interpretation was that we tapped the incorrect source, until it was revealed through x40 magnification that all experimental fabrics preserved fine lath-like shale particles in similar distribution to the original material. Evidently, fine shale particles appear naturally in the clay and can enter the paste without the potters' knowledge, as it did with us. The presence of coarse shale inclusions is not as easily explained. Some of these particles are in excess of 15mm and simply could not have gone unnoticed by the potters. So far, no known clay sources with naturally occurring coarse shale inclusions have been recorded in the oasis, and the only known outcrop for this type of shale is a band running across the northern escarpment of the oasis (Warfe pers observ., January 2003). If this served as the point of extraction, considerable time and labour costs would be added to the procurement process.

If we can take the low failure rate as an indicator – only two vessels removed from the fire pit were extensively pitted and another exhibited minor fractures along coil joins – the techniques selected during the construction stage appear to have been appropriate. One of the more interesting insights derived from this process was how the fabrics performed at different times of the day. Although we had difficulties dealing with the elements (i.e. sun and wind), it is possible that the Sheikh Muftah capitalised on these by scheduling different stages of construction throughout the day. Assuming this process involved the production of several vessels at once, it is likely that parts of the vessel were constructed first then allowed to partially dry before the completion of the vessel at a later point (for instance, Rye 1981, 21). Such a process may explain how the Sheikh Muftah potters managed to produce such thin-walled material whereas we were forced to produce thicker walled pottery in order to maintain the structural integrity of the vessel in its wet stage. As we did not allocate much attention to treating the vessels this process was not sufficiently addressed in the study, though it perhaps goes without saying that the application of coats and compaction would require some time and effort.

The low failure rate also says something about the drying process. Even the thicker objects indicate that 48 hours was a sufficient period of time to remove the bulk of 'shrinkage water' (Rice 1987, 63-64), but was not too rapid to produce deformation or stress cracks. Evidently, the temperature, lack of humidity and the afternoon winds provides an ideal environment for drying and one that is comparatively short – ethnographic examples indicate this process can take up to several weeks (Arnold 1985, Table 3.1).

The surface colours of the experimental objects, as with their scratch resistance and transverse strength, tell us that the firing process was also of sufficient duration, and that appropriate temperatures were reached. The extensive clouding on these objects indicates that the firing atmosphere was oxygen-starved, resulting from a poor choice of apparatus, or fuel, or both: dung can have a smothering effect and a more balanced oxidised-reduced atmosphere is attainable through open fires (Warfe in press). While the objects were not removed for 42 hours this was felt to be excessive, especially as the ethnographic record documents pottery being removed from non-kiln firings less than 30 minutes after ignition (Rye 1981, Table 3).

Drawing on these points, one of the interesting outcomes of this study was that we regularly overestimated the time and labour investments required for each stage of manufacture. We now feel that these investments could be reduced considerably at a number of stages. In fact, it is estimated that the entire process could be reduced to three or four days on the grounds that a modest quantity of vessels were to be produced (i.e. roughly a dozen vessels), and that at least three able adults were involved in the process. The collection of materials, and the preparation and construction could all take place in one day, provided that minimal effort was expended in producing the paste and that construction involved a well-organised production line of sorts. The costs involved in collecting the materials cannot be compromised. Likewise, the drying process cannot be accelerated and two days must be dedicated to this phase of manufacture. As for the firing process, all indicators suggest that this could be successfully completed within a matter of hours, not days (Warfe in press). It is noteworthy that this final stage of manufacture could also be incorporated into other 'communal' activities, such as food preparation, in which case the costs involved in collecting the materials become diffused. These are interesting points when considered within the wider framework of Sheikh Muftah organisational patterns.

It was mentioned in the introduction that Sheikh Muftah groups were highly mobile, an assessment based principally on the absence of architectural remains and storage facilities (McDonald et al. 2001).[10] It is well known that mobility places a range of constraints on the potter often impeding or preventing him/her from completing their task: it can distance the potter from the materials they require for production; it can situate the potter in a cold, moist or wet environment, making the collection and preparation of materials dangerous or exceptionally labour/time intensive; and it can reduce the necessary time required for critical stages of production, resulting in a process with high failure rates. While these points stem from Arnold's (1985, 109-126) ethnographic survey based on modern-day potters, it is no coincidence that the emergence and/or increased production of pottery in antiquity was often concomitant with shifts towards more settled adaptations (Hoopes and Barnett 1995, 4).

It is significant then, that mobile groups from a number of regions still produce pottery (Arnold 1985, 119-120). This often involves adopting strategies that serve to minimise or obviate the problems noted above. Alternatively, groups may occupy regions that are warm, dry and have abundant resources, in which case these problems may not arise, or if they do, they may not be as significant. The results of this experiment indicate that Dakhleh was one such niche, and this begins to explain how Sheikh Muftah groups could maintain a technology more suited to sedentary lifestyles.

The environmental conditions and the access to resources resulted in a process that we feel could be undertaken in a matter of days. Although we are unsure of the precise nature of the Sheikh Muftah settlement patterns – whether groups maintained set routes, the number of stops made on a seasonal round, the length of time for each stop, the range of movement, and so on – it is unusual to find residentially mobile groups spending less than a few days on the same patch (i.e. Kelly 1983, Table 1). It might be assumed then, that the average Sheikh Muftah stop was of adequate length to conduct all stages of pottery manufacture. It may also be assumed that if movement was confined largely to the oasis lowlands, then the necessary materials – with the exception of coarse shale –

[10] There is little evidence for specialised activities on Sheikh Muftah sites to attest the dispersal/aggregation patterns typically associated with more complex settlement strategies, which gives the impression that the Sheikh Muftah were practicing a form of 'residential mobility' (i.e. Binford 1980). This said, it is possible that more 'permanent' sites may be buried beneath the modern agricultural plots in the oasis lowlands (McDonald et al. 2001, 9).

could be accessed on the spot. There would be no need to deviate from the usual rounds to collect resources or to carry them as a form of 'embedded procurement' practice (Binford 1979). In short, it appears that pottery-production could be worked into the organisational patterns of the Sheikh Muftah irrespective of the nature of the settlement systems.

This is not to say that the settlement systems had no impact on the technological organisation. Presumably, the Sheikh Muftah potters were faced with the usual problems associated with constantly transporting pottery – namely, a high breakage rate of vessels (i.e. Arnold 1985, 119-120). This perhaps explains why so much of the Sheikh Muftah pottery appears to be crudely made. While there was evidently enough time to undertake all stages of manufacture, the apparent slapdash construction could reflect a tradition that places less emphasis on producing finely made pottery, with the expectation that vessels have a relatively short lifespan. In other words, we may be dealing with an 'expedient' technology (i.e. Binford 1979), in which production investments were kept to a minimum given the high replacement costs. Of course, as with the experiment, far more research needs to be undertaken before we can offer anything more than first approximations in regard to technological organisation.

Conclusion

To recap, the aim of this study was to highlight the usefulness in conducting experiments as a way of understanding processes that are no longer visible in the ceramic record alone. Although this has been presented as a pilot study, and hence a wide range of issues have received only superficial attention, the instructive results highlight the potential of this approach. We now have a better understanding of the materials and techniques used by the Sheikh Muftah potters to perform their craft, and a much clearer understanding of the time and labour costs involved in this process. In a broader sense, these findings have contributed to a better understanding of the overall organisational patterns of the Sheikh Muftah Cultural Unit.

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