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APPLYING ORGANIC RESIDUE ANALYSIS IN CERAMIC STUDIES – A FUNCTIONAL APPROACH

Tania F.M. Oudemans

Abstract

This article defines organic residue analysis and its importance as supplier of independent information about the actual use of ceramic vessels in the context of functional ceramic studies in archaeology. In organic residue analysis, analytical chemistry is used to detect and identify organic compounds preserved in association with ceramic vessels. When applied to functional ceramic studies, the goal is to identify the original vessel contents of different groups of vessels, in order provide evidence for functional differentiation of vessels.

This paper aims to present archaeologists and ceramicists with a review of the possibilities and limitations of the application of organic residue analysis within the context of functional ceramic studies. Sampling strategies, research questions, and evaluation criteria for results will be discussed.

Introduction

A functional perspective towards ceramics in archaeology

Pottery assemblages are frequently studied by archaeologists in search of information about a variety of different aspects of past societies, such as socio-economic developments, the organisation of production and trade, and the mechanisms of cultural interaction. Pottery is an optimal source-material for archaeological studies because it was used in daily activities, was commonly produced locally (reflecting local values and needs), had a relatively limited use-life, and is frequently preserved in archaeological context.

In order to make behavioural inferences from the shattered remains of a once thriving community, a clear understanding of the function or use of the original vessels is essential (Hally 1983; Henrickson 1990). The archaeological information stored in any assemblage of artefacts can only be interpreted fully if the actual use of the objects is known. If an accurate assessment could be made of the original vessel use, both the kind of questions that can be addressed (Hally 1986) and the quality and specificity of the archaeological inferences could be improved (Skibo 1992: 4-5).

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Intended vessel function versus actual vessel use

In spite of this clear rationale, the identification of vessel use is perhaps one of the most difficult problems for those studying archaeological ceramics. Vessel use has received surprisingly little attention amongst archaeologists until the late 1980s (Henrickson 1990; van der Leeuw and Pritchard 1984). In the last three decades the systematic investigation of functional aspects of vessel assemblages has been recognised as an informative strategy for archaeologists interested in domestic activities within ancient settlements (Henrickson 1990).

Most archaeological methods to identify vessel function are directed at the study of "intended vessel function" – the job (or range of jobs) the potter had in mind when making the vessel. Such studies are based on the assumption that morphology as well as other physical and technological attributes of pottery can be optimised to suit a particular use or range of uses (Erickson and Stickel 1973: 356) or are constrained by the intended use context (Braun 1983). The research strategy is primarily aimed at uncovering specific characteristics of vessel morphology and technology that identify functional vessel categories. However, the relationships between morphology, technology and use are not uniform and specifiable but complex and variable, and their study commonly results only in major use categories (Howard 1981; Rice 1990) or local ethnographic classifications (Henrickson and McDonald 1983). Although the comparison of cross-cultural data shows that some relationships are almost universally upheld (Varien and Mills 1997), many of the predicted relationships between form, technology and function have been found to be somewhat equivocal (Henrickson and McDonald 1983; Plog 1980: 60-62). In addition, a growing number of archaeological (Mills 1999; Sinopoli 1999; Woods 1986) and ethno-archaeological studies (Arnold 2000; Aronson et al. 1994) provide evidence that a variety of factors including environmental and social factors determine the processes of pottery manufacture and use. One illustrative example of the complex nature of the relationships between vessel morphology, technology and use, is the study of the optimal characteristics of cooking pots. Cooking vessels are expected to make efficient use of heat for cooking. It has become generally accepted that cooking vessels have certain forms (rounded rather than angular contours) to avoid thermal damage and permit greater exposure of the vessel base; are relatively thin walled to conduct heat better and prevent thermal stress inside the vessel wall; and are course textured, porous, and tempered with materials that have low coefficients of thermal expansion (burned shell, crushed ceramic material or grog) to accommodate thermal stress (Henrickson and Mc Donald 1983; Rice 1987: 237; Rye 1976). Contrary to these general rules a wide range of shapes has been recorded in cooking pots in the past and present (Rice 1987: 239). The study of archaeological material from Britain shows many flat based cooking vessels and a majority of vessels have sandy fabrics, thus contradicting the theories concerning thermal shock resistance properties of pottery (Woods 1986). A study of factors influencing Kalinga users in their choice of cooking pots, illustrates that although technical arguments (differences in strength and weight of the vessel) play a role, kinship and social affiliation of consumers strongly influences their choice of cooking vessels (Aronson et al. 1994; Longacre and Stark 1992).

An alternative archaeological approach to identify vessel function is directed at the study of "actual vessel use" – the way vessels were put to task by the user. These studies can give independent information about the original utilitarian role of the vessels. The traditional archaeological approach of inferring actual vessel use – through the study of recovery context – is usually limited in scope by the small quantities of vessels recovered in their original use-context (Orton et al. 1993: 28-30). The most direct and detailed way to identify "actual vessel use" is through the study of "use alterations" – traces of use found in and on the ceramic material. Although the importance of the study of use-wear traces in functional studies of artefacts such as stone tools (Semenov 1964: 6) and ceramics (Matson 1965: 204-208) was already formulated in the mid 1960s, the term use-alterations was only introduced in ceramic studies in the 1980s (Hally 1983).

The use alteration perspective

Following Hally (1983), Skibo (1992: 42-45) defined use-alterations as any chemical or physical change that occurs to the surface or substance of ceramics as a result of use. Four types of alterations were defined:

1) Attrition or wear of the ceramic. Use-wear can be the direct result of vessel use through stirring or scraping of the vessel contents, or be a secondary effect such as salt erosion and thermal spalling. Careful study of such phenomena can give indications of the original use (Beck et al. 2002; Bray 1982; Hally 1983, 1986; Henrickson and McDonald 1983; Skibo 1992). However, a number of non-use phenomena may cause similar attritions. Confusion between use-wear and non-use wear can be avoided by comparing old and fresh break surfaces, and comparing wear patterns on neighbouring shards.
2) Discoloration of the clay also called fire clouding. Colour changes of the clay may occur due to changes in oxidative state of iron in the clay during heating of the ceramic.
3) Soot depositions on the exterior of vessels can occur due to condensation of wood smoke against the (relatively) cooler ceramic. Both soot deposition and colour changes of the ceramic have both been used as indications of cooking over an open fire (Hally 1983) or for the type of cooking technique employed (Arthur 2002; Hally 1983; Henrickson 1990; Kobayashi 1994; Skibo 1992: 42-49; Skibo and Blinman 1999). Skibo showed that the presence of a light coloured patch on the bottom of the vessel indicates that the vessel was placed in the fire, while vessels with an entirely black bottom were hung over a fire. The study of these discolorations can only be performed successfully on whole vessels and must be employed carefully as to prevent confusion with accidental secondary heating of vessels after their discard.
4) Organic residues directly associated with vessels can contain remains of the original vessel contents and as such be indicative of the original use of ceramics. Non-use

effects such as secondary deposition of organic materials after discard or growth of plants or fungi can also form organic residues in ceramics. The chemical characterisation of organic remains found in direct association with vessels, is one of the more recently developed methods in the functional study of ceramics. Although first applied in the 1920s and 30s (see Rottländer and Schlichtherle 1980 for references), organic residue analysis has only been widely used since the 1980s (see Evershed et al. 1999; and Heron and Evershed 1993 for references) as a result of improvements in micro-analytical instrumentation and an increasing interest in functional aspects of archaeological ceramic assemblages.

Analytical strategies in organic residue analysis

Organic residue analysis in ceramic studies is here defined as all research aimed at the detection, identification and explanation of the chemical characteristics of amorphous organic residues found in direct association with ancient ceramics. Direct association implies that the organic substance is contained by, stuck to, or absorbed into the ceramic matrix of the vessel.

Organic residue analysis is a typical science-based archaeological approach, and results depend heavily on the availability of high-tech analytical instrumentation and the application of an analytical protocol that fits the research question. However, the success of organic residue analysis also depends on a clear archaeological problem definition, a matching sampling strategy and a sophisticated interpretation of chemical results within their archaeological context. A research plan is most successful if designed by archaeologists in cooperation with a specialist in organic residue analysis. In order to facilitate this interdisciplinary cooperation, some of the main areas of consideration within organic residue analysis are discussed below.

Detection and identification of molecular characteristics

Organic residue analysis is geared towards the detection and identification of chemical compounds preserved in the residues in order to determine its origin. The study of small amounts of complex organic materials preserved in the ground for thousands of years provokes many analytical and methodological challenges.

The possibilities and limitation of detecting and identifying organic compounds is to a large extent determined by the chosen analytical protocol. The sample preparation, the chosen (combination of) analytical techniques and the sensitivity of the instrumentation determine the range of compounds and the detail of the molecular information that can possibly be detected. Many classes of chemical compounds have been detected in ceramics from ancient times. Much research has been aimed at the identification of extractable compounds such as lipids and waxes (Heron et al. 1994; Evershed et al. 1995, 1999); resinous materials and wood pitches (Eerkens 2002; McGovern et al. 1996) and proteinaceous materials (Buckley et al. 1999; Craig and Collins 2000, 2002;

Craig et al. 2000, 2005; Evershed and Tucross 1996). Other studies have successfully identified classes of less-soluble compounds such as amino acids and small peptides, polysaccharides, polynuclear aromatic hydrocarbons (Oudemans and Boon 1991, 1996; Oudemans et al. 2005, 2007). The detailed discussion of different micro-analytical technique goes beyond the scope of this article and can be obtained from earlier studies (Heron and Evershed 1993; Oudemans 2006; Oudemans and Erhardt 1996).

Detecting organic compounds in ancient ceramics does not mean they were necessarily present in the ceramics during their original use. Many chemical formation-processes played a role in shaping the residue as it is now. Both preservation processes (charring, absorption into the ceramic vessel wall, mixing and polymerisation, drying and encrustation) as well as degradation processes (thermal degradation, loss of water soluble compounds, microbial degradation, oxidation and contamination) have their effect on the final residue. These residue formation-processes will be discussed in a later section. In summary, it can be said that many organic compounds can be detected (lipids, waxes, resins, amino acids, small peptides, sugars, markers for starch, smoke condensates), and that although many molecular characteristics of the original organic materials have been lost as a result of extensive degradation during cooking and additional post-depositional degradation, a surprising amount of specific characteristics have been preserved within the context of charred or otherwise preserved residues.

The archaeologists and ceramic specialists interested in applying organic residue analysis (ORA), may want to consider the expected original pottery use; the kind of materials used; and the compound classes these materials may originally have contained, and discuss the possibilities for detection of these compounds with their ORA specialist.

Problem definition – from diet to vessel-use and changing subsistence systems

Organic residue analysis has been used to address different types of research questions within ceramic studies, ranging from simple single vessel studies to complex systematic studies of different groups of vessels within ceramic assemblages, and from single compound identifications to the study of changing subsistence systems.

The study of molecular characteristics is often aimed at a specific well-preserved residue (or small number of residues) in order to determine the nature of their origin. Such studies have shed light on processing and preparation of certain specific diet components, such as plant leaf waxes in Iron Age cooking pots from Britain (Charters et al. 1997; Evershed et al. 1991) and the identification of palm fruit lipids in Egyptian vessels (Copley et al. 2001), however the study of individual residues has only a limited scope.

The application or organic residue analysis to functional ceramic studies requires the study of a larger number of residues from a specific group of vessels. Many publications are aimed at determining the original use of one or more groups of vessels. The early identification of lipids in amphorae showed oil transport in such vessels (Condamin et al. 1979) and, more recently, the study of chemical characteristics of cocoa showed the use of a special class of ancient Maya vessels (Hurst et al. 1989); the use of Corinthian figurine vessels as perfume bottles (Gerhardt et al. 1990); and the processing of fermented beverages in pre-and proto-historic Chinese vessels (McGovern et al. 2004). More and more studies address the essential functional question: what was this type of vessel actually used for during their original use-life? Indirectly these studies also address the fact that some types of vessels may be used for several daily uses, while others were always used for one specific task. How kosher was this house, this village, this group of people? Is there any evidence for functional specialisation among different types of vessels, or were vessels used for a specific use? These questions are best addressed when organic residue analysis is possible on larger number of residues from multiple groups of vessels. A few such systematic studies have been performed, for example on Roman Iron Age cooking and storage vessels from Uitgeest-Groot Dorregeest (Oudemans and Boon 1996); on different types of medieval ceramics (Evershed et al. 1997) and on vessel types recovered from the Roman settlement of Sagalassos in southwest Turkey (Kimpe et al. 2004). Although still few in number, these studies show the most promising application of organic residue analysis in ceramic functional studies in archaeology.

Another sophisticated application of organic residue analysis has been in studies of changing subsistence systems in northern and Western Europe in the Early Neolithic. Craig and co-workers have produced a number of papers directed at the spread of prehistoric dairying activities (Craig et al. 2000, 2005; Spangenberg et al. 2006) in Western Scotland, and the continued use of aquatic products in the Early Neolithic in northern Europe after the transition to agriculture (Craig et al. 2007).

The archaeologists and ceramic specialists interested in applying organic residue analysis (ORA) to answer questions on such a large scale, have to consider their sampling strategy critically prior to excavation. Systematic study of vessel-use requires the presence of a good number of residues for each type of vessel. The additional collection of soil samples for comparison of preservation and degradation in surrounding soil is also needed. The study of changing subsistence systems requires the presence of residues on very specific vessels used for a particular activity and a analytical protocol that is designed to detect and identify – without any doubt – the presence of a specific chemical compound. Optimal preservation of organic residues after excavation must also be considered and may require the presence of a freezer unit (see also Oudemans and Erhardt 1996). Preferably, residues will be taken from intact vessel-profiles by an ORA specialist in order to determine the position of the residue on the vessel profile and to insure minimal sample contamination.

Choice of sample materials – absorbed residues versus solid surface residues

The selection of the best materials for analysis is an essential part of designing a good research plan. Like a good crime scene investigation, a well-designed ORA research plan is geared towards detecting the right things in the right place. Only then do they provide the nessesary evidence to convince the listener.

In organic residue analysis, much research is aimed at the identification of extractable compounds such as lipids and waxes, resinous materials and wood pitches and proteinaceous materials. Usually these residues are preserved inside the actual ceramic fabric of the vessel. All these studies apply selective extraction techniques. An alternative approach is the analysis of solid organic surface residues preserved as crusts or films adhering to the interior or exterior surface of ceramic vessels. These solids can be studied through the application of solid-state techniques or through molecular characterisation using pyrolytic fragmentation methods (Oudemans and Boon 1991, 1996; Oudemans et al. 2005; Regert and Rolando 2002).

Although the chemical characterisation of solid surface residues is often more complicated then in the case of extractable residues, there are various methodological arguments in its favour.

Firstly, the study of surface residues makes it possible to sample only one layer of material. Microscopic examination of cross-sections was performed on all residues in this study, and prevents the incorporation of multiple use-phases in one sample. Absorbed residues are a combined deposit of multiple use-phases, possibly including primary and secondary use remnants. Mixing of different use-phases in one extraction may hinder the interpretation of chemical results. Extractions of absorbed residues may also include post-firing sealing products complicating results even more. Post-firing surface sealing with organic mixtures is common amongst traditional potters and is performed with a variety of materials including common foodstuffs such as milk and various starch-rich foods (see references in Rice 1987: 163-164), as well as less edible materials such as beeswax, various resins and other plant materials (Arnold 1985: 139-140; Diallo et al. 1995; Kobayashi 1994).

Secondly, absorbed residues have usually been exposed to a more severe thermal regime (both in time and in temperature) than residues situated on the interior surface of the vessel. Although heating plays an important role in the preservation of surface residues (through charring or condensation), thermal degradation also causes the loss of many distinct chemical characteristics in organic remains (Boon et al. 1994; Braadbaart 2004; Braadbaart et al. 2004a, 2004b; Oudemans et al. 2007b; Pastorova et al. 1993, 1994). Extended exposure of foods to temperatures above 300°C makes identification of biomolecular markers of the original foodstuffs increasingly difficult (Oudemans et al. 2007a).

A final strong argument for the study of surface residues is the fact that the archaeologist frequently has no prior knowledge of the nature of the original materials involved. Choosing the appropriate extraction method is complicated by this lack of knowledge and the extracted sample may not be representative for the residue under study. The overall chemical composition of organic residues needs to be better known prior to the application of extraction techniques.

The archaeologists interested in applying ORA would be best served when considering what kind of organic residues best represents the vessel use they want to detect, and what kind of residues have the best preservation potential in the context of their excavation. The choice of sample material is in practice also determined by what kinds of residues are actually present in the recovered assemblage.

The archaeological value of chemical evidence

The final archaeological value of organic residue analysis depends on the range of organic compounds that can be detected; on the extent to which the origin of the different compounds can be traced back to prehistoric times and to what extend questions of original vessel usage can be addressed.

Transformation processes

The ability to infer the use of particular biomaterials in prehistoric times through organic residue analysis is to a large extent determined by a correct understanding of the transformation processes that influence the chemical composition of the remaining residues.

Transformation processes are summarized in Figure 1 and include processes in the original prehistoric context or "systemic context" the so called C_1-tranforms (cultural transforms), and processes in the post-depositional context or "archaeological context" including the so called N-transforms (natural transforms) as well as the C_2-transforms (cultural transforms) that can take place during and after excavation (Schiffer 1972, 1983). Each of the transformation processes creates a change in the chemical composition of the original organic materials in the vessels. Some of these chemical changes will complicate the chance of recognising the original materials due to their degradation of specific chemical characteristics (degradation processes), while other chemical changes will enhance the preservation of such typical chemical characteristics of the original materials (preservation processes).

Post-firing treatment

The habit of treating ceramic containers after they are fired but prior to use (for the purpose of surface sealing or increasing appearance), has frequently been described in ethnographic and ethno-archaeological studies. Post-firing treatment with mixtures of organic components is common amongst traditional potters and is performed with a variety of materials including common foodstuffs such as milk and various starch-rich foods (see references in Rice 1987: 163-164), as well as less edible materials such as beeswax, bitumen, various resins and other plant materials (Arnold 1985: 139-140; Diallo et al. 1995; Kobayashi 1994). Most commonly the treatment involves the application of an organic liquid or paste to the pots while they are still hot from firing. Post-firing treatment can result in the formation of residues that may well be interpreted as part of a use residue, although non-edible sealing materials such as plants gums or resins are more easily distinguished from foodstuffs prepared in ceramics. Depending on the sealing material and technique, it is likely that organic components are both absorbed into the ceramic of the vessel and deposited onto the interior (or exterior) of the vessel. Although the thermal regime of cooking vessels may well result in a relatively complete thermal degradation of the original sealing material after a few hours of cooking, both residues extracted from ceramic and residues scraped from the surface of the vessel may well be "contaminated" with sealing materials. However, microscopic investigation of the surface residues can help prevent mixing of different layers, while extraction technique will never be able to distinguish between post-firing treatments and use residues (if similar materials are used). In short, post-firing treatments with common foodstuffs would be extremely difficult to distinguish from use residues in cooking vessels.

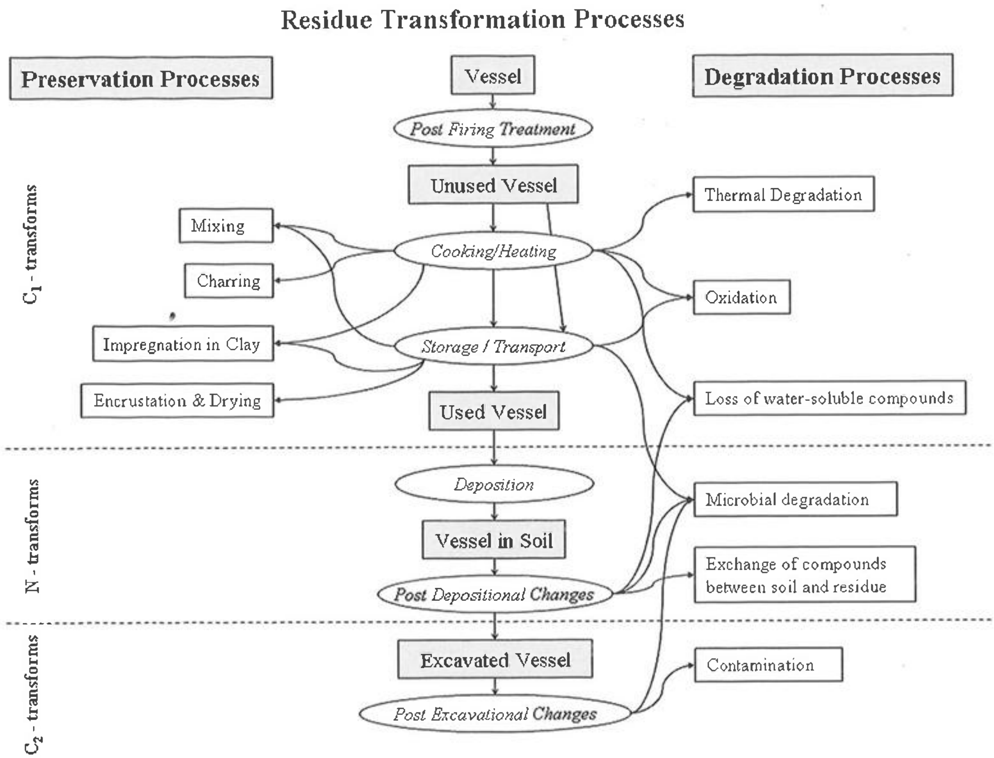

Figure 1: Residue Transformation Processes. Transformation processes include processes in the original prehistoric context or "systemic context" the so-called C_1-tranforms (cultural transforms), and processes in the post-depositional context or "archaeological context" including the so-called N-transforms (natural transforms) as well as the C_2-transforms (cultural transforms) that can take place during and after excavation. Each of the transformation processes creates changes in the chemical composition of the original organic materials in the vessels. Some of these changes cause the degradation of specific chemical characteristics (degradation processes), while other chemical changes will enhance the preservation of such typical chemical characteristics of the original materials (preservation processes).

Food and non-food preparation

Preparation of non-food materials (e.g., glues, dyes, paints, lamp oils, medicines) as well as foodstuffs in ceramic vessels would involve two important chemical processes: mixing and cooking or heating.

Mixing has both preserving and degrading effects. It obscures the original biomolecular characteristics of an organic material making it harder to identify its origin, but it also creates possibilities for the formation of new resistant compounds (for instance melanoidins are formed when proteins and sugars are heated together).

Cooking and heating result in an even more extreme combination of chemical effects. Heating of organic liquids in a ceramic vessel will certainly lead to preservation processes such as impregnation of organics into the ceramic material of the vessel and the formation of chars on the surface of the vessel. On the other hand, the loss of water-soluble compounds and the thermal degradation that takes place also results in the loss of specific biomolecular characteristics. Charring is one of the most important formation processes that result in preservation of solid organic residues on ceramic vessels. However, the chemical changes that take place during charring are complex and can obscure a lot of the original markers.

Storage and transport

Using ceramic vessels for serving, storage or transport of organic materials (whether it be foods or non-foods) may leave residues behind. Liquids especially may be absorbed into the ceramic of the vessels, although sealing materials may have been used to prevent this effect in long-term storage or transport vessels. Examples of recognisable archaeological residues of such liquids are plentiful and involve mostly residues of wines or other fermented beverages (Gerhardt et al. 1990; McGovern et al. 1996, 2004), oils (Condamin et al. 1979; Shedrinski et al. 1991) and medicines (Gibson and Evans 1985). However, storage or transport of solid materials is a lot less likely to leave residues behind, and may only be indicated by the presence of encrustations or absorbed residues that show no chemical signs of thermal degradation, but show signs of severe oxidation due to long-term exposure to the air.

Post-depositional changes

After a ceramic vessel has been discarded, a number of degradation processes are expected to influence the chemical composition of the organic residues: loss of water-soluble compounds, microbial degradation and the exchange of organic compounds between the residue and soil that surrounds it.

Deposition in (or on) the soil may cause further loss of water-soluble compounds due to the presence of rain or ground water.

Microbial degradation is an important degradation process to take into account. Many studies have already been directed at the microbial degradation of lipid characteristics in buried fats and bog bodies (den Dooren de Jong 1961; Evershed 1991, 1992; Morgan and Titus 1985; Morgan et al. 1984;), and some experimental studies have assessed the microbial lipid contribution to degraded fats and oils in absorbed residues (Dudd et al. 1998). Charred residues may be less susceptible to microbial degradation due to the partial denaturation of the organic materials during charring, but no clear evidence has yet been presented in the case of organic residues in archaeology.

Exchange of compounds between residue and soil is a clear possibility that has been questioned by others before. Remarkably, no evidence of significant impregnation of soil compounds into the residues has been found as of today (Evershed and Tuross 1996; Heron et al. 1991). However, it has always remained unclear what was lost during deposition – no evidence can be found for what is no longer present. Careful consideration must be given at all times to compounds that could originate from soils, and comparison need to be made to experimentally prepared residues in order to consider missing compounds, that might have been lost during burial.

Post-excavational changes

Post-excavational contamination occurs regularly in archaeological samples. Especially significant are contaminations with human skin fats from the hands of archaeologists and the compounds originating from packaging and cleaning agents. Additional microbial degradation may well take place after excavation. Growth of microorganisms and fungi can be prevented by dry or cold storage and microscopic inspection of residues prior to sampling.

Final composition

The way in which these transformations take place is partially determined by cultural phenomena specific to the given culture, and partially the result of chemical processes. Optimally, the chemical processes that play a role in the preservation and degradation of biomolecular characteristics can be understood and explained. The remaining variation in chemical characteristics can then be understood and interpreted as resulting from variation in prehistoric behaviour (for instance in the use of ceramic vessels or the choice of foodstuffs cooked in the vessels).

Further research

Organic residue analysis and its place within the study of archaeological ceramics have undergone revolutionary changes since the early 1980s. Ongoing instrumental innovations in analytical chemistry have enabled the analysis of smaller organic samples while increasing the sensitivity and range of compounds detected. Both extractable compounds such as lipids, resins and waxes can be studied, as well as more complex solid compounds such as proteinaceous materials, polysaccharides and more condensed complex materials (chars) resulting from cooking and heating food and non-food materials in ancient times. It has become clear that an amazing amount of information about the original material has been preserved in the form of absorbed residues or residues adhering to the surface of ceramics.

In order to fully employ all the possibilities ORA within the context of archaeological ceramic studies, a number of important research questions still needs to be addressed. Although some of these issues are primarily related to understanding purely chemical processes, some relate directly to the work of archaeologists and ceramic specialists.

Firstly, there is a need for archaeologists and ceramic specialists to re-evaluate the way ceramics are perceived. Many traditional ceramic collection plans and treatment protocols geared only towards the registration and understanding only of all inorganic characteristics of ceramics. With the successful application of so many recent organic residue studies it has become clear that ceramics, whether or not they contain visible organic residues, should no longer be viewed as exclusively organic materials, but rather as a composite material with both an organic and an inorganic component. Not only may this open the eye of archaeologists to the possible application of ORA, but it may also result in a review and evaluation of the conservation protocols for ceramic artefacts with regard to their possible effects of organic components. Especially cleaning and consolidation treatments that are traditionally applied to ceramics will affect the chemical composition of organic use-residues in a serious way.

Secondly, it would be of great value to integrate organic residues studies in a broader context of use-alteration studies of ceramics. Only if systematic use-alteration studies are performed can we put the results of organic residue analysis in the context of an overall ceramic use-range within an assemblage. Balancing the amount of variation that can be detected in organic residues against the overall use-alteration variation visible on an assemblage will indicate more clearly what vessel-uses will leave behind organic residues and which will not. General vessel-use studies can also be performed on ethnographic collections on in the context of ethno-archaeological studies.

Last but not least it must be stated that the real and most exciting challenge for the study of organic residues in ceramics, would lie exactly on the interface between technological and functional ceramic studies. It is exactly here that researchers have the greatest challenge to face in understanding how and why people create a variation in vessel form and technology and how they perceive this variation in terms of function and use.

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NOT FIT FOR FIRING: UNFIRED VESSEL FRAGMENTS FROM LATE BRONZE AGE TELL SABI ABYAD, SYRIA, AND THEIR VALUE FOR THE STUDY OF POTTERY TECHNOLOGY

Kim Duistermaat

Abstract

The discovery of several pottery workshops, updraft kilns, potter's tools, wasters and unfired vessel fragments at the site of Tell Sabi Abyad offered the opportunity for a detailed study of pottery production organization.[1] *Studies of production organization and workshops or kilns are rare in Near Eastern archaeology. Unfired vessel fragments are even less often reported, and if they are published, they are never discussed in detail. However, at Sabi Abyad these remnants of vessels and waste from the shaping process proved valuable for the reconstruction of different aspects of the production cycle, including clay preparation, shaping and spatial organization in the workshop.*

Introduction

Tell Sabi Abyad is a low mound located in the steppe of northern Syria (Figure 1). In the Late Bronze Age, at around 1200 B.C., the valley of the Balikh River and the region around it formed the westernmost province of the Middle Assyrian kingdom. The small settlement at Sabi Abyad was a *dunnu*, or private agricultural estate, owned by the grand vizier and viceroy of Assyria and managed by a state official. The *dunnu* was a fortified settlement including a tower, a residential building for the owner, offices, houses and workshops. More than 360 clay cuneiform tablets inform us about the daily life and the administration of agriculture, border control, beer production, payments of rations to workers and even espionage (Akkermans 2006; Akkermans and Wiggermann in press). The Middle Assyrian remains at Sabi Abyad are divided in four stratigraphical levels, numbered from the top down (Levels 3-6). Archaeological evidence for local pottery production was found in three levels (4-6). Large and small updraft kilns were found in all three levels, but buildings identified as pottery workshops were only found in Levels 5 and 6 (Figures 3 and 2). In Level 6, the first Middle Assyrian settlement, the workshops were dedicated spaces at the eastern edge of the *dunnu*. They were part of a chain of workshops running around the fortress, and were surrounded by a dry moat. The pottery workshops measured around 323 m² and consisted of a number of simple rectangular rooms and adjacent courtyards. Two large pottery kilns were located close to the workshops. Large amounts of unfired and fired pottery, potters' tools (including two basalt potters' wheel bearings) and some wasters provided additional

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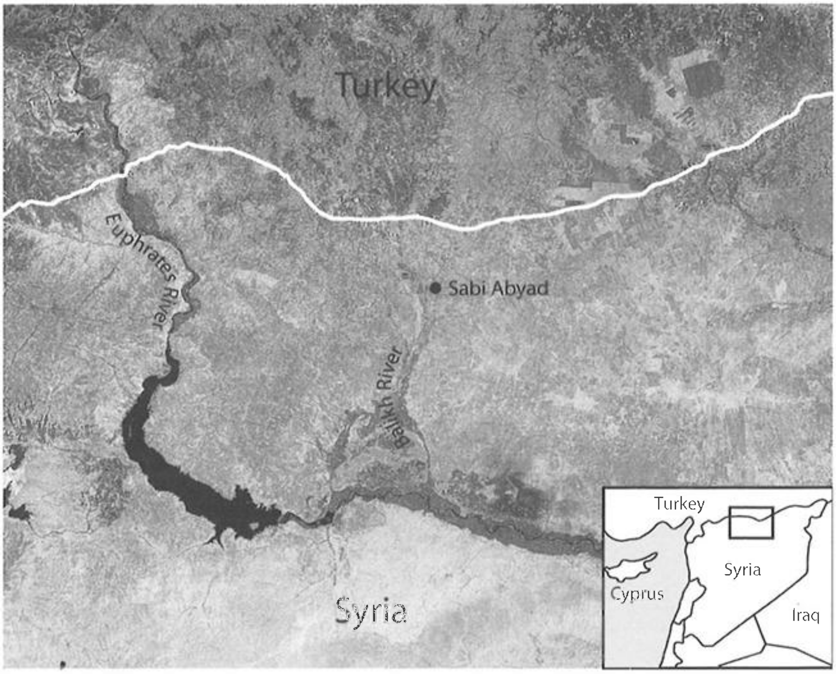

Figure 1. Sattelite image of the Balikh Valley in northern Syria, with the location of Tell Sabi Abyad.

evidence for pottery production in these areas. In Level 5 the workshop was still located in the east of the settlement. It occupied an unused courtyard and a room of the house of the scribe. A large kiln was located a bit further away outside the settlement walls, while two small kilns were used inside the workshop. The workshop proper measured 294 m², but kilns and other evidence for pottery production (including unfired pottery) were found at several other locations in the north and west of the settlement (Duistermaat in press).

Although the organization of the agricultural sector and several other crafts in the Middle Assyrian kingdom is quite well-known from textual sources, the organization of pottery production is not. Throughout Mesopotamian history, potters were rarely mentioned in cuneiform texts, especially when compared to other craftspeople (Steinkeller 1996: 233-234; Sallaberger 1996: 38). One text from Tell Sabi Abyad mentions a potter (Wiggermann in press), and four other potters are mentioned in texts from provincial settlements and the capital (Jakob 2003: 475). Although they provide us with some information, for example that potters could bè sent to other settlements, and that they sometimes received daily rations, these texts do not inform us about the organization of their work. Studies of production organization and workshops or kilns are rare in Near

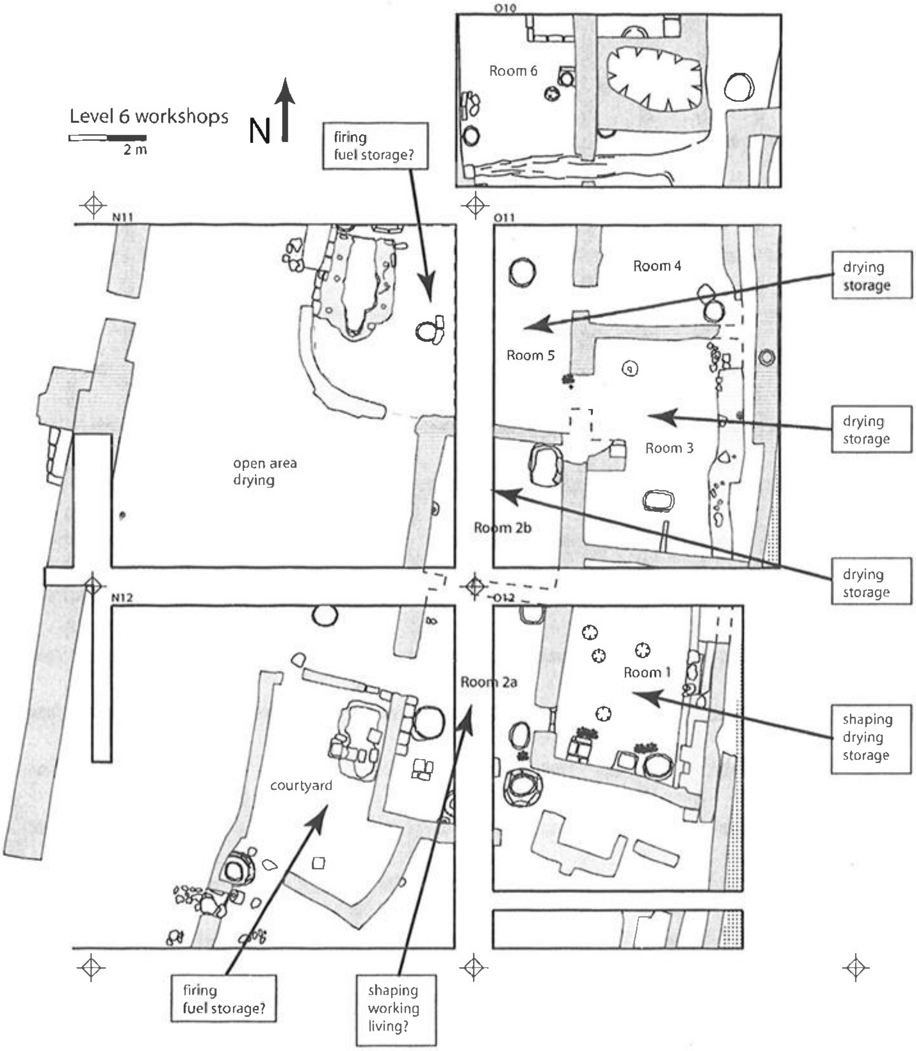

Figure 2. Pottery workshop architecture in Level 6.

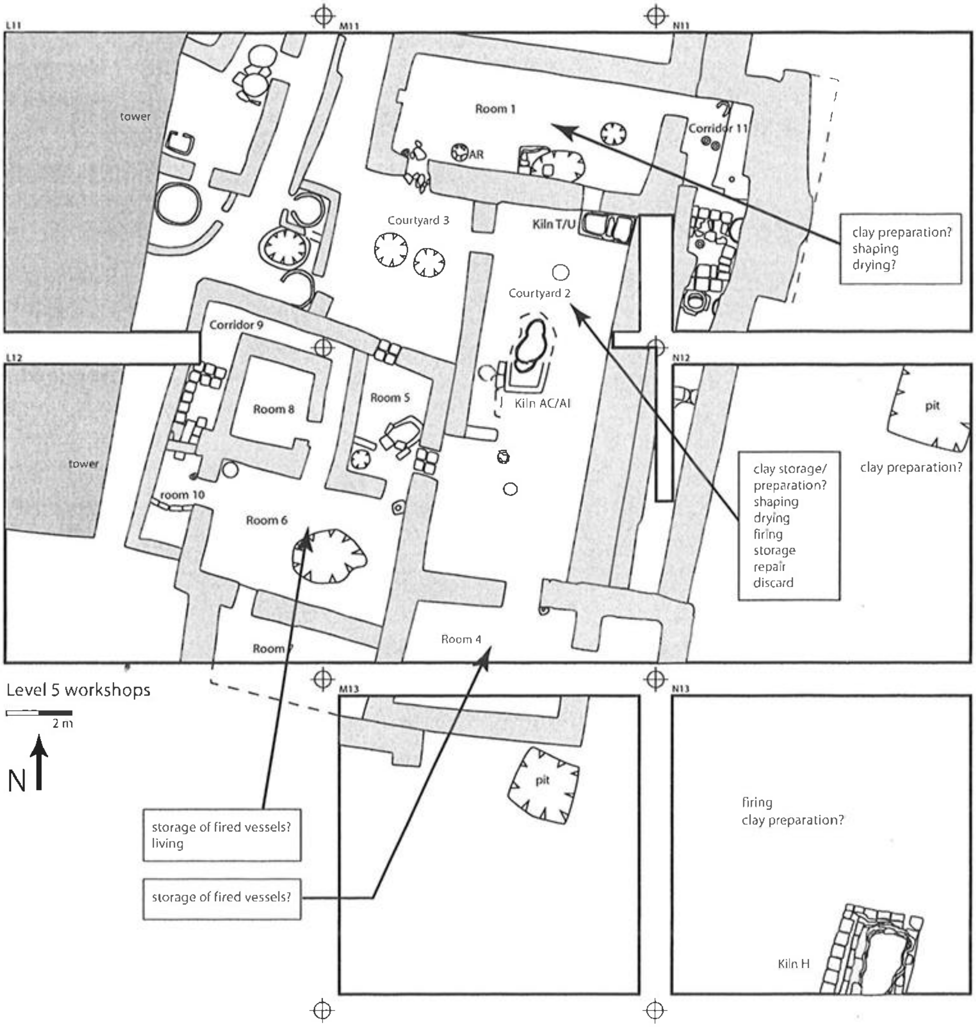

Figure 3. Pottery workshop architecture in Level 5.

Eastern archaeology (but see Anderson 1987, 1989; Rose 1989; Morandi Bonacossi 2002, 2003, in press; Magrill and Middleton 1997). Pottery kilns were found at several sites, but Middle Assyrian workshops were not excavated before. An earlier attempt was made to reconstruct Middle Assyrian production organization (Pfälzner 1995). However, in the absence of a workshop he could only use the different aspects of the vessels themselves (e.g., shape, size, standardization, quantity) as a source of information, and his study did not focus particularly on production organization. The finds from Sabi

Abyad therefore offered a unique opportunity to study the organization of pottery production in a Middle Assyrian provincial estate settlement.

A careful analysis of all evidence related to pottery production (Duistermaat in press) showed that the organization of pottery production was of a professional but unassuming and practical nature. One or two professional, skilful and efficient potters and several assistants (women, boys, members of his family?) produced the daily utilitarian pottery at the *dunnu* for the *dunnu* staff and their dependents, and occasionally at other *dunnus* as well. They had a good knowledge of their resources, how they needed to prepare them and what the problems in shaping and firing would be, but they balanced the time and effort needed to overcome these problems against the small advantages of a perfect product. They used efficient shaping techniques and professional tools and kilns, and were most probably involved full-time in pottery production. It is likely that the local administration paid them for their work in rations or perhaps also with a sustenance field. Although they were in this way part of the Middle Assyrian state organization, they probably did not have a very large role in it, and did not have a high status. The administration was apparently not much concerned with how the potter acquired his resources or his assistants, and did not exercise much control over the work of the potter. The products the potters made were rather uniform and comprised a rather limited set of shapes. For some shapes they made pots in different size groups, but the exact size or capacity was not important. Although the potter was part of the Middle Assyrian administrative system, he does not seem to have been an "attached" specialist. Rather, the picture that emerges is that of a relatively independent potter working in an individual workshop organization, but commissioned by and under the protection of the Middle Assyrian *dunnu* administration. This would compare most closely to an "estate" or "state" individual workshop organization (cf. Peacock 1982: 8-11), or to individuals performing their corvée obligations. The unfired vessel fragments contributed in various ways to this conclusion.

Unfired vessel fragments and production waste from Tell Sabi Abyad

Unfired pottery is one of the clearest pieces of evidence for the local production of pottery. Fired pots may have been transported from the place of production to sites at a considerable distance, especially when they were transported as containers for other goods. Unfired fragments, like kiln wasters, were certainly not transported anywhere, but were discarded at the site of production. Unfired waste of pottery production makes it possible to study the raw materials in an unfired condition. It may also provide new insights into the shaping techniques, and give an indication of the range of shapes produced by the local workshop(s). When found in a workshop context, it may provide information on the use of space within the workshop. Unfired vessel fragments are almost never published (but see Magrill and Middleton 2004; Rose 1993: 128, Fig. 136), and if they are, they are never discussed in detail.

At Sabi Abyad, unfired fragments were mainly found in Level 6 and Level 5, while some fragments came from Level 4. They were usually associated with the pottery workshops and kiln locations. More than sixty rim fragments, almost sixty base fragments, and several hundreds of body fragments from bowls, jars and goblets were found. Additionally, more than 150 disc-shaped pieces, more than two kilogrammes of kneaded pottery clay and several unfired clay cones were found among the waste left over from the shaping process.

Analysis of the raw materials

The unfired vessel fragments presented a nice opportunity to study the raw materials and their properties. These affect the possibilities and problems with the shaping and firing of the pottery, they influence the quality of the finished products, and illustrate how raw materials were prepared before shaping. Complemented by WD-XRF analyses and thin-section analyses of fired sherds, the composition of the clay mixture and its behaviour during shaping and firing was described.[2] Two samples were analysed in this way: SN96-12 (body fragments of shallow carinated bowls, also Samples V404-407 in Table 1) and SN96-130 (a body fragment of a large bowl, Figure 4). Samples of clay from the Balikh River collected in 1983 (Sample 1744) and 1996, clay from mud bricks at Tell Hammam et-Turkman (Sample 4421) and at Tell Sabi Abyad, and clay from Neolithic clay sealings from Sabi Abyad (Duistermaat and Schneider 1998) were used for comparison with loçal materials.

The WD-XRF analyses (Table 1) show that the chemical composition of the unfired fragments is very similar to the local Balikh clays and other local clay samples from Sabi Abyad. A multivariate cluster analysis confirmed the similarity of unfired pottery and other Sabi Abyad clay samples. There is no evidence for the import of clay from other regions. All clays are marly loams that contain a rather high amount of CaO around 21%. The salt content (Na_2O) of the unfired pottery is relatively low, although evidence for the presence or additon of salt was found in several thin-sections of fired pottery (see below). The slightly lower amount of K_2O in the unfired ceramics and the sealings, as opposed to the samples from mud-brick walls, might be related to levigation processes possibly employed to obtain finer clays for sealings and pottery (Schneider 2006: 395).

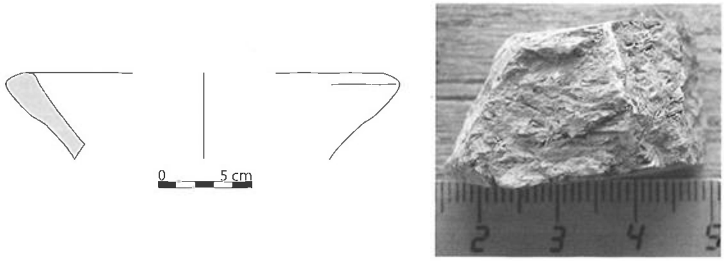

Figure 4. Rim fragment of the bowl analyzed as Sample SN96-12.

The results of these analyses are comparable to the results obtained with electron microprobe and ICPMS analyses by Ildiko Boesze, who studied twenty fired Middle Assyrian sherds from Sabi Abyad Level 6 (I. Boesze, personal communication). Comparisons with local clays from the Khabur Valley and Tell Sheikh Hamad in northeastern Syria (Schneider 1994, 2006) show that these clays are a bit different, although they still belong to the same marly type characteristic for the whole northeastern region of Syria.

	Elements																						
Sample no.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	(S)	(Cl)	V	Cr	Ni	Zn	Rb	Sr	Y	Zr	Ba	(Ce)	GV
V404	48.87	0.853	13.18	6.66	0.095	4.85	21.39	0.89	2.92	0.28	0.17	0.17	128	250	105	95	66	455	26	170	375	75	17.66
V405	48.83	0.850	13.08	6.66	0.105	4.85	21.47	0.94	2.89	0.33	0.13	0.15	135	255	107	98	70	428	25	171	389	70	17.81
V406	49.19	0.845	12.96	6.64	0.090	4.77	21.42	0.86	2.90	0.32	0.20	0.17	129	250	106	95	66	526	26	172	513	47	17.66
V407	49.17	0.854	13.15	6.70	0.089	4.75	21.24	0.87	2.90	0.28	0.14	0.16	137	249	105	92	69	406	26	173	349	55	17.67
average unfired pottery	49.02	0.851	13.09	6.66	0.095	4.80	21.38	0.89	2.90	0.30	0.16	0.16	132	251	106	95	68	454	26	172	407	62	
1744	47.66	0.863	15.34	7.41	0.113	5.13	21.06	0.31	1.87	0.23	0.12	0.02	129	206	167	93	84	552	28	159	324	65	0.00
4421	47.89	0.834	14.58	7.00	0.111	5.18	19.32	1.17	3.52	0.40	0.58	0.58	114	188	152	89	75	619	22	151	316	54	0.00
average sealings	49.28	0.867	13.35	6.70	0.116	4.75	20.61	1.04	2.87	0.43	0.65	0.13	127	286	132	106	70	415	27	182	345	59	
average pisé walls	50.03	0.841	14.97	7.38	0.122	4.85	16.89	0.98	3.37	0.57	1.16	0.13	123	219	152	118	74	407	28	164	315	68	

Table 1. WD-XRF analyses of the chemical composition of local clays.[3]

In the low-tech analyses, the fabric composition, cohesive strength, colour and workability were studied. Under the microscope,[4] Samples SN96-12 and SN96-130 looked clean, without any coarse mineral inclusions. Only some very fine quartz grains were visible, smaller than 250 μ and in a negligible quantity of less than 2% by weight. They belong to the natural clay and were not added by the potter. The rest of the minerals belong to the silt fraction. Although the spontaneous reaction with HCl(++) confirmed that the mixture contained large amounts of CaO, no lime grains were visible. The added organic inclusions that had once been present had completely disappeared. The colour of the bone dry fabric was 7.5YR6/4 (light brown). The firing colour after exposure to 750°C under oxidizing conditions was 5YR6/6 (reddish yellow).

In bone-dry condition, the clay was strong, had much cohesive strength and did not crumble easily. By mixing the dry clay with water it was brought in a plastic condition. The resulting clay was plastic enough, but lacked some 'bones'. Without any added inclusions, the clay proved to be good for coiling and just suited for wheel-throwing, although cracks would occur. Adding more water made the clay softer and more workable, and its cohesive strength increased. It now allowed the 'piglet tail's test' (Figure 5) without snapping and showing only the beginning of cracks. However, the clay now missed the firmness necessary for throwing pottery on the wheel. The addition of fibrous non-plastic material was needed to add firmness and cohesive strength. In simulation of the original situation, 15% by volume of fine organic fibres were added to the mixture. This made the clay markedly shorter, but also much firmer. After a day of damp storage, the workability of the clay improved, because the fibres had absorbed the moisture

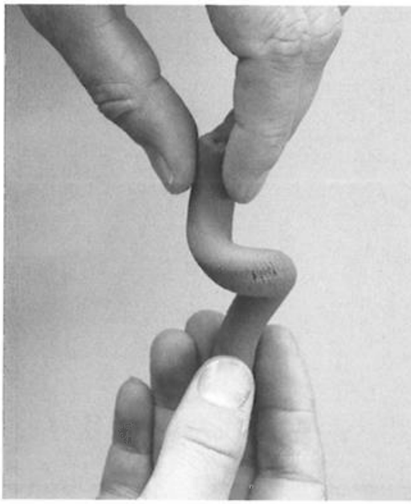

Figure 5. Piglet tail's test for sample SN96-12.

from the clay. It is not known what kind of fibres were added by the Sabi Abyad potters. The thin- sections showed that they consisted of small longitudinal particles with a flat triangular and sometimes heart-shaped section, with a maximum length of about 5 mm (Figure 6). They may have been chopped grasses or straw, or perhaps the fine wind-blown particles left after the harvest on the fields or threshing floor. Fibres may also have been added in the form of animal dung. Apart from the fibres, dung adds cohesion and plasticity, qualities that may have been especially desirable for this short clay (van As and Jacobs 1992: 535-536; Franken and van As 1994: 508). The linear drying shrinkage was about 6-7% both before and after adding the fibres, illustrating the shortness of the clay. The drying shrinkage was more or less equal to the total shrinkage after firing at 700°C. The addition of organic fibres prevented cracks during shaping and drying. It also yielded lighter and more porous vessels, a quality that was perhaps desired by the potter or the users. Other additions were not needed for a workable clay. Indeed, the thin-section analyses showed that no other temper was added. About 10% of all vessels (small goblets and bowls) were made of a fine clay without any added inclusions (see below).

Thin-sections were not studied for samples of unfired vessel fragments. However, the presence of a kiln waster and all common Middle Assyrian shapes (including those present in the collection of unfired fragments) in one of the fabric groups made by thin-section analyses, suggest that this group represents vessels made from local materials. To complete the description of the local raw materials, we will have a brief look at what they look like under the polarizing microscope.[5] The thin-section in Figure 6 was taken from a typical carinated bowl, a shape that was very popular and is even seen as the

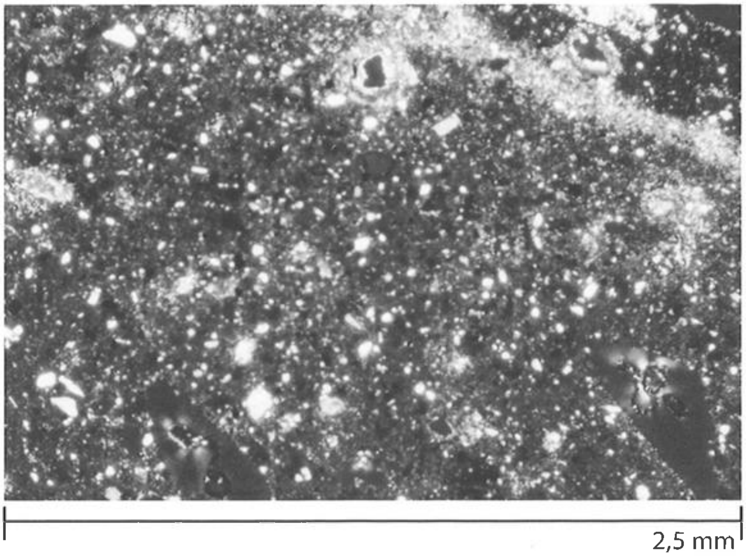

Figure 6. Thin-section (with crossed Nicols, xpl) of a carinated bowl made from local clay (Duistermaat in press, Fig. C.27).

characteristic type-fossil for the Middle Assyrian period (cf. also Figure 12). In the thin-section we clearly see the high amount of fine calcite inclusions (dull beige/white particles). A medium to high firing temperature has caused the calcite particles to decompose, but secondary calcite has formed in clouds throughout the matrix and around the edges of the voids left by the decomposed calcite. Just below the surface of the sherd (in the top right corner of Figure 6), a 0.25 mm thin band of secondary calcite is visible. At the surface, the matrix is greener and more isotrope, and contains less visible calcite. This effect is due to the migration of salts to the vessel surface during the drying stage. The salts act as a flux at the surface of the sherd, creating a greener and more glassy matrix there. Organic inclusions are visible in this thin section as triangular voids (e.g., at the bottom right corner of the thin section). In most wheel-thrown vessels, the organic inclusions showed a preferred orientation parallel to the surface of the sherd and parallel to the plane of the rim. Since thin sections are cut perpendicular to the plane of the rim, the voids show the sections of the inclusions. Other mineral inclusions are very fine and evenly mixed with the matrix, confirming that they were part of the natural clay and not added by the potter. The recognized minerals included iron oxides, quartz grains (the bright white particles in Figure 6), mica, rock fragments, chert, feldspar, pyroxene and hornblende.

Analysis of the unfired vessel fragments showed that the potters at Sabi Abyad made their wares of the local marly clays that contained a bit of salt. It is not sure whether the salt was added on purpose, but it probably helped to avoid lime spalling (Schneider 1994: 103, 2006: 395; Rice 1987: 119; Hudson 1997: 136). In a modern workshop in northeastern Syria near Qamishly the clay already contained enough salt (Taniguchi 2003: 146). In the assemblage of fired pottery, lime spalling occurred in only 2.3% of all diagnostics, and only in those sherds with visible calcite inclusions. This is a remarkably low percentage for pottery made from highly calcareous clays. The potters added fine organic fibres (dung?) to the clay to make it stronger and more plastic, so that it was suitable for wheel-throwing. To make fine-ware vessels (mainly goblets) no fibres were added, and so the potters had to deal with the problems presented by a lean clay while shaping and drying the vessels (see below). The raw clays were probably only cleaned of larger inclusions, and there is little evidence for levigation. The fabric would have benefited from a limited amount of soaking, and several pits possibly used for this purpose were found near the pottery workshops (Figure 3).

Reconstruction of the shaping techniques

An on-site analyses of the shaping techniques by the Leiden Department of Pottery Technology, and careful analyses of the traces and surface features by myself, clearly showed that the majority of the pottery at Sabi Abyad was made with several wheel-throwing techniques. The study of the unfired vessel fragments and the thin-sections confirmed this: especially the larger and oblong inclusions showed preferred orientations parallel to the surface of the sherds in vessels thought to be wheel-thrown, and random orientations in large handmade storage vessels (Magrill and Middleton 2004, but see Courty and Roux 1995).

More interestingly, the unfired fragments not only included rims and bases of finished vessels, but also a variety of scraps, shapes and pieces apparently left over from the shaping process. These yielded an insight in the shaping techniques, in particular of small goblets. Without the unfired fragments, reconstruction of these techniques would have been much more difficult.

Middle Assyrian goblets are clearly wheel-thrown. They have very thin walls and rims, and rather thick rounded bases ending in nipple or knob-shaped protuberances (Figure 12, third row in the middle). They were made of fine local clays without any added inclusions. Unfired fragments of the same ware included many disc-shaped pieces, between 2.8 and 4 cm in diameter, with string-cut traces on both sides (Figures 7 and 8). Also, unfired goblet bases with attached discs were found (Figure 8, bottom right), while these shapes did not occur among the fired pottery. The shaping technique for goblets was reconstructed as follows (Figure 9). First, the goblet was thrown from the cone. An incision was made with a sharp object (e.g., a knife) in the cone near the base of the goblet, to indicate the proper final thickness of the base. Then, the vessel was cut from the cone a bit below the incision, so that a "disc" was left attached. The vessel was then put aside to dry a little and wait for the next shaping stage (the finishing of the base). The disc was left attached to prevent the base from

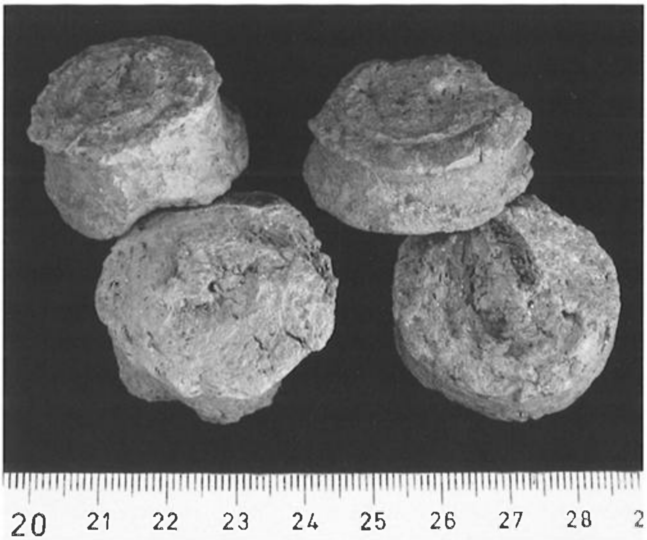

Figure 7. Unfired disc-shaped pieces left over from the shaping of small goblets.

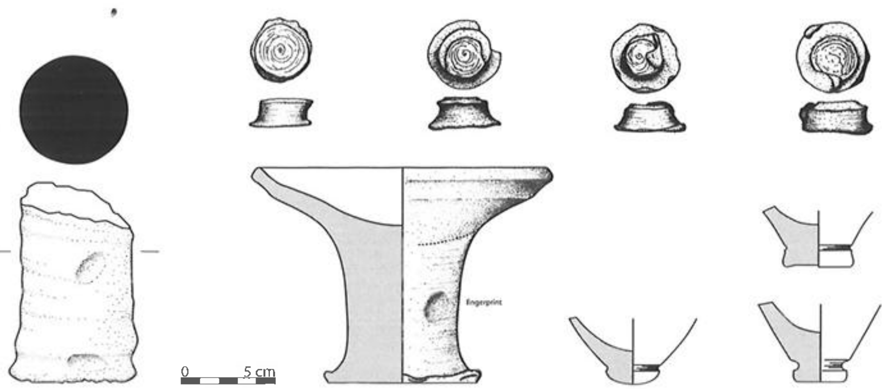

Figure 8. Unfired waste of pottery production.

drying too quickly before it could be finished, and to provide the goblet with a stable support so that it could dry without having to put it on its still wet and fragile thin rim. Also, the attached disc slowed the drying process, which was important to prevent cracks in the base (since the bases were much thicker than the walls they were especially prone to drying cracks). When the rim was dry and strong enough, the vessel was then put rim-down back on the wheel, probably on a chuck support (as indicated by traces of sticking on the inside wall of many straight-sided goblets; perhaps the support was a clay cone like the one in Figure 10). The disc was now cut off with

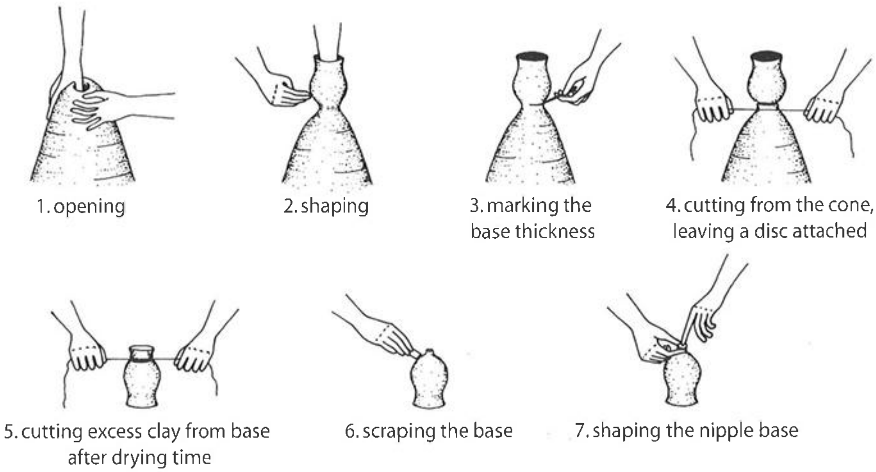

Figure 9. Reconstruction of the shaping of goblets.

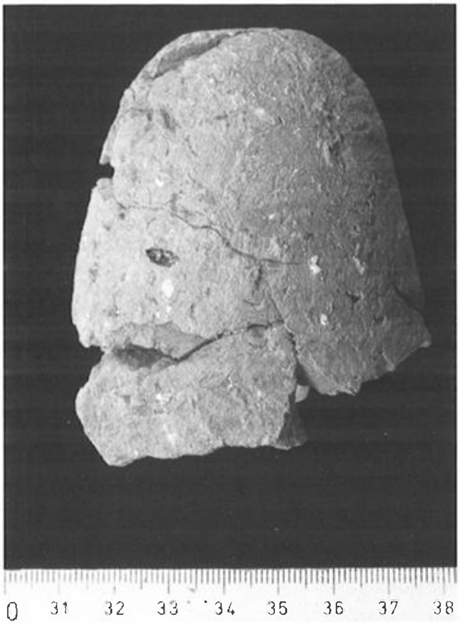

Figure 10. Unfired clay cone, perhaps used as a chuck support to set goblets upside down back on the wheel.

a string or knife, while the incision indicated the spot where to cut, so that the base would not become too thin. Then the base was scraped and shaped into a nipple or knob shape with a sharp knife and wet hands. The incisions always occurred on one side of the discs only, while the string cut traces were present on both sides. The spiral traces on these discs as well as on the inside and outside of unfired and fired vessels, showed that the wheel direction of the potters' wheel at Sabi Abyad was counterclockwise. The knife incisions were clearly cut when the vessel was still upright on the wheel. The spiral string cut traces had the same directions on each side, which is only possible when the vessel with the disc attached had been put upside down when the disc was cut off.

A few examples were found of small bowls with a cylinder of clay still attached to their base side (Figure 8, bottom row in the middle). Small bowls were thrown from the cone, and mostly their bases were not further scraped or treated. These unfired bowls were probably thrown from the last bit of clay left on the wheel, and for some reason they were never cut loose from it.

An interesting issue concerning both these fragments and the amounts of unused kneaded pottery clay, is why they were never used again. It would have been easy to remoisten the clay and make it plastic again, saving the time to dig and clean new clay. Possibly, the resources of pottery clay were so abundant and easy to process that recycling of unfired fragments was not considered to be efficient. Or there may not have been a following shaping session, for example if pottery production did not take place continually. Perhaps intervals in pottery production occurred in the wet winter months, or when the potter was busy in agricultural jobs or at other sites. Ethno-archaeological studies show that pottery making is often combined with agricultural tasks (e.g., Ionas 2000). Moreover, a cuneiform text from Sabi Abyad (Wiggermann in press: Text T93-3) indicates that potters could be asked to go to other sites to produce vessels on the spot, thus interrupting their work at home.

Identifying the range of locally produced shapes

One of the lines of enquiry into pottery production organization deals with the used technology or the technological tradition in which pottery was made, including shaping techniques, tools, production in series or with pre-fabricated parts, surface treatments, focus on efficiency, standardization, decoration, firing procedures, etc. All this information can be 'read' from traces on the surface of the vessels themselves. However, it is particularly important to attempt to define the locally produced assemblage first. Otherwise imported vessels, possibly coming from a different tradition or production organization, are mixed with the local assemblage. Some unique vessels were easily recognized as belonging to a different tradition, because of differences in the techniques or raw materials. A cooking pot found at Sabi Abyad, but made from a clay that only occurs in Syria's coastal area is the best example. However, in northeastern Syria the marly clays are similar everywhere, and differences in mineral components are unvisible without high-tech analyses. In that case, kiln wasters and unfired vessel fragments can illustrate which shapes were definitely produced at the site.

Figure 11 presents an overview of the shapes of the diagnostic unfired vessel fragments. Of course, a multitude of wall fragments was found as well, often recognizable as fragments from large jars, deep bowls, small bowls or goblets. In contrast to the fired pottery, however, it was mostly impossible to fit unfired fragments in an attempt to reconstruct the original shape. Figure 12 shows a selection of the typical Middle Assyrian shapes. At all Middle Assyrian sites, these shapes form the vast majority of the assemblage. Especially the carinated bowls (Figure 12 upper row, the two bowls on the left), the V-shaped and S-shaped goblets (third row), the large ovoid jars (fourth row on the right) and the large deep bowls (lower row on the right) are characteristic for the period (cf. Pfälzner 1997: Abb. 2). Most of the characteristic shapes were found among the unfired diagnostics. Others, like the cylindrical pot stands (Figure 12 second row on the right) were not found among the unfired fragments but did occur among the kiln wasters. Unfired fragments of the very heavy and large, handmade storage vessels (like Figure 12, lower row on the left, and other, larger examples) were found as well. The size and weight of these vessels also suggest that they were made locally.

Other shapes, like cooking pots, pilgrim flasks and deep bowls with a spout, were identified as 'foreign' to the site and the production tradition. This was confirmed by the absence of these shapes among the unfired diagnostics. In addition, most of these shapes also differed in paste composition, shaping techniques, or surface treatment.

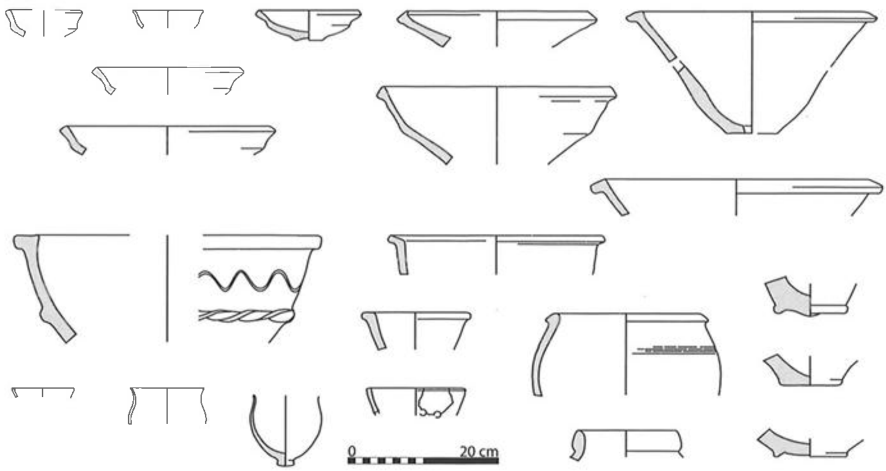

Figure 11. Diagnostic unfired vessel fragments.

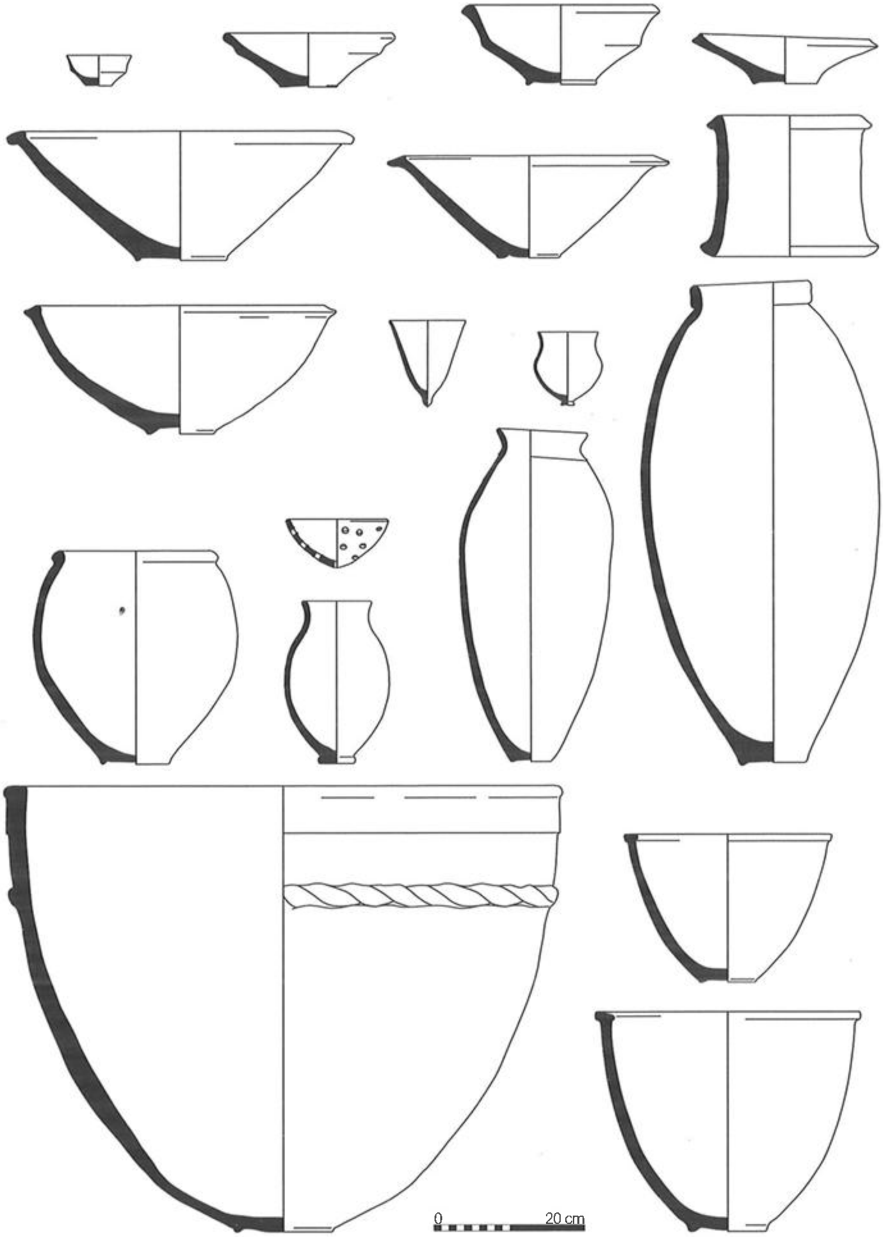

Figure 12. Typical Middle Assyrian pottery shapes.

Indications for the use of space in the workshop

Many fragments of unfired vessels and production waste were found in the workshop buildings in Levels 6 and 5. Although a detailed analysis of deposition processes and spatial distributions was not yet carried out at Sabi Abyad, I did recognize some patterning in the distribution of these finds, which was helpful for the interpretation of the use of space. In Level 6 (Figure 2), Room 1 was recognized as the central workshop space where the shaping of vessels took place. The basalt potters' wheel bearings were found here, as well as numerous small bowls and some jars, and a large kiln waster. Most unfired fragments here were waste from shaping goblets and small bowls and lumps of kneaded, clean potters' clay. Unfired vessel fragments included a thick handmade base of a large storage pot set against the wall, and rim fragments of a handmade, square bin. In Room 2b, mainly unfired fragments of goblets and small bowls were found. Waste from shaping bowls and goblets was found here as well. In contrast, the unfired vessel fragments from Room 5 were mostly from large jars. It is possible that the northern part of the workshop (or Kiln Q) was specifically designated for making large jars, and that the distinction in the two collections of unfired fragments is related to differences in the use of space. The analysis of the shaping techniques showed that both the small bowls and the large jars were produced in series. The potters would most probably make batches of a single shape and set them to dry before starting on another type of vessel. So, it is also possible that the two different collections of unfired fragments reflect two different production events. The fill of Kiln L contained many fragments of vessels and production waste as well, suggesting that pottery making was still continuing even after this kiln went out of use. Probably Kiln Q was still used at that time. Smaller amounts of unfired fragments were found in Rooms 3 and 4, and in the open areas around the kilns and in front of the workshop. The shaping of vessels apparently took place in Rooms 1 and 2 (a or b), while the finished vessels were dried in Rooms 1, 2b, 3, 5 and in the outer areas around Kiln Q.

In the Level 5 workshop a similar pattern emerged. The core area of the workshop (Figure 3) was the northern part of Courtyard 2, where large amounts of cracked, repaired, deformed or otherwise misfired small bowls and goblets were found. Two small updraft kilns were also located in this area, and there is evidence for the presence of large amounts of clean clay and a potters' wheel emplacement. Unfired fragments in the northern half were mainly fragments of goblets, large straight-sided bowls and large carinated bowls with thick walls. In the southern half of Courtyard 2, next to the door into the house, a concentration of unfired vessel fragments contained mainly goblet and small bowl fragments and waste from shaping these vessels. Again, the fill of Kiln AC/AI contained many unfired fragments, which were not found in the fill of Kiln T/U. This suggests that Kiln AC/AI was already filling up with debris while Kiln T/U was still in use. Smaller amounts of unfired vessel fragments and waste from shaping were found in Room 1, Courtyard 3, Room 8 and in the open areas to the east and north of the workshop.

At the western end of the Level 5 *dunnu*, two small kilns were built in the corners of a room that apparently was out of use. This area was not identified as a real workshop, but was probably only occasionally used by the potter (e.g., when easterly winds dominated in the winter months). In the fill of Kiln H/AE a large amount of unfired fragments was found, both from vessels and from production waste. The fill of Kiln I in the same room hardly contained any unfired fragments. Another large concentration of unfired fragments was found in the corridor north of the room. In contrast to the finds in Level 6 and the Level 5 workshop, the collections found in the western location contained a large variety of both small goblets and bowls, as well as large bowls, jars and pots.

Conclusions

The unfired vessel fragments and production waste contained a variety of small but valuable clues contributing to the reconstruction of the organization of pottery production. Since unfired clay is often well-preserved at Near Eastern sites, I expect that these fragments have been found at many other sites in the region, but they are seldomly published. Pottery experts should therefore have access to the registers of unfired clay artefacts, and include the fragments in their publications. Archaeologists in the field should scrutinize every unfired clay 'lump' and consider the possibility that it may stem from (pottery) production activities. They should be collected as artefacts, in the same way as flint debitage is systematically collected, and studied by pottery specialists. This is especially important if other finds (kilns, tools, wasters, workshops) point to the local production of pottery as well.

Acknowledgements

A small-scale analysis of shaping techniques of the Middle Assyrian pottery was carried out at Sabi Abyad in 1996 by L. Jacobs and A. van As from the Leiden Department of Pottery Technology. L. Jacobs also carried out the low-tech analysis of the unfired vessel fragments and raw materials, and contributed his findings to this article. WD-XRF analyses of the raw materials were done by G. Schneider at the Arbeitsgruppe Archäometrie of the Free University of Berlin. The thin-section analyses were carried out by myself under dr. Schneider's guidance. The macro-photos of the sherd fractures were made by N.C.F. Groot at the Centre of Art and Archaeological Studies of Delft University. I thank them all for their enthusiastic help and invaluable comments and assistance. The research on the organization of pottery production at Late Bronze Age Tell Sabi Abyad was carried out within the framework of a Ph.D. thesis prepared for Leiden University. Although the work was largely self-funded, additional financial assistance was provided by the Netherlands Organization for Scientific Research (NWO) in the form of a sabbatical scholarship (grant number 365-62-003) and a travel scholarship (grant number R 28-530). The Foundation for Anthropology and Prehistory in the Netherlands (SNMAP) supported the archaeometric research in Berlin. Practical assistance was offered by the German Archaeological Institute in Damascus (DAI) and the National Museum of Antiquities (Leiden).

Notes

1. This study was carried out in the framework of a Ph.D. thesis at Leiden University; and will be published as Duistermaat in press.

2. The low-tech analyses (properties of the raw clay) were carried out by L. Jacobs at the Ceramic Laboratory of the Leiden Faculty of Archaeology. The high-tech analyses (thin-section analyses and WD-XRF analyses) were carried out by the author and by G. Schneider at the Arbeitsgruppe Archäometrie of the Free University of Berlin.

3. Wavelength dispersive X-ray fluorescence analysis (WD-XRF) of ignited samples, major elements are normalized to a constant sum of 100% not including S and Cl. Sample weight = 1 gr. Major elements in % oxide by weight, trace elements in parts per million (ppm).

4. A stereo zoom-microscope was used, with 10 to 50x magnification.

5. In total, 45 thin-section slides were studied. The samples were first impregnated with a bonding substance and then abraded to a thickness of 0.025 mm and fixed between glass plates. The minerals were identified by their optional characteristics under parallel and crossed polarized light (ppl and xpl, Rice 1987: 376-382, Schneider and Daszkiewicz 2002, Whitbread 1995: 365-396).

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SOME TECHNOLOGICAL ASPECTS OF LATE URUK POTTERY FROM JEBEL ARUDA, SYRIA

Abraham van As

Abstract

This article is concerned with some technological aspects of a Late Uruk pottery assemblage (3400-3000 B.C.) from Jebel Aruda that was excavated during the archaeological salvage operations in the middle Euphrates valley in the early 1970s by a team of Leiden University. The analysis of the pottery was done in the wider context of technological research into pottery traditions in the course of the various successive archaeological periods in this area. This contribution on the Late Uruk pottery is mainly focused on the reconstruction of the advanced shaping techniques that were applied in a period that the fast potter's wheel made its first significant appearance in the Near East.

Introduction

In the late 1960s and early 1970s a dam was constructed in the middle Euphrates near the village of el-Thawra (Tabqa) in Syria. The antiquities in the area to be drowned were threatened with destruction. For this reason the Syrian Department of Antiquities made an appeal in 1971 through UNESCO to the international world of archaeology to start archaeological research and rescue excavations in this region, now Lake Assad. Thanks to the funds of the Netherlands Organization for Scientific Research (NWO) professor Franken of Leiden University could reply to this appeal by starting a research programme into the development of the potter's craft from the Uruk period (4th millennium B.C.) up to and including the early Islamic period. This research project, the so-called Tabqa project, was set up to study the relation between clay composition and different techniques of making pottery in antiquity. It provided a unique opportunity of applying the technological approach to ceramic studies as developed by Henk Franken and Jan Kalsbeek in their study of Early Iron Age pottery from Tell Deir 'Alla, Jordan (Franken and Kalsbeek 1969) to other archaeological pottery assemblages. The aim of the Tabqa project was to collect stratigraphically a diachronic series of pottery and to obtain by means of techno-analytical research an insight into the pottery traditions in the Tabqa region. This region lent itself particularly to such research, since it is a geographically restricted area (approximately 80 × 80 km) and it could be assumed that local Euphrates clay had been used. On the basis of large samples of pottery – fragments and complete shapes – an investigation was made as to continuity/discontinuity in the

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pottery traditions. The Tabqa area was surveyed and excavations took place at three different sites (1972-1975). Pottery was collected from a succession of cultural periods: the Late Uruk period (Jebel Aruda), the Bronze Age (Tell Hadidi, Shams ed Din) and the Byzantine/Early Islamic period (Ta'as, Tell Hadidi). Although the results of the Tabqa project have been published (van As 1984, 1987, 1989; Franken 1978; Franken and van As 1994; Franken et al. 1998, van der Leeuw 1976; Kalsbeek 1980), an English version of the technological study of the Late Uruk pottery from Jebel Aruda (Dutch version see van As 1987: 15-52) is still missing. Following is a revised and shortened version of this study.

Jebel Aruda

During the archaeological salvage operations in the middle Euphrates valley in the early 1970s a number of sites with characteristics of the 'classic' southern Mesopotamian Uruk material culture were discovered: Habuba Kabira (Strommenger 1980), Tell Qannas (Finet 1979), and Jebel Aruda (van Driel and van Driel-Murray 1979, 1983) The sites dated to the Late Uruk or Late Chalcolithic 5 period (3400-3000 B.C.) seem to be colonies of southern Mesopotamians living in Syria (see Akkermans and Schwartz 2003: 190). For a summary of the various opinions on the explanation of the Uruk expansion the reader is referred to Akkermans and Schwartz (2003: 203-205).

Jebel Aruda is a ca. 180 m high mountain named after a local saint and situated on the west side of the Euphrates flood plain (Figures 1 and 2). From a far distance one can see the hard dolomite limestone layer on top. An archaeological survey on the Jebel Aruda – at the beginning of the Tabqa project – showed that a lower plateau of Jebel Aruda was inhabited during the Uruk period. With the exception of the remains of a Byzantine building at the edge of the promontory 60 m high overlooking the Euphrates, no later habitation traces have been found. Because of its high location, Jebel Aruda was the only site, within the Tabqa project, that was not threatened by the rising water of the storage reservoir. Consequently, the site could be excavated in later years on a much larger scale. During the Tabqa project campaigns several test trenches were excavated in 1972. Further excavations took place in 1974 under the direction of Sander van der Leeuw. These excavations were continued in 1975 under the joint direction of Henk Franken and Govert van Driel. In these years a small part of the monumental temples with niched and buttressed façades surrounded by large tripartite houses has been unearthed (Figures 3 and 4). In the following years the administrative and/or religious centre on Jebel Aruda has been further excavated under the direction of Govert van Driel and Carol van Driel-Murray (van Driel 2002; van Driel and van Diel-Murray 1979, 1983).

The pottery

A large part of the Jebel Aruda pottery was donated to Leiden University by the Syrian authorities. In 2004 this collection was transferred to the National Museum of Antiquities

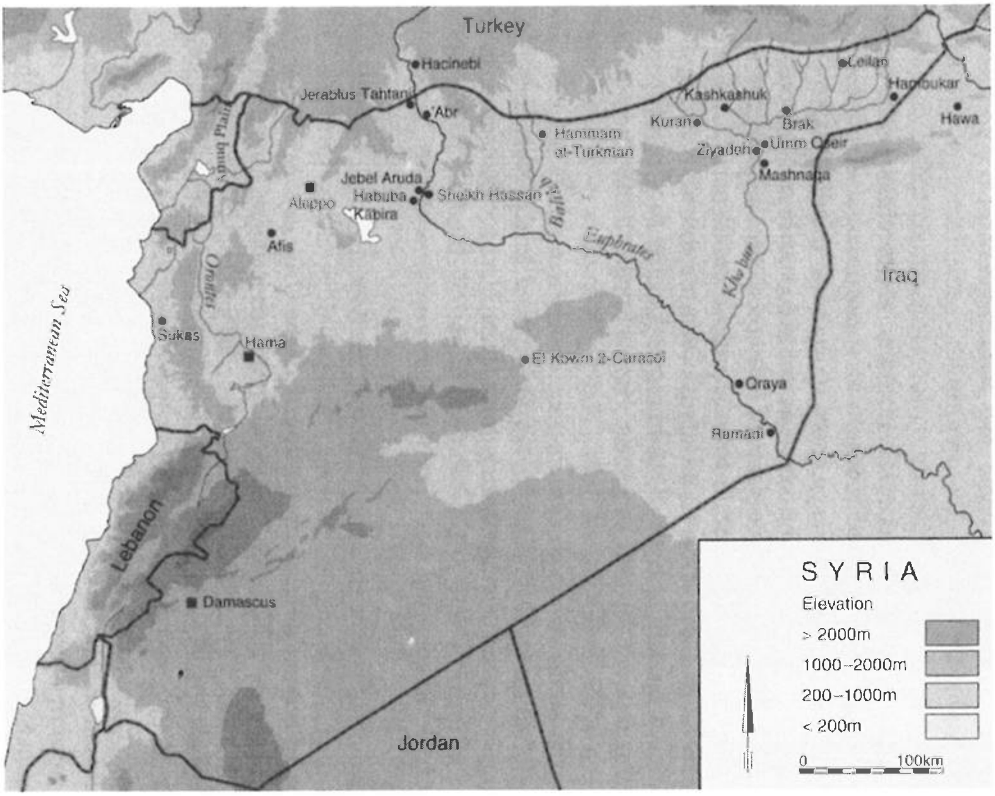

Figure 1. Syria in the fourth millennium B.C. (Akkermans and Schwartz 2003: Fig. 6.1.).

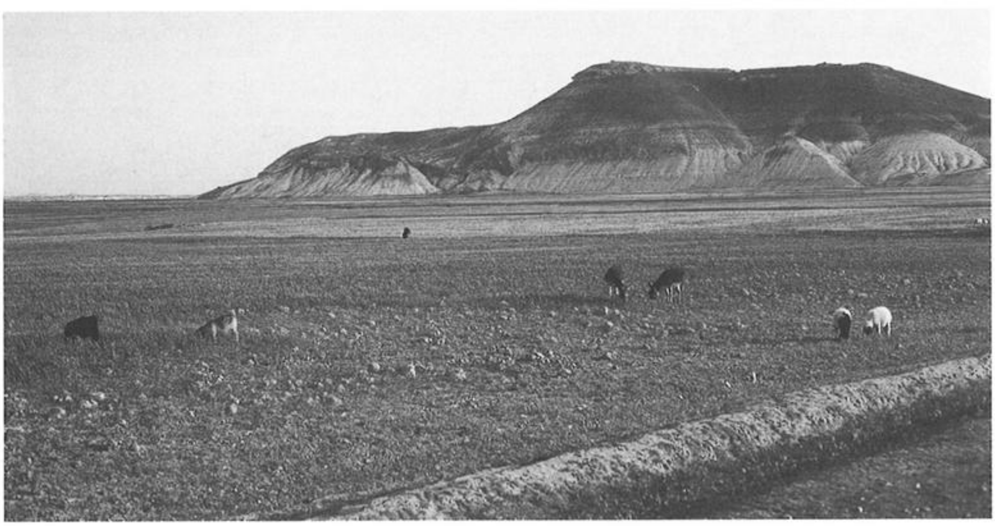

Figure 2. Jebel Aruda and its promontory seen from the north (photo A. van As, 1974).

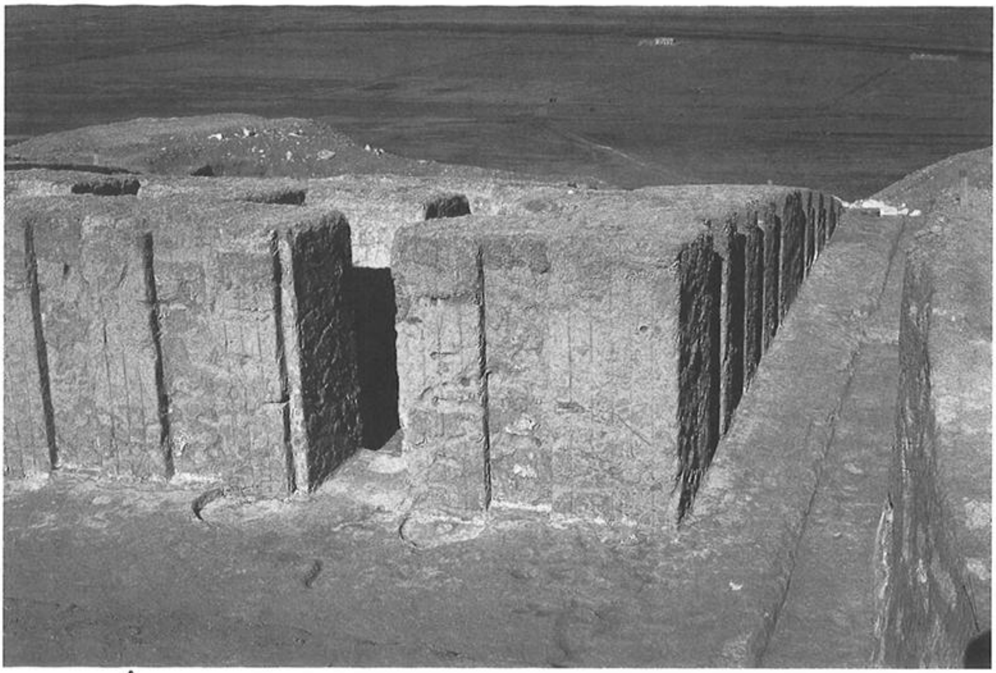

Figure 3. Partly excavated temple complex at Jebel Aruda (photo W.R.K. Perizonius, 1975).

Figure 4. Part of the settlement at Jebel Aruda (photo A. van As, 1975).

in Leiden (see also Renske Dooijes et al., this volume: 61-76). The pottery that will be discussed here was excavated in the period 1972-1975. The shaping techniques that could be distinguished will be described. These are variants of the two main forming techniques, scilicet without and with the use of the fast potter's wheel (handmade and wheel-made pottery). Next, the results of the fabric analysis will be summarized. In the epilogue attention will be given to the archaeological relevance of the technological analysis. Also, the pottery technology of the Uruk period in relation to the techniques applied by the potters in later periods will be elucidated.

Handmade pottery

Possibly the most Uruk diagnostic pottery category is the so-called bevelled rim bowl (Glockentopf; l'écuelle grossière a lèvre biseautée) (Figures 5 and 7: 1). From the Late Uruk period onwards they appear in large numbers. The majority of these mass-produced crude bowls are all of the same size, with little variation.

We may assume that this type of bowl had a rather specialized function. Numerous suggestions of an explanation have been given, such as bowls for meting out rations to dependents of public institutions (Nissen 1988), moulds for baking bread (Chazan and Lehner 1990; Millard 1988) and bowls used for salt processing (Buccellati 1990). Others consider them as votive bowls. Likewise, the opinions on the manufacturing technique of the bevelled rim bowls are not unanimous. According to Johnson (1973)

Figure 5. Bevelled rim bowl, height ca. 8 cm (Kalsbeek 1980).

they were made by pressing clay into small pits of about the same size as the bevelled rim bowls. Nissen (1988: 90) supposes that they were produced in moulds. Also Akkermans and Schwartz (2004: 194) consider them as "apparently made from molds". To me, however, the analysis of Kalsbeek (1980) based on the interpretation of the technological characteristics and supported by simulation experiments seems the most plausible reconstruction of the shaping technique (Figure 6).

Kalsbeek thinks that the bevelled rim bowls were handmade without using some sort of mould. The following indications amongst others led him to this reconstruction: a spiral-shaped mark in the exterior surface of the base (not always visible); a rough exterior surface; a more or less moistened interior surface; traces of sand or manure and dry clay dust on the outside; a height that does usually not exceeds the length of a hand, imprints of the hand at the exterior upper outside (dimensions dependent of the size of the potter's hand); a bevelled rim; finger impressions at the inside near the base; impression of the fist (knuckles of the fingers) in the interior base; traces of scraping on the interior and exterior surface.

The bevelled rim bowls have been made of short clay including a lot of fine (dung) or coarse organic material (chopped straw). The organic temper served to increase the coherence and plasticity of the clay. Following Kalsbeek's reconstruction of the shaping technique, first a cone-shaped piece of clay was twisted off from a lump of clay (Figure 6: 1 and 2). Next, a hole was made into this piece of clay (Figure 6: 3). Then a recipient was shaped (Figure 6: 4). During this action (pinching) cracks developed due to the bad quality of the clay. They were plugged by simply pressing the clay into a funnel shape. By modelling and smoothing the interior with a wet hand, while the other hand supported the outside, a bowl was made (Figure 6: 5 and 6). The supporting hand in which the bowl was continually moved was roughened with sand in order to avoid that the bowl slipped away. This explains the more or less angular appearance of the exterior wall of the bowl. During modelling the interior of the bowl, the thumb of the wet hand rested on its edge. Consequently, the rim was smoothed and obtained a concave form (a bevelled rim) (Figure 6: 7). Hereafter, the potter placed the bevelled rim bowl on one sand-powdered hand and pushed the fingers of the other hand on the transition of the wall and base at the inside (Figure 6: 8). Finally, by pressing the joint middle knuckle-bones into the interior, the base was flattened (Figure 6: 9). During these last two stages of the forming process, little cracks developed on places of the strongest pressure. According to Kalsbeek (1980) this is the explanation of the rough (tree bark-like) exterior surface.

Although it is in general rather easy to recognize the characteristics of the above-described shaping technique, we may notice some technological variants. For instance, if the inside is not finished with a wet hand the edge of the bowl will be flat instead of concave.

In the remaining pottery repertoire only two handmade vessels have been found: a jar (Figure 7: 2) and a flat tray (Figure 7: 3). To make the jar, first a bowl-like shape was shaped. Next, by adding coils of clay, the wall was made. A different technique was used for the manufacture of the flat tray. On a flat base, strewn with straw and dry clay dust

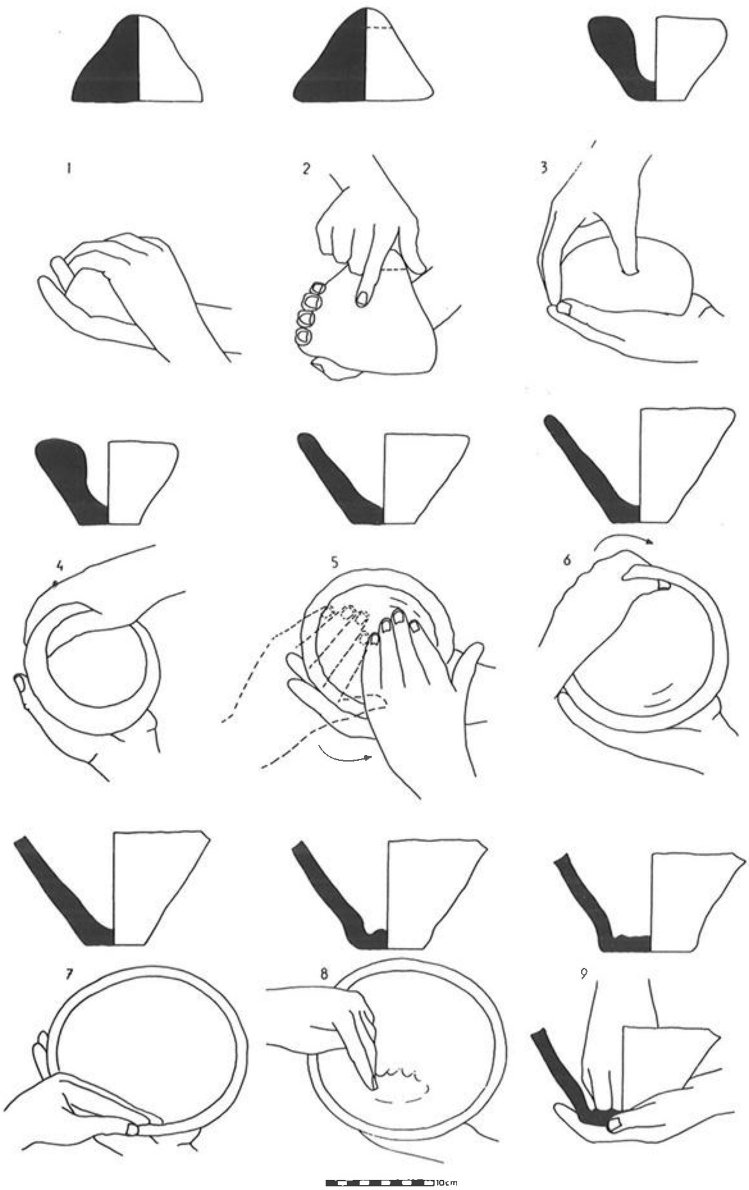

Figure 6. Bevelled rim bowl: construction drawing (Kalsbeek 1980).

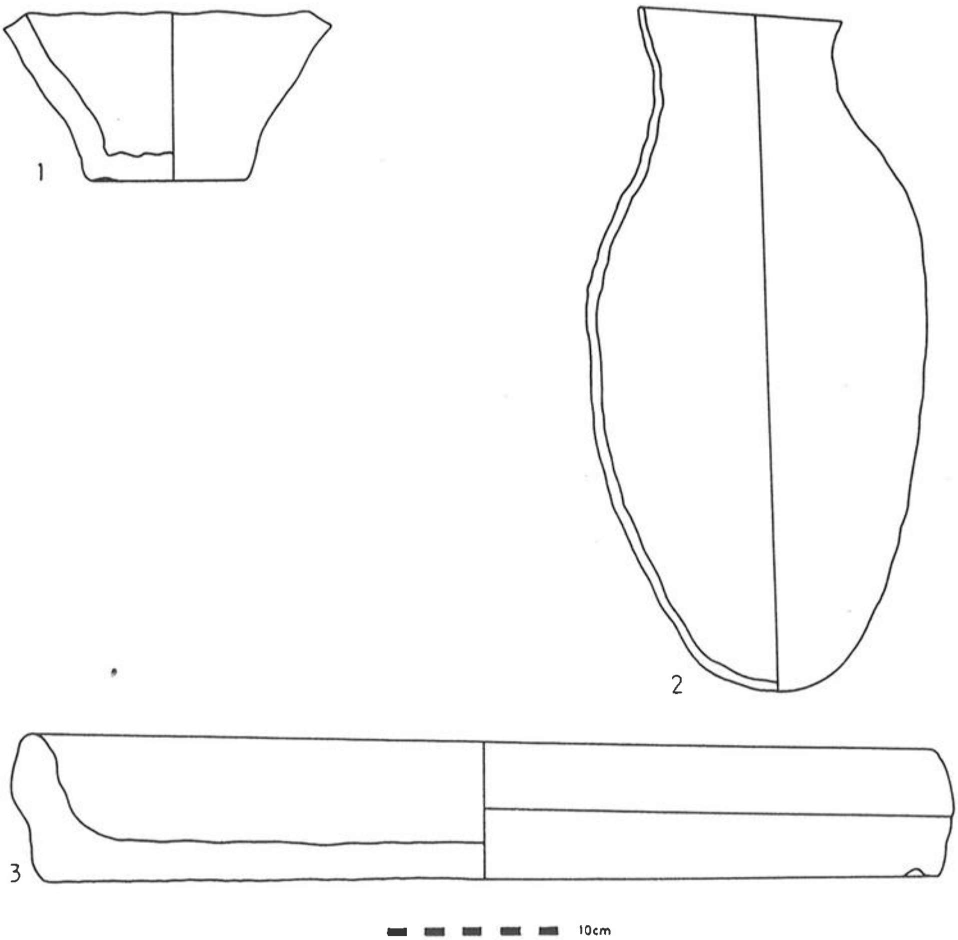

Figure 7. Handmade pottery: (1) bevelled rim bowl, (2) jar; (3) tray.

in order to prevent the wet clay from sticking to it, a piece of clay was squeezed to make an oval base, approximately 2 cm thick. Next, a coil of clay was fixed around the circumference of the base. By rubbing the clay coil with a wet hand the rim was made. This technique did not put special demands on the plasticity of the clay body. In order to prevent tearing as a result of drying shrinkage a large amount of chopped straw was added to the clay.

Wheel-made pottery

The majority of the pottery was wheel-made. A number of variants of the throwing technique could be distinguished.

Like the bevelled rim bowls, the majority of the so-called flowerpots (Blumentöpfe; les pots des fleurs) were also mass-produced (Figure 8). Since the flowerpots are in every respect, except for the manufacturing technique, so similar to the bevelled rim bowls, we may assume, according to Nissen (1980: 90), that the flowerpots fulfilled the same function, namely ration bowls. Nissen (1988: 90) considers them to be thrown from the cone. According to Kalsbeek (1980), however, they were thrown on the potter's wheel, during which the clay was pulled up quickly in comparison to the throwing speed (Figure 9). The following indications amongst others led him to this reconstruction: throwing ridges on the outside; the upper rim is more or less horizontal, sometimes locally thickened; thumb impression on the exterior wall surface; traces of the use of a rib on the smoothed interior surface; fluent or angular (with a pointed cone in the centre of the base) transitions from the base to the wall on the inside; marks of a string-cut base; deformation at one side of the wall and impressions of the fingertips at the other side.

Like the bevelled rim bowls, the flowerpots have been made of short clay tempered with dung or straw. The clay contained also pieces of chalk. Following Kalsbeek's reconstruction of the shaping technique, a lump of clay was centred on the potter's wheel and

Figure 8. Flower pot, height ca. 13 cm (Kalsbeek 1980).

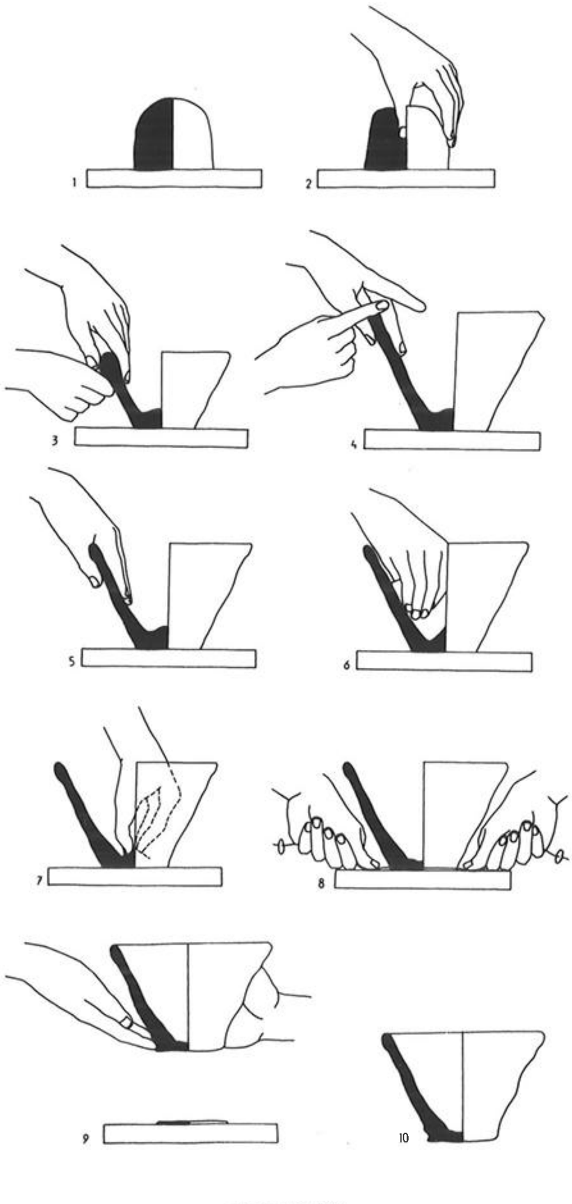

Figure 9. Flower pot: construction drawing (Kalsbeek 1980)

opened (Figure 9: 1 and 2). Next, the wall was pulled between both hands (Figure 9: 3). The form of the throwing ridges shows that the wheel was slowly rotating during this quick action, for the pieces of chalk in the clay did hinder the potter to move the wheel more quickly. As a consequence the rim became rather irregular. Therefore, the rim had to be smoothed and levelled (Figure 9: 4 and 5). Then, the inside was scraped with a rib (Figure 9: 6). If a pointed tool had been used a small pointed cone is visible in the centre of the base on the inside (Figure 9: 7). Sometimes this cone was pinched off. The use of an oval tool resulted in a fluent transition between base and wall on the inside. The flowerpot was cut from the rotating wheel with a little string (Figure 9: 8). Finally, the potter lifted the flowerpot from the wheel (Figure 9: 9).

The remaining wheel-made pottery was made in one of the following variants of the throwing technique: throwing from the cone; throwing from one piece of clay; coil throwing; section throwing; and throwing with the use of a mould.

Throwing from the cone (throwing off the hump) is a quick production method in which several small pots are thrown (Figure 10: 1-9), one after the other, of one big chunk of clay pressed into a conical shape. When one piece is finished it is cut from the cone with a knife, a needle, a string or a piece of metal wire. Unless trimmed away in a later stage, the traces are visible on the bottom side of the small vessels. The limited-sized vessels illustrated in Figure 10: 10-12 were thrown from one piece of clay (simulation experiments by Loe Jacobs, see Figure 11). The throwing ridges are clearly visible. In order to obtain a uniform thickness of the base and wall, the bottom-side of the base (and sometimes also the interior) was scraped. This was done in a leather-hard stage, either by hand or on the rotating wheel. On some vessels a handmade spout was attached after a hole was made into the wall.

Coil throwing is done when throwing from one piece of clay is problematic, for instance with regard to the desired size. The advantage of this method is that the clay needs not to be stretched so much. For this reason, short clays are very suitable for this manufacturing method. In principle, throwing in coils makes it possible to make a large variety of shapes. Each time, after a short drying phase, the vessel was built up higher by attaching a new coil of clay after which throwing was continued. It is rather difficult to recognize the joints of coils.

Vessels with a small diameter were made by putting pre-fabricated cylinders on top of each other (Figure 12). Loe Jacobs carried out a number of simulation experiments. In general, section throwing is not used for the manufacture of vessels with a diameter larger than 30 centimetres. Otherwise, the pre-fabricated cylinders would become unmanageable during stacking and the poor plasticity of the clay would also become problematic. In some cases, thickenings on the inside indicate the joints of the cylinders. After stacking the cylinders, the vessel was given its final shape. By scraping the outside in a leather-hard stage the wall was made thinner. Finally, the still weak vessel was removed from the potter's wheel and laid aside for drying. Consequently, some vessels show an indented wall. Sometimes, the vessels were provided with a handmade spout.

Like in Habuba Kabira South, situated 4 km south of Jebel Aruda, a part of the pot-

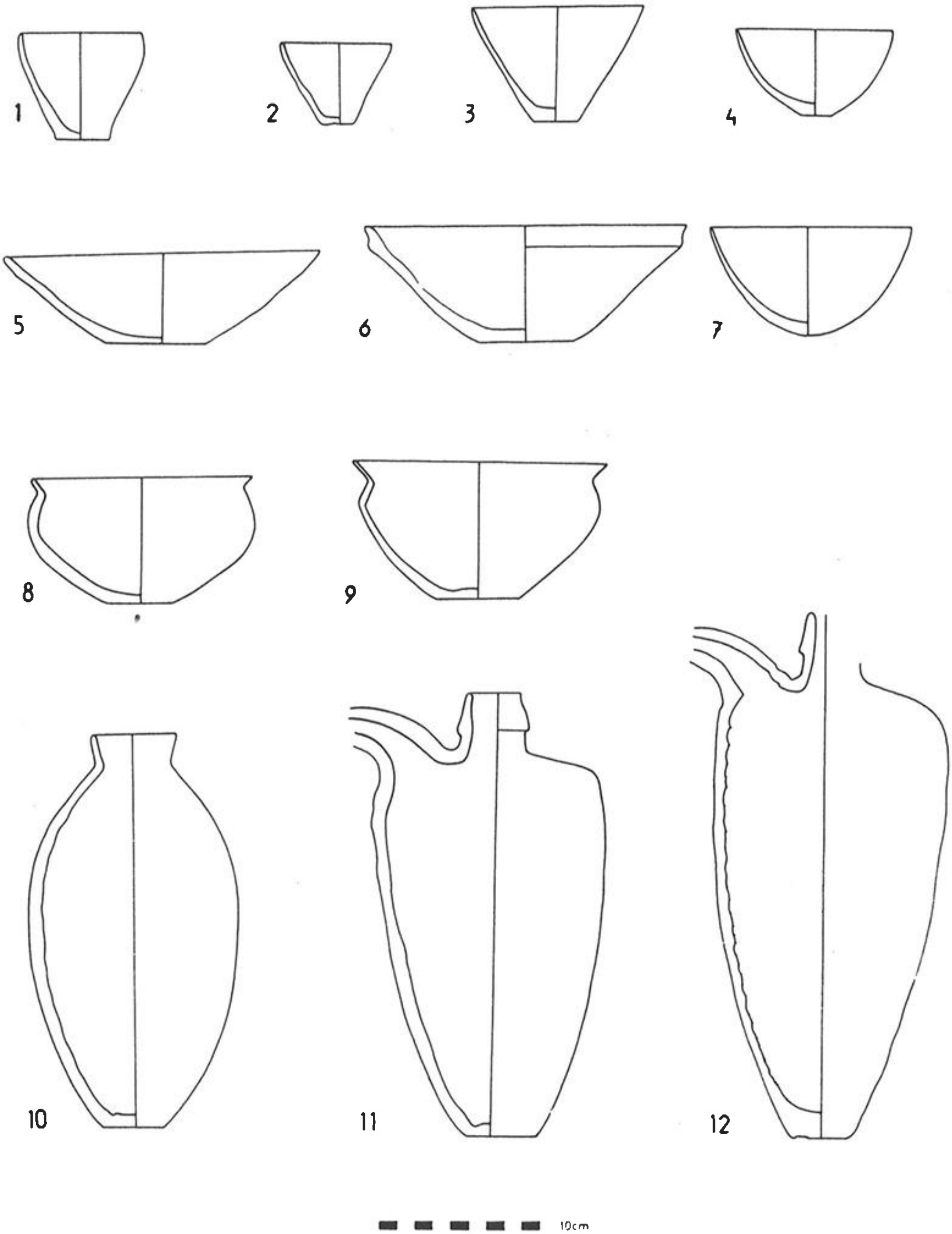

Figure 10. Selection of wheel-made pottery: (1-9) thrown from the cone; (10-12) thrown from one lump of clay.

Figure 11. Selection of pottery thrown from one lump of clay: simulation experiments by Loe Jacobs.

tery repertoire was made in a combination of moulding and throwing (Figure 13). According to Sürenhagen (1974/1975: 90-91) the base and lower part of these vessels was pressed into a mould. As soon as this part was dry, it was taken from the mould and put on the potter's wheel. Now, the shoulder and neck were thrown.

Some of the Jebel Aruda vessels show certain characteristics of another composed technique that seems to be comparable with a technique applied for the manufacture of some Early Dynastic vessels from Tell Sabra as reconstructed and simulated by Loe Jacobs (Jacobs 1987: 91-93 and Plates 103-105). In this case, the vessels were made with the aid of a wheel. Given the size of most of the vessels, the wheel did not rotate very fast. First, clay coils were made in various sizes. Next, a bat was put on the wheel-head of the potter's wheel and a beehive-shaped dome was thrown in the coiling technique. When the beehive-shape was sufficiently firm, it was put upside down in a mould on the wheel. The clay was still so soft that it took on the shape of the mould. Then the bat was cut free and the inside of the vessel was pressed into the mould with a scraper. While the vessel was still in the mould the upper wall was thrown inwards. Finally, a foot was

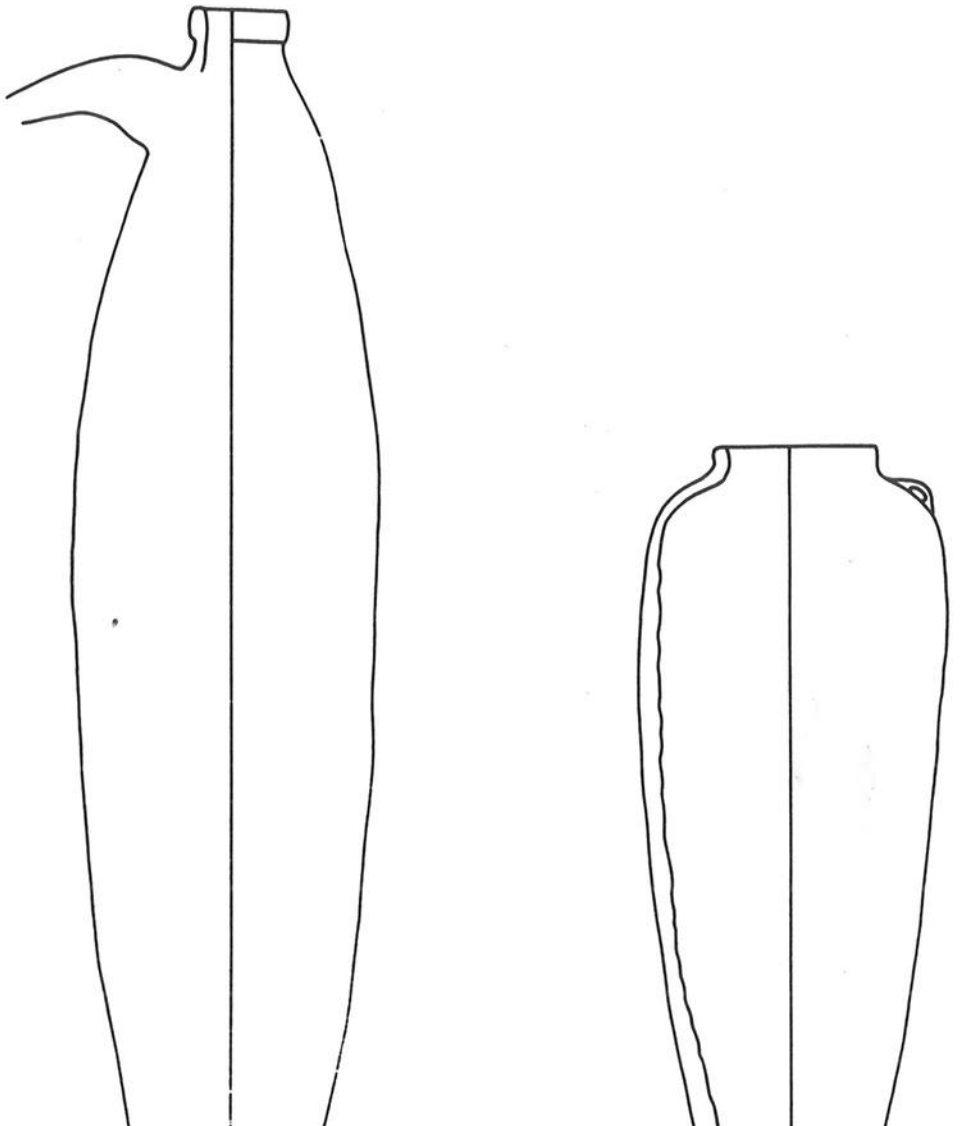

Figure 12. Selection of pottery thrown in sections.

made from a separate piece of clay that was applied after the vessel was removed from the mould and turned upside down.

The finishing touch

Scraping and trimming in a leather-hard stage often belongs to the final surface treatments. In a number of cases the vessels were provided with foot stands, spouts, lugs, or horizontally pierced 'nose lugs' applied to their shoulders for suspension. In general the pottery is undecorated. Apart from decorating the pottery with incisions in the wet clay, some pottery was also decorated by means of a slip or engobe layer and sometimes burnished afterwards. An engobe is used to cover a clay and give a different surface, texture and colour. If an engobe contains a rather high iron content, the surface will become red in an oxidizing firing atmosphere. Some vessels have a reserved slip – a technique in which the slipped or wet-smoothed surface of the vessel is wiped in a pattern of oblique radial lines.

Fabric analysis

Test sherds of the various categories of pottery described-above were analysed. After refiring the sherds in an electric kiln in an oxidizing atmosphere at successively 900°C, 1050°C en 1100°C, two groups of firing colours (inside, outside and core) could be observed: (1): light colour (900°C: 5Y-8/3 pale yellow, 10YR-7/3 very pale brown; 1050°C: 10YR-8/3 very pale brown, 2.5Y-8/4 pale yellow: 1100°C: 5Y-8/3 pale yellow, 2.5Y-7/4pale yellow), and (2) reddish colour (900°C: 2.5YR-6/4 light reddish brown, 2.5YR-6/6 light red; 1050°C: 2.5YR-6/4 light reddish brown, 2.5YR-6/6 light red; 1100°C: 10R-4/3 weak red). The colour difference can be explained by the various ratios of iron, lime and salt present in the clay (Jacobs 1991/1992).

The fabric was microscopically investigated on a fresh break and a grounded edge (40× magnification). For the identification of calcareous inclusions the HCl test was carried out. All sherds contain in varying degrees and sizes the following components: quartz, glimmer, red and black iron particles, microfossils, calcium compounds and some organic material. Only the bevelled rim bowls and flowerpots are heavily organically tempered.

Based on technological investigations of chronologically later pottery assemblages studied in the Tabqa region and on the analysis of second millennium B.C. pottery from downstream Tell ed-Dēr and Nippur (van As and Jacobs 1992; Franken and van As 1994), we may conclude that the pottery was made of naturally Euphrates clay. It is short clay, which did not require the addition of sand before use. The clay held all kinds of minerals transported by the river southwards from the Anatolian mountains and a varying amount of chalk deposited from the side-wadis into the river's floodplain.

Epilogue

One of the aims of archaeological ceramic research is to obtain insight into human activities in the past. In this context we may refer to book titles such as *Ceramics and Man* (Matson 1965) and *Pottery and People. A Dynamic Interaction* (Skibo and Feinman 1999). Here, ceramic studies extend beyond simple description and classification of pottery. The effects of the pottery's use-life are included in the archaeological study and evaluation of the artefact. Apart from the raw materials and the manufacturing process of the pottery, the production organization, function, use, and discard of the pottery play an important part. However, it is rather difficult to recover the minutiae of these various aspects. The technological analysis of a small part of the Late Uruk pottery from Jebel Aruda yielded information on some aspects of the production sequence. The study was especially focused on the reconstruction of the shaping techniques. By reading the traces left by the potters and supported through simulation experiments, we have obtained an impression of the Late Uruk potters at work. The results of this analysis seem to correspond with the data of Sürenhagen's extensive technological study of a much larger assemblage of contemporary pottery from Habuba Kabira South (Sürenhagen 1974/1975). We may assume that the pottery used on the Jebel Aurda was produced here, on the Euphrates river,. The majority of the pottery of Habuba Kabira was also wheel-made. Sürenhagen, together with the ceramist H. Juraneck, distinguishes a number of shaping techniques for the manufacture wheel-made pottery, e.g., throwing from the cone, coil throwing and section throwing. They also notice the use of a mould in combination with wheel throwing. According to Sürenhagen (1974/1975), these '*Produktionsgewohnheiten*' or pottery traditions in a narrow sense belong to the pottery tradition in a broader sense ('*Produktionsbereich*') that points to professionalism. Sürenhagen (1974/1975) considers the makers of the mass-produced handmade bevelled rim bowls also to be professionals. The remaining handmade pottery, however, belongs to the non-professional '*private* '*Produktionsbereich*'. We may conclude that the characteristics of both pottery assemblages from Habuba Kabira South and Jebel Aruda fit well in the picture we have of the complex southern Mesopotamian-style Late Uruk society, in which the earliest variety of written texts (numerical tablets), cylinder seals and seal impressions on tablets and jars form the various aspects of bureaucratic administration.

Finally, if we place the technology of the Late Uruk pottery from Jebel Aruda in a chronological perspective, the following may be remarked. In contrast to the professional full-time (often mass-) production of mainly undecorated pottery in the fourth millennium B.C. as described in this article, throughout much of the preceding millennium, potting was probably a part-time activity that may have taken place mainly at the household level (Akkermans and Schwartz 2003: 171). In the course of this period (Ubaid period), together with the introduction of the fast potter's wheel, the painted vessels seem to gradually have been replaced by undecorated ware and eventually disappeared completely. Pottery manufacture changed into a mode of production at the workshop level. In the Late Uruk period the methods of the potters on Jebel Aruda were

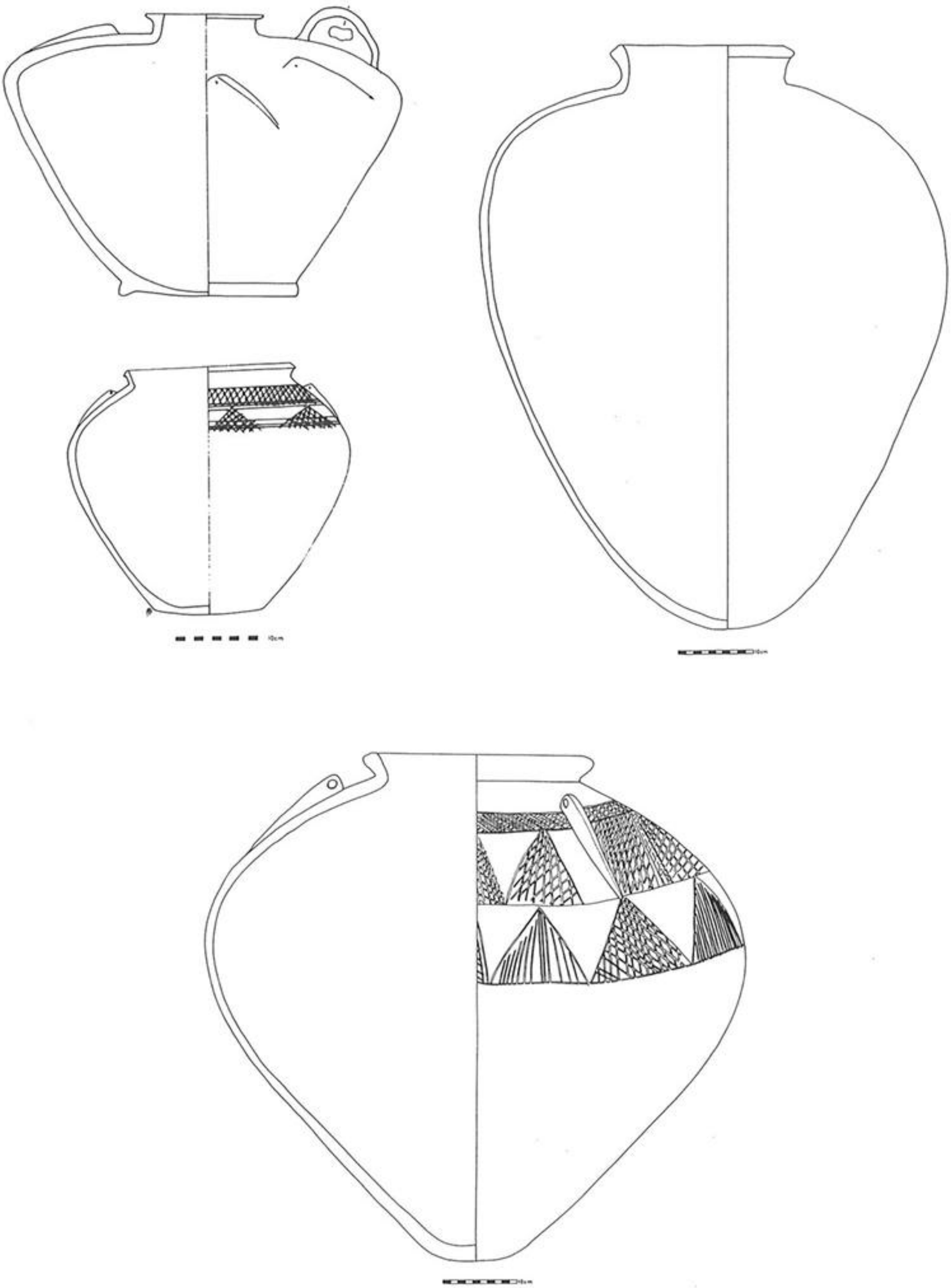

Figure 13. Selection of pottery formed by moulding and throwing.

fairly basic. As we have seen, the various variants of wheel throwing are connected with the size of the vessels. The technological study of pottery of later periods in the Tabqa area showed us that the consumer ware made of Euphrates clay required the application of existing methods rather than inventiveness.

Acknowledgements

The author is much indebted to Jan Kalsbeek (†) and Loe Jacobs for the discussions about the technology of the Jebel Aruda pottery. Both carried out simulation experiments that play an important role in the reconstruction of the manufacturing technique of the pottery. Thanks are due to Erick van Driel for the drawings of the pottery.

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RESTORATIONS ON THE LATE URUK POTTERY OF JEBEL ARUDA – OLD AND NEW

Renske Dooijes, Frederike Burghout, Marianna H. Düring and Olivier P. Nieuwenhuyse

Abstract

In this paper we report on the recent (2007) restoration of ceramic vessels from the Jebel Aruda excavations, currently kept within the National Museum of Antiquities in Leiden. We discuss the decisions taken at various stages of the restoration process and the materials and techniques used. During the restoration we discovered ancient restorations dating to the Late Uruk period. These ancient repairs have thus far not been reported from any Uruk period site.

Introduction

In spring 2004 a remarkable transport of archaeological objects arrived at the National Museum of Antiquities in Leiden. A large collection of Uruk pottery from Jebel Aruda (Syria) was transferred from its original owner, Leiden University, to its new host, the museum. The Dutch rescue excavations at Jebel Aruda began in 1972 as a result of the construction of the Tabqa dam (van Driel 2002; van Driel and van Driel-Murray 1979, 1983; see also van As, this volume: 42). The distribution of finds between the Syrian and Dutch authorities made it possible to transfer part of the find material to Leiden University for future research and educational purposes.[1] Upon arrival in the museum, the two main aims were to conserve the collection, and to keep it accessible. The finds were repacked, and the complete pots were placed in cupboards with glass doors. The available information on the collection was entered into TMS (The Museum System), the registration database of the museum.

The acquisition of the collection led the National Museum of Antiquities to organise an exhibition on the archaeological excavations on Jebel Aruda (April 6 - August 12, 2007). This exhibition had a strong emphasis on the ceramic vessels, exploring their uses in the past, the ceramic technology available to Late Uruk potters, and the provenance of the pottery. The selection of the vessels for the exhibition tried to give a representative overview of the range of technologies, shapes and sizes present at Jebel Aruda. Most pieces shown were plain, but one remarkable vessel (JAF 217) combined a number of characteristic Late Uruk stylistic traits such a red slip, an engraved decoration, two spouts, and so-called *nose lugs* just above the shoulder (Figure 3). We also

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included a number of rare or unique vessels. For instance, JA 1642 represented an example of a category of Late Uruk vessels showing vertical stripes of bitumen on the exterior surface (Figure 9, right). Possibly these may be associated with ancient restorations (see below). Vessel JA 1649 was among the highlights. The lower part of this interesting jar was covered with small clay appliqués, spread just below and around the carination (Figure 9, left). The function of these dots is unclear: they may have been decorative, but may well have had a functional use as well. This massive vessel weighs around 30 kilograms and would therefore have been difficult to move around; the appliqués may have facilitated handling the pot.

The poor condition of most of the vessels made it clear that significant restoration was imminent. Below, we will briefly describe the restoration process. We shall focus on the techniques and materials used, the problems that came to light during the restoration process and the restoration ethics involved. We shall also present a recent study on the removal of remnants of plaster from the surface of Late Uruk ceramics by chemical agents, carried out as part of an MA thesis at the Netherlands Institute for Cultural Heritage (Düring 2005). Finally, we wish to draw attention to ancient pottery repairs from the Late Uruk period that came to light during the project.

The condition of the objects

Following the excavations of Jebel Aruda, a considerable number of the vessels had already been restored by the excavators themselves, assisted by an enthusiast group of volunteers (C. van Driel Murray, pers. comm. 2003; van Driel and van Driel-Murray 1983: 24). They had reassembled hundreds of vessels, so that they could be drawn and photographed. Because the main aim at the time was to provide the archaeologists with complete profiles, little attention was given to the actual execution of the restorations. Often, the assembled sherds did not align. In many cases, missing parts of pots were quickly, and roughly, filled in with white plaster. Often this plaster also covers the original surface of the object. A type of glue based on cellulose nitrate was used, which through time has become very brittle and unstable. This causes the objects to fall apart again, especially in the case of the big, heavy storage jars, of which there are many in the collection. Of course these problems could not have been foreseen in the past; nevertheless many ceramic objects from Jebel Aruda are now in a very fragile condition.

A condition survey quickly brought to light a range of additional problems. Jar JA 1649 had been reconstructed in two separate halves during its previous restoration, which were subsequently put together (Figure 1). Unfortunately, these two parts did not perfectly align after reassembling, leaving a broad gap all around the object. This gap, as well as a large missing fragment in the belly of the jar, had been filled in with plaster. Another jar, JA 55, showed excess adhesive and plaster, covering a large part of the original surface. The sherds of this object were bonded in such a way that they did not align, the resulting tension of which had caused a crack near the shoulder (Figure 2). The overall condition of JAF 217, too, was very poor (Figure 3). The surface was very fragile, and

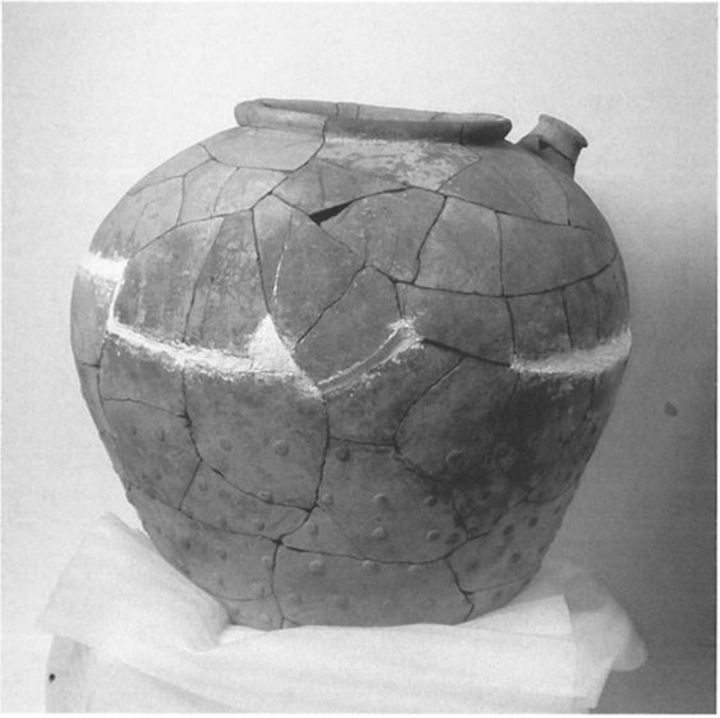

Figure 1. JA 1649 before restoration, showing a broad gap around the object, filled-in with plaster.

almost the entire interior surface had been smeared with plaster. Several sherds were loose, either because the old glue had become so brittle that they simply fell off the object, or because the previous restorers never found their right location on the object.

Dismantling the previous repairs

Because all the objects had been bonded with an unstable glue based on cellulose nitrate, the adherence between the sherds had become severely weakened. It was clear that the objects had to be completely dismantled where possible in order to re-restore them properly. For most vessels we followed a similar work scheme. To start with, compresses soaked in acetone were placed on the break lines to soften the glue. We covered the compresses with cling film or aluminium foil to prevent the acetone from evaporating, after which we left them working the surface of the pots for some time (Figure 4). Subsequently, the vessels could be dismantled. The break edges of the sherds were then cleaned using scalpels, soft brushes, and cotton wool swabs dampened with acetone and ethanol. The plaster fillings were carefully removed using small chisels, scalpels and soft brushes with water.

Figure. 2. JA 55 before restoration showing a large crack below the shoulder, resulting from the tensions caused by the 1970's restoration.

In the case of JAF 217, we used demineralised water and acetone to test the condition of the slip and its solubility in either one of these two solvents. The top layer was found to be very sensitive and even soluble to water, but resistant to acetone. Since the slip was very thin and fragile, great care had to be taken when cleaning the surface and break edges mechanically. During the disassembling of the vessel it also became apparent that the sherds forming the bottom were in a very poor condition. The ceramic body of the base consisted of laminated layers. Perhaps to enhance stability the interior base

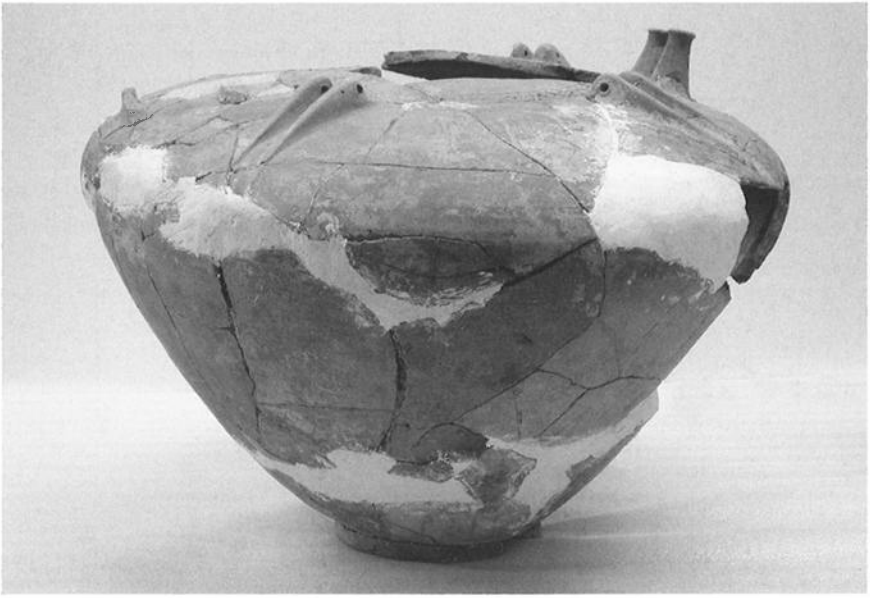

Figure. 3. JAF 217 before restoration, showing the old plaster filling covering a large part of the original surface.

Figure. 4. JAF 217 covered with compressors soaked in acetone.

had been smeared with plaster during the previous restoration. Because of the fragile condition of these sherds it was impossible to remove all the old plaster fillings at this location.

The big storage jar JA 1642 did not have to be dismantled. To be sure, here as well the cellulose nitrate based glue had become brittle, so that several sherds were loose or had even fallen out (Figure 5). In spite of this only a few areas of the pot appeared to be missing, and its lower part in particular seemed in a reasonably stable condition. For these reasons, and also because in this case only a small amount of the joins were misaligned during the previous restoration, we decided not to dismantle the object completely. To improve the condition of the object we only took apart those few sherds that were misaligned, rebonded the various loose fragments, and filled in the gaps.

Reconstructing the vessels

For those objects that had been completely dismantled, we laid out the cleaned sherds in jigsaw fashion, and then began to reassemble them again (Figure 6). We rebonded them using Paraloid B72 in acetone (50% solution) as a glue. Masking tape, clamps, and a sand-filled tray were used to hold the sherds together. As soon as the base of a jar had been reassembled, it was placed in a support made of polyethylene foam. The pot could then be gradually assembled working from its base upwards, using large fragments that had first been assembled from smaller sherds.

In the case of JAF 217 the cleaned break edges first had to be impregnated with a 5% solution of Paraloid B72 in acetone, to strengthen them. The reassembling of this vase was carried out in different stages. To start with, the sherds belonging to the bottom and the top part of the vase were bonded. These two parts were then put together with the support of a cardboard frame, necessary to maintain stability during bonding and to keep the sherds in the right position (Figure 7). Reassembling jar JAF 217 turned out to be difficult, because of the very bad condition of the laminated sherds. Bonds had to be strengthened with stripes of glass-fibre matting fastened to the interior surface with a 10% solution of Paraloid B-72 in acetone. In fact, due to these problems the work on jar JAF 217 is still in progress. It was not possible to complete the restoration in time for the exhibition. Making good use of this delay, the incomplete JAF 217 was put on display in a special showcase during the exhibition, as a prime example of difficult restoration work in progress.

The large missing fragments had to be filled in to improve the stability and the aesthetic quality of the objects. Strips of cardboard cut to size were fastened behind the gaps, as a support for the plaster fillings. The plaster was tinted with dry pigments matching the colour of the objects. After drying, the plaster was scraped with various instruments and then smoothed with sandpaper (Figure 8). In some cases, we decided to re-use some of the old plaster fillings, provided they were still in a good condition. At the neck of JA 55, an old plaster fill was partly re-shaped and glued back into place.

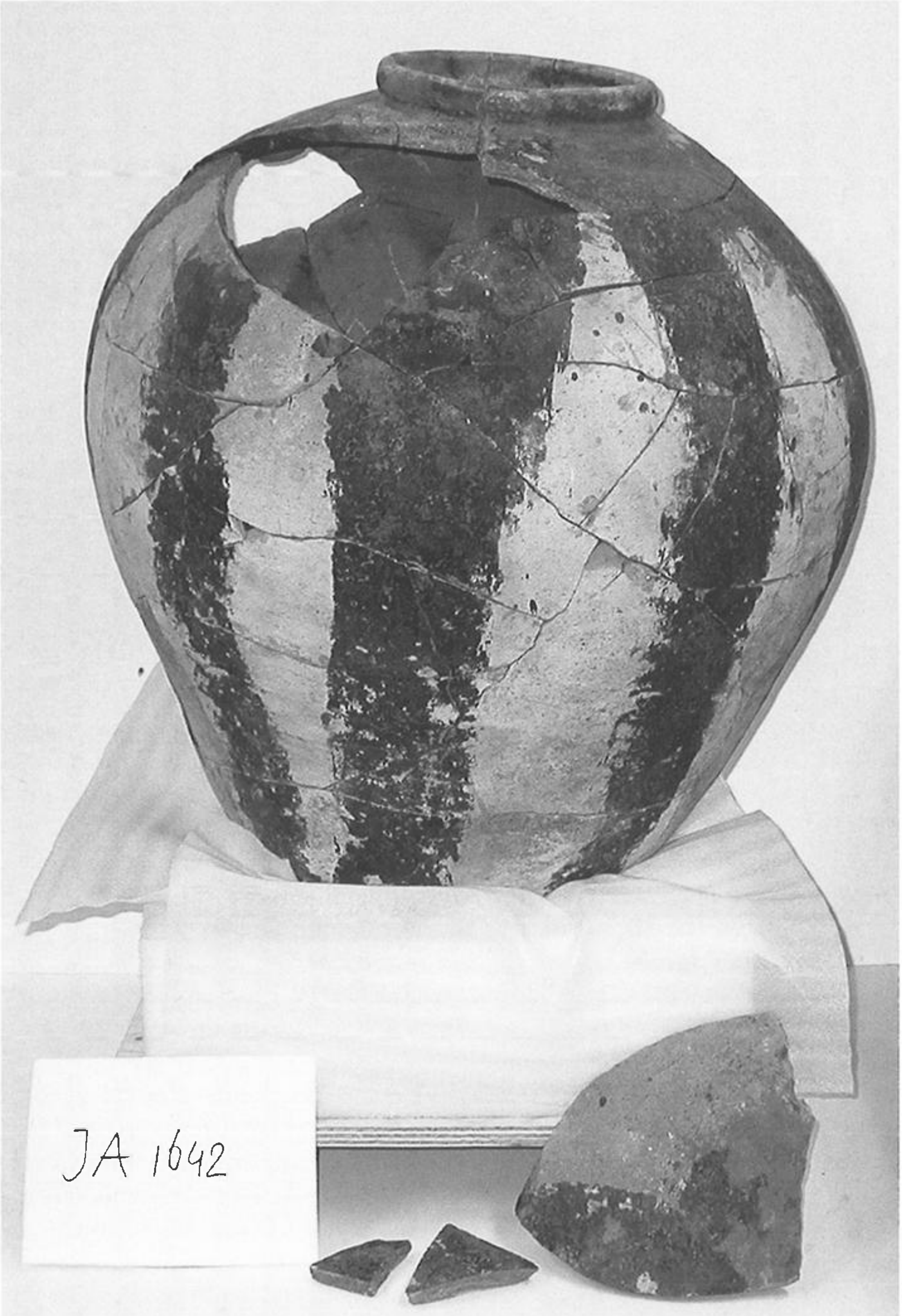

Figure.5. JA 1642 before restoration. For the most part this object was stable, but part of the upper body had fallen out.

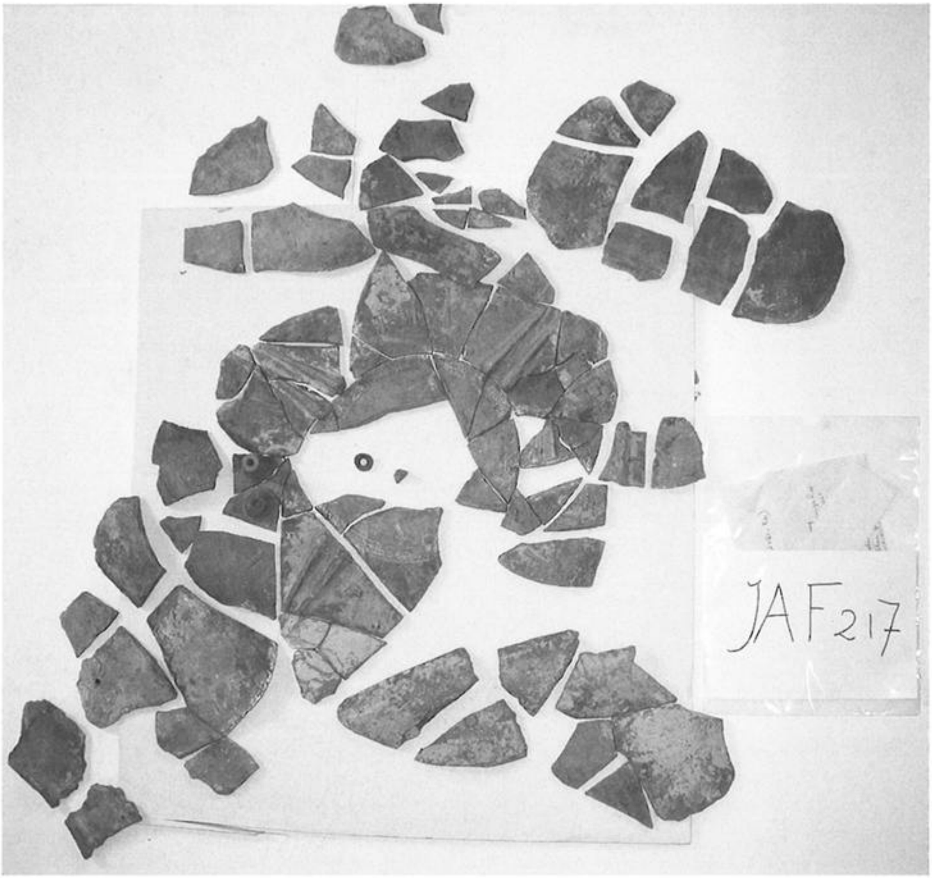

Figure. 6. JAF 217 during restoration, before reassembling.
The cleaned sherds are laid out in a jigsaw fashion.

Retouches and restoration ethics

All restoration work within the National Museum of Antiquities is carried out following ethic standards currently accepted by restorers internationally, described by the ICOM code of ethics.[2] Thus, for aesthetic reasons, the final retouching was executed to the extent that the appearance of the fillings matched the original colour of the pot (Figure 9, left and right). However, care was taken that the fillings would still be recognizable as modern additions to the objects. The finished fillings were retouched with Golden acrylic colours mixed with dry pigments and Golden Porcelain Restoration Glaze (matte). Before applying these final retouches, a protective coating of Golden Restoration glaze thinned with water was applied to the surface of the plaster fillings, to minimize the porosity of the surface and to improve the adherence of the paint.

Figure. 7. JAF 217 during reassembling. A cardboard frame is fastened to the interior surface to keep the sherds in position.

Figure. 8. One of the big storage vessels from Jebel Aruda (JA 1642) during restoration. The gap has been filled with plaster tinted to the colour of the object. The filling is being scraped into shape.

Figure. 9. JA 1649 (left) and JA 1642 (right) during restoration. The plaster fills have been retouched to the original colour of the pot.

Furthermore, it was decided not to fill in the break lines between the sherds. A major practical reason for this decision was simply lack of time. A welcome additional advantage was that we could now show the public exactly from how many sherds the object had been assembled before, something the ordinary visitor would not be able to observe with completely finished restored objects. Furthermore, to visitors we wanted to bring home the point that the objects on display derived from an archaeological context, and that they should therefore be expected to be incomplete and fragmented.

Removing old plaster

As will have become clear at this point, plaster was abundantly used in the previous restoration of the Jebel Aruda pottery. At the time, the aesthetic appearance of the pots after restoration was not considered a priority, and many of the vessels now show plaster stains on the surface. Unfortunately, because plaster tends to bond strongly to the original ceramic surface, it can be difficult to remove without damaging the object. Removing plaster from unglazed earthenware is painstaking work, usually done mechanically with a stencil brush and water. The material can be softened by soaking in water, making it easier to remove it mechanically, but even then surface damage is difficult to avoid. Chemical treatments, such as for instance with acids, are generally avoided because of the danger of damaging the ceramic body. Apart from the often very unsightly appearance of white plaster stains, a prime reason to remove the plaster layer is the risk of salt problems caused by the migration of water through the plaster layer (Düring 2005).

Plaster, also known as "Plaster of Paris", is a calcareous material known chemically as calcium sulphate ($CaSO_4$). It has been in use as a filling material for ceramic restoration for a considerable time. Little research has been done into the possibilities of using chemical agents to remove surplus residue of plaster. Chemical agents have been used to remove other calcareous incrustations from ceramics, such as calcium carbonate based marine crusts (Hodges 1986; Moncrieff 1975; Olive and Pearson 1975; Price 1996). Calcium sulphate is a major component of air pollution crust on stone and stained glass. In these fields of restoration research has been carried out on the potential of various chemical agents for removing incrustations (De Witte and Dupas 1992; Ferrazzini 1977; Kavenagh and Wheeler 2003; Laterna and Matteini 2000). Using this literature a number of promising chemical agents was selected for testing: EDTA (ethylene-diamine-tetraacetic acid) tetrasodium, triammoniumcitrate, sodiumhexametaphosphate, ammonium carbonate, and ammonium carbamate (Figure 10).

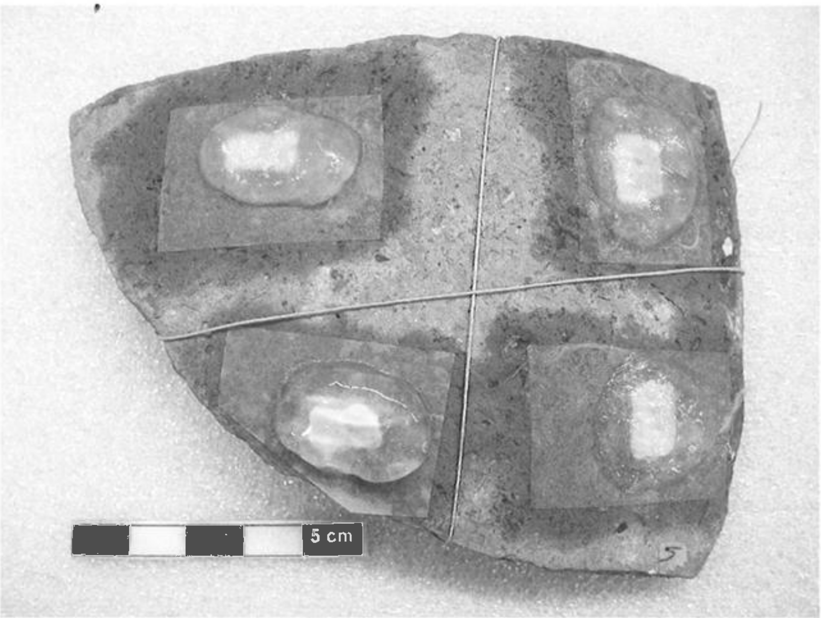

Figure. 10. Testing various techniques for plaster removal on a sample from one of the Jebel Aruda vessels. Moving clockwise from upper right: EDTA tetrasodium, triammoniumcitrate, de-ionised water, and ammoniumcarbamate in Laponite.

The chemical agents had to be able to remove calcium sulphate selectively from the surface while leaving the components of the ceramic body untouched. Other criteria for establishing the usefulness of the various agents were, firstly, that they should be more effective in removing the plaster residue than the traditional, mechanical method. Secondly, they should result in less surface damage. Thirdly, there should be no negative side effects on the surface of the pottery, such as a white film, decolourisation or staining.

The study began with a chemical analysis of the clay body of a sample of Late Uruk sherds from Jebel Aruda, using XRD (X-ray diffraction) and XRF (X-ray fluorescence) techniques. This demonstrated that the material contained a relatively high amount of calcium carbonate and iron oxide. Initial experiments to establish the selective effectiveness of the various agents on calcium sulphate while leaving other components of the clay body untouched showed that sodiummetahexaphosphate and ammonium carbamate were unsuitable. Further experiments carried out with the remaining three agents showed that both EDTA tetrasodium and triammoniumcitrate gave good results.

The best results were achieved by first removing most of the plaster mechanically, leaving only a thin surface layer. The chemicals can then be applied as a poultice in Laponite synthetic clay, to minimize the amount of water needed and to assure that the chemicals stay put.[3] Japanese tissue paper was used as a layer between the poultice and the ceramic body to minimise the risk of Laponite stains. This strategy offers the advantage that there is little mechanical contact with the surface of the sherd. Also, it effectively removes the plaster from pores and crevices. The appearance of the original is modified less than with mechanical methods, because other residues are not removed. On the other hand, we emphasize that the study only tested ceramic objects from one site, the Jebel Aruda, the material of which represents specific properties. More research is needed to test the method with other ceramics, and investigate the long-term effects of the treatment on the ceramic body, before it can be applied more broadly.

Late Uruk period pottery repairs

Most interestingly, the dismantling of the Late Uruk vessels from Jebel Aruda brought to light a number of earlier restorations, dating to the Late Uruk period itself. At least three pottery vessels clearly were restored in the past, using bitumen as a glue.[4] One large jar (JA 1642) shows a large amount of bitumen covering the exterior rim and large parts of the shoulders, drooping in broad, vertical bands down the body (Figures. 5 and 9, right). The break edges of a large loose sherd, situated just below the rim, had been covered with bitumen (Figure 11). The vessel had clearly already been broken in the past at this location, possibly during firing. In the case of another large, plain jar (JA 1296), bitumen was applied abundantly on both surfaces covering a number of breaks. The bitumen can be clearly observed between the breaks. In this case it appears that some sherds were taken out of the vessel, generously smeared with bitumen, and then replaced. A medium-sized jar with red-slipped and engraved decoration (JA 1801) received a massive blob of

Figure. 11. One of the sherds from JA 1642 showing bitumen covering the break edges. Also visible are remnants of the glue during the previous modern (1970's) restoration.

bitumen on its interior, covering a number of breaks and seeping through these breaks onto the exterior surfaces (Figure 12). The vertical bands observed with JA 1642 may have been applied to the surface with brushes. Possibly these mark the locations where supportive or protective netting was added after the vessel had been repaired, the bitumen functioning to keep it in place or to protect the surface of the pot.

In the Near East the use of bitumen is widely attested in the Uruk period for waterproofing pottery and baskets, as a raw material for sculpting art works, as a mortar for bricks, as a pigment, and as a hafting material for flint tools (Algaze 1989, 1993; Connan and Deschesne 1996; Schwartz et al. 2000: 70; Stein 2000); its use for repairing broken pottery has thus far not been reported for the Uruk period. This does not necessarily mean that bitumen-repaired Uruk pottery was never found. Ancient repairs have long been neglected in archaeological research, both from a descriptive and a theoretical perspective, but their systematic investigation is gradually gaining ground today (Chapman and Gaydarska 2007; Dooijes and Nieuwenhuyse 2007; Duistermaat 2008; Nieuwenhuyse 2007). In most archaeological reports, unfortunately, ancient repairs on the excavated artefacts are ignored entirely, or they are mentioned only casually. Thus, for the Late Uruk period, we cannot state with certainty if pottery vessels at Jebel Aruda were repaired more often or less than was common elsewhere, or if similar techniques

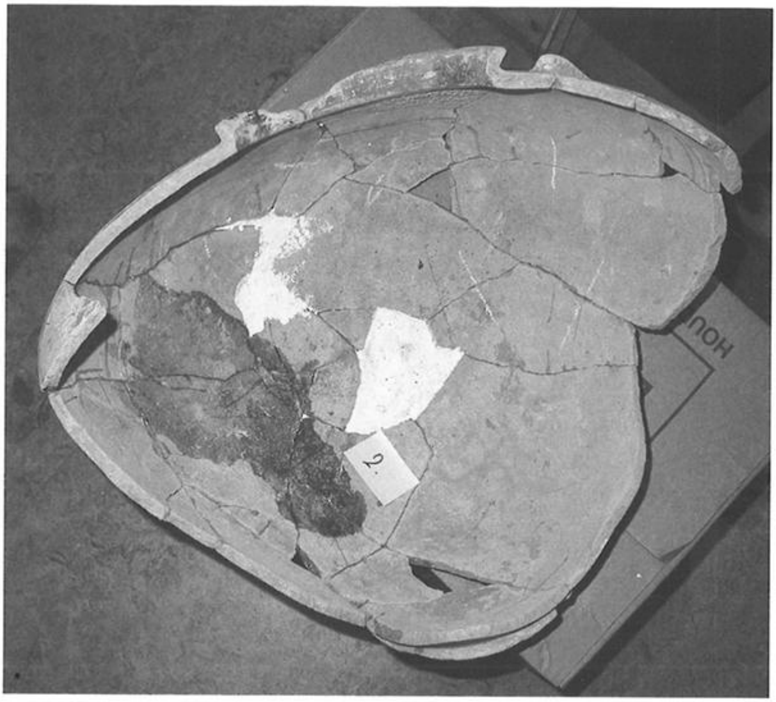

Figure. 12. The interior of JA 1801 showing bitumen seeping through the breaks.

for pottery restoration existed throughout the Uruk world. Presently we have detected no other types of pottery repairs, such as perforations combined with metal clamps, in the Jebel Aruda collection. It is possible, therefore, that bitumen repairs represented the only way of mending broken vessels at Late Uruk Jebel Aruda.

Apparently, the uniquely isolated location of the settlement, clustered on a high spur overlooking the valley, may have made it valuable to occasionally restore a large, heavy storage vessel rather than replacing it with something new. Pottery was not produced locally at Jebel Aruda: each vessel had to be uplifted onto the mountain from the contemporaneous settlement of Habuba Kabira, located far below on the Euphrates river bank. Given the visible character of the coarse repairs, it may be argued that aesthetic considerations were of minor concern, and that the repairs were purely functional. A preliminary inspection of the spatial context of the various bitumens and bitumen-treated ceramic vessels suggests an even distribution across the excavated settlement. Most likely the occasional pottery repair was done within the individual household compounds whenever need arose, by melting the bituminous material and pouring or brushing it in place.

Future prospects

Presently further restoration work on the Late Uruk vessels from Jebel Aruda is planned. Partly this will take shape within the framework of a series of internships by students of the Netherlands Institute of Cultural Heritage (ICN) in Amsterdam. Most of the field documentation of the ceramics is still stored in the Netherlands Institute for the Near East (NINO), but will be relocated to the National Museum of Antiquities in the near future. The collection will be made as accessible as possible to specialists wishing to work on the material. Further work is also planned to explore the use of bitumens at Jebel Aruda, and establish the chemical composition and provenance of the material.[5]

Acknowledgements

The authors wish to thank our colleagues from the Nethelands Institute of Cultural Heritage (ICN) in Amsterdam, and the National Museum of Antiquities Leiden (RMO). The chemical analysis of the Jebel Aruda bitumens is in the careful hands of dr. Jaques Connan, University of Strassbourg and shall be reported elsewhere. Finally, we thank the editors of the LJPS for their comments and useful suggestions.

Notes

1. The material now in the National Museum of Antiquities in Leiden consists of several complete (restored) pots, larger fragments, huge quantities of sherds, as well as various samples of bitumen and wood and other finds such as flint, bone, metal and sealings.

2. See www.icom.org.

3. A 1 Molair solution (36% EDTA or 25% triammoniumcitrate) was added to the Laponite gel, using 25 ml solution per 100 grams of Laponite. This results in a ¼ Molair solution of the chemical in Laponite (which equals a solution of 8,5% EDTA tetranatrium en 6% triammoniumcitrate).

4. These are vessels JA 1642, JA 1801, and JA 1296.

5. This study is carried out in a joint effort with dr. Jaques Connan, The University of Strassbourg.

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CERAMIC TECHNOLOGY OF SELECTED HELLENISTIC AND IRON AGE POTTERY BASED ON RE-FIRING EXPERIMENTS

Gloria A. London, Robert D. Shuster, and Loe Jacobs

Abstract

Re-firing Hellenistic and Iron Age II sherds, from the original excavation at Hisban in Jordan, allows us to assess choices and changes ancient potters made in their craft. We examine surface colors, presence/absence of cores, impact of firing on surface treatment, and choice of tempering materials in relationship to kiln temperature. To assess limestone or calcite inclusions and burnish treatment, we focus on the so-called Iron Age "Ammonite Ware" excavated at Hisban and Tell al-'Umayri in Jordan.

Introduction

Over thirty years ago, pottery from Hisban in Jordan (Figure 1) was published in a preliminary report (Lugenbeal and Sauer 1972) immediately following the excavation sponsored by Andrews University (Borass and Horn 1969, 1973, and 1975). Subsequently, Sauer (1982, 1986, and 1994) described various aspect of the collection, especially chronological issues and Islamic era pottery, before his untimely death. More recently, Larry Herr and Gloria London have undertaken publication of the final Hisban pottery report and work with material Sauer originally collected and sorted. In 1995, Sauer was in consultation with G.A. London and both A. van As and L. Jacobs of the Leiden Department of Pottery Technology to investigate certain technological aspects of the ceramics. One of the questions Sauer raised in his 1994 publication, and was curious to learn about, concerns the color of "distinctively bluish cores" of certain locally made Hellenistic wares (Sauer 1994: 249). In Leiden a plan was devised to re-fire Hellenistic sherds to answer questions concerning the nature of the firing color.

When the study began in 1999, another category of pottery excavated at Hisban was also included in the re-firing assessment. Several hundred years earlier in date, are the Iron II Age black burnished bowls, known as "Ammonite Ware", a name that originates from the abundance of bowls in the Madaba Plains region, an area traditionally associated with the ancient Ammonites. Most samples mentioned here have a number that is part of the larger suite of samples examined by geologist R. Shuster of the University of Nebraska, Omaha. Together with his former students Jason Blair and Sheryl Kelly, the petrographic Hisban (PH) study of 230 samples will be published as part of the final Hisban pottery report. G.A. London selected the 230 sherds, dating to the Iron Age – Islamic Era, from the collection stored with L.G. Herr at Canadian University College,

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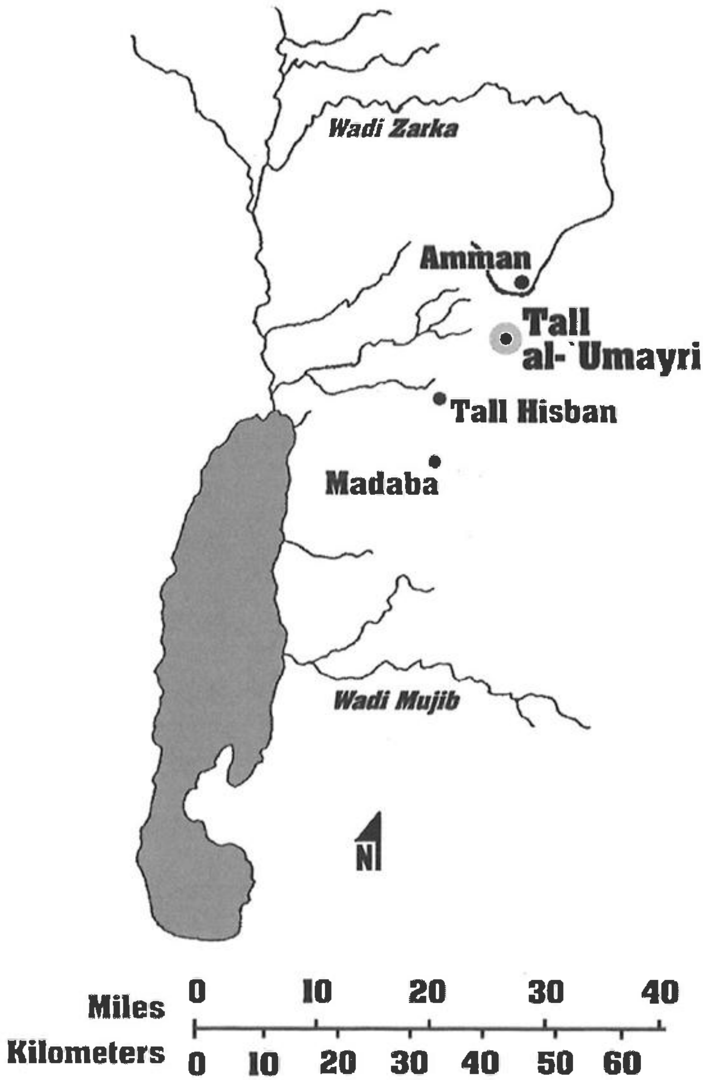

Figure 1. Location of Hisban and Tell al-'Umayri in the Madaba Plains, Jordan.

Lacombe, Alberta, which are on loan from Andrews University. Paul Ray submitted approximately 20 additional samples of bowls and cooking pots, stored at Andrews University, from the original Hisban excavation. For comparative purposes, burnished bowls excavated at Tall al-'Umayri are incorporated into the study. We also discuss the broader implications of the firing strategies adopted by the ancient potters. The firing technology and the clay bodies had significant impact on the final appearance of

Hellenistic and Iron Age pottery we discuss. Our report starts with the Hellenistic Ware since it was the catalyst for the re-firing study Sauer envisioned. We then turn to the Iron Age burnished bowls before assessing the choices ancient potters made and changes in their craft through the 2000-year time span covered by Hisban ceramics.

Hellenistic ware

In Leiden the work was initiated by re-firing two gray/blue sherds (Figure 2), at a temperature of 850 degrees C in an oxidizing atmosphere for 30 minutes. Other sherds, such as jar PH 161, display the same gray/blue firing color, which is apparent either on the surface or in a layer within the core running parallel to the surface. As a result of re-firing, the sherds became red throughout and no longer with a differentiated darker core. It was determined that the original gray color was the outcome of a kiln firing that was insufficient to burn out and eliminate the organic matter in the clay. Had the ware been fired longer or to a higher temperature, the carbonaceous material would have been burned away, thereby creating a red fabric.

In Leiden the presence of limestone inclusions in the clay was determined by using the HCl test. Petrographic analysis of 230 thin sections, of sherds of all periods represented at Hisban, determined that carbonates are often found in Hellenistic and other pottery excavated at Hisban. A common challenge in working with a clay body containing limestone, or other carbonates such as calcite, is the tendency for expansion and/or decomposition if kiln temperatures become too high.

Certain non-plastics, especially the carbonates such as limestone and calcite, can decompose at a relatively low temperature, possibly at 650-750 degrees C depending on the type of clay and non-plastics (Rice 1987: 97-98). Matson (1971: 77) found that temperatures as low as 600-700 degrees C maintained for 30 minutes could cause carbonates to decompose in some instances. When fired over 870 degrees C, calcium carbonates are known to completely decompose and become hygroscopic with the capacity to absorb water from the air. The water causes limestone and calcite non-plastics to expand and ultimately exert considerable pressure on the clay causing 'lime popping' or spalling (Rhodes 1973: 65). However, limestone inclusions in the gray

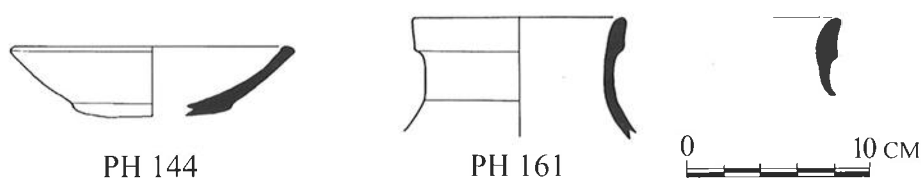

Figure 2. Hellenistic Era sherds, excavated at Hisban.: PH 144 was re-fired. PH 161 was not re-fired but is a jar that originally fired with the bluish/gray core under investigation.

Hellenistic sherds display no damage associated with a high firing temperature. The clay fired quite hard and without any indication of disintegration.

There are at least two explanations why carbonaceous material in the gray firing Hellenistic sherds remained in tact. At high temperatures, over 1000 degrees C, calcium can form new compounds rather than causing decomposition, although this does not explain our Hellenistic ceramics. Another way to alleviate decomposition of carbonates is to fire the pottery in a reducing atmosphere, especially if the limestone is ground sufficiently fine (Rice 1987: 98). Measurements of inclusions, collected as part of the thin section analysis, demonstrate that for the post-Iron Age Hisban material, limestone fragments rarely measure over 1.5mm. In contrast, limestone in Iron Age pottery measures anywhere from 0.5-3.0mm and can be as large as four and five mm, especially in jars.

Hellenistic period jars from Hisban contain 5-60% limestone inclusions. When not the chief inclusion, limestone normally is one component of a blend of minerals, as in jar PH 161. Since limestone is common in the clay, potters perhaps regularly chose to avoid firing the pots long enough to burn out the organic matter. The result is a reducing atmosphere producing a gray/blue color. The core and color of the Hisban Hellenistic sherds might reflect a reluctance of the potters to fire a fabric containing limestone to an overly high temperature that could cause the lime to disintegrate. While a fully oxidizing atmosphere and a higher temperature would have eliminated the core and dark color, the potential for damage to the limestone inclusions posed a risk the potters intentionally avoided.

The original firing temperature of the Hellenistic ware likely ranged between 850 and 950 degrees C. The ware is extremely hard, possibly due to high potassium content. A combination of circumstances would induce the potters to fire the ware in a manner that produced the dark color without potential subsequent damage to the limestone. The precise mix of the clay, potassium content, size and type of non-plastics resulted in the need to limit firing temperature and duration. For the overall solid, hard, and compact fabric, Jacobs proposes the descriptive term: Hellenistic "hard ware."

Iron Age burnished bowls

For the Hellenistic pottery, the re-firing analysis focused on the color of the interior wall. Color and the presence/absence of sheen were the features that intrigued us about the first millennium B.C.E. Iron II burnished bowls (Figure 3). Despite their designation as "black burnished bowls", some are neither black nor burnished. The signature burnish sheen of the red and/or black firing bowls, known in the literature as "Ammonite ware", is entirely absent at times. Ten randomly selected, red and black, Hisban samples were re-fired to 800 degrees C under oxidizing conditions. The ten samples were not part of the petrographic study. The result invariably is a red firing color throughout with no discolored core. Re-firing caused the once black firing sherds to become red on the inner and exterior surfaces as well as throughout the vessel wall. The discolored gray/brown core vanished, but not without repercussions. At 800 degrees C the sheen on some bowls

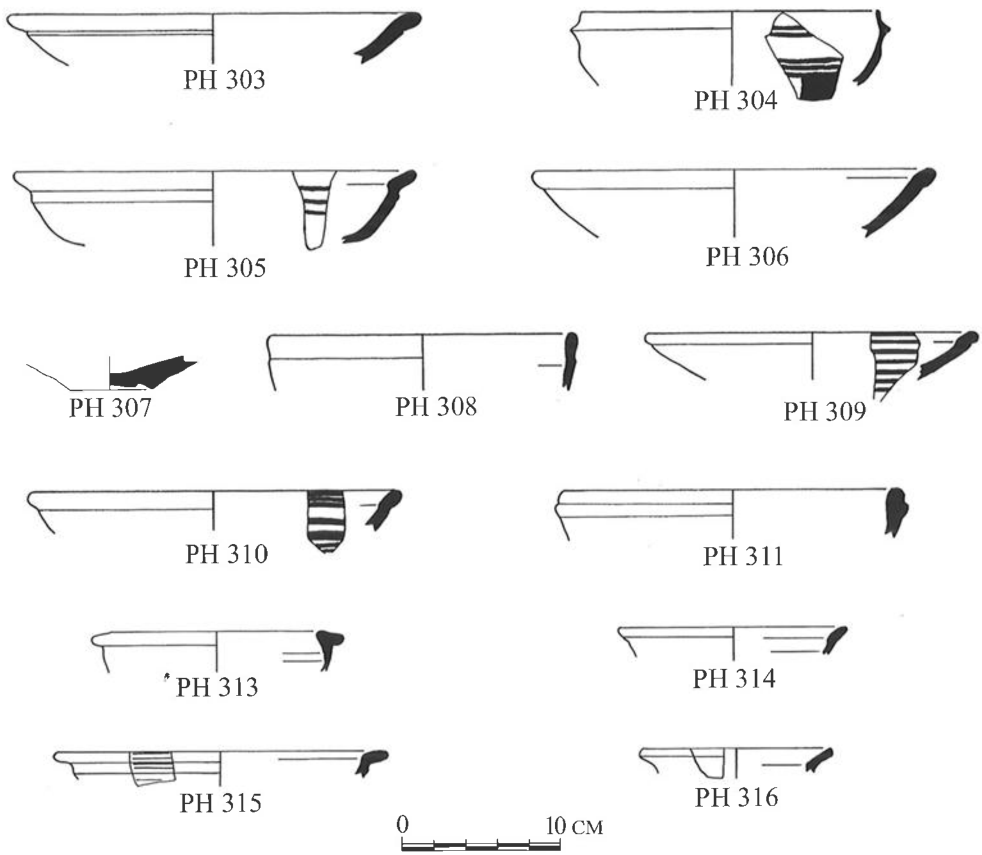

Figure 3. Selection of burnished bowls from Hisban and Tall al-'Umayri of the types submitted for re-firing.

became less dazzling. We assume that the ideal burnished bowls display a shiny, black surface and that red bowls, with or without sheen, were less desirable.

The impact of firing can be more detrimental to burnished and painted surfaces in contrast to incised or raised designs. Painted motifs might be barely visible if the pot surface does not fire to a contrasting color that provides an appropriate background to accentuate the painted decoration. Also troublesome is the burnished surface that can lose its sheen when over-fired due to firing shrinkage (Shepard 1976: 25; 190). To burnish the surface of a clay body before it is completely dry, any hard object rubbed or pressed on a surface area causes alignment of the surface particles in a manner such that they reflect light and sheen results. The fine clay slip particles become aligned more readily in contrast to non-slipped surfaces (ibid. 192). Potters or their helpers will intentionally burnish a surface, especially after applying a slip layer.

After drying, the bowl is fired to reveal one of several surface finishes. Intentional or unintentional sheen will remain only if the vessel is not over-fired which for many Levantine clays means above a relatively low temperature (ca. 750 degrees C). To maintain the sheen requires care during the firing stage and, at times, avoiding a fully oxidizing atmosphere. Although such a strategy pre-serves the sheen, one consequence is a darkened core. Rather than indicative of a 'poorly fired' pot, a dark gray core indicates control over the raw materials. By conserving fuel and firing for a shorter length of time, the sheen survives while a minor disadvantage was a discolored core. There is a direct link between firing temperature, surface treatment and the presence/absence of a dark core in burnished wares.

In the Leiden Ceramic Laboratory an additional 150 sherds, largely body sherds not included in the petrographic analysis and not refired, were examined. Determined was that some bowls contain either calcite or limestone or both, normally in small quantities. This observation concurs with the petrographic analysis of 22 thin-sections of selected burnished bowls. Bowls with predominantly limestone, present two risk factors that challenge attempts to survive a temperature high enough to burn out the organics while maintaining the burnish sheen and black color. For one, decomposition of the limestone was a potential hazard. The second problem was damage to the burnished sheen, as a result of an overly high kiln temperature. To prevent both undesirable outcomes, there are two appropriate choices: 1) a lower firing temperature; and/or 2) the creation of a reducing atmosphere in the kiln.

Clay type in part limits the firing temperature and destructive damage it can trigger. Matson (1971: 77) found that temperatures as low as 600-700 degrees C maintained for 30 minutes could cause carbonates to decompose in some instances. Franken and Steiner (1990: 84) recorded that 700 degrees C was the temperature at which the organics burned off the surface. The surface begins to turn red as soon as the iron oxidizes, which starts as low as 300 degrees C. This is even before the clay loses its plastic properties. Yet to eliminate the darkened core in a 1.0 cm thick sample of clay required a temperature of 750 degrees C maintained for one hour. Even more heat would have been required to obtain an entirely red core.

For the Iron Age bowls, potters and their clientele tolerated a red and/or black firing burnished ware, with or without a darkened core. Potters could fire all the wares black in a reducing atmosphere, but then create an oxidizing environment to convert the color to red if they could eliminate carbonate decomposition. With persistent care the limestone might not decompose and the sheen could remain undiminished. An alternative was to either remove or reduce the size of the limestone/calcite in the clay. When the carbonates are pulverized to under 0.5 mm, there is less likelihood for decomposition given that smaller grains are less prone to break down below 800 degrees C than larger fragments. Limestone fragments under 0.5 mm were more typical of post-Iron Age pottery than earlier periods.

Examined as part of the larger Hisban petrographic and INAA study, are the 22 burnished Iron Age bowls, which were not subjected to the refiring. Petrographic analysis undertaken by Shuster and his students identifies the predominant inclusions as: 1) limestone: 2) grog; or 3) a blend of non-plastics, including some limestone. Calcite and limestone can be present in individual samples. Despite the normally unfavorable effects and problems encountered in firing carbonates of any type, burnished bowls often, but not always, were made from clays containing the unruly, capricious limestone.

Other potters or workshops did, however, veer away from clay containing carbonates. For example, grog-rich fabrics at Hisban characterize a small number of burnished bowls and a cooking pot examined in thin-sections. More often than not, the grog-rich wares spanning 2000 years, from the Iron Age throughout the Islamic Era, can be associated with a painted surface treatment rather than a burnished finish. Grog is ideal for painted pots since the grog, unlike rock inclusions, can absorb the paint. Another advantage of grog is the ability to withstand high firing temperatures to achieve a red color throughout the pot wall, without a risk of decomposition or popping. Grog wares are more laborious to prepare than others given the need to grind the sherds. Instead of switching entirely to grog or other non-calcareous inclusions in order to avoid limestone decomposition, popping or loss of burnish sheen, the Iron Age potters chose to deal with the situation by resorting to a reducing kiln atmosphere.

Based on the Hisban thin-section analysis of sherds dating from the Iron through the Islamic Ages, we observe a change through time as local potters choose to avoid limestone or calcite in clay. Quartz became the dominant inclusion. Iron II Age potters were on the cusp of dramatic changes in the ceramics industry that would persist throughout the Classical Eras and beyond. Prior to the shift away from carbonates, at times, the gray/black firing burnished Iron Age bowls display a superior burnish than the red fired bowls. The difference in the sheen might result from both the reducing atmosphere and lower firing temperature for the gray/black sherds. The reducing kiln conditions and low kiln heat would preserve the burnish shine and simultaneously prevent the limestone from reaching a stage at which it would decompose. Jacobs stresses that the clay body was intentionally designed to create a shiny black surface, which could retain the sheen and avert subsequent lime popping. He observes that the 'rough' uneven, irregular cover of the pattern burnish implies that it was achieved while the bowls were rotating. A low gloss, that does not completely cover the surface, appears more as concentric circles frequently on the 150 sherds he examined.

The resulting black-burnished bowls are strikingly handsome. Black-burnished ware from east of the Jordan River might have been traded outside the region, as exemplified by the bowl excavated at Tell Batash (Kelm and Mazar 1985: 110). Initial testing at the Hebrew University determined that the Batash example did not match a burnished bowl excavated at 'Umayri (personal communication L.G. Herr 2000). The reason the Batash sample did not chemically match for the 'Umayri sample becomes apparent following INAA of a larger sample of burnished bowls from Tall al -'Umayri and Hisban carried out by Neff and Glascock at the MURR laboratory at the University of Missouri, Columbia. In the larger INAA, it becomes apparent that there are minimally three chemically distinct sources of the burnished bowls. Petrographic analysis identifies even more than three clay bodies, some of which are grog-rich while others contain the normal blend of carbonaceous inclusions. The full report of the INAA, completed in 2000, is part of the final Hisban pottery publication.

With the above data related to specifics of selected Hellenistic and Iron Age wares, we now examine implications of the refiring study to assess how the firing strategy concerns the overall ceramic technology. More than knowing the original firing temperatures, re-firing the sherds aids in understanding why the sherds appear as they do: with or without a core, burnish, paint, or slip.

Discussion: implications of sherd re-firing for understanding ancient ceramic technology

Our interest in firing and re-firing sherds from Hisban concerns: surface colors, presence/absence of cores, impact of firing on surface treatment, and relationship of kiln temperature to the choice of tempering material. Darkened core areas, sandwiched by thin margins of terra cotta colors, typify Hisban sherds of the pre-Classical archaeological periods, including the burnished Iron Age bowls. The blue-gray Hellenistic sherds are an outstanding exception. For all other ceramics, the characteristic pattern of a darkened core can result from the partial oxidation typical of highly carbonaceous clays wherever they are in use (Shepard 1976: 193). As organic materials (straw, dung, seeds, etc.) in the clay body burn early in the heating process, they create an initial dark color. As the firing continues, the interior and exterior pot surfaces become lighter, but the gray, brown or black central core zones remain due to the failure to fully oxidize the kiln atmosphere long enough for the oxygen to escape from deep within the vessel wall. Had the potters fired their wares longer, reached higher temperatures, and used more fuel, the surfaces and cores would fire a uniform color.

Other considerations determining the appearance of the darkened core are the amount and type of organic material, vessel wall porosity, and the bonding specific to the surfaces of the clay particles. A fully oxidized, monochrome color of the sherd wall is too often designated as evidence of a 'well-fired pot'. In fact, fully oxidized red-firing pots lacking a darkened core could represent 'mistakes', especially if the most important feature is the sheen. A fully oxidizing kiln atmosphere might cause the organics to burn away, but at the expense of the burnish sheen. The 'well-fired' and completely oxidized pot was not always the most desirable nor the most critical aspect for the potters or their clientele. No one normally took note of the core or even saw it until a pot broke. Ancient potters may have preferred partial oxidation of the wares rather than the fully fired pot. They were undaunted by the darkened cores. Factors far more vital than the normally concealed interior ware color are the: overall exterior appearance; and the efficient use of fuel.

Two categories of pottery that experience problems in a fully oxidized kiln atmosphere are burnished wares described above and cooking pots tempered with carbonates, such as calcite or limestone. Both vessel categories were sampled in relatively large number in the Hisban sample.

Decomposition of carbonates is preventable by: (1) a reduction of non-plastics size; or (2) a reduction in kiln temperature. When ground to a powder, calcite and limestone can better withstand higher temperatures than the larger, angular grains that result from merely crushing the rocks (Rice 1987: 98). For clay bodies with carbonates, limiting the firing time and temperature conserves fuel, resulting in the incomplete oxidation of the wares. Kiln temperatures maintained below 700 degrees C can help to avoid decomposition of the carbonates, but produce a darkened surface and core zone. The presence of a discolored core, invisible while the pot is in use, is of little consequence to the pot owner. But if over-fired, disintegration of the limestone inclusions can occur within days or months of the firing (Rhodes 1973: 63), resulting in a marred surface. Certainly by the time archaeologists excavate limestone rich wares the unattractive spalling can be abundantly obvious. A reducing atmosphere resolves the decomposition problem as long as darkened surfaces and/or cores are acceptable. Another solution is the use of a different non-plastic that can survive the higher firing temperatures. Quartz, grog, or other tempering materials do not decompose with the normal heat of the kiln. The single disadvantage of grog is the need to grind it. Otherwise it is the preferred inclusion or tempering material of potters to this day. It comes pre-fired, pre-shrunk, and well prepared to adhere to wet clay.

The impact of firing can be more detrimental to burnished and painted surfaces in contrast to incised or raised designs. Painted motifs might be barely visible and masked if the pot surface does not fire to a contrasting color that provides an appropriate background to accentuate the painted decoration. Too much heat may cause painted patterns to drip and lose their form. Another troublesome surface finish involves burnished wares that lose their sheen when over-fired due to firing shrinkage (Shepard 1976: 25; 190). To burnish the surface of a clay body before it is completely dry, any hard object rubbed or pressed on surface area that is not completely dry will cause the surface particles to align themselves in such a manner that they reflect light and sheen results. Often potters or their helpers will intentionally burnish a surface, especially after applying a slip layer. The fine clay particles of the slip become aligned more readily in contrast to non-slipped surfaces (ibid. 192).

After drying and firing, the bowl will have a burnish sheen only if it is not 'over-fired' which for many Levantine clays means above a relatively low temperature. To maintain the sheen requires care during the firing stage and, at times, avoiding a fully oxidizing atmosphere. Although such a strategy preserves the sheen, one consequence is a darkened core. Rather than indicative of a 'poorly fired' pot, a dark gray core indicates control over the raw materials. By conserving fuel and firing for a shorter length of time, the sheen survives while a minor disadvantage was a discolored core. There are direct links among firing temperature, surface treatment, and presence/absence of a core in burnished wares.

Another advantage for potters adept in firing burnished wares at a well-controlled temperature, besides maximizing their fuel, they could fire cooking pots in the same kiln. Their goal was to prevent the temperature from exceeding the point at which carbonates, such as limestone and calcite, decompose. A lower fire temperature averts both carbonate disintegration and the firing shrinkage responsible for sheen loss. Consequently, the incentives for Iron Age potters to limit firing temperature and time include: (1) preserving the burnish sheen; (2) avoiding carbonate breakdown; (3) firing cooking pots along with the regular repertoire of forms; and (4) conserving fuel.

Alternatively, pulverizing the calcite, or switching to a different type of rock, mineral or grog for use as tempering, avoids the problems related to high kiln temperatures. Towards the close of the Iron Age, major developments in the ceramics industry include: less reliance on carbonate inclusions and adoption of quartz; wheel throwing; and higher kiln firing temperatures. All advances imply that the impetus was to mass produce pottery in a manner previously unknown. With the post-Iron Age shift to quartz temper, burnish treatment disappears along with the carbonate inclusions. Neither could endure high kiln temperatures or the demand for cheap pottery, quickly made and easily replaced.

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IN SEARCH OF THE CERAMIC TRADITIONS OF LATE IRON AGE IIC POTTERY EXCAVATED AT TELL DEIR 'ALLA IN THE CENTRAL JORDAN VALLEY

Niels C. F. Groot

Abstract

Presented here are the results of a study of the Late Iron Age IIC (± 650-539 B.C.) pottery from Tell Deir 'Alla (phases VI and V/VI) in the Central Jordan Valley, executed in the scope of a current research project by the Centre of Art and Archaeological Studies (Delft University of Technology and Leiden University) focussed on the question of continuity and change of pottery traditions. The study is concentrated on the analysis of pottery shapes, manufacturing technique and fabric. The shape of the majority of the vessels is typical for Central Transjordan. Low-tech fabric analysis shows that these vessels were partly made of local clay, partly of non-local clay. The pottery, of which the shape is comparable with Palestinian vessels, is made of non-local clay. The provenance of the non-local clays and the archaeological implications will be investigated in a later stage of the research.

Introduction

This article deals with the pottery from Tell Deir 'Alla phases VI and V/VI, i.e., the Late Iron Age IIC, dated to the late seventh and sixth century B.C. (Figure 1). In the beginning of this period, the Central Jordan Valley, where Tell Deir 'Alla is situated, was part of the Neo-Assyrian vassal kingdom of Ammon.[1] Around 580 B.C. Ammon was incorporated in the Neo-Babylonian empire till 539 B.C., when the Persian king Cyrus II took over this empire. Therefore, Tell Deir 'Alla VI (Neo-Assyrian) and V/VI (mainly Neo-Babylonian) offer an insight into a political turbulent period. The study of continuity and change of ceramic traditions at Tell Deir 'Alla VI and V/VI can illustrate the vicissitudes of life during this period.

In the Late Iron Age II and III (± 1000-350 B.C.), Tell Deir 'Alla was characterised by an alternating sequence of village or hamlet occupation and abandonment (see van der Kooij and Ibrahim 1989; van der Kooij 2001). Phases VI and V/VI on the eastern summit of the site illustrate this fluctuation.

Phase VI represents a village settlement. The subsequent phase probably represents a hamlet or farmhouse(s), but remains are predominantly a large amount of courtyard accumulation and pits. Phase VI can be dated to the seventh century B.C. while phase V/VI is wedged between the previous phase and the early Persian period village (Phase V) around 500 B.C (van der Kooij 2001: 296, 297, 301).

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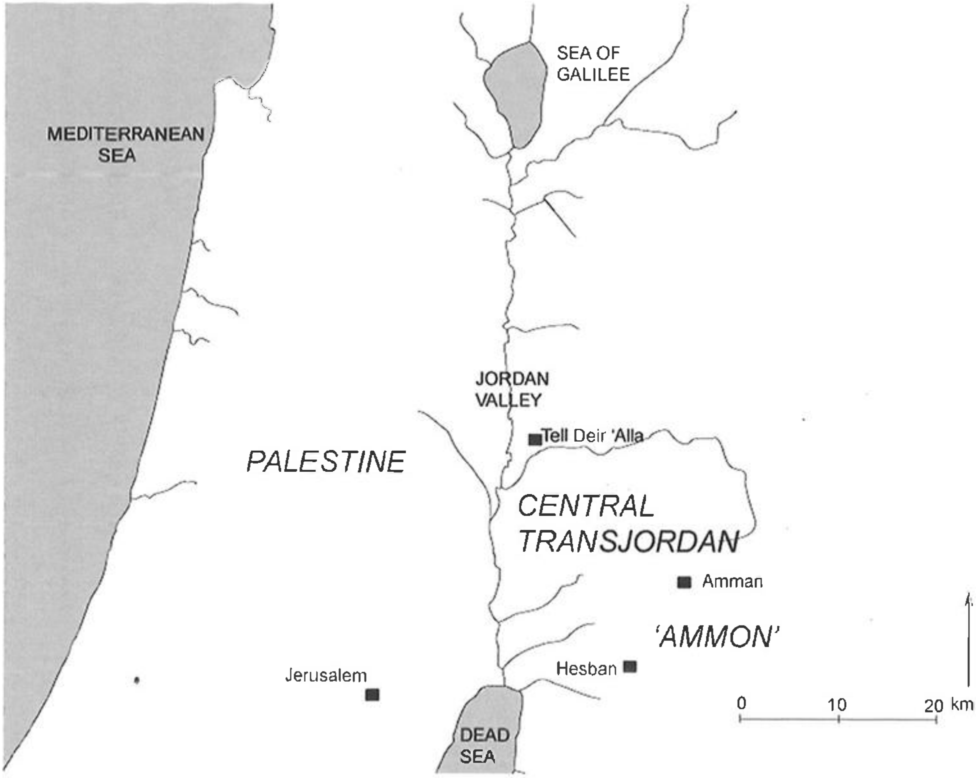


Figure 1. Map of the Central Southern Levant

This study forms a part of an ongoing PhD research on pottery from the Iron IIC-Persian period phases (734-332 B.C.) of Tell Deir 'Alla, executed on the initiative of the Centre of Art and Archaeological Studies (CAAS) (see Groot and Dik 2006). In order to get understanding of the question of continuity and change, it presents a summary of the various diagnostic pottery categories, data concerning the manufacturing technique and the results of a low-tech fabric analysis of the Tell Deir 'Alla VI and V/VI pottery.

Material and methods

The entire representative sample that was studied included 1319 sherds selected from the various diagnostic categories (Table 1)[2]:

The description of the forming techniques is based on the observation and interpretation of marks left behind by the potter. For the fabric analysis a representative sample of 253 (phase VI: 195 / phase V/VI: 58) sherds was taken. After re-firing these sherds

	VI	V/VI	Total
Rims: Open bowls	262 (28,63%)	111 (27,48%)	373
Rims: Closed bowls	160 (17,49%)	64 (15,84%)	224
Rims: Jars/jugs	170 (18,58%)	64 (15,84%)	234
Rims: Cooking pots	91 (9,95%)	33 (8,17%)	124
Rims: Lamps	20 (2,19%)	17 (4,21%)	37
Rims: Black-burnished ware	35 (3,83%)	4 (0,99%)	39
Bases	177 (19,34%)	111 (27,48%)	288
Total:	915 (100%)	404 (100%)	1319

Table 1. Overview of the selected sherds

at 725°C in an oxidizing atmosphere at the Leiden Ceramic Laboratory, the non-plastic inclusions in fresh and polished breaks were analysed using a binocular microscope (10-50x magnification).

A summary of the diagnostic pottery categories[3]

The pottery assemblage of Tell Deir 'Alla VI and VI/V includes the following diagnostic categories: open bowls (rim diameter = widest vessel diameter), closed bowls (rim diameter < widest vessel diameter), jars/jugs, cooking pots (characterized by a distinct red fabric and a coarse temper), lamps (a bowl-like shape with a distinct pinched spout), black-burnished ware (densely polished and fired in a completely reducing atmosphere), and bases. See also Table 1.

On the basis of comparisons with pottery shapes from other sites, the Deir 'Alla VI and VI/V repertoire can be assigned to four regional groups: (1) Local (shapes found in the Central Jordan Valley), (2) Central Transjordanian (shapes found in the Middle and Southern Jordan Valley east of the River Jordan and on the highland around Amman), (3) Palestinian (shapes found in Palestine west of the River Jordan) and (4) Southern Levantine (shapes found in the entire Southern Levant encompassing Central Transjordan and Palestine).

Open bowls

Phase VI. The repertoire of open bowls is predominantly a reflection of the assemblages found in the Central Transjordanian highlands around Amman, which was the core-region of the kingdom of Ammon (MacDonald 1999) (Figure 2: 1, 7-19, 22-24).

A shape that seems to be confined to the Deir 'Alla region is the so-called 'mansaf' bowl (Figure 2: 8). It is a large heavy bowl, that appeared in the Early Iron Age of Deir 'Alla Phase F (Franken 1969: 157-160) and continues into the Late Iron Age IIC, where it constitutes in phase VI almost 3% of the repertoire. It is indicative for a strong continuity of a regional tradition.

The only clear Palestinian shape is a bowl with a slight incurving wall (Figure 2: 20). This type of bowl, ring-burnished on the inside and rim, has been found at several sites in Southern and Middle Palestine, including Jerusalem, where these are designated as Class 4, small bowls (Franken and Steiner 1991: 103-104).

The more general Southern Levantine bowl types (Figure 2: 2-6, 21) are technologically less sophisticated and morphologically distinct from the finer and quite typical 'Ammonite' bowls (Herr 1989: 305, figs. 19.9.1-19).

Phase V/VI. Generally, continuation of phase VI apart from the Palestinian open bowl (Figure 3).

Closed bowls

Phase VI. Central Transjordanian shapes dominate (Figure 4: 1-4; 11). The most frequent type is the hole-mouth bowl (Figure 4: 1). This crater-type is a large deep bowl, with a shallow ring base, curving walls and thickened rim. This bowl is almost absent in Palestine (Lugenbeal and Sauer 1972: 50-51; Herr 1989: 304). The repertoire contains also several general Southern Levantine closed bowls (Figure 4: 5-10). Only the large heavy bowls with a thick rim are typically Palestinian (Figure 4: 11). Many Late Iron Age II examples have been found at Jerusalem (Franken and Steiner 1991: 116-119).

Phase V/VI. Largely a continuation of phase VI apart from the Palestinian closed bowl (Figure 5).

Jars and jugs

Phase VI. A very frequent Central Transjordanian shape within the repertoire has a fairly short, inward sloping neck with a small out splayed or pointed rim (Figure 6: 7). Also at Tell Hesban it is a dominant type (Lugenbeal and Sauer 1972: 54). Variants of this type have a grooved neck. The characteristic carrot-shaped bottle is represented by complete examples, rims and the pointed bases (Figure 6: 8, 9). This type of, mainly elongated, sometimes squatted, pointed bottles, likely an imitation of an Assyrian type (Amiran 1969: 296), have black lines painted around the body of the vessel.

The repertoire contains also Southern Levantine shapes, such as the decanter (Figure 6: 11) and two storage jar rim types (Figure 6: 1, 2)

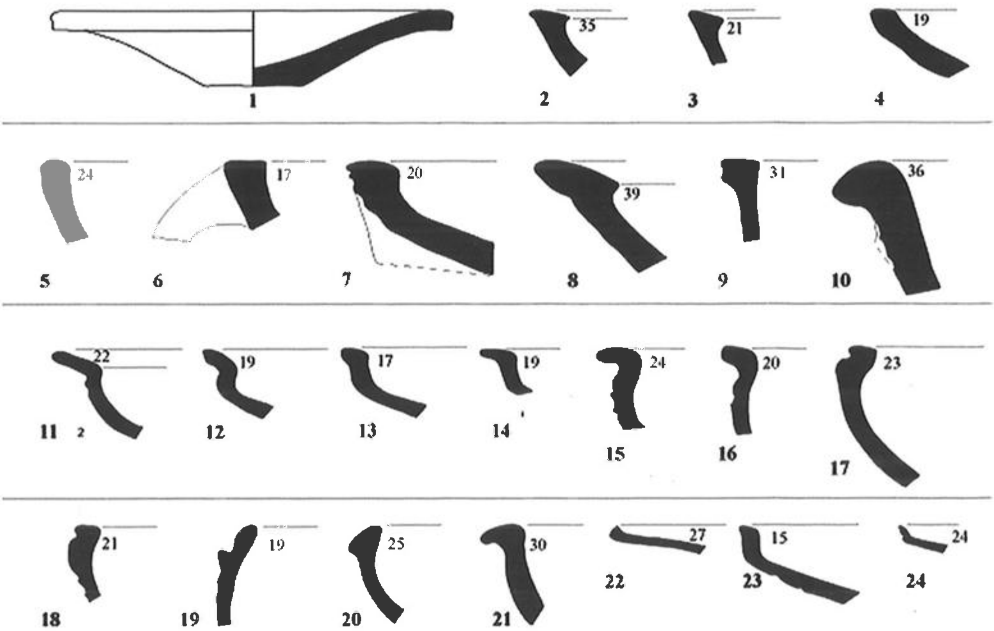


Fig. 2

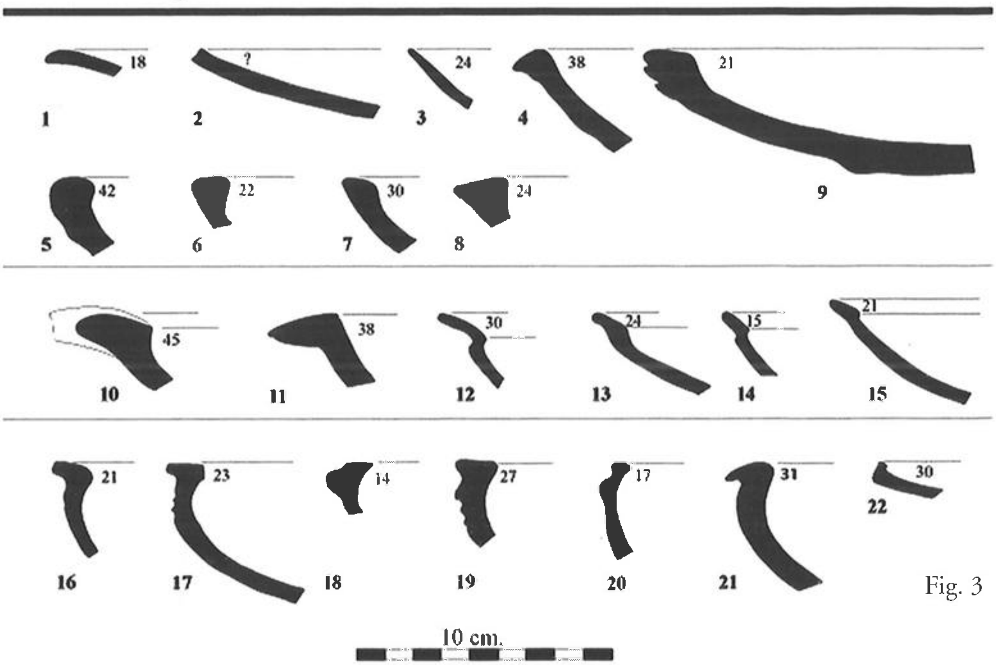


Fig. 3

Figures 2 and 3. Selection of open bowls from phase VI (Fig. 2) and V/VI (Fig. 3).

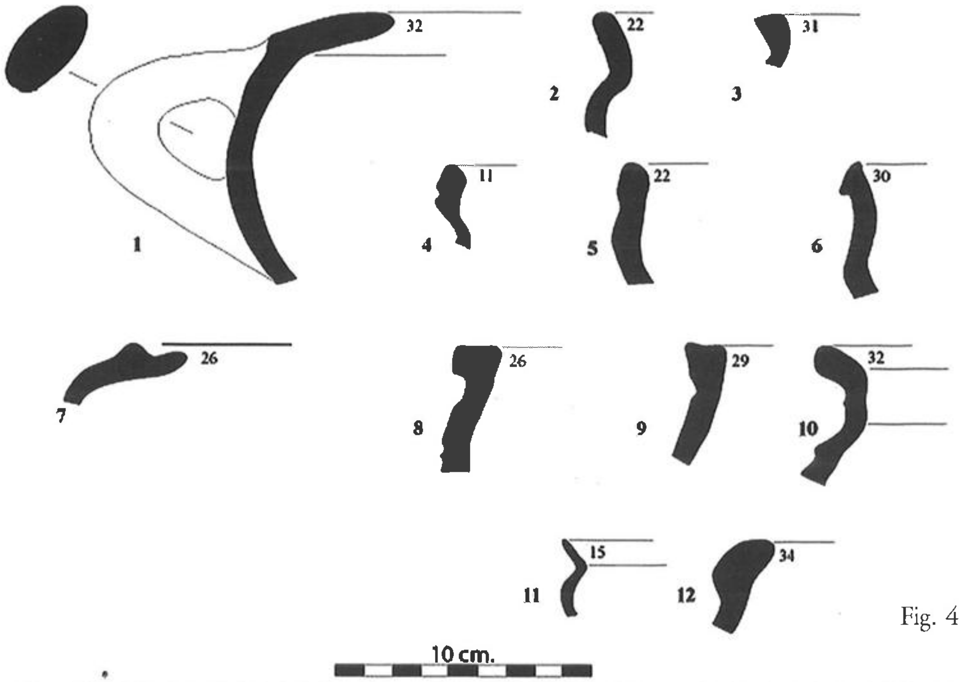


Fig. 4

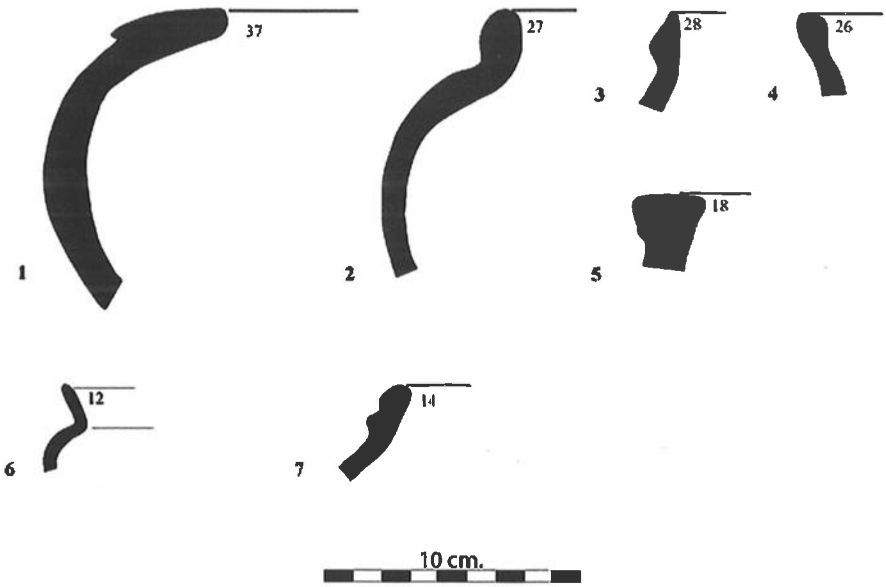


Fig. 5

Figures 4 and 5. Selection of closed bowls from phase VI (Fig. 4) and V/VI (Fig. 5).

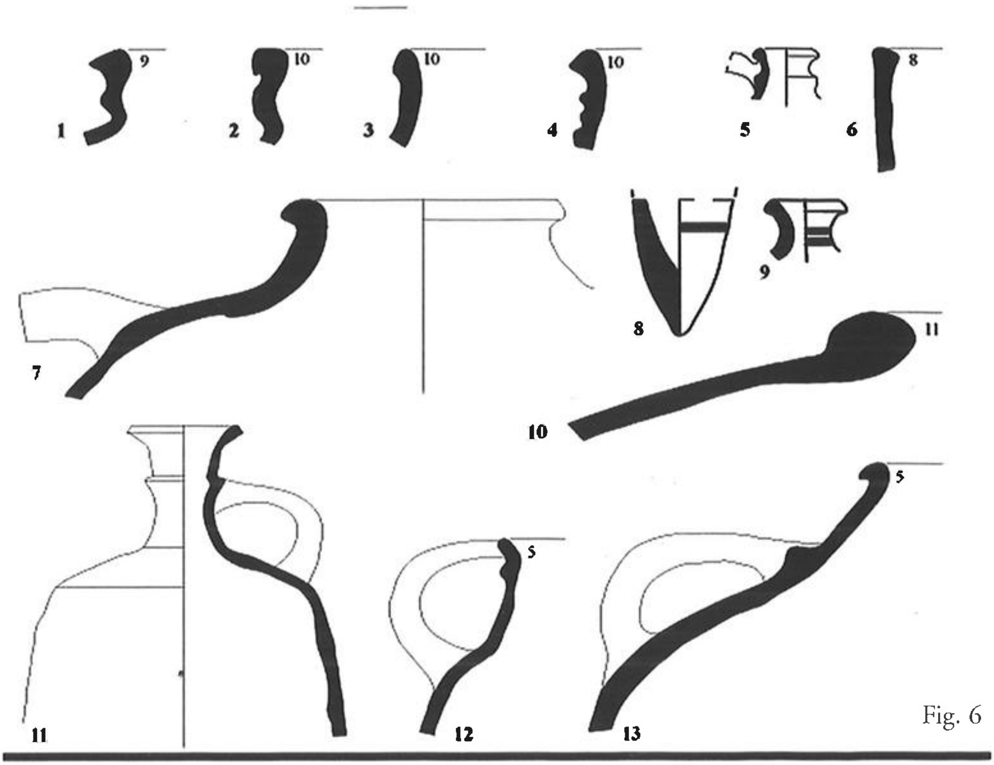


Fig. 6

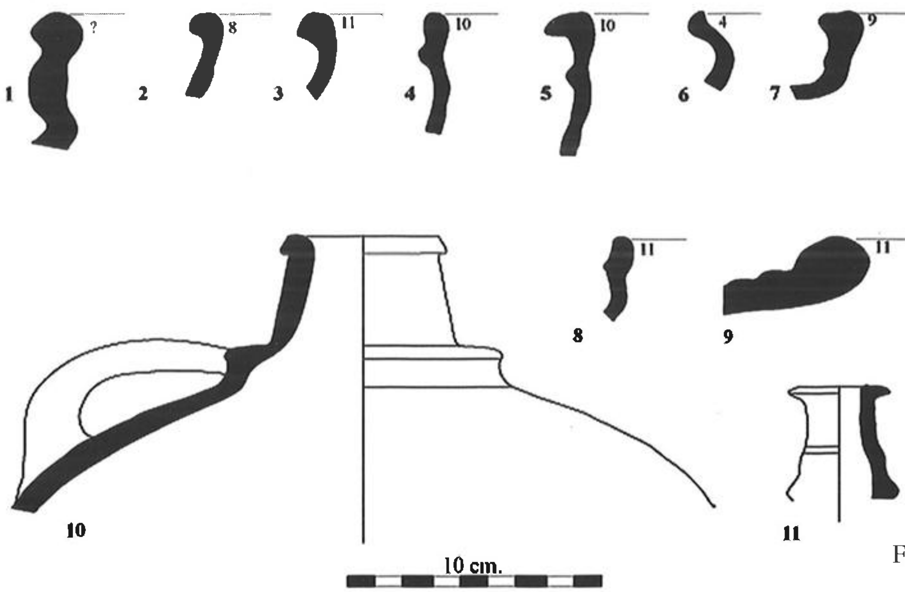


Fig. 7

Figures 6 and 7. Selection of jars and jugs from phase VI (Fig. 6) and V/VI (Fig. 7).

Phase V/VI. In general, a continuation of phase VI (Figure 7). In this phase one well burnished and slipped earthenware alabastron has been found (Figure 7: 11). It is a popular shape in the entire Southern Levant, which is also executed in glass and alabaster. This shape seems to be mainly used in Transjordan and Southern Palestine between the end of the seventh century and the fifth century B.C. They were common during the sixth century B.C. (Stern 1982).

Cooking pots

Phase VI. The repertoire includes two distinct Central Transjordanian shapes. The cooking pot type with a thickened, sometimes ridged, vertical rim is the dominant shape (Figure 8: 1, 2; 4). The second shape is a variant of the previous type. It possesses also a thickened rim, but has a characteristic groove underneath the rim (Figure 8: 3, 6, 7).
Phase V/VI. Both types of the preceding phase continue almost unchanged. Additionally, a marginal type in phase VI, a triangular slightly necked, cooking pot, became more prominent (Phase VI: Figure 8: 5; Phase V/VI: Figure 9: 6).

Lamps

Phase VI. At Tell Deir 'Alla almost exclusively, wheel-made Transjordanian lamps were used, typical for the region around Amman (Lugenbeal and Sauer 1972: 59-60; Dornemann 1983: 52) (Figure 11).
Phase V/VI. Continuation of phase VI (Figure 12).

Black burnished ware

Phase VI. The black burnished ware (mainly open bowls and a few closed bowls) is a characteristic type of pottery (Figure 10: 1-12), which is mainly encountered in Ammon (Herr 2006: 525).
Phase V/VI. Decrease of the black burnished vessels.

Bases

Phase VI. The characteristic base-type associated with ceramic traditions in Central Transjordan, is the double disc base (Herr 1989: 307). It is a frequent type within the Deir 'Alla repertoire. The ring base is dominant.
Phase V/VI. The distribution of base types is comparable with the previous phase, except for a slight increase in the double disk bases.

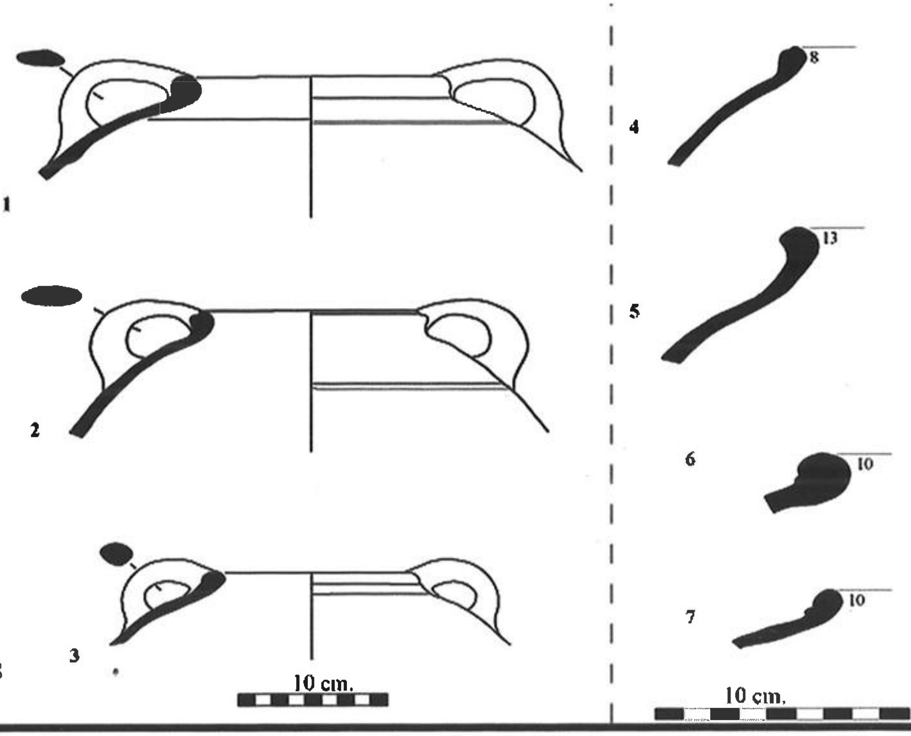


Fig. 8

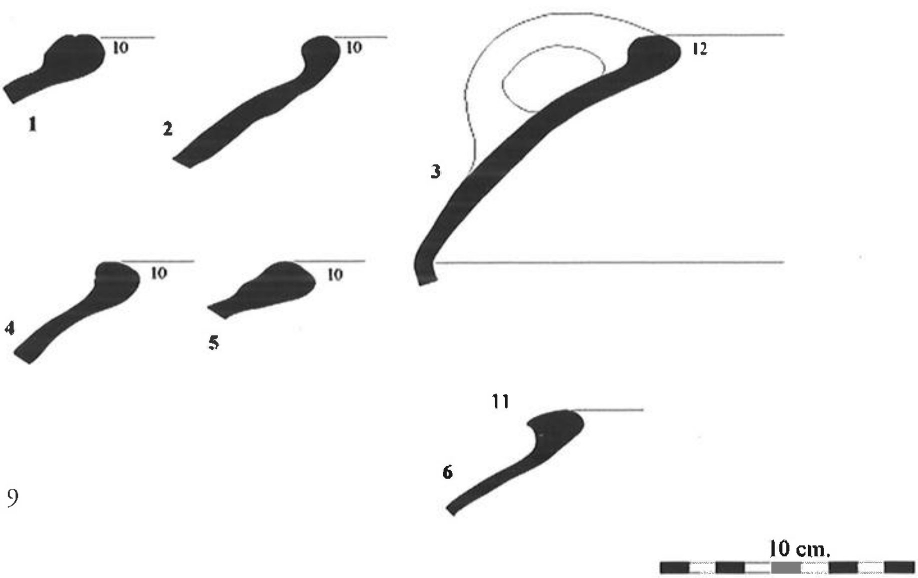


Fig. 9

Figures 8 and 9. Selection of cooking pots from phase VI (Fig. 8) and V/VI (Fig. 9).

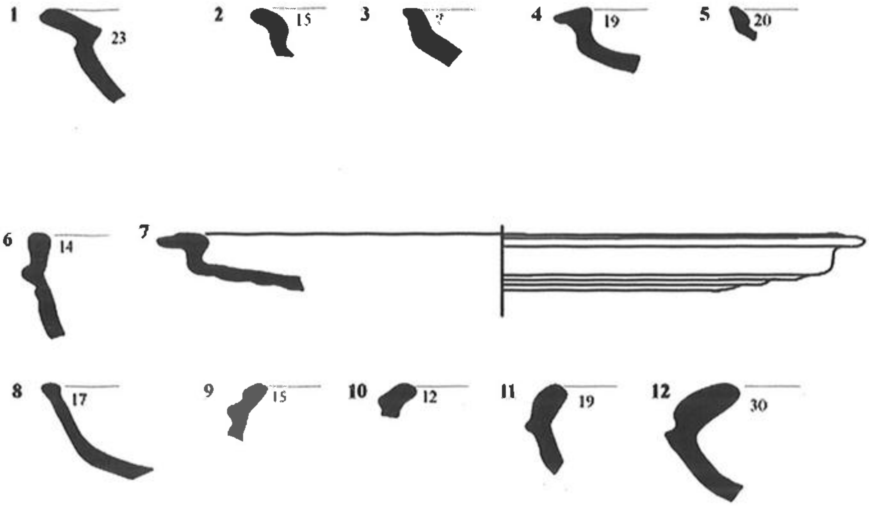


Figure 10. Selection of black burnished bowls from phase VI.

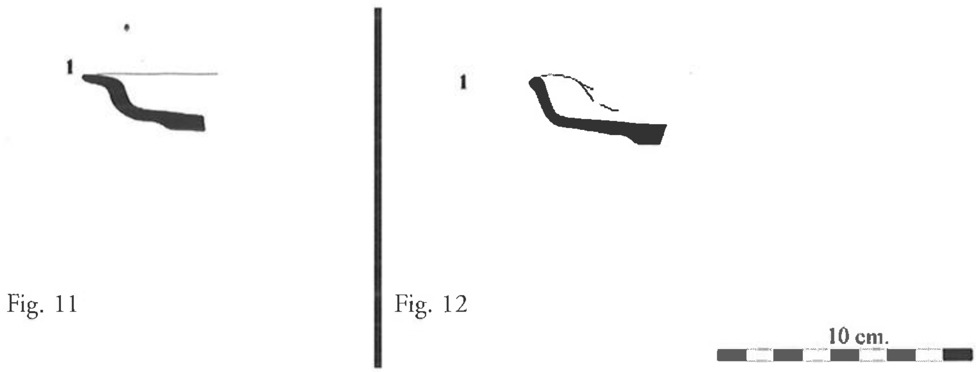


Figure 11 and 12. Selection of lamps from phase VI (Fig. 11) and V/VI (Fig. 12).

The manufacturing technique

Primary shaping technique

Mould-made. The 'mansaf'-bowl, (Figure 2: 8), was made by pressing a clay slab into a mould. The rim was then folded inside. The majority of the cooking pots were also made with the help of a mould (Figure 8: 1-3). Since the Late Bronze Age, the lower half of the main cooking pot-types was made by this method. The upper half was made by coiling (see Franken 1969: 118-120).

Coiling and slab building. Coil building on a slow rotating wheel was applied among others for the production of the large closed bowls (Figure 4: 7-10). The hole-mouth bowls (Figures 4: 1 and 5:1) were thrown closed in the coiling technique. The large pithoi from phase VI (Figure 6: 10) and V/VI (Figure 7: 9) were made, with the use of a slow wheel, in the slab building technique.
Wheel-made. Already reintroduced during phase VII (Ibrahim and van der Kooij 1997: 101), the use of a fast wheel became common. In the Deir 'Alla VI and V/VI repertoire several shapes have been made on the wheel, such as lamps, several of the finer open bowls (Figures 11; 12; 2:11-16, 22-24), the thin carinated bowl (Figures 4: 11; 5: 6), the carrot flask (Figure 6: 8,9), decanters (Figure 6:11) and the alabastron (Figure 7: 11).

Secondary shaping techniques

Slip and burnish. The following combinations of the use of a slip layer and burnishing (mainly ring burnish) were distinguished (based on Franken and Steiner 1991: 91).

1. Slip inside or outside	6. Slip inside and burnish inside and outside.
2. Slip inside and outside	7. Burnish inside and outside.
3. Slip and burnish inside and outside.	8. Burnish inside.
4. Slip and burnish inside.	9. Burnish outside.
5. Slip and burnish outside	

Table 2: Combinations of slip and burnish.

The application of burnish and/or slip remains constant in Deir 'Alla phases VI and V/VI. A relatively large number of open bowls (especially the fine ware) and closed bowls (especially the carinated bowls) were provided with a red slip (Figures 2: 22-24 and 3: 22). The jars and jugs seldom show a slip layer. Burnish is mainly observed on open bowls

Painting. Vessels are sometimes painted with typical 'Ammonite' motives of black and white bands (see Ibrahim and van der Kooij 1983: pls. XXV.2 and XXVI.2).

Firing

The vessels were predominantly fired in an oxidizing to neutral atmosphere. They were generally reasonably well fired. A method of firing at a high temperature in reducing circumstances to produce a hard, almost glassy ware like the contemporaneous Assyrian palace-ware was seldom practiced. Only, some non-slipped, pinkish/reddish variants of the carinated bowls possess a hardness which is similar to the Assyrian palace ware (Figures 4: 11; 5: 12).

The production of black burnished ware

Since the black burnished ware is a distinct ware, it is discussed separately. The black burnished ware, in some instances provided with a slip layer, is often dense or completely ring burnished. In general, the vessels were fired in entirely reducing circumstances. After re-firing a sample in oxidizing circumstances at 725°C, the sherds became reddish. This indicates that the reducing firing temperature did not reach a level above 900°C, when the iron oxide (Fe_2O_3) converts into the powerful flux FeO (Rice 1987: 94). This process of vitrification cannot be reversed again by re-firing.

Fabric

The fabric of a sample of 253 sherds has been analysed. A number of sherds could be assigned to a well-known local clay deposit. The fabric of the remaining sherds could not be ascribed to this local clay source. In a later stage of the research, the results of the low-tech fabric analysis of these sherds, together with the results of the still ongoing fabric analysis (thin-section and chemical analysis) at Delft University of Technology, will be compared with a reference collection of local clay samples.

Local fabric

The local fabric from earlier phases of Deir 'Alla is described by Franken (1992) and Vilders (1992). The fabric is characterized by the presence of clay particles, which can be called an early form of mudstone. These particles, generally of a reddish/ brownish colour, do not fall apart completely when soaking time has been too short or mixing insufficient (Franken 1992: 106-107). In ceramic thin-sections of sherds from Late Bronze Age Deir 'Alla and the Mameluk site of Abu Gourdan, adjacent to Tell Deir 'Alla, these particles contrast with hematite on basis of their translucence.[4] The clay source is the Damya formation, consisting of a sequence of differently coloured clay layers. It has been deposited in the last phases of the existence of Lake Lisan, Lake Damya, during 14-13.000 to 10.000 B.C. (Abed and Yaghan 1999: 23-26). The formation is easily accessible, due to the presence of several natural outcrops above the current valley floor. Tell Deir 'Alla is situated on one of the natural outcrops (van der Kooij and Ibrahim 1989: 76).

110 sampled sherds of Deir Alla VI and V/VI could be assigned to the local Damya formation consisting of three fabric types (Table 3). Type 1 is characterized by a high percentage of non-plastics. The most dominant non-plastic in this fabric is quartz sand, followed by mudstone. Lime is not frequently present. Furthermore, the fabric is marked by a high amount of fibres. Type 2 is characterized by the dominant presence of mudstone, followed by lime. Hematite and quartz sand are less frequent. Type 3 is characterized by the dominant presence of lime, followed by mudstone. Generally, the non-plastic elements are smaller, especially the size of the lime grains. It might be that the smaller size of the mudstone indicates a better levigation or a deliberate choice of

Damya clay. The finer wheel-thrown shapes (Figures 2: 11; 2: 12) and some black burnished vessels (Figure 10: 1, 4) could have required the use of a finer paste.

Local clay of the Damya formation (types 1-3) is used exclusively used for the production of the 'mansaf' bowl. The Central Transjordanian pottery shapes are partly made of local clay, partly of other clays.

Central Transjordanian fabric

The fabric analysis of 110 sherds taken from Central Transjordanian pottery shapes yielded among others the following distinct larger fabric groups: fine ware, sandy ware and a category that is typical for phase V/VI (Table 3: types 4-6).

The fine ware is characterized by a pinkish colour and the small size of the inclusions particles, mainly lime. The sandy ware is characterized by the presence of quartz particles in the silt fraction. New in phase V/VI is a fabric group characterized by a low amount of non-plastics and quartz sand as dominant particles (used amongst others for a new type of open bowl (Figure 3: 14).

Palestinian fabric

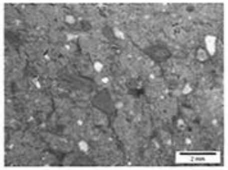
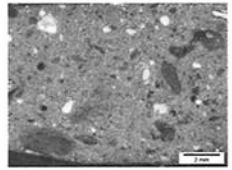
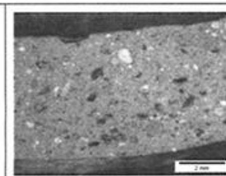
Fifteen sherds taken from two bowls with predominantly Palestinian parallels differ from the groups above. This category consists amongst others of two mainly red-firing predominantly lime-containing fabrics and one fabric that contains quartz sand (Table 3: types 7-9).

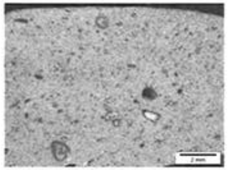
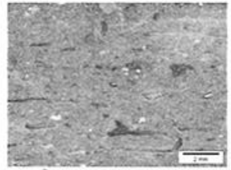
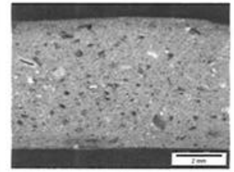
Cooking pot fabric

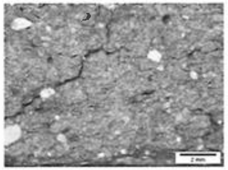
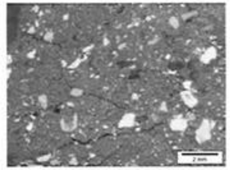
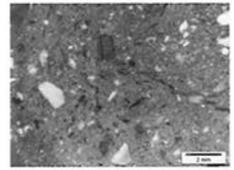
The fabric analysis of eighteen sherds taken from cooking pots yielded two fabric types: (1) a red firing fabric that contains mainly quartz and some lime (Table 3: type 7) and (2) a red firing fabric that contains a mixture of coarse mixed sand and lime (Table 3: types 8-9).

The first type goes together with the Central Transjordanian cooking pot with a thickened, sometimes ridged vertical rim (Figure 8: 1-2). The mainly quartz-containing cooking pot fabric follows upon the calcite-containing cooking pot fabric at Tell Deir 'Alla in phase VII. A similar development can be seen in Transjordan (London 1999: 91) and in seventh century B.C. Jerusalem (Franken and Steiner 1991: 82). Quartz is, like calcite, an ideal temper to withstand rapid changes in temperature of cooking pots during use. Potters, however, are not confronted with the problem of lime spalling.

The second fabric type is connected with the Transjordanian cooking pot with a thickened rim and a characteristic groove underneath the rim (Figure 8: 3, 6). This fabric type can be subdivided into two subtypes. Fabric type 2a is rather fine (Table 3: type 8). Fabric type 2b is rather coarse, with large particles and more organic temper (Table 3: type 9). The description of a cooking pot from Tell Hesban (Lugenbeal and Sauer 1972: type 3) might be indicative for a provenance of this type within the Central Transjordanian cultural sphere.

Local Fabric Type 1		Local Fabric Type 2		Local Fabric Type 3	
Samples	Σ = 49		Σ = 41		Σ = 11
Mineral Inclusions					
Dominant Particle(s)	**Mudstone** **Quarts Sand**		**Mudstone** **Lime**		Lime/Calcite Mudstone
Dominant Size	1.0-0.5 mm.		1.0-0.5 mm.		0.8-0.2 mm.
Roundness	**Mudstone:** Low Sphericity: Sub-Angular/ Sub-Rounded **Quarts Sand:** Low/High Sphericity: Angular/Sub-Angular/ Sub-rounded		**Mudstone:** Low Sphericity: Sub-Rounded/ Rounded **Lime/calcite:** Low Sphericity: Angular/Sub-Angular		**Lime/Calcite:** Low/High Sphericity: Angular/Sub-Angular **Mudstone:** Low Sphericity: Sub-Rounded/ Rounded
Less dominant particles	**Lime/Calcite** **Hematite**		**Hematite** **Quarts sand**		**Quarts sand** **Hematite**
Sporadically	**Sandstone**				Sandstone
Percentage	25-35 %		20-30 %		25-30 %
Sorting	Very poor		Poor		Poor-Fair
Fibres					
Percentage	1:2-1:4		1:5-1:6		1:3-1:5
Maximum length	1.5 mm.		1.0 mm.		0.8 mm.

Central Trans-Jordanian Fabric Type 4		Central Trans-Jordanian Fabric Type 5		Central Trans-Jordanian Fabric Type 6	
Samples	Σ = 7		Σ = 15		Σ = 6
Mineral Inclusions					
Dominant Particle(s)	**Lime/Calcite**		**Quarts Sand** **Lime/Calcite**		**Quarts Sand**
Dominant Size	0.5-0.2 mm.		0.5-0.2 mm.		0.5-0.2 mm.
Roundness	**Lime/Calcite:** High Sphericity: Angular/Sub-Angular/ Sub-rounded		**Quarts Sand:** Low Sphericity: Sub-Angular/ Sub-Rounded **Lime/Calcite:** Low/High Sphericity: Angular/Sub-Angular/ Sub-rounded		**Quarts Sand:** High Sphericity: Angular/ Sub-Angular/ Sub-rounded
Less	**Mudstone/Hematite**		**Mudstone/hematite**		**Lime** **Hematite**
Sporadically	–		–		Calcite
Percentage	8-12%		10-22%		10-6%
Sorting	Fair-Good		fair		fair
Fibres					
Percentage	1:8-1:10		1:3-1:8		1:2-1:7
Maximum length	0.3 mm.		3.0 mm.		0.5 mm.

Cooking pot Fabric Type 7		Cooking pot Fabric Type 8		Cooking pot Fabric Type 9	
Samples	Σ = 7		Σ = 3		Σ = 4
Mineral Inclusions					
Dominant Particle(s)	**Quarts Sand**		**Calcite** **Lime**		**Calcite** **Whitish stone**
Dominant Size	0.5-0.25 mm.		2.0-0.1 mm.		2.0-0.5 mm.
Roundness	**Quarts Sand:** Low Sphericity: Sub-Rounded/ Rounded		**Calcite:** Low Sphericity: Angular/Sub-Angular /Sub-rounded **Lime:** Low/High Sphericity: Angular/Sub-Angular/ Sub-rounded		**Calcite:** Low/High Sphericity: Angular/ Sub-Angular/ Sub-rounded **Whitish stone:** High Sphericity: Sub-Angular/ Sub-rounded
Less dominant particles	**Lime** **Hematite**				**Lime** **Hematite**
Sporadically	Mudstone		**Whitish stone** **Hematite**		–
Percentage	30-45 %		30-40 %		25-35 %
Sorting	Fair-Good		Poor-fair		Poor-fair
Fibres					
Percentage	1:9-1:10		1:7-1:8		1:3-1:4
Maximum length	–		1.0-0.5 mm.		1.0-0.5 mm.

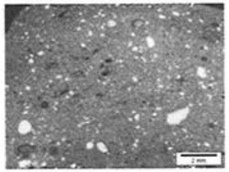
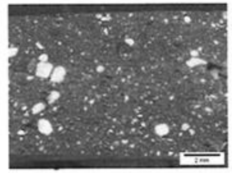
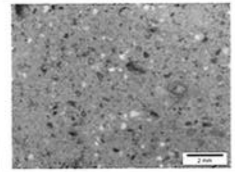
Palestinian Fabric Type 10		**Palestinian Fabric Type 11**		**Palestinian Fabric Type 12**	
Samples	Σ = 3		Σ = 2		Σ = 1
Mineral Inclusions					
Dominant Particle(s)	**Lime / Calcite**		**Lime**		**Quarts sand** **Calcite**
Dominant Size	0.5-0.25 mm.		0.25-0.1 mm.		0.25-1.0 mm.
Roundness	**Lime/Calcite:** Low Sphericity: Angular/Sub-Angular/ Sub-rounded		**Lime:** Low/High Sphericity: Sub-rounded/Rounded		**Quarts Sand:** Low/High Sphericity.: Angular/Sub-Angular **Calcite:** Low Sphericity.: Angular/Sub-Angular
Less dominant particles	Hematite Mudstone		–		Lime Hematite
Sporadically	Quarts		Hematite Quarts sand		–
Percentage	± 20 %		± 25 %		± 30 %
Sorting	Fair		Fair		Fair
Fibres					
Percentage	1:6		1:3-1:4		1:4-1:5
Maximum length	1.0 mm.		1.0 mm.		1.0 mm.

Table 3: Selection of fabrics from Phase VI and V/VI

Summary and conclusion

The pottery repertoire of Tell Deir 'Alla V and V/VI is dominated by shapes, which are limited to Central Transjordan and includes amongst others the typical black burnished ware. Of this regional category, the 'mansaf' bowl seems to be confined to the immediate region of Tell Deir 'Alla and has been made of local clay (Damya formation). Other Central Transjordanian shapes consist of this local clay fabric or of other fabrics ('Central Transjordanian' fabrics). Two shapes with mainly parallels from Palestine, possess fabrics, which belong neither to the local or the other encountered Central Transjordan fabric-types, hence these are assigned to another category ('Palestinian' fabric).

The study of shape, manufacturing technique and fabric shows a relatively unhindered continuity of pottery traditions during this period. Nevertheless, two small changes occur. Firstly, the bowls comparable with Palestinian shapes are limited to phase VI and seem to have disappeared in phase V/VI. Secondly, the amount of black burnished ware has sharply decreased in phase V/VI.

This study and future research including high-tech fabric analysis of the pottery and local clays, will be the basis for the search into the continuity and change of pottery traditions found at Tell Deir 'Alla during the Iron Age IIC-Persian period.

Acknowledgements

The author would like to thank Bram van As for valued comments and corrections. To Gerrit van der Kooij and Joris Dik I thank for their support. I am also indebted to Erick van Driel for providing the drawings. As promised, I would like to thank the students who helped to prepare the fabric samples.

Notes

1. See for discussion about the extent and history of Ammon: MacDonald 1999; Herr 1999; Dion 2003.

2. The sherds come from a large number of loci. Since more loci are attributed to phase VI than to phase V/VI, the number of ohase V/Vim, the amount of sampled sherds of phase VI is higher.

3. A comprehensive study is in preparation by the author.

4. The thin-sections, stored at the Faculty of Archaeology of Leiden University, were prepared for and are discussed in the following publications: Franken and Kalsbeek 1975 and Franken 1992.

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SOME THOUGHTS ON THE APPEARANCE OF POTTERY IN THE LOWER DANUBE PLAIN (ROMANIA)

Laurens Thissen, Abraham van As and Loe Jacobs

Abstract

We aim to provide a background for the recent involvement of the Department of Pottery Technology (Leiden Faculty of Archaeology) and of TACB[1] *in the Southern Romanian Archaeological Project (SRAP) carried out by Cardiff University and directed by Douglass Bailey. Preliminary reports of our work have appeared in previous issues of this journal. We are also participating in the associated project by Radian Andreescu and Pavel Mirea concerning the neolithisation of the Lower Danube region. Among the set of issues addressed by our ceramic research, the appearance of pottery in Neolithic pastoral societies in the Lower Danube valley is a key one. We have first-hand acquaintance with two early sites here, both subsumed under the generic name of Măgura, near the modern town of Alexandria in South Romania, where the earlier one, at about 6000 cal BC, is in fact independent from the larger, main site first settled some time later during the Starčevo-Criş period.*[2]

Ceramic programme of SRAP

The Southern Romanian Archaeological project (SRAP) provided the impulse to treat settlement patterns, land-use, and material culture within a micro-regional context (Bailey et al. 2002). In terms of pottery, SRAP is concerned with a set of research issues that are being addressed to sites and materials within this region dating from the first uses of ceramics during the early Neolithic (ca. 6000-5600 cal BC) to the subsequent Dudeşti and Vădastra phases (ca. 5500-5000 cal BC), up until the 5th millennium Boian and Gumelniţa periods. Major research issues the SRAP ceramic programme is dealing with focus on:

- Technology: resource acquisition (clays, tempering materials, pigments and fillers); fabric analysis (making use of microscopic observations, and, eventually, of thin-sections); forming techniques, *chaînes opératoires*, surface-finishing and decoration techniques; firing procedures; motor habit patterns;
- Morphology and categorisation: establishing suitable, quantified typological schemes to come towards an *emic* categorisation of assemblages making use of the technological analyses, the gestures involved in handling pottery, the use-functions (cooking, serving, storage, ritual uses);

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- Specific analysis making use of counting, weighing, sizing of all sherd material; the sizing of sherds helps in establishing deposition and post-depositional aspects, giving insights into pottery use, discard patterns, use-lifes, but also into use and functions of spaces (pits, dwellings, discard areas, courtyards, pens, outdoor working areas, etc.);
- The social context of pottery: local, domestic production (producers = users) vs. the existence of production centres (producers ≠ users); pottery as a sign for the degree of sedentarisation, mobility or seasonality (intensification and diversification of pottery, growing capacity of vessels, storage); the use of pottery in meals, feasts and rituals; discard patterns of pottery; (post-) depositional aspects); the assessment of tradition, transmission and know-how chains;
- The regional context of pottery: to identify patterns of consistent regional styles, the backgrounds of such patterns (exogamous marriage practices, production centres);
- To try to observe and trace these issues in the Lower Danube over time.

While not wanting to impose such aims on other research projects in the wider region, assemblages in the Lower Danube studied beyond the immediate goal of typo-chronology and the paradigmatic quest for origins and influences (which will remain adaptable as more sites will be excavated) will yield insights that taken together result in an at once more complex but also inherently more fruitful means of coming to grips with the role of material culture in society, that society's capacity for innovation and its technical and social adaptability. Traditional concerns with chronology, seriation and origins will be automatic by-products of such an approach, certainly so when in-depth studies of the various classes of material culture are dealt with in a comprehensive way and their results intertwined. We think that similar research questions may be profitable for investigating pottery production and use in the widest sense (e.g., functional, social, practical, as reflections of ordering principles, in ritual and feasts) in the wider Danube region. Underlying this viewpoint is the conviction that strong cultural links exist in the Lower Danube catchment area, more specifically the plains in South Romania between the Iron Gates in the west and the Bucharest field in the east, as well as the Northern Bulgarian hilly country north of the Stara Planina draining onto the Danube.

The appearance(s) of pottery in the Lower Danube valley

Just to elaborate on the last research issue mentioned, viz. the development of pottery making over time in the region, work in progress by Laurens Thissen on the main site of SRAP, as well as the spectacular work being carried out on an adjacent site, are beginning to yield insight in the emergence(s) of ceramic technology here. The two sites referred to are assumed to represent, each for their own time span, a larger collection of sites sharing the setting in the landscape, the animal and plant husbandry specifics and their material culture. The earlier site, Măgura ('hillock' in Romanian), is not ^{14}C dated as yet but by analogy its occupation will have occurred somewhere in the 6th millennium cal BC (cf. Biagi et al. 2005; Whittle et al. 2002 for a new series of dates for this general horizon).[3] Settlements of this age are currently best subsumed under the generic label 'Pre-Criş' in Romanian prehistory and represent the earliest farming villages in the region (Ciută 2005). Strong parallels exist with similar sites in the southern part of of the Danube valley in Bulgaria (Elenski 2004), and with locations in Serbia and Macedonia. Generally, occupations on all these sites were short, and they appear to have been abandoned after one, maximum two generations.[4] While the geographic distribution of these villages is extensive, their material culture is remarkably cohesive. The second place we are making reference to is the site Teleor 003, the earliest occupation of which dates to the Starčevo-Criş period, that is, anywhere in the 58th century cal BC (Mirea 2005). Teleor 003 was founded on nearly the same spot as Măgura. A dense pattern of settlements from this period extends all over Romania, North Bulgaria and Serbia. Also for these sites, deep sequences are rare if not absent, and single occupation horizons may have shifted horizontally or regionally over short time spans only. Since the subsequent stage in the Lower Danube is exemplified by a rather different material culture and its oldest stages date only to the 55th C cal BC (Bailey et al. in press), we assume a second lull in village life during the early 6th mill. Cal BC. People may have moved to less accessible landscapes or to less visible lifestyleş leaving ephemeral traces in the present-day record. Interestingly, from the Dudeşti period onwards, this record proceeds uninterrupted, and there is a strong sense of coherence and continuity pervading the various stages of late 6th and the whole 5th millennium cal BC, leading up to finally more 'settled' lifestyles during the Gumelniţa period (Bailey 2000). These assumed 'quiet' periods in the Lower Danube valley, or rather the possibility of a pattern of in/visibility in early Neolithic southern Romania have an impact on how to approach the appearance of pottery as well as its use in the region.

We have, for instance, to take into account that in fact there may have been possibly separate and manifold 'appearances' of pottery, that development was not unilinear; the 'invention', cq. adoption may represent repeated, yes, repeatable events. Perhaps we must begin to move towards a model where the invention of pottery and its modalities occurred on the regional scale rather than only once or twice. It is common knowledge by now that – globally – pottery manufacture has taken place at many different places at many different times independently from each other, often first developed in hunter-gatherer-fisher societies (cf. Rice 1999; Thissen 2007). Multiple local inventions are already attested on the scale of larger regions such as Anatolia. Pottery may have begun to be made first in the central part of the area, where at the site of Çatalhöyük chaff-tempered fabrics were used shortly after 7000 cal BC. But different traditions, technologies and form concepts are underlying the earliest potteries from the southwest-, southeast and Syro-Cilician parts of Turkey, and a causal relation with Central Anatolia seems unlikely (Thissen 2007). Different trajectories may have led to similar outcomes. Where we have argued, for instance, that the pottery in early Neolithic Thessaly was of independent origin as well, its superficial similarity with Central Anatolia in terms of 'primitiveness' has misled evolutionists to relate the two, conveniently bypassing the fact that at Çatalhöyük such fabrics stayed in use for several centuries. The 'primitive' Thessalian pots were, first, part of sophisticated assemblages from the outset, and second, if preceding these high quality wares at all they must have evolved within a matter of generations. 'Room' for the obsolete model of ceramic development, enabling a long fermenting stage of trial and error was, by the way, provided by an erroneous and selective manipulation of the ^{14}C evidence, creating the huge time necessary to incorporate the evolutionist model (Reingruber 2005; Thissen 2005b; contra Perlès 2001). The appearance(s) of pottery is a particularised set of independent or perhaps obliquely dependent inventions, a split-up process not isolated from particular local/regional circumstances both on the environmental and on the social levels.

Linking these thoughts back to the Lower Danube sequence as summarised supra and given the disparities in the ceramic assemblages from its different stages, we can now work from the hypothesis that ceramic technology and know-how may have become obsolete after its first enthusiastic adoption, and even that this may have occurred more than once. At present there are two archaeologically invisible periods in the Lower Danube Plain record (see Table 1). While possibly only the result of survey bias, insufficiently studied assemblages, or the poor record of ^{14}C dates, the new assemblages emerging after these absences are sufficiently different or modified in important respects (manufacture, firing, categorisation etc.), that we have to presuppose some links missing. A general pattern of presence/absence may be explained by people possibly relocating to different ecological niches outside traditional surveying, or even by societies becoming ephemeral (maybe not only in the archaeological sense?), as is currently most strikingly the case with the Mesolithic populations in South Romania, which must have been active in the Danube Valley judging from the rich contemporary evidence from the Iron Gates upstream of the Danube to the west, and from the Bug and Dniestr sites to the east (Thissen 2005a).

Age cal BC	Archaeological phase
2nd half 5th mill.	Gumelniţa phases (= Chalcolithic)
Early 5th mill.	Boian phases (= late Neolithic)
Late 6th mill.	Vădastra phase (= middle Neolithic)
ca. 5500/5400	Dudeşti phase (= middle Neolithic)
56th/55th centuries	Archaeological invisibility (?)
ca. 5800/5700	Starčevo-Criş phase (= early Neolithic)
59th/58th centuries	Archaeological invisibility (?)
ca. 6000	Earliest Neolithic farming sites (= 'Pre-Criş')
Pre-6000	Archaeological invisibility (Mesolithic)

Table 1. Lower Danube Plain chronology.

Studying the specific needs and circumstances that may have promoted the invention and/or adoption of pottery in specific locations and regions in SE Europe would, therefore, have to focus on four big questions. Why the invention, cq. adoption of pottery technology, which, in the case of our region simultaneously involves the adoption of agriculture? How invention? Where logging the various *chaînes opératoires* going into the making of ceramics, and this by contrasting the various regions, will yield basic technology sets providing potential avenues for inclusion or exclusion?[5] Where invention: which would involve a consideration of local circumstances and the necessity of embedding the new technology in existing ones (perishable container technology/replacement isomorphs [e.g., *NN* for pots – metal for pots – plastic for metals]). And is there a pre-pottery 'software' horizon (cf. Vandiver 1987)? And finally when invention/adoption, necessitating radiocarbon sampling on an extensive scale, which for SE Europe is only now beginning.

While further treatment of these questions is beyond the scope of this paper, we have elaborated elsewhere on the embedding of existing technologies within new ones, where, to be specific, old methods of cooking using pre-heated stones in perishable containers might have migrated to the new ceramic technology (Thissen 2005a).

New proof for cooking stones

The experiment we undertook to test this theory, viz. that cooking stones might have been used to bring water, cq. foodstuffs, to the boil in cooking vessels, instead of putting these over a fire has been described extensively and need not be repeated (van As et al. 2005). It was mainly a combination of factors including the heaviness of the pots from the Starčevo-Criş and Dudeşti periods at Teleor 003 (certainly when filled)[6], the absence of soot traces, and the presence of attrition marks on the insides that led up to this idea. On the basis of rim and base fragments from the Starčevo-Criş deposits on Teleor 003 we made a reconstruction of an early Neolithic cooking vessel. The exteriors were originally treated with a thick, worked slip (*barbotine*), or were covered with nail- and finger impressions and pinchings.

The use of cooking stones with pottery is of course known from Native American societies (e.g., Sassaman 1995), but we do not need to go this far neither in space nor in time. Gradually, evidence from SE Europe itself is emerging backing up the idea of stone boiling or 'indirect moist heating' (the term is Sassaman's, o.c.). From the Chalcolithic site of Drama (Bulgaria) a vessel with cooking stones inside was retrieved from a domestic context, suggesting that this ancient practice persisted deep into the 5th millennium (Figure 1). From Teleor 003 a broken vessel in situ, dating to an early stage of the Dudeşti period also contained stones.[7]

Most exciting is the fact that from the earliest Neolithic site of 'Măgura' substantial amounts of lightly baked clay objects came to light, of different sizes and shapes (oval, spherical, disc), sometimes perforated or half-perforated (Mirea, p.c., August 13, 2006). They are retrieved from house contexts and from pits, are often fire-cracked and also otherwise show signs of burning and heating (Figure 2).

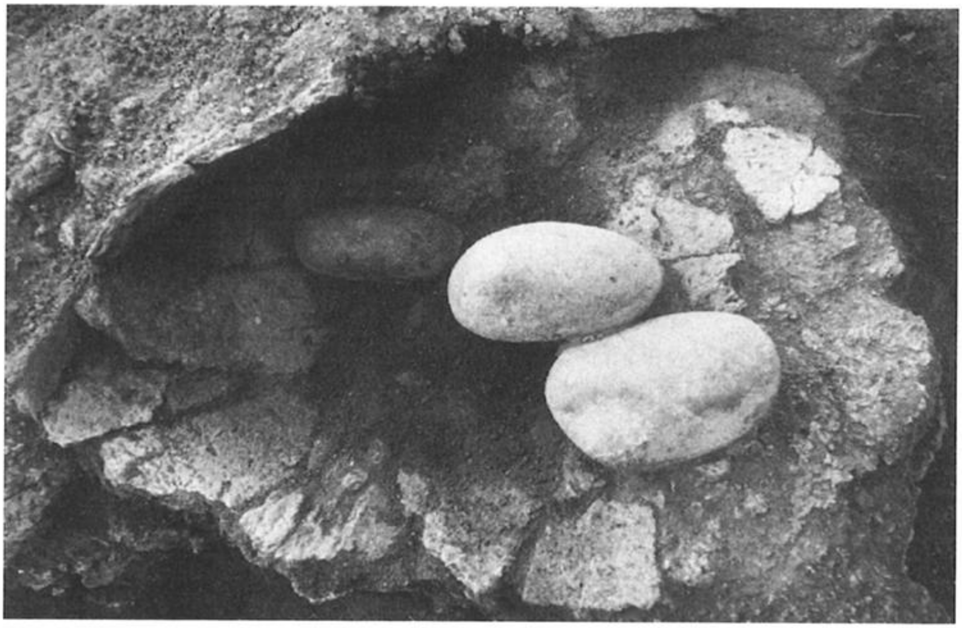

Figure 1. Cooking vessel with cooking stones. House no. 380 in the Chalcolithic level from Drama (Bulgaria) (after A. Fol et al. 1989, Plate 19).

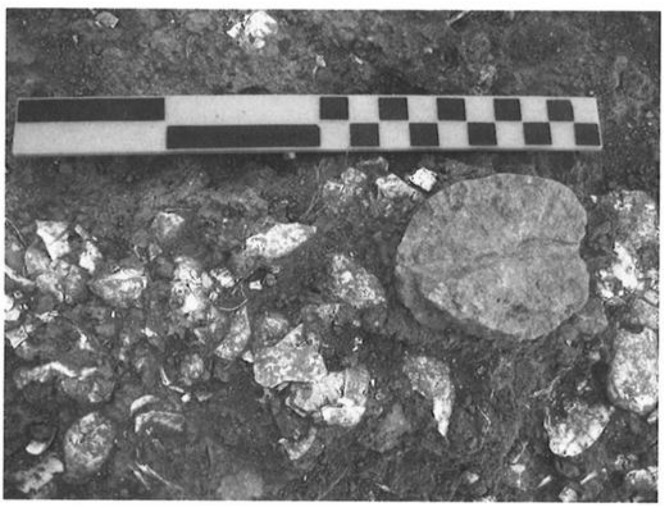

Figure 2. Măgura (Romania). Find context from the earliest Neolithic, ca. 6000 cal BC. Fire-cracked 'cooking stone' with perforation. (Photo courtesy of Pavel Mirea, Teleorman County Museum).

Equally, many stones show similar signs, suggesting the complementary use of both utensils. A restricted, originally handled vessel with a stone inside from the site yields further corroborative evidence (Mirea, p.c., December 18, 2007) (Figure 3).

All this evidence suggests that the use of preheated stones and clay balls in domestic contexts was large-scale, where it is not yet clear if they were used for cooking or heating container contents (be they of perishable or baked clay), or, for heating rooms (as suggested for the profusion of small clay balls as heat transfer devices in Çatalhöyük (cf. Suponcic 1999). The example from Măgura makes also clear that the use of these objects was very much part of domestic practice already at the onset of the Neolithic in the Lower Danube Plain.

We may begin to move towards an idea where such heat transfer devices may have been rather ubiquitous in prehistoric contexts both in Anatolia and SE Europe. Apart from being possibly used for room heating, the evidence from the Lower Danube suggests the use of stone and possibly clay balls in heating the contents of cooking pots. Given the tight correspondences in material culture between Măgura's earliest Neolithic and other Balkan sites, from the same general horizon, it is worth considering that stone boiling was practised in these settlements as well.

The clay balls from the early Neolithic site of Donja Branjevina in the Serbian Vojvodina (Figure 4) are interpreted by the excavator as sling stones; similar clay objects from Starčevo-Criş contexts in Romania are nearly always defined as net sinkers, or loom weights (cf. Lazarovici 1969: Fig. 2). While some of them may indeed have played a role in weaving (e.g., the notched ones), net sinkers are ruled out given the material. Like the cooking stones from Măgura, the examples from Donja Branjevina may be perforated, or half perforated, or can be solid as well, exemplifying rapid manufacture possibly in large quantities, as again evidenced by the Măgura output. The perforations were obviously used to facilitate manipulation of the balls with sticks, as has been proven with similar objects in native North America (Sassaman 1995). It is highly likely that such lightly baked objects were often missed during excavation, simply overlooked, or at best treated as insignificant and unidentified clay objects, while in fact they must have been an important item of every household in the early Neolithic all over the Balkans (cf. Karmanski 2000, Figs. 51, 62).

Concluding remarks

To our view the use of cooking stones reflecting Mesolithic (or even older) cooking methods is favourable to arguments for a local adoption of 'the neolithic way of life', i.e., not brought on by demic diffusion. This does not dichotomise foreign input of know-how concerning pot-making, where maybe Richards' conclusions on the basis of both mitochondrial DNA and Ychromosome analyses "that dispersals bringing the Neolithic to Europe may have been demographically minor and that contact and assimilation had an important role" (Richards 2003: 135) should be expanded in that it was women who transmitted this technical (and undoubtedly also the stylistic) know-how

Figure 3. Măgura (Romania). Cooking pot with stone inside, in situ. Earliest Neolithic, about 6000 cal BC. (Photo courtesy of Pavel Mirea, Teleorman County Museum).

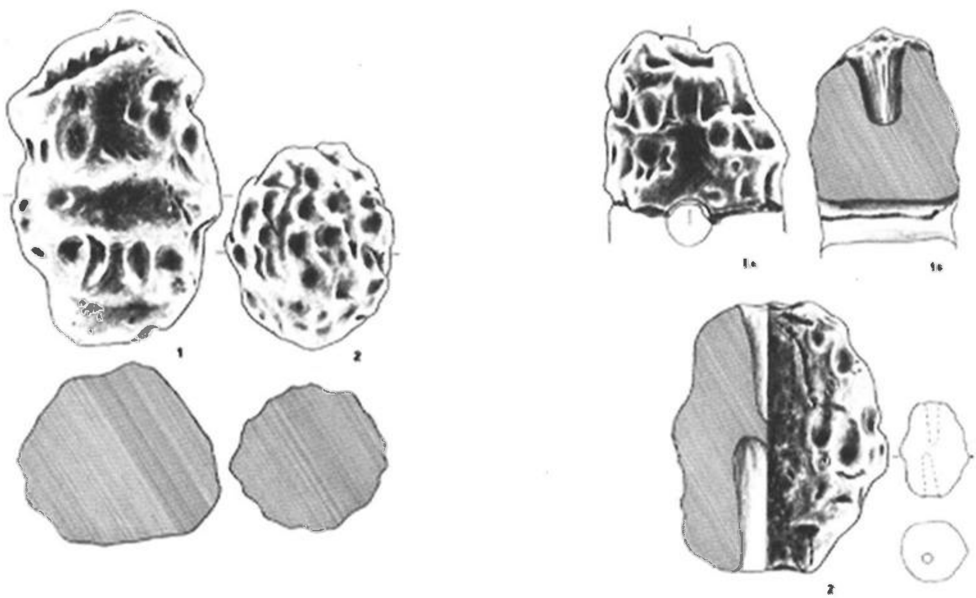

Figure 4. Clay objects from Donja Branjevina (Serbia), early Neolithic (after Karmanski 2000, Pls. 116, 118).

as well as mental templates of shapes and decorations into local, essentially 'Mesolithic' society through exogamous marriage patterns. The large quantities of pottery present in even the earliest Neolithic contexts immediately discredit the idea of 'imports' and also of pottery representing a rare, ritual good (contra Vitelli 1989), but rather suggest local production. Local manufacture is proven both for the Starčevo-Criş period (Teleor 003), as well as for its earlier precursor (Măgura) on the basis of clay sourcing alone (cf. van As et al. 2004, ibidem, internal ms., resp.). Around 6000 cal BC, and very likely much earlier, along the traditional Meso-Neolithic interface societies will have been in flux constantly and continuously, and the networks of which they were part will have been extensive and expandable. Understanding the adoption of new subsistence techniques and new technologies will ultimately have to be embedded in understanding such networks.

Acknowledgements

We wish to thank Pavel Mirea for kindly granting permission to include some pictures from the 2007 campaign at Măgura, just 'cooked', so to speak, and for sharing precious information concerning early Neolithic clay balls. Many thanks are also due to Douglass Bailey and to Radian Andreescu.

Notes

1. Thissen Archaeological Ceramics Bureau (www.tacb-pottery.com).

2. To avoid confusion, *Măgura* will be used for the earlier site, while the main site will be referred to under its original survey code *Teleor 003* (site no. 3 in the Teleorman 'valley survey – Cardiff University, see Bailey *et al.* 2002).

3. This small settlement is currently being dug by Pavel Mirea of the Teleorman County Museum.

4. The sites of Nea Nikomedeia and Anza in Macedonia are earlier examples of similar short-lived occupations.

5. Because the operational chain for manufacturing pots in early Neolithic Thessaly involved the slab technique, Thessaly is a less likely region serving as knowledge base and inspirational model for pot manufacture in the Balkans, where down till the Early Bronze Age the main technique was coiling (cf. van As *et al.* 1988; Wijnen 1993).

6. Current TACB work on SRAP materials measured weights of Dudeşti cooking vessels of up to 6 kg (empty!).

7. Teleor 003, Sondage 22, Complex 24.

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PLYMOUTH:
A LATE-PREHISTORIC CERAMIC COMPLEX OF TOBAGO

Arie Boomert

Abstract

This article discusses the characteristics and cultural affiliations of the late-prehistoric Plymouth complex, a ceramic tradition on the island of Tobago. It analyses the Plymouth vessel repertoire and its assemblage of pottery, stone, bone and shell artifacts. In all fourteen archaeological sites have yielded Plymouth ceramics, e.g., the type site, Lovers' Retreat Section C (formerly called Plymouth), Great Courland Bay, King Peter's Bay, Speyside 2, and Bacolet. The Plymouth complex appears to be closely related to the late-prehistoric Suazan Troumassoid subseries of the Windward Islands and Barbados. It represents the direct descendant of Tobago's Golden Grove complex which shows significant ceramic similarities with the preceding Troumassan Troumassoid subseries. However, just as Golden Grove, the Plymouth complex also shows individual pottery features shared by the ceramics of the contemporaneous Arauquinoid series of Trinidad, the Orinoco Valley and the coastal zone of the Guianas. According to criteria of pottery style and calibrated radiocarbon dates, the Plymouth complex can be placed between cal A.D. 1150 and 1400/1450.

Introduction

The Plymouth complex forms the final major ceramic assemblage of pre-Columbian Tobago known to date, also showing the widest distribution of the island's successive Amerindian pottery complexes. It can be taken to have evolved from Tobago's Golden Grove complex, which was previously discussed in this journal (Boomert 2005). While Golden Grove appears to be affiliated to the Troumassan Troumassoid subseries of the Windward Islands and Barbados, Plymouth clearly represents the Tobagonian counterpart of the subsequent Suazan Troumassoid subseries, which is equally distributed throughout the southern Lesser Antilles. This article analyses the characteristics of the Plymouth complex, briefly describing its ceramics and other items of material culture, subsistence patterns and distribution in Tobago as well as its dating and relations with the contemporaneous Amerindian cultural traditions of the region. It is noteworthy that settlement sites of the Cayo complex, which apparently represents the ceramics of the protohistoric Island Caribs in the Windward Islands, are unknown from Tobago to date. However, some individual pottery fragments showing Cayo-like characteristics have been encountered at a few multicomponent sites, also yielding Plymouth complex materials (Boomert 1996: 25).

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The sites

Pottery of the Plymouth complex has been found at in all fourteen archaeological sites on Tobago, four of which represent multicomponent deposits. They are situated all around the island (Figure 1). As the Golden Grove complex is restricted to the southwestern portion of Tobago, the island-wide distribution of sites yielding Plymouth ceramics may suggest a certain measure of population increase in late-prehistoric times. As to geographical and ecological situation the Golden Grove and Plymouth sites are quite alike. The latter include five settlement sites, characterised by one or more midden deposits and human

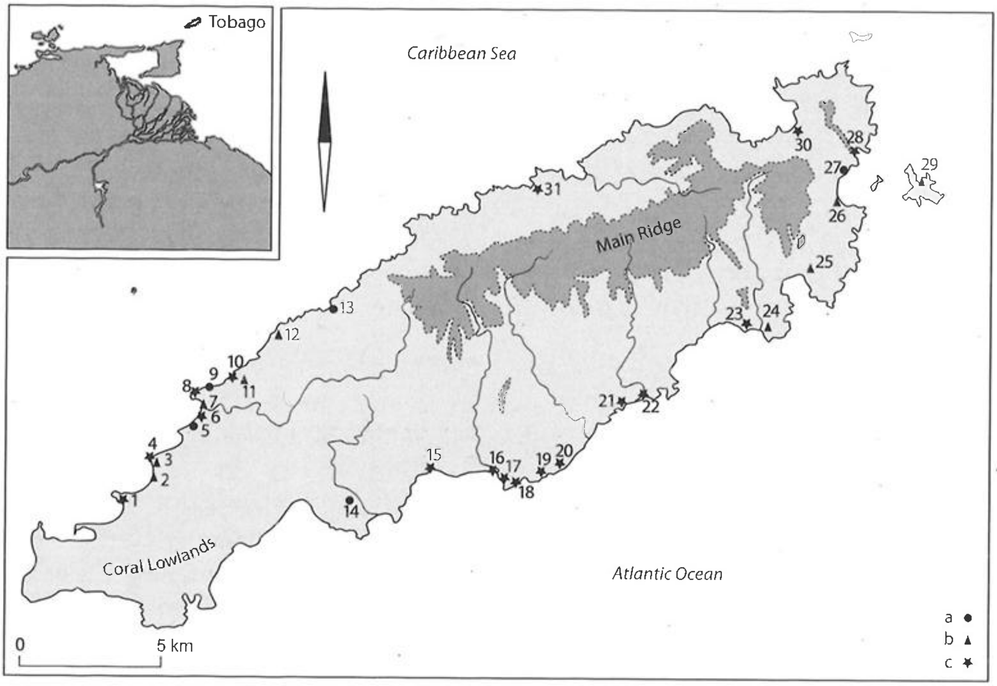

Figure 1. Map of Tobago, showing the distribution of archaeological sites of the Plymouth complex and unspecified Troumassoid sites. *Legend:* (a) settlement sites, Plymouth complex; (b) ephemeral camp or bivouac sites, Plymouth complex; (c) unspecified Troumassoid sites. Key to site numbers: (1) Buccoo 1; (2) Mount Irvine 3; (3) Mount Irvine 5; (4) Rocky Point; (5) Great Courland Bay; (6) Turtle Beach 1; (7) Turtle Beach 2; (8) Plymouth; (9) Lovers' Retreat; (10) Arnos Vale Bay; (11) Arnos Vale Sugar Factory; (12) Culloden Bay; (13) King Peter's Bay; (14) Bacolet; (15) Hillsborough Bay; (16) Barbados Bay 1; (17) Barbados Bay 2; (18) Granby Point; (19) Goodwood; (20) Goldsborough 2; (21) Pembroke; (22) Richmond Bay; (23) Queen's Bay; (24) Indian Point 1; (25) King's Bay; (26) Speyside 1; (27) Speyside 2; (28) Anse Brisant; (29) Little Tobago 2; (30) Cambleton; (31) Parlatuvier Bay. Inset: geographical situation of Tobago offshore the South American mainland.

burials, i.e., Lovers' Retreat (TOB-69), Great Courland Bay (TOB-23), King Peter's Bay (TOB-64), Speyside 2 (TOB-56), and Bacolet (TOB-82). Of these only Lovers' Retreat and Great Courland Bay are archaeologically sufficiently known. In addition, nine Plymouth complex pottery deposits have been identified, probably representing ephemeral camp or bivouac sites which were utilised by the prehistoric Amerindians during fishing, hunting or collecting expeditions (see Boomert 1996). Besides, seventeen similar sites have yielded Troumassoid ceramics in quantities insufficient to allow assignment to either Golden Grove or Plymouth. All of these sites represent pottery deposits. The Plymouth complex sites are to be found close to the present coastline, i.e., predominantly at less than 250 m from the shore. Most sites are situated near a source of potable water, generally a permanent freshwater stream. They are characterised by an original vegetation cover consisting of littoral woodland grading into either deciduous seasonal forest or lowland tropical forest. Just as the sites of the Golden Grove complex, those of the Plymouth complex are often in the neighbourhood of mangrove woodlands and/or offshore reef complexes. Pedologically they are typified by alfisols, either haplustalfs or tropudalfs, eutropepts and ustropepts (inceptisols), rarely by usthortents (entisols). Site elevation is generally less than 10 m; slope differences are insignificant.

The type site, Lovers' Retreat, which was formerly called Plymouth, represents a multicomponent midden deposit occupying a rocky headland on Tobago's western (leeward) coast. A permanent stream flows to the southwest of the site which shows a distinct horizontal stratification and can be divided geographically into three parts, i.e., Sections A, B, and C, representing midden deposits associated with inhumation burials belonging to the Saladoid Friendship complex and the Troumassoid Golden Grove and Plymouth complexes, respectively. The site was investigated archaeologically by Cambridge in 1948, Bushnell in 1955, Gilchrist in 1961 and 1963-1964, Llanos in 1968, Harris in 1976, Boomert in 1981-1982 and 1985, Bernett in 1989, and Reid in 2004-2005. Section C, which occupies an area of about 70×30 m in the central and northeastern part of the Lovers' Retreat promontory, was examined by Harris, the author and Reid. It yielded pottery and artifacts of stone, bone and fossil coral, next to some shells and food remains of the Plymouth complex. The cultural deposit was found to be concentrated in a 'carpet' of large pieces of pottery, packed on top of each other in horizontal position, resting on decomposed coral limestone bedrock at a depth of 15-20 cm below the present surface. In the central part of the plateau the Plymouth complex pottery is mixed artificially with historic materials dating from the late-nineteenth century. A single inhumation burial was encountered eroding out of the cliff edge at the eastern margin of Section C (Boomert 1996: 68-77, 2000: 181-182; Harris 1980; Reid 2004, 2005).

The Great Courland Bay site is to be found on Tobago's western (leeward) shore, stretching along the beach in between the mouths of two permanent freshwater streams, just south of Plymouth. The site's area can be estimated at 375×50 m.[1] The author conducted limited salvage operations at the site in 1982-1983 and 1985, followed by Merlin and Kameneff in 1992. Finally, extensive excavations were carried out by Kameneff and the Karrek Ven Training Group in 1998 (Boomert and Kameneff

2003; Kameneff 1998, 1999; Merlin 1993). According to horizontal stratification, the site can be divided into a midden area in its western part, stretching to the seashore, and a residential portion towards the interior, situated at a slightly higher elevation. The latter is characterised by a pattern of postholes representing a probably circular house structure and two inhumation burials. The archaeological deposit appeared to extend to a depth of almost 220 cm below the present surface. The site yielded tremendous quantities of Plymouth complex pottery, in all some 28,000 pieces, and artifacts of stone, shell, bone, and fossil coral, next to charcoal and archaeozoological remains, notably shells and animal bone materials.

The King Peter's Bay, Speyside 2 and Bacolet sites are much less known. King Peter's Bay is a multicomponent midden deposit occupying a low hill on Tobago's western (leeward) shore, situated close to the mouth of a permanent freshwater stream.[2] The site includes two small deposits, one measuring some 30×20 m at the western end of the terrace and a second one covering 10×20 m on a low ridge toe 150 m towards the interior. It yielded predominantly Plymouth complex pottery next to some Friendship pieces and food remains, artificially mixed with historic materials dating from the late-eighteenth and early-nineteenth centuries, at the inland deposit extending to a depth of at least 65 cm below the present surface. The site was inspected by the author in 1982, followed by an extensive survey and limited testing by Clement in 1997 (Boomert 1996: 66; Clement 2000). Speyside 2 represents a small midden deposit associated with a human burial close to the mouth of a permanent freshwater stream, the Doctor's River, on the northeast (windward) shore of Tobago. A collection of pottery and food remains was made at the site by Williams in 1988. The association of these materials with a similarly recovered European pipestem, possibly dating from the late-seventeenth century, is questionable (Boomert 1996: 99-100). Bacolet, finally, is a large multicomponent settlement site of the Friendship and Plymouth complexes associated with human inhumation burials, which was discovered and destroyed due to the construction of a soccer stadium, some 900 m inland from the shore of Tobago's southeast (leeward) coast. The site occupies a slowly rising area on the bank of a major freshwater stream, the Bacolet River, and yielded pottery, stone and shell artifacts next to food remains. Surface collecting and limited testing were conducted by Clement in 1999, Kameneff in 1999, Knott in 1999-2000, and Chauharjasingh in 2000 (Chauharjasingh 2000; Léonid Kameneff, pers. commun.; Jeremy Knott, pers. commun.).

The archaeozoological remains recovered from the Lovers' Retreat, Great Courland Bay, King Peter's Bay, Speyside 2, and Bacolet settlement sites indicate that the subsistence practices of the Amerindians of the Plymouth complex did not deviate from those of their immediate predecessors in Tobago, the manufacturers of Golden Grove complex pottery (Boomert 2005). They clearly subsisted on horticulture, notably the cultivation of ground provisions such as bitter cassava and sweet potatoes, next to hunting, fishing and food collecting, thus establishing a broad-spectrum diet. Analysis of the food remains encountered at the Great Courland Bay site suggests hunting for mammals such as agoutis (*Dasyprocta agouti*), black-eared opossums (*Didelphus marsupialis*), collared peccaries (*Tayassu tajacu*), and red brocket deer (*Mazama americana*), next to that for reptiles including sea turtles (Cheloniidae) and iguanas (Iguanidae). The Lovers' Retreat (Section C) food remains suggest the exploitation of the extensive coral reefs and eel-grass beds offshore southwest Tobago for fishing, notably of parrotfish (Sparisoma sp.), jacks (Carangidae) and sharks (Squaliformes), as well as the gathering of mollusks, especially Queen conchs (*Strombus gigas*). The mangrove woodlands close to King Peter's Bay and Great Courland Bay yielded Flat tree oysters (*Isognomon alatus*) and Thick lucinas (*Phacoides pectinatus*), while rocky shore gastropods as West Indian top shells (*Cittarium pica*) were collected by the former inhabitants of all Plymouth settlement sites. Finally, marine/brackish Cross-barred venus (*Chione cancellata*) clams, at home in a shallow-water, sandy-bottom lagoonal environment, are known from King Peter's Bay (Boomert 1996: 75; Boomert and Kameneff 2003; Harris 1980; Kameneff 1999).

The pottery

The present discussion of Plymouth ceramics is primarily based on the quantitative analysis of the author's finds from the Lovers' Retreat, Section C (1982) and Great Courland Bay (1982-1983, 1985) sites. It will be supplemented by a qualitative investigation of the cultural materials excavated by Harris at Lovers' Retreat (1976) and those encountered by Kameneff at Great Courland Bay (1998). At Lovers' Retreat (Section C) the author dug a north-south bearing 2×2-m trench, divided into 1-m squares and controlled in 10-cm artificial levels, adjoining the trench excavated by Harris (1976) in this part of the site to the south. Excluding pottery artifacts, the author's trench yielded in all 1876 potsherds (weight 20,510 g) of the Plymouth complex next to 30 pottery artifacts (weight 1130 g). The extensive survey of an area of about 50×30 m conducted by the author in the western (midden) portion of the Great Courland Bay site resulted in a collection of in all 1544 potsherds (weight 34,930 g) next to 49 pottery artifacts (weight 3050 g). All Lovers' Retreat finds are kept in the collection of the University of the West Indies (UWI), St. Augustine, Trinidad, while those from Great Courland Bay are divided between UWI and the Tobago Museum (TM), Scarborough, Tobago. The terminology of ceramic description is similar to that employed by the author in his analysis of the Golden Grove complex (Boomert 2005).

Manufacture and fabric classification

Technologically Plymouth pottery closely resembles the ceramics of its predecessor, the Golden Grove complex. According to Jacobs (2007), hematite-containing clays were used for pottery making. Coiling apparently formed the primary method of manufacture. Bases were either made using moulds or by flattening out of a slab of clay. The vessel walls were built up by coiling. Coils were firmly fixed and thinned out by scraping and smearing the wall. Subsequently the vessel surface was smoothed to varying degrees, causing a selfslip when it was slightly moistened. Firing must have taken place in an open fire. The clay used by the Plymouth complex potters at Lovers' Retreat (Section C) and Great Courland Bay[3] appears to contain several non-plastic impurities, i.e., varying quantities of local Tobagonian waterworn sand, containing very fine to coarse-sized particles of predominantly plagioclase feldspar and minor amounts of translucent quartz, next to small quantities of kaolinite and dark minerals, including pyroxene or amphibole, augite and hornblende, as well as translucent green minerals, notably epidote (Jacobs 2007; Cassandra T. Rogers, pers. commun.).[4]

According to surface treatment, fabric, colour, texture and thickness, the Plymouth ceramics, just as those of the Golden Grove complex, can be divided into five major categories, i.e., Fine Ware, Medium Ware, Coarse Ware, Coarse Scraped Ware, and Coarse Scratched Ware (Table 1). The Fine Ware and Medium Ware categories can be considered to form the high-quality ceramics of the Plymouth complex, primarily serving purposes of ceremonial or at least non-domestic nature, while the Coarse Ware, Coarse Scraped Ware and Coarse Scratched Ware were clearly used exclusively in purely household contexts. Consequently, these two major pottery classes had specialized functions and as a result different occupational and gender associations in Amerindian society. The high-quality pottery encountered at LRC and GCB comprises in terms of potsherd numbers/weight 44.1/29.0% and 52.6/42.7%, respectively, while the low-quality ceramics amount to 55.9/71.0% and 47.4/57.3%. The large difference between the number and weight percentages of the high-quality potsherds at LRC is due to the much higher ratio of breakage among the latter as compared to the low-quality pieces. Interestingly, some potsherds from GCB show thin deposits of tar along the edges, suggesting that this was used for mending. Indeed, a plain Coarse Ware vessel appears to have been used for the melting of asphalt (Kameneff 1999: 31).[5]

Fine Ware. This ware contains predominantly well-sorted, very fine to medium particles of plagioclase feldspar and minor amounts of quartz sand. Besides, a sample of GCB Fine Ware appeared to include a substantial quantity (up to 20%) of dark minerals, mainly hornblende, most likely originating from decomposed diorite (Jacobs 2007). This ware shows a well-kneaded, compact, relatively fine-grained texture without air pockets and burnished, generally even surfaces, yellowish orange to dark reddish in colour. The non-plastic inclusions, which are evenly distributed throughout the paste, are hardly visible on the vessel surface. The feldspar and quartz grains are 50-1000μ in size; particles <500μ are predominant. The dark minerals are typically between 50 and 250μ in size. It is likely that this blackish sand was deliberately added to the clay of the sherd sample investigated (Jacobs 2007). Wall thickness is minimally 3 mm; mean thickness is 5.5 mm. Surface hardness is 2.5-3.5. Firing conditions were well controlled: oxidising is generally complete, which obviously caused this ware's typical surface colour (Loe Jacobs, pers. commun.). Fire clouds are absent (Figures 13-14).

Medium Ware. This ware contains predominantly well-sorted, fine to medium particles of plagioclase feldspar next to minor amounts of quartz sand and dark minerals. It shows a well-kneaded, relatively compact and fine-grained texture occasionally showing air pockets and burnished to smoothed, even to somewhat uneven surfaces, yellowish orange to yellowish grey in colour. The non-plastic inclusions, which are quite evenly distributed throughout the paste, are sometimes visible on the vessel surface. The feldspar and quartz grains are 50-1000µ in size; particles <500µ are predominant. The dark minerals are typically between 50 and 250µ in size. Vessel exteriors are generally better finished than interiors which sometimes show unobliterated clay coils. Wall thickness is minimally 4 mm; mean thickness is 6.5 mm. Surface hardness is 2.5-3.5. Firing conditions varied: oxidising is incomplete to rarely complete. Fire clouds are rare.

Coarse Ware. This ware contains predominantly relatively unsorted, fine to medium particles of plagioclase feldspar and minor amounts of quartz sand. Dark minerals are rare in the GCB Coarse Ware (Jacobs 2007). The ware shows a poorly kneaded, occasionally friable, coarse-grained texture with many air pockets and badly smoothed, very uneven and sometimes bumpy surfaces with interiorly unobliterated clay coils, yellowish grey to dark grey in colour. The non-plastic inclusions, which are quite unevenly distributed throughout the very gritty paste, are often visible on the vessel surface. The grains are 50-1000µ in size; particles >500µ are predominant. Wall thickness is minimally 6 mm; mean thickness is 7.5 mm. Surface hardness is 2.0-3.0. Firing was uncontrolled: oxidising is incomplete. Fire clouds are common.

Coarse Scraped Ware. This ware contains predominantly relatively unsorted, fine to particles of plagioclase feldspar and minor amounts of coarse quartz sand. Dark minerals are rare in the GCB Coarse Scraped Ware (Jacobs 2007). The ware shows a poorly kneaded, occasionally friable, coarse-grained texture with many air pockets and badly smoothed, very uneven and sometimes bumpy surfaces with marks produced due to smoothing without properly obliterating clay coil boundaries and thin, light scratches either occasioned by sticking-out temper grains or by smoothing with a small bundle of grass (Hofman and Jacobs 2004; Jacobs 2007). These 'scraping' marks are typically unidirectional, apparently covering only small, widely dispersed parts of the vessel surface. Surfaces are yellowish grey to dark grey in colour. The non-plastic inclusions are quite unevenly distributed throughout the very gritty paste. The grains are 50-1000µ in size; particles >500µ are predominant. Wall thickness is minimally 6 mm; mean thickness is 7.5 mm. Surface hardness is 2.0-3.0. Firing was uncontrolled: oxidising is incomplete. Fire clouds are common.

Coarse Scratched Ware. This ware contains predominantly relatively unsorted, fine to particles of plagioclase feldspar and minor amounts of coarse quartz sand. Dark minerals are rare in the GCB Coarse Scratched Ware (Jacobs 2007). The ware shows a poorly kneaded, occasionally friable, coarse-grained texture with many air pockets and badly smoothed, very uneven and sometimes bumpy surfaces with marks produced due to smoothing without properly obliterating clay coil boundaries and deep, wide scratches occasioned primarily by smoothing with a bundle of grass or twigs when the clay was still leather dry. These 'scratch' marks are typically closely spaced and groups of them tend to be multidirectional, apparently covering large parts of the vessel surface.[6] Surfaces are yellowish grey to dark grey in colour. The non-plastic inclusions are quite unevenly distributed throughout the very gritty paste. The grains are 50-1000µ in size; particles >500µ are predominant. Wall thickness is minimally 6 mm; mean thickness is 7.5 mm. Surface hardness is 2.0-3.0. Firing was uncontrolled: oxidising is incomplete. Fire clouds are common (Figures 15-16).

Vessel shape classes

Nine major vessel shapes, including four rare forms, can be distinguished (Table 2). Vessels are small to large-sized, i.e., showing orifice diameters up to 72 cm, if circular in horizontal cross section. The various vessel shapes are ascribed to tentative functional categories using the criteria developed by Henrickson and McDonald (1983), Rice (1987: 237-240) and Harris (1995).

Form 1. Dish, bowl or jar with unrestricted orifice, showing simple contours (Figure 2:1-12; Boomert and Kameneff 2003, Figures 2, 4). This vessel shape may be circular or oval in horizontal cross section. Circular orifice diameters vary between 6.5 and 72.0 cm. This is the 'Open Bowl', 'Small Bowl' and 'Bowl' of Harris (1978) and the 'well finished Bowl', 'coarse paste Bowl', 'coarse paste Rimlugged Bowl', and 'coarse paste Goblet' of Harris (1980). It includes forms B2-6, B9, B11, B18-20, S2, S4, S6-12, and S16-20 of Kameneff and Merlin (1994). In terms of potsherd numbers, this is the most popular vessel shape. It encompasses high-quality as well as low-quality ceramics. Both categories are clearly distinct in size while only high-quality forms may be oval in horizontal cross section. The high-quality pieces show typically small to medium dimensions with orifice diameters not exceeding 26 cm, if circular in horizontal cross section, while the low-quality specimens tend to be much larger, exhibiting medium to large proportions. Besides, the coarse-ware forms often show fire traces. The high-quality pieces may have been used for serving liquids and the storage or display of particular substances or artifacts and food preparation without heating. Most likely the low-quality specimens were used as cooking pots.

Form 2. Dish with unrestricted orifice and simple contours, showing bisectioning by an interior dividing panel (Figure 3:1). This is an extremely rare shape of high-quality ceramics, circular in horizontal cross section, one piece of which was encountered by Harris at LRC in 1976. It is his 'well finished Divided Bowl' (Harris 1980), showing an orifice diameter of 25.0 cm. This dish may have been used for similar purposes as the high-quality ceramics of Form 1.

Form 3. Dish, bowl, or jar with restricted orifice, showing simple contours. This vessel shape, which is circular in horizontal cross section, is occasionally provided with handles (Figures 3:2-9, 8:1, 14). It is predominantly made of low-quality ceramics. Orifice diameters vary between 8.5 and 60.0 cm. This is the 'Inturned Bowl' of Harris (1978) and the 'well finished Inturned Bowl' and 'coarse paste Inturned Bowl' of Harris (1980). It includes forms B7, B16-17, B22, B24, S1, S5, S13-15, and S21-23 of Kameneff and Merlin (1994). The high-quality and low-quality categories of this vessel shape are different in size. The high-quality pieces show typically small to medium dimensions with

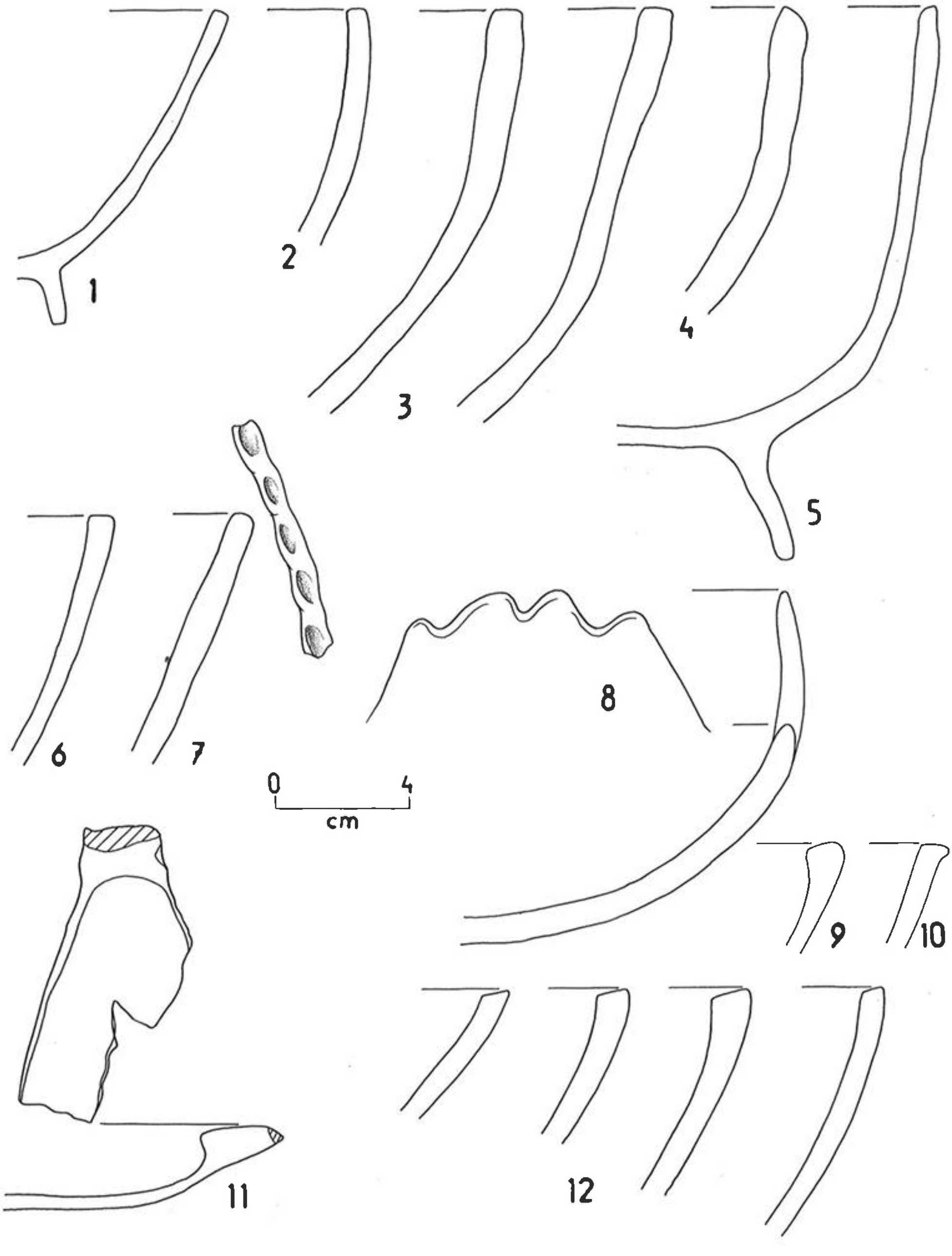

Figure 2. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (1-2,6,9) and Great Courland Bay (3-5,7-8,10-12): (1-12) Vessel form 1; (1,5) Base form E; (1,12) Rim type 2; (2-5,8) Rim type 1; (7) Fingertipping; (8) Simple modelling Motif 1; (9) Rim type 3; (10) Rim type 4; (11) Base form A.

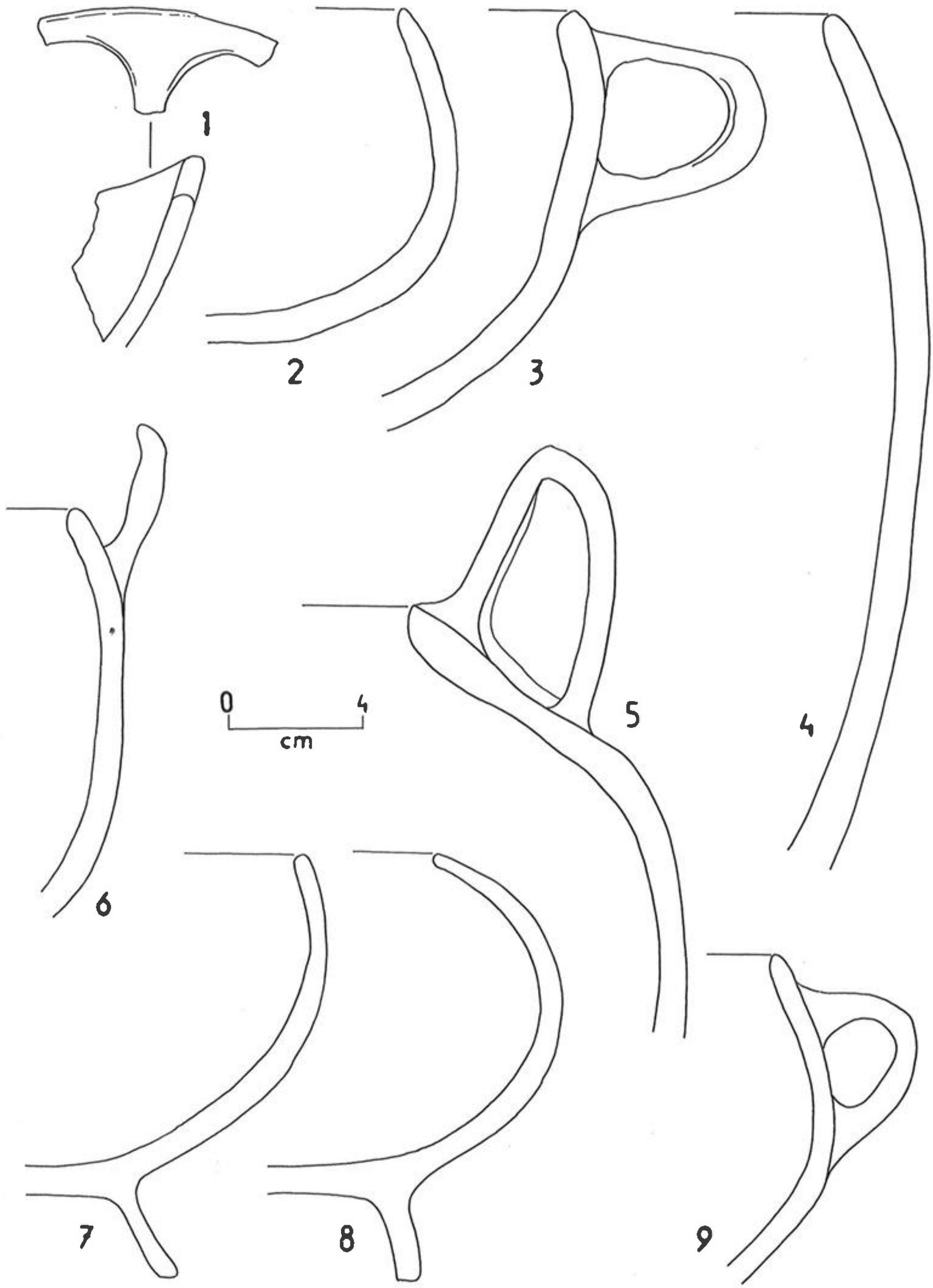

Figure 3. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (1,4) and Great Courland Bay (2-3,5-9): (1) Vessel form 2; (2) Base form A; (2-9) Vessel form 3 and Rim type 1; (3,5,9) Handle type 1; (7-8) Base form E.

orifice diameters not exceeding 38 cm, while the low-quality specimens tend to be larger, exhibiting medium to large proportions. Besides, the coarse-ware forms often show fire traces. The high-quality and low-quality ceramics of this vessel shape may have been used for similar purposes as those of Form 1.

Form 4. Dish or bowl with restricted orifice, showing composite contours (Figures 4:1-10, 8:5, 13; Boomert and Kameneff 2003, Figure 1). This characteristic vessel shape, which is circular in cross section, is exclusively made of high-quality ceramics. It shows a predominantly convex, rarely concave profile above its corner point and represents the second most popular vessel form. Orifice diameters vary between 14.0 and 38.0 cm. This the 'Angular Inturned Bowl' of Harris (1978) and the 'well finished *Cazuela*' of Harris (1980). It includes forms B1, B12-14, B21, and B23 of Kameneff and Merlin (1994). Vessels of this shape are typically small to medium in size. These dishes obviously served similar ends as the fine-ware pieces of Form 1.

Form 5. Bowl with probably restricted orifice and composite contours, showing a concave profile above its corner point (Figure 4:11). This is an extremely rare vessel shape of high-quality ceramics, circular in horizontal cross section, one piece of which was found by Kameneff at GCB in 1998. Its orifice diameter cannot be determined. This bowl form may have been utilised for similar purposes as the high-quality ceramics of Form 1.

Form 6. Bowl or jar with independent restricted orifice, showing inflected contours. This vessel shape, which is circular in horizontal cross section, is occasionally provided with handles (Figures 5:1-9, 15). It is the second most popular vessel shape. Orifice diameters vary between 7.0 and 42.0 cm. No preference for either high-quality or low-quality ceramics can be shown. This is the '*Canari*' of Harris (1978) and the 'well finished Small Urn', 'well finished Vase', 'coarse paste Necked Bowl' and 'coarse paste Necked Inturned Bowl' of Harris (1980). It includes forms B15 and S24 of Kameneff and Merlin (1994). Vessels of this shape are typically medium to large in size. Both the high-quality and the low-quality pieces of this vessel shape may have been used for the storage of liquids, possibly the fermenting of cassava beer.

Form 7. Bowl or jar with independent restricted orifice, showing composite contours. This vessel shape, which is circular in horizontal cross section, is occasionally provided with handles (Figures 6:1-2, 16). Orifice diameters vary between 16.0 and 22.0 cm. This vessel shape is exclusively made of low-quality ceramics. It includes form S3 of Kameneff and Merlin (1994). Vessels of this form are medium in size and probably served as cooking pots.

Form 8. Jar with restricted orifice, showing complex contours. It shows a wide, biconical upper part, resting on a high pedestal-like lower portion which is only partially known (Figures 6:5, 7:1). This extremely rare vessel shape, which is circular in horizontal cross section, is of medium proportions and exclusively made of high-quality ceramics. Two examples were encountered by Kameneff at GCB in 1998. The orifice diameter of this pedestalled jar is about 28 cm. This is a vessel with yet undetermined, probably ritual, functions.

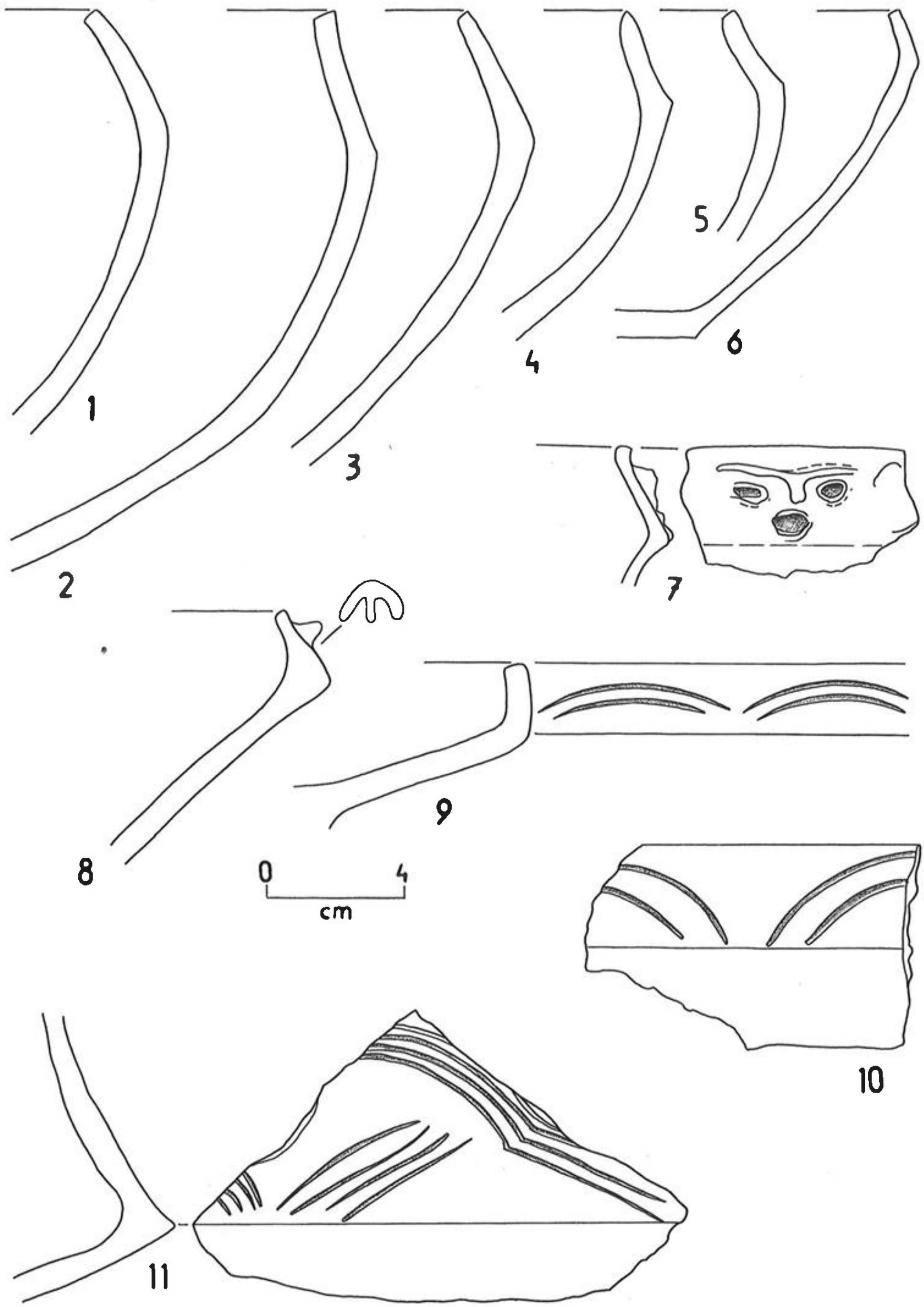

Figure 4. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (1-3) and Great Courland Bay (4-11): (1-10) Vessel form 4; (1-3,5-6) Rim type 2; (4) Rim type 1; (6) Base form B; (7) Complex modelling Motif 1; (9-11) Incising and gouging Motif 2; (11) Vessel form 5.

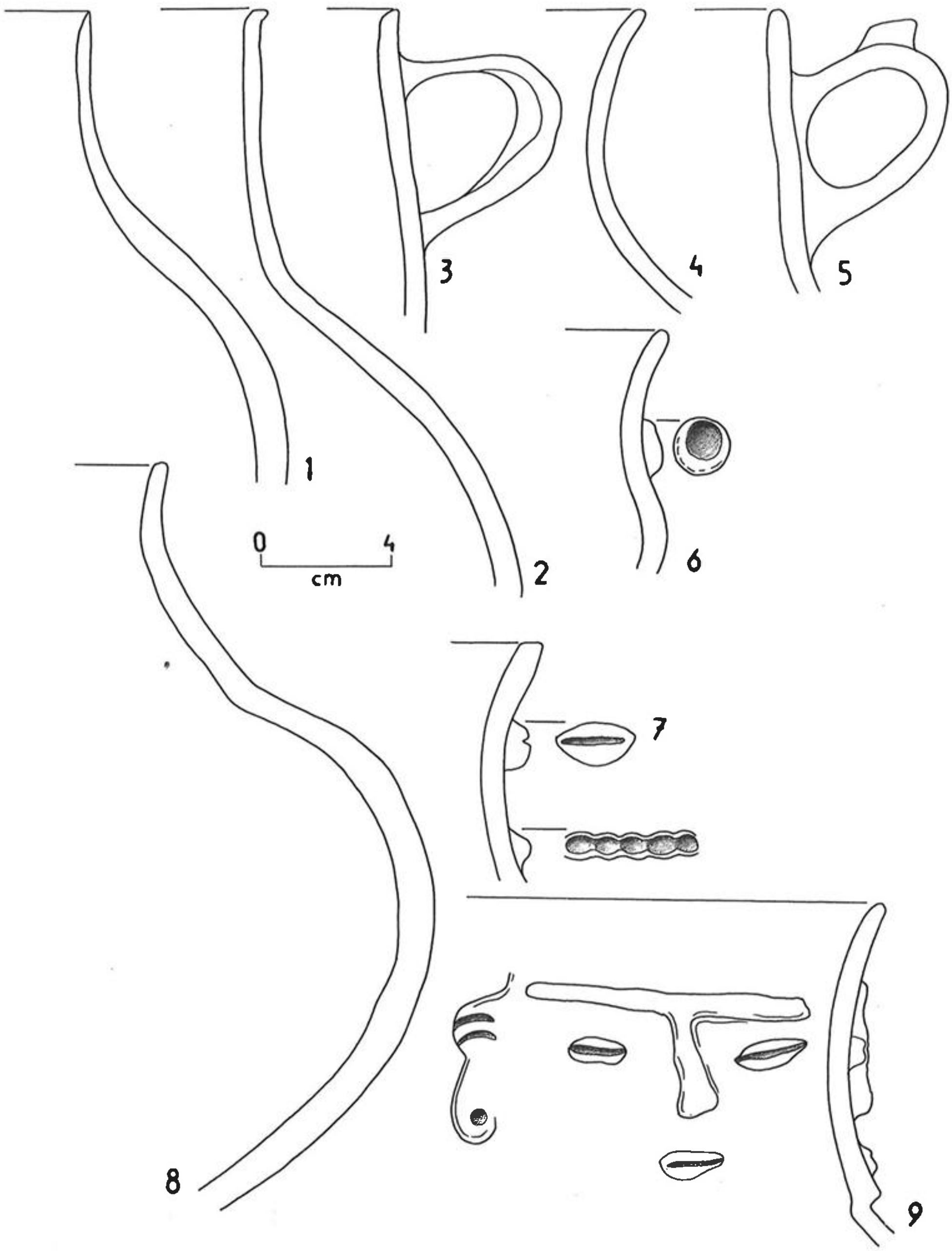

Figure 5. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (6) and Great Courland Bay (1-5,7-9): (1-9) Vessel form 6; (2) Rim type 4; (3,5) Handle type 1; (4-5,9) Rim type 1; (5-7) Simple modelling Motif 3; (7) Fingertipping; (9) Complex modelling Motif 1.

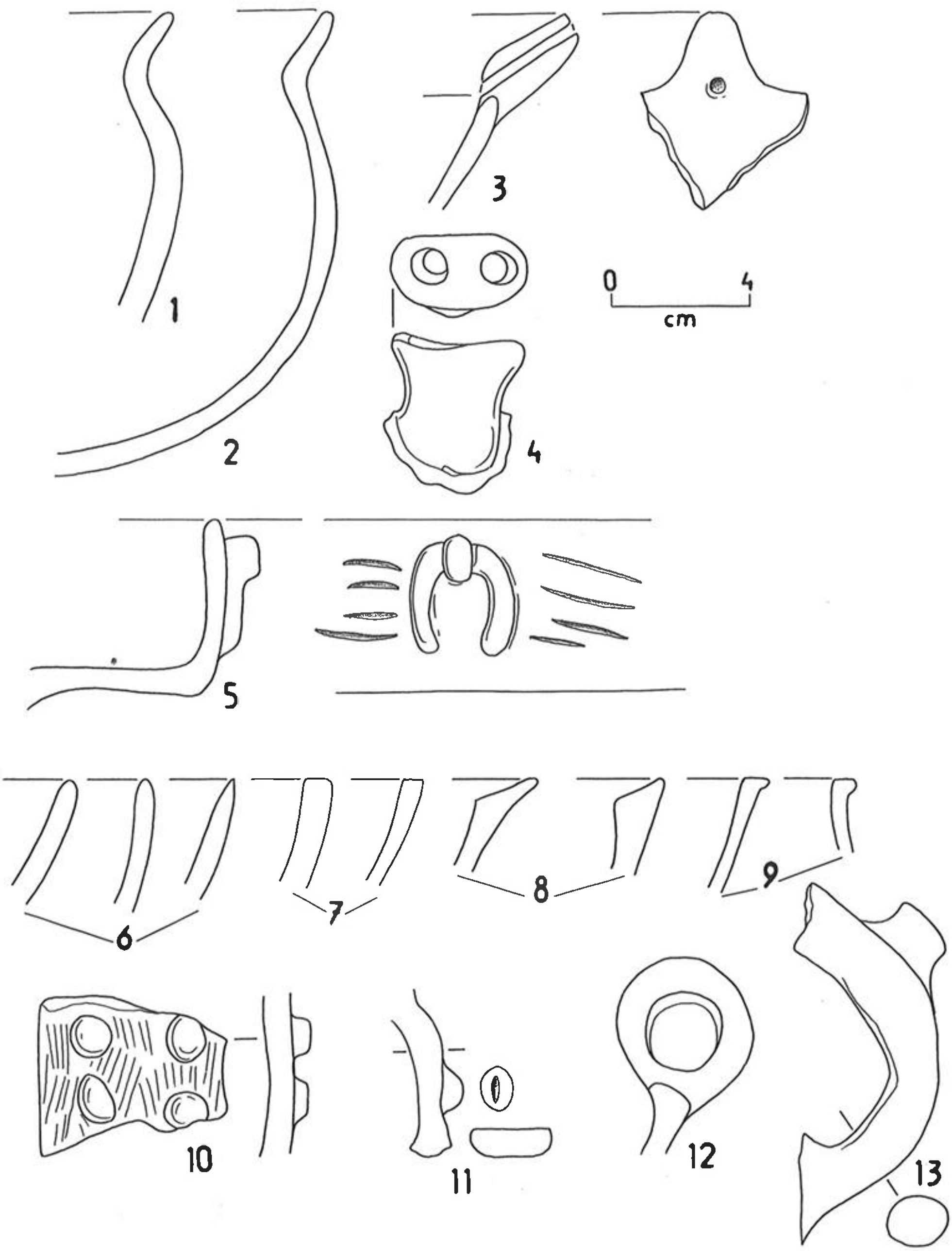

Figure 6. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (10-12) and Great Courland Bay (1-5,13): (1-2) Vessel form 7; (3-4) Vessel form 9; (5) Vessel form 8, Incising and gouging Motif 2 and Complex modelling Motif 3; (6) Rim type 1; (7) Rim type 2; (8) Rim type 3; (9) Rim type 4; (10) Handle type 1; (10-11,13) Simple modelling Motif 3; (11-13) Handle type 2.

Form 9. Bowl with unrestricted orifice, showing simple contours, provided with a heavy, once or twice longitudinally perforated trapezoidal extension (Figure 6:3-4). Its orifice diameter cannot be determined. This is the 'coarse paste Nose Vessel' of Harris (1980). Two examples of this form, both circular in horizontal cross section, were found by Kameneff at GCB in 1998. This rare vessel shape most likely represents a so-called 'nostril bowl' or 'sniffing bowl', used for either inhaling hallucinogenic drugs or, more likely, the pouring of tobacco juice into the nose during shamanic healing ceremonies.

Base forms

Six base forms, all circular in horizontal cross section, can be distinguished (Table 3).

Base A. Rounded to flat, showing an unmodified basal angle (Figures 2:11, 3:2, 7:2, 13:right). This represents the second most popular base form. It is associated with vessels of Forms 1, 3, 4, and 7. No preference for either high-quality or low-quality ceramics can be shown.

Base B. Flat, showing a pedestalled basal angle (Figures 4:6, 7:3). This rare base form is associated with vessels of Form 6. No preference for either high-quality or low-quality ceramics can be shown.

Base C. Concave, showing an unmodified basal angle (Figure 7:4). This rare base form shows no preference for either high-quality or low-quality ceramics.

Base D. Flat and solid, showing an unmodified basal angle (Figure 7:5-6). This rare base form apparently forms part of the pedestal-like lower portion of vessels of Form 8.

Base E. Annular ('ring-shaped'), showing an unmodified basal angle (Figures 2:1,5, 3:7-8. 7:7, 8:1, 13:left, 14). This represents by far the most popular base form which is predominantly associated with high-quality ceramics, especially vessels of Forms 1, 3, and 4.

Base F. Rounded, provided with four short feet which are triangular in horizontal cross section (Figure 7:8) Only a few specimens of this base form are known.

Rim types

Four rim types can be distinguished (Table 4).

Type 1. Direct, showing a rounded lip (Figures 2:2-5,8, 3:2-9, 4:4, 5:4-5,9, 6:6, 7:1, 8:1). This is the most popular rim type, associated with vessels of Forms 1, 3, 4, 6, and 7.

Type 2. Direct or occasionally somewhat swollen, typically showing a flattened lip (Figures 2:1,12, 4:1-3,5-6, 6:7). This is another popular rim type, equally associated with vessels of Forms 1, 3, 4, 6, and 7.

Type 3. Interiorly thickened and bevelled, showing a rounded lip (Figures 2:9, 6:8). This is a less common rim type, associated with vessels of Forms 1 and 3.

Type 4. Exteriorly thickened, showing a rounded lip (Figures 2:10, 5:2, 6:9). This is a rare rim type, associated with vessels of Forms 1, 6, and 7.

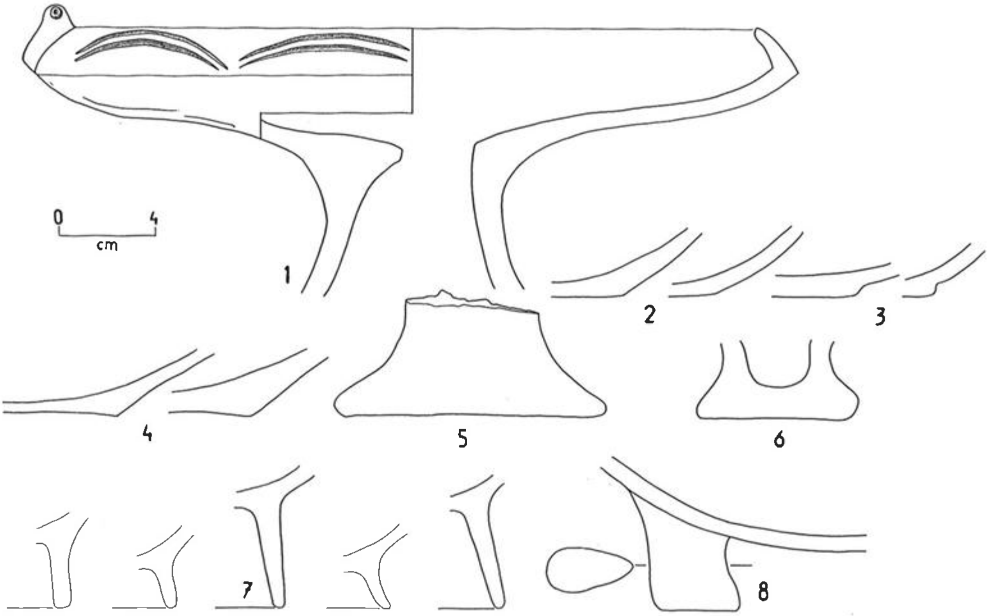

Figure 7. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (6) and Great Courland Bay (1,5,8): (1) Vessel form 8, Rim type 1, Incising and gouging Motif 2, and Complex modelling Motif 2; (2) Base form A; (3) Base form B; (4) Base form 4; (5-6) Base form D; (7) Base form E; (8) Base form F.

Handle forms

Two handle forms are known (Table 5).

Type 1. Vertical, D-shaped, and strap-like in cross section (Figures 3:3,5,9, 5:3,5, 6:10, 10:1, 15-16; Hill Harris 1988, Plate VII). This is by far the most popular handle form. It is associated with vessels of Forms 1, 3 and 7.

Type 2. Vertical, D-shaped, and rod-like in cross section (Figures 6:11-13). This form is extremely rare.

Decorative techniques and motives

According to potsherd numbers, in all 2.2% (LRC) and 7.3% (GCB) of the Plymouth complex ceramics show some form of ornamentation. The decorated pottery predominantly comprises high-quality ceramics: 78.0% (LRC) and 83.2% (GCB) of the decorated potsherds belong to the Fine Ware and Medium Ware categories (Table 6). The various vessel shapes show significant differences as to their being decorated or not.

While in terms of potsherds most vessels of Forms 1, 3, 6, and 7 are undecorated, a majority of Form 4 vessels typically show some kind of ornamentation (Table 7). Six techniques of decoration can be distinguished, i.e., (1) incising and gouging, (2) punctating and nicking, (3) fingertipping, (4) painting, (5) simple modelling, and (6) complex modelling (Table 8).

Incising and gouging. This is the most popular technique of ornamentation, occurring on 66.9% of the decorated potsherds. The linear design elements are relatively narrow and U-shaped in cross section, measuring 1-5 mm, predominantly 1.5-2.0 mm, across. Lines were applied with a stylus with rounded end or, more likely, a small gouge made of a bird bone or perhaps a hollow reed (Mr. Loe F.H.C. Jacobs, pers. commun.). Three motifs can be distinguished: (1) single or multiple, horizontal, oblique or vertical straight lines below the rims on the inside or outside of vessels of Forms 1, 3, 5 and 6 and on appendages attached to the rims of Form 1 vessels (Figures 8:2, 9:3,8,10-12, 10:6); (2) single or multiple, curving or wavy lines, semicircles or arcs and circles on the outside of vessels of Forms 1, 3, 4, 5, 6, and 8, appearing as individual motifs on, e.g., Forms 3, 4 and 8, or associated with simple modelled appendages on Form 1 (Figures 4:9-11, 6:5, 7:1, 8:1,5, 13-14; Boomert and Kameneff 2003, Figure 1); and (3) friezes consisting of combinations of one or two parallel, horizontal of somewhat arc-shaped, relatively long lines alternating with one or two parallel, vertically placed, short lines, applied to rims of Types 2 or 3 belonging to Form 1 open bowls (Figures 8:3-4, 9:1, 10:2). On average, motifs (1), (2) and (3) include 19.4%, 73.1% and 7.5%, respectively, of the potsherds decorated with incised or gouged designs at LRC and GCB. Motif (2) is especially popular in association with the high-quality biconical bowls of Form 4 (58.1%).

Punctating and nicking. This decorative technique encompasses 14.4% of the decorated potsherds. Three motifs can be distinguished: (1) series of impressions applied with a bird bone or hollow reed, occasionally showing a damaged tip, associated with vessels of Forms 1, 3, and 5 (Figure 8:8-9); (2) rows of notches or short gashes on the squarish or bevelled rims of Types 2 and 3 of vessels of Forms 1 and 4 (Figures 9:6, 10:2); and (3) shallow, round or ovalish punctations, applied with a broad stylus with rounded end, occurring singly or in combination with incised/gouged designs on vessel walls, on rims of Types 2 and 3 or on simple modelled appendages as well as associated with complex modelled anthropomorphic face designs on Form 1 vessels (Figure 9:1-3).

Fingertipping. In all 14.8% of the decorated potsherds show this technique of ornamentation. Designs include single rows of fingertips occurring on the round or squarish rims of Types 1 and 2 of Forms 1 and 3 vessels as well as at the neck base of Form 6 jars (Figures 2:7, 5:7).

Painting. This is an extremely rare technique, which is known only from three potsherds found by Kameneff during his excavations at Great Courland Bay in 1998 and one piece collected at this site by Thomas C. Cambridge in the 1940s or 1950s. The painted designs encompass irregular black lines, measuring 4-10 mm across, perhaps applied with the fingertips to the vessel surface which was previously covered with a glossy light-brown slip. Motifs include: (1) rows of crude semicircles placed on the

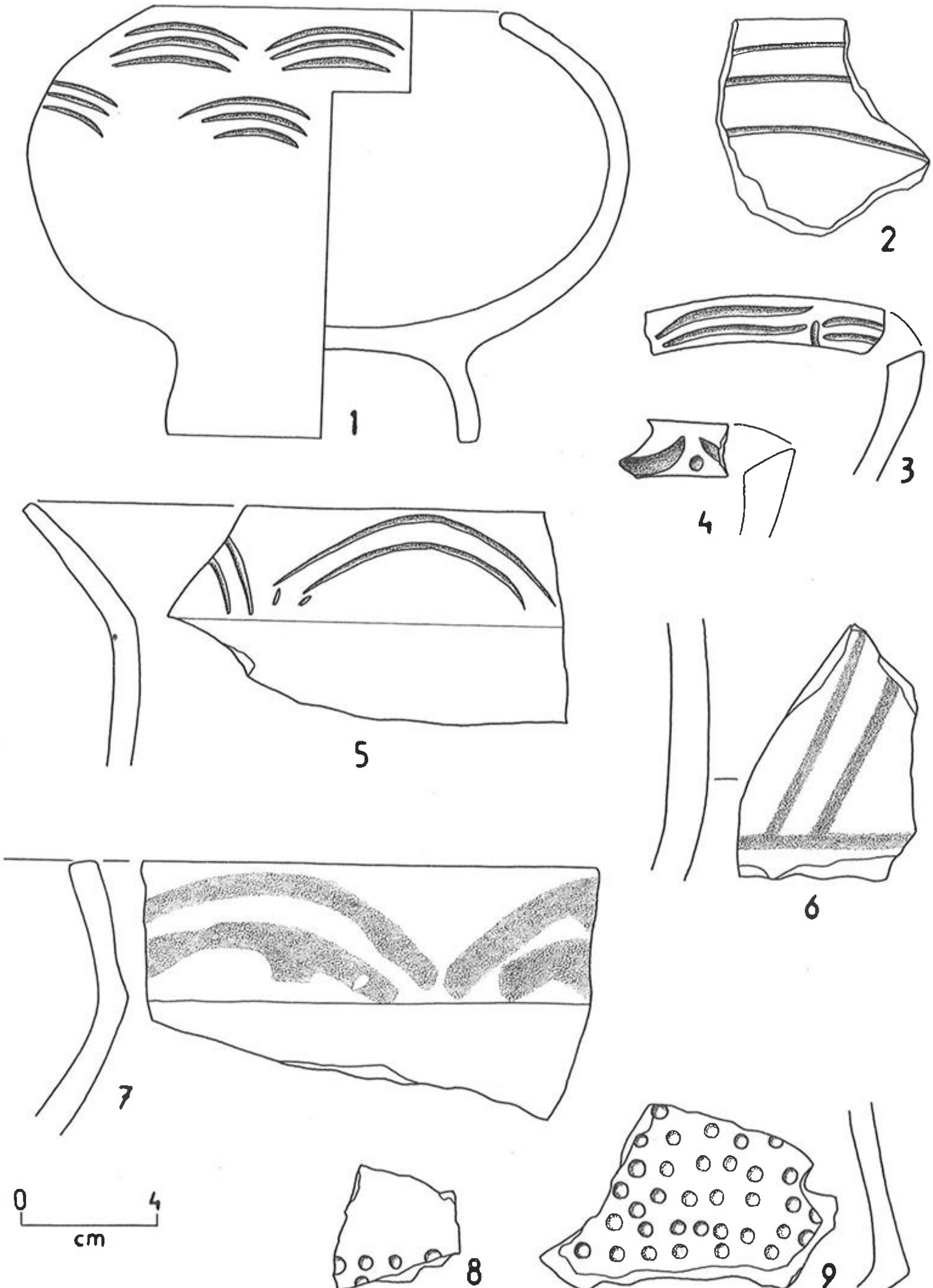

Figure 8. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (2,4) and Great Courland Bay (1,3,5-9): (1) Vessel form 3 and Base form E; (1,5) Incising and gouging Motif 2; (2) Incising and gouging Motif 1; (3-4) Incising and gouging Motif 3; (5) Vessel form 4; (6) Painting Motif 2; (7) Painting Motif 1; (8-9) Punctating and nicking Motif 1.

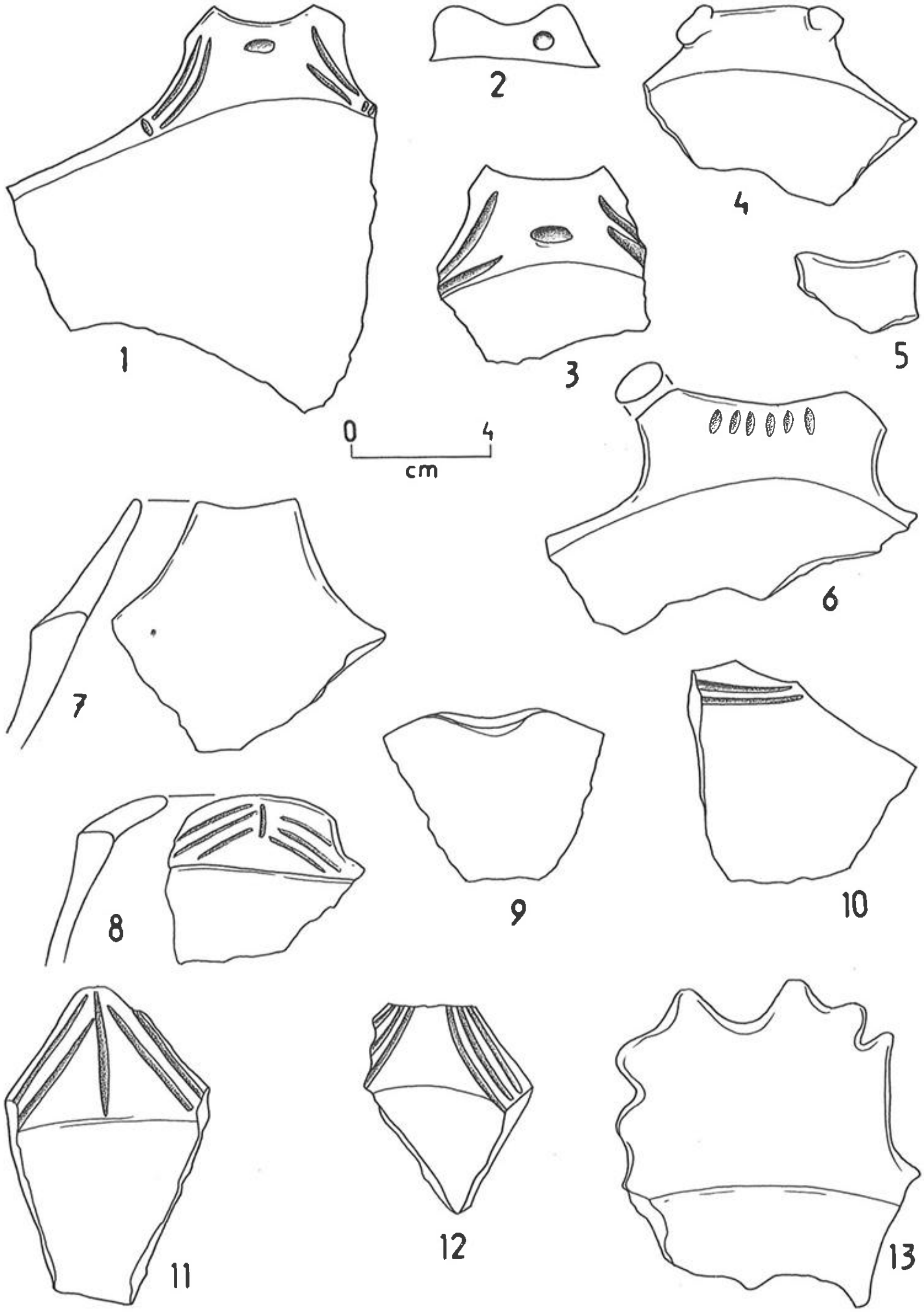

Figure 9. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (3,5,8-9) and Great Courland Bay (1-2,4,6-7,10-13): (1) Incising and gouging Motif 3; (1-3) Punctating and nicking Motif 3; (1,3-8,10-13) Simple modelling Motif 1; (3,8,10-12) Incising and gouging Motif 1; (6) Punctating and nicking Motif 2; (9) Simple modelling Motif 4.

upper portion of a carinated bowl of Form 4 (Figure 8:7); and (2) fields of straight or hooked lines, covering the exterior of probably Form 6 vessels (Figure 8:6). This technique may represent a local imitation of the delicately painted linear designs in black on red or buff shown by the contemporary Caliviny Polychrome ceramics of the Windward Islands and Barbados. Alternatively, these Tobagonian pieces may represent 'trade' pottery from the Windwards or Barbados (Boomert and Kameneff 2003).

Simple modelling. This is the second most popular technique of ornamentation, shown by 21.7% of the decorated potsherds. Four motifs can be distinguished: (1) simple triangular, trapezoidal, semicircular or 'horned' lugs, occasionally showing undulating sides, typically attached to the rims of open bowls of Form 1 (Figures 2:8, 9:1,3-8,10-13, 10:2,6; Boomert and Kameneff 2003, Figure 2; Hill Harris 1988, Plate IX); (2) ovalish, wedge-shaped appendages, showing a flat upper side, placed on top of the rim of a Form 1 open bowl (Figures 11:3, 12:1); (3) round or oval single or double, plain or punctated, knobs, placed on the rims, walls or handles of vessels of Forms 1, 4, and 8 (Figures 5:5-7, 6:10-11,13, 10:1); and (4) rim depressions, only occurring on Form 1 vessels (Figure 9:9). On average, motifs (1), (2), and (3) include 56.1%, 2.4% and 41.5% of the potsherds decorated with simple modelled designs at LRC and GCB.

Complex modelling. This is a rare technique of ornamentation, including only 3.7% of the decorated potsherds. It encompasses a number of designs, often showing complex modelling associated with incised/gouged and puntated/nicked decorative elements. Two motifs can be distinguished: (1) anthropomorphic face designs, often consisting of modelled arching eyebrows and noses, appliquéd to the vessel wall, next to 'coffeebean' eyes, associated with vessels of Forms 1, 4 and 6 (Figures 4:7, 5:9, 10:2-5; Boomert and Kameneff 2003, Figure 3); (2) anthropozoomorphic head lugs, often representing frogs and birds, attached to the rims and walls of vessels of Forms 1, 4, and 5 (Figures 7:1, 10:6-16, 11:1, 12:1); and (3) geometric head lugs of variable execution, attached to Forms 1 and 4 (Figure 6:5). Open, triangular lugs, consisting of three joined clay 'pillars', belong to this category (Figure 11:2). Interestingly, the Speyside 2 site yielded a rimsherd decorated with a small anthropozoomorphic headlug in low relief showing two 'eyes' consisting of tiny knobs impressed with a hollow reed or bird bone, which closely resembles similar *adornos* of the Cayo and Koriabo complexes in the Windward Islands and the Guianas, respectively (e.g., Boomert 2004, Figure 4:4).

Ceramic artifacts

Eight types of pottery artifacts have been found at LRC and GCB, i.e., (cassava?) griddles, vessel supports ('pot rests'), spindle whorls (?), an ear plug, pendants, beads, pestles ('loom weights'), and figurines.

Griddles. These represent the most frequently encountered category of pottery artifacts: in all 49 fragments are known from the LRC and GCB collections discussed here. They are typically made of low-quality ceramics, predominantly Coarse Scratched Ware, and show uneven, often somewhat crinkled or scratched bottom sides. Griddle

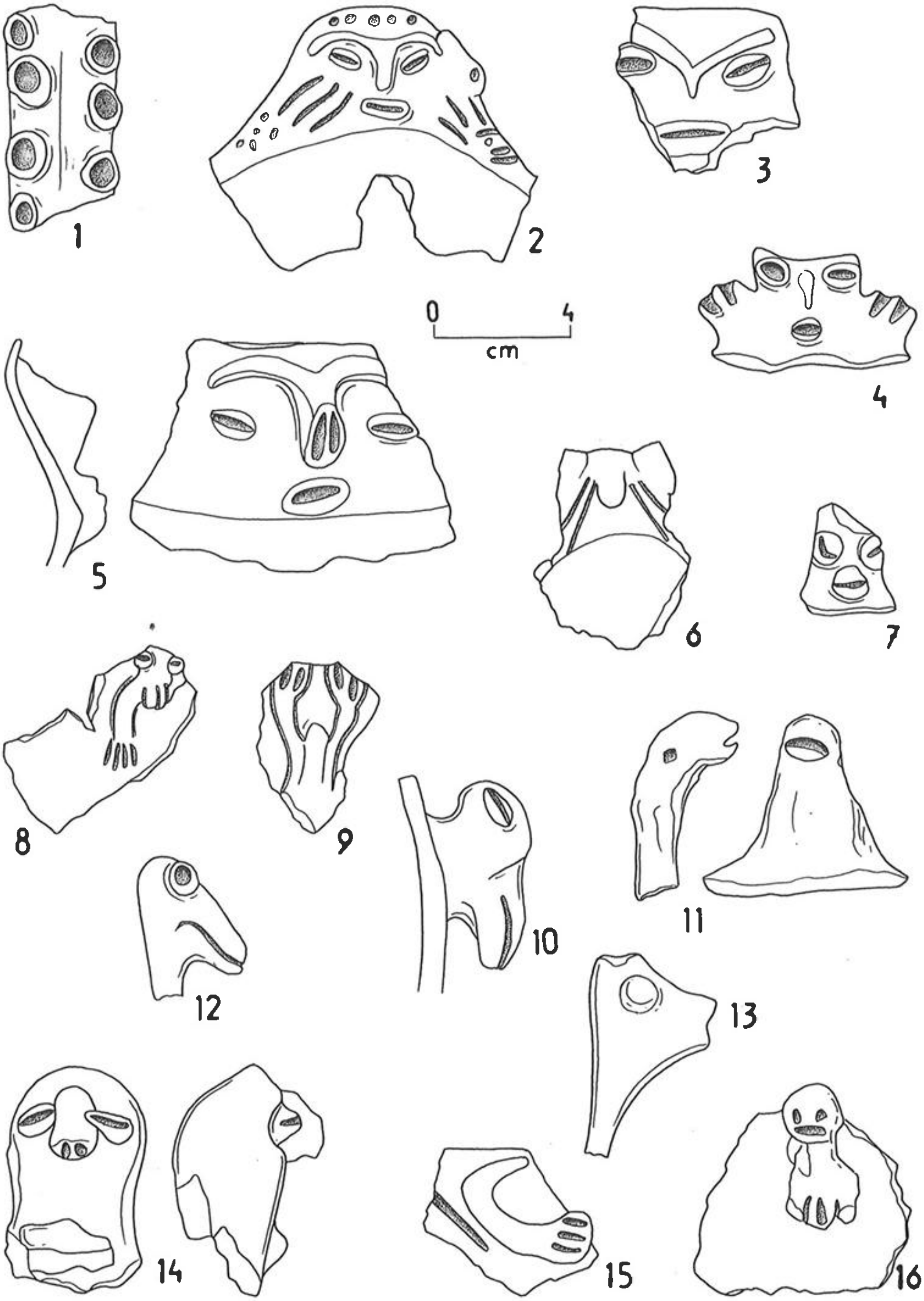

Figure 10. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (6-7,11,14) and Great Courland Bay (1-5,8-10,12-13,15-16): (1) Handle type 1 and Simple modelling Motif 3; (2) Incising and gouging Motif 3 and Punctating and nicking Motif 2; (2-5) Complex modelling Motif 1; (2,6) Simple modelling Motif 1; (6) Incising and gouging Motif 1; (6-16) Complex modelling Motif 2.

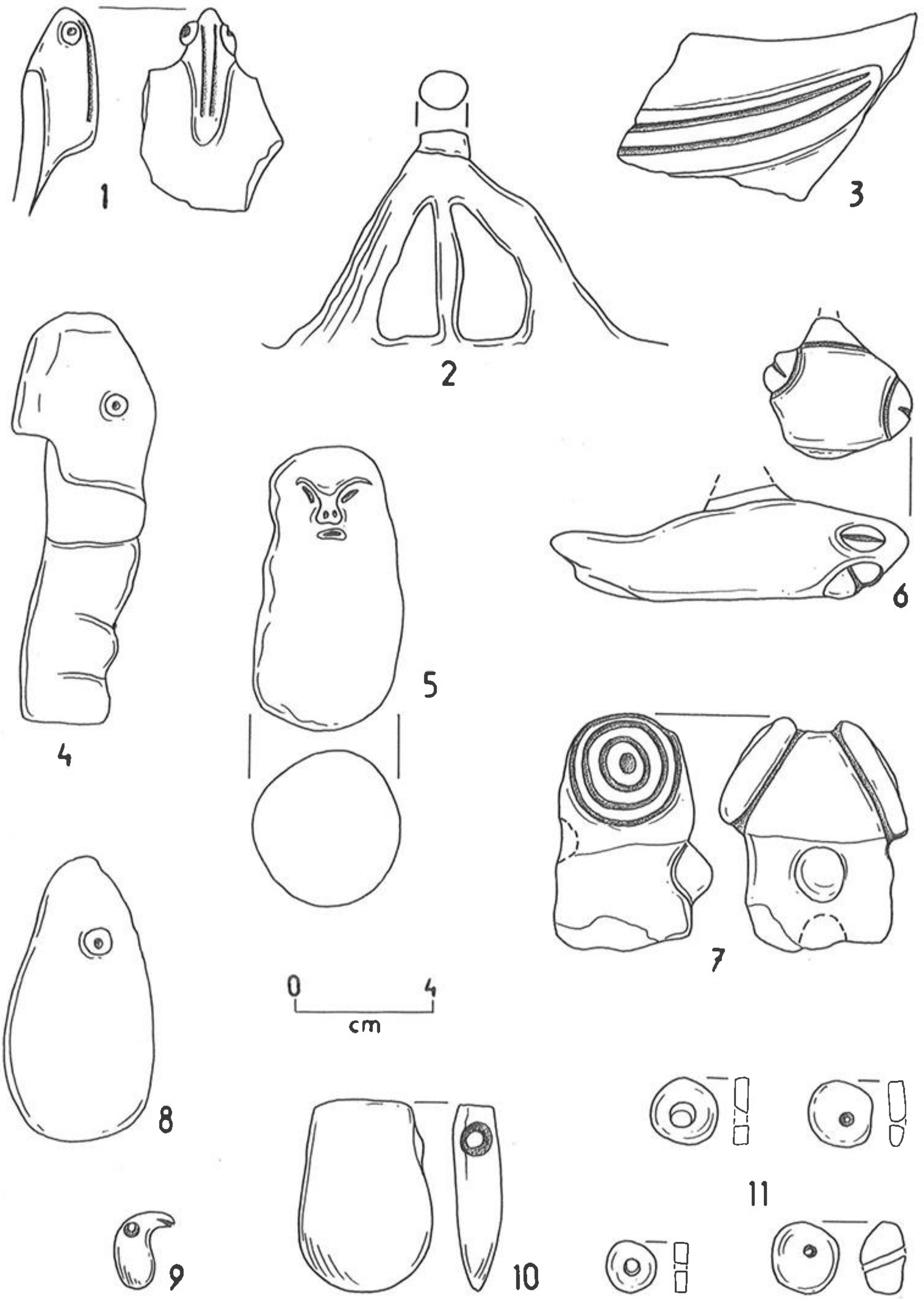

Figure 11. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (1,7) and Great Courland Bay (2-6,8-11): (1) Complex modelling Motif 2; (3) Simple modelling Motif 2; (4,6-7) Figurines; (5,8) Pestles; (9-10) Pendants; (11) Beads.

diameters vary between 35 and 52 cm; thickness varies between 10 and 21 mm. Two types are known: (1) platters provided with flat, unmodified or slightly upturned rims, most likely utilised for the processing of both discs of cassava bread and pellets (Figure 12:5); and (2) similar platters provided with three or four massive slab-like, triangular feet. In addition, such a heavily scratched griddle foot was encountered by Geoffrey H.S. Bushnell at LRC in 1955 (Bushnell n.d.: 15; Hill Harris 1988, Plate VII), while another one was found at this site by Harris in 1976 (Figure 12:4).

Vessel supports. These artifacts, also known as 'pot rests', are ring-shaped and made of low-quality ceramics. Diameters vary between 11.5 and 14.0 cm. In all 17 fragments have been found (Figure 12:8).

Spindle whorls (?). Two centrally perforated discs of low-quality ceramics, found during Kameneff's excavations at GCB in 1998, may represent spindle whorls. Diameters vary between 7 and 9 cm, thickness between 5 and 8 mm (Figure 12:6-7).

Ear plug. A coarse-ware ear plug was encountered by Kameneff during his excavations at GCB in 1998. Its diameter is 3.0 cm (Figure 12:2).

Pendants. A tiny bird-shaped pendant of high-quality ceramics was found by the author at GCB (Figure 11:9) while Kameneff encountered two coarse-ware axe-shaped pendants with transversal perforations at this same site in 1998 (Figure 11:10).

Beads. Four beads of low-quality ceramics are known from Kameneff's excavations at GCB in 1998. Diameters vary between 1.4 and 1.9 cm; thickness between 1.3 and 0.4 cm (Figure 11:11; Boomert and Rogers 2007, Figure 3).

Pestles. Two pottery artifacts resembling pestles have been recovered from GCB during Kameneff's excavations of 1998. Both measure 8.2 cm in height, are horizontally perforated and show circular cross-sections. One of them is decorated with an anthropomorphic face design with arching eyebrows on its upper portion (Figure 11:5); the other one shows only a partial face (Figure 11:8). A third specimen, possibly found by Thomas C. Cambridge in the 1940s or 1950s at GCB, only has two eye-like hollows; it measures 6.8 cm in height (Figure 12:3). Similar pestle-like objects from contemporary sites in the Windward Islands and Barbados have been interpreted as 'loomweights'. More likely, they represent pestles used for pulverizing plant foods or perhaps hallucinary substances and originally belonged to the local shaman's religious/ceremonial paraphernalia.

Figurines. Part of a female figurine, showing arms, legs and prominent breasts, was found during Kameneff's excavations at GCB in 1998. It measures 11.9 cm in height (Figure 11:4). A less naturalistically modelled figurine shows a pregnant belly (Figure 11:7). Finally, a zoomorphic figurine in the shape of a shark was collected at the GCB site by Patricia Lewis about 2005; it is kept in her private archaeological collection (Figure 11:6).

Stone, bone, and shell artifacts

As this article is primarily concerned with the ceramics of the Plymouth complex, its non-pottery artifacts will be discussed only summarily.

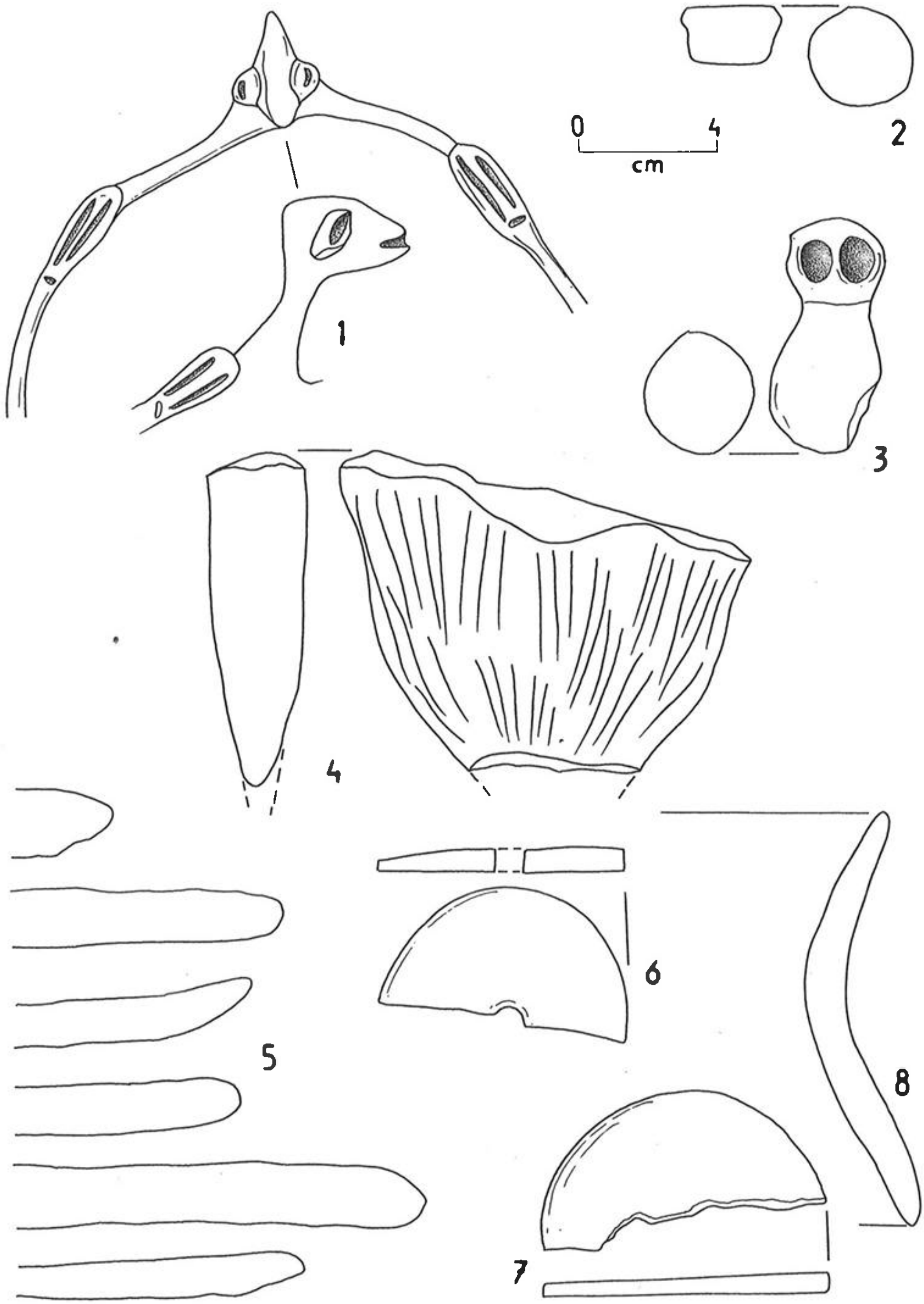

Figure 12. Pottery of the Plymouth complex, Tobago, found at Lovers'Retreat, Section C (4) and Great Courland Bay (1-3,6-8): (1) Simple modelling Motif 2 and Complex modelling Motif 2; (2) Ear plug; (4-5) Griddles; (6-7) Spindle whorls (?); (8) Vessel support.

Stone artifacts. The utilitarian stone artifacts found at the LRC and GCB sites comprise axe and adze heads, grinding stones and manos, coral rasps, hammerstones, pestles, anvils, various flake tools, discs, polishing stones, and stones with cupholes (Boomert and Rogers 2007; Harris 1980; Kameneff 1999: 44-50). The stone axe and adze heads, showing rounded, pointed and rectangular butts, represent the most common tool category. The largest ones are about 15 cm in length. All appear to have been made of local Tobagonian rock types, including greenstone, greenschist, serpentinite, andesite, and diorite. Several have been reused for other purposes after breakage, grounded into a more suitable form or used as hammerstones. Similarly utilitarian tools include grinding stones and manos, used for pulverizing wild and domesticated plant foods, and rasps, made of fossil coral of various species, which were presumably used for sharpening celts, polishing beads or even scaling fish. The tool kit was supplemented by stone pestles for mashing plant foods, hammerstones, various flake tools, employed for various purposes, anvils ('pitted stones') for cracking palm nuts, and polishing stones for smoothing pottery. Finally, stone discs may have been used as pottery lids, perhaps of jars of Form 6. They are 6-10 cm in diameter. The grinding and polishing tools are made of quartzite, andesite, diorite, sandstone, and quartz, the pounding tools of greenstone, metaconglomerate, andesite, diorite, and mudstone.

All other stone artifacts are non-utilitarian, including beads, pendants, and miniature axes (Boomert and Rogers 2007; Harris 1980; Kameneff 1999: 42-43). The locally made stone beads are button-shaped, barrel-shaped and cylindrical. Both bead blanks in various stages of manufacture and finished specimens have been encountered. Button-shaped beads, measuring 0.5 to 2.0 cm in diameter, are most numerous. Workshops specialised in manufacturing beads made of local Tobagonian diorite obviously existed at several Plymouth complex sites, including at least GCB and Bacolet (Boomert and Rogers, 2007, Figure 4). They continued the tradition of diorite bead making which started as early as Friendship (late Saladoid) and Golden Grove (Troumassan Troumassoid) times. In addition, Kameneff's excavations at the GCB site have yielded a cylindrical bead made of Tobagonian greenschist, and two biconical beads, made of quartz crystal, which most likely represent exchange objects from northern South America. The same applies to a turquoise pendant and a fragmentary ear plug, made of jet, which were equally encountered by Kameneff at GCB (Boomert and Rogers 2007, Figure 3; Kameneff 1999: 43). In contrast, another pendant and two blanks of pendants shaped as 'miniature axes' are made of local Tobagonian greenstone and greenschist.

Finally, a most interesting stone artifact found at GCB by the author is represented by a quite large and heavy local piece of sericite schist showing a group of three cup-shaped cavities on one face. A fragmentary second specimen of this same type of rock is provided with a series of five cupholes. Boulders showing groups of such round cavities, often associated with petroglyphs, are well known from the South American tropical lowlands and the West Indies (Dubelaar 1986: 4-5). The function of these cupholes is disputed; it has been suggested that they were used for grinding pigments or hallucinogenic substances.[7]

Bone artifacts. These are rare, encompassing an originally bipointed projectile point which was most likely used for tipping a fish spear and a broken peccary tusk which may originally have been worn as a pendant (Harris 1980; Kameneff 1999: 49).

Shell artifacts. These include scrapers made of Thick lucinas (*Phacoides pectinatus*), which may have been used for peeling cassava tubers or scaling fish, next to knives or chisels and a spatula-shaped artifact made of Queen conch wings (*Strombus gigas*) (Harris 1980; Kameneff 1999: 51).

Dating

Four radiocarbon dates of charcoal samples, collected by Kameneff during his excavations at the Great Courland Bay site, are available for the Plymouth complex. The results of three of these measurements are quite consistent, indicating that GCB was inhabited in the fourteenth century of our era. They confirm the estimated dating of the Plymouth complex, approximately A.D. 1150-1400/1450. Unfortunately, the fourth sample appeared to be contaminated with modern materials. The dates are: (1) Stratum F, 'zone' 6, 600±50 B.P. (Beta-129,265), i.e., cal A.D. 1299/1415; (2) Stratum E, 'zone' 4,

Figure 13. Fine Ware vessels found at Great Courland Bay (1998).
Left: Vessel form 4, Base form E and Incising and gouging Motif 2.
Right: Vessel form 4, Base form A and Incising and gouging Motif 2.

550±60 B.P. (Beta-129,264), i.e., cal A.D. 1307/1433; (3) Stratum A, 'zone' 5, 590±40 B.P. (Beta-129,262), i.e., cal A.D. 1305/1403; and (4) Stratum A, 'zone' 4, Modern (Beta-129,261). All measurements had a $^{13}C/^{12}C$ ratio of -25.0* per mil.

Cultural affiliations

The local Tobagonian evolution of Plymouth complex pottery from that of Golden Grove times is exemplified by comparing the respective fabric classes, form categories, and types of ceramic decoration. First of all, both complexes duplicate each other in terms of pottery wares and differ only with respect to the ratios of the various low-quality ceramic

Figure 14. Fine Ware vessel of Form 3 found at Great Courland Bay (1998), showing Base form E and Incising and gouging Motif 2.

categories. Coarse Scratched Ware appears to be significantly more abundant in the Plymouth complex than during Golden Grove times as opposed to Coarse Ware and Coarse Scraped Ware (Table 1). Similarly, the types of pottery artifacts encountered in Golden Grove context, notably cassava griddles, spindle whorls and vessel supports, are found back in the Plymouth complex. However, the latter assemblage shows a much higher variety of ceramic objects than Golden Grove, including an ear plug, pendants, beads, pestles showing anthropomorphic face designs, and figurines. Besides, footed griddles are restricted to the Plymouth complex. The dichotomy between the high-quality and low-quality wares in both the Plymouth and Golden Grove complexes clearly refers to comparable pottery functions and similar occupational and gender associations. It can be assumed that the high-quality vessels predominantly served purposes of ceremonial of at least non-domestic nature, e.g., the serving and keeping of cassava beer or food during individual meals or communal and inter-village gatherings. This implies that this ware was primarily associated with the male sphere of activities in the Golden Grove and Plymouth communities. The low-quality pottery obviously served exclusively in domestic contexts and, consequently, was affiliated with the female sphere of activities. Most likely the coarse ware vessels were used only for cooking next to food storage and as cassava-brewing containers.

The genetic relationship between the Plymouth and Golden Grove complexes is clearly shown by the respective vessel form categories. Several vessel shapes are identical: Plymouth Forms 1, 3, 5, 6/7, and 9 closely resemble Golden Grove Forms 1/2, 3, 5, 4, and 6, respectively (see Boomert 2005). In contrast, Plymouth Forms 2, 4 and 8 are unique, although the (high-quality) *cazuelas* of Form 4 may have developed out of Golden Grove Form 5. The latter shape is extremely rare in the Plymouth complex. Also, the large majority of Golden Grove and Plymouth base forms as well as rim types are quite comparable. Finally, the classes of ceramic ornamentation of both complexes show similarities as well as differences. With respect to decorative techniques, Plymouth and Golden Grove share the predominance of incised/gouged designs, followed by simple modelled ornaments, and the scarcity of painted/slipped and complex modelled decorative elements. The various incised/gouged and simple modelled motifs of both complexes exactly duplicate each other while this applies as well to most of the complex modelled motifs. In contrast, relatively popular Plymouth techniques as punctating/nicking and fingertipping are rare or even nonexistent in the Golden Grove complex. Besides, the typically Plymouth anthropomorphic face designs are lacking completely in the Golden Grove complex.

Although the Plymouth complex is clearly affiliated to the Suazan Troumassoid ('Suazoid') subseries of the Windward Islands and Barbados (Allaire 1991, 2003; Boomert 1987; Bullen and Bullen 1976), it shows a number of specific ceramic features suggesting that Tobago formed a separate stylistic zone within the Troumassoid interaction sphere, just as during Golden Grove times. While the same seems to apply also to Peak Bay, the local Suazan complex of Barbados (Hill Harris 1991, 2000, 2007a), the various Suazan pottery assemblages typifying the Windward Islands are sufficiently alike to consider them to form one extended, tightly-knit stylistic zone. These ceramic complexes include Suazey of Grenada (Bullen 1964: 48-52, 60-64; Bullen and Bullen 1968a; Cody Holdren 1998: 142-147, 161-167; Donop 2007), Miss Pierre of the Grenadines (Sutty 1976, 1990), Fitz-Hughs of St. Vincent (Bullen and Bullen 1972: 142-147, 161-167), Fannis of St. Lucia (Bullen and Bullen 1968b, 1970; Bullen et al. 1973; Friesinger 1986; Harris 2001; Hofman and Bright 2004; McKusick 1960: 116-119, 149-151), Macabou of Martinique (Allaire 1977: 317-327, 1981; Vidal er al. 2004), and Soufrière of Dominica (Petitjean Roget 1978). Beyond the latter island, Terre-de-Bas, Les Saintes, and La Désirade in the Guadeloupe archipelago have yielded the northernmost clearly Suazan Troumassoid sites (de Waal 2006: 219-234, 253, 286-291; Hofman 1995; Hofman et al. 2004). Obviously the individuality of the Suazan Troumassoid assemblages of Barbados and Tobago is due to the geographically marginal position with respect to the Windward Islands of both islands. Besides, in the case of Tobago cultural influences from Trinidad and the South American continent, reaching Tobago across the Galleons' Passage, may have played a role. The position of the island in terms of Amerindian communication with the mainland is illustrated by the documentary evidence indicating that in early historic times Tobago formed an indispensable midway station for the Amerindians of the Windwards travelling by canoe to the coast of the Guianas vice versa (Boomert, 2002).

The characteristic vessel shapes and decorative motifs of the Plymouth complex illustrate Tobago's special position within the Suazan interaction sphere. Annular-based carinated bowls or dishes (*cazuelas*), comparable to those (Form 4) which dominate Plymouth high-quality ceramics, are well known from the Troumassan and Suazan communities of the southern Lesser Antilles. However, in the Windward Islands and Barbados the typically Tobagonian ornamentation of these *cazuelas*, consisting of rows of incised or gouged semi-circles (Motif 2) on the incurving upper parts of these vessels, is replaced by Caliviny Polychrome black-painted linear designs on red- or buff-coloured burnished surfaces, typically consisting of scrolls or parallel wavy lines, rarely rows of semi-circles (e.g., Bullen and Bullen 1968b). The presence of potsherds at GCB crudely imitating Caliviny painting suggests influence from and direct contacts with the Windwards, but simultaneously, together with the Tobagonian replacement of painting by incision or gouging, a lack of local technological abilities to reproduce the fine-line painted Caliviny designs. Conversely, a high-quality piece encountered at the Heywoods/Port St. Charles site in Barbados, which shows a series of fine-line incised arches 'unusual for Barbados' (Hill Harris 2001), may represent a Suazan exchange item from Tobago.

Similarly, the common Plymouth high-quality round or oval-shaped effigy bowls or dishes (Form 1) are duplicated in the Windwards and Barbados. The same applies to the characteristic simple-modelled triangular, trapezoidal, semicircular or 'horned' lugs attached to these vessels. Such lugs, showing round perforations, punctations or depressions, are known from the Troumassoid ceramics of the Windward Islands and Barbados, but similarly pierced 'horned' *adornos* have been encountered in the Bontour complex of the Arauquinoid Guayabitan subseries of Trinidad as well (Boomert 1985). Consequently, the source of inspiration of these Suazan zoomorphic lugs is still undetermined. The Plymouth complex high-quality necked jars (Form 6), showing anthropomorphic face designs executed in typically Suazan fashion, also find close parallels in the Guayabitan subseries and contemporaneous Arauquinoid complexes of the South

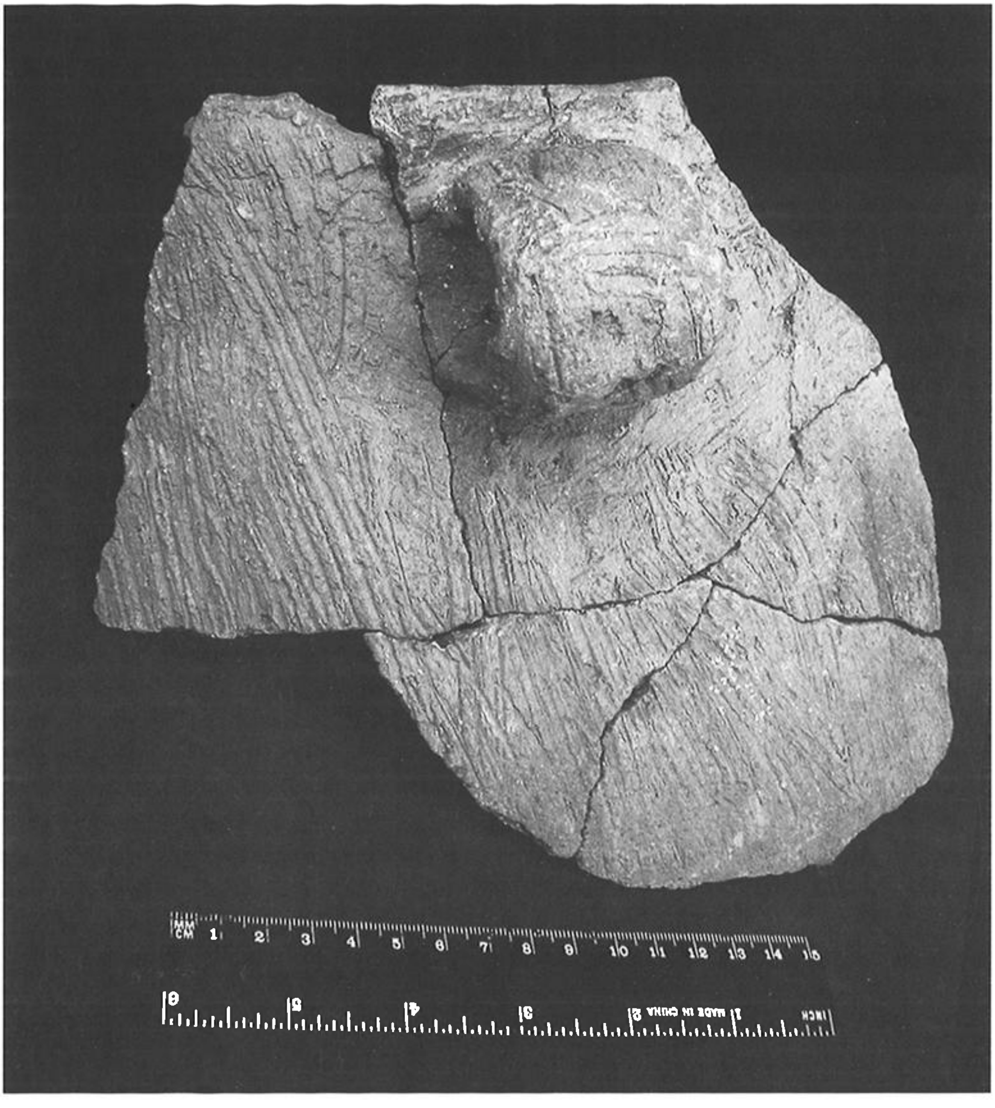

Figure 15. Coarse Scratched Ware vessel of Form 6 found at Great Courland Bay (1998), showing Handle type 1.

American mainland. Such jars are virtually unknown from the Windward Islands where practically all Suazan anthropomorphic representations form part of rim lugs. However, they have been encountered in Barbados. An apparent 'trade' piece from Tobago, showing a complex modelled anthropomorphic face design on the neck of a 'polished, red-brown vessel [...] unlike anything seen in Barbados', was recovered from the Silver Sands site (Hill Harris 1991, Figure 52:174, 2000).

Rare Plymouth vessel shapes such as the compartmental or divided vessels of Form 2, the nostril bowls of Form 9 and the high pedestalled jars of Form 8 find their counterparts in both the Windward Islands and Barbados. For instance, compartmental vessels are reported from Suazan contexts at Caliviny Island, Grenada (Bullen and Bullen 1968a), and Grand Bay, Carriacou (Hill Harris 2007b). High pedestalled or footed (tripod) vessels are known from the entire Suazan interaction sphere (e.g., Friesinger 1986) while the same applies to footed griddles and ceramic pestles ('loomweights') showing anthropomorphic face designs, such as those from Tobago. The popularity of finger-tipped rims on the low-quality domestic pottery of Suazan Tobago closely resembles that in the Windwards and Barbados although this type of ceramic designs, including also fingernail marking, is most complex in the latter island. In contrast, heavy scratching of

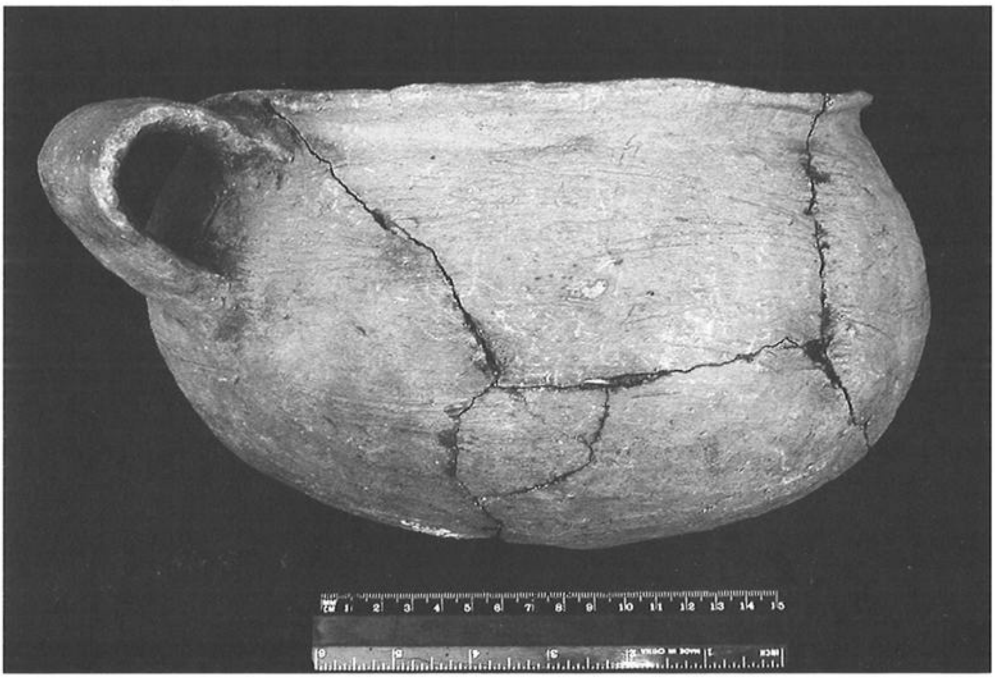

Figure 16. Coarse Scratched Ware vessel of Form 7 found at Great Courland Bay (1998), showing Handle type 1.

vessel surfaces, popular in Tobago as well as the Windward Islands and further north, is much less frequent in Suazan Barbados. Specific parallels can be noted with respect to the Tobagonian low-quality handles showing simple-modelled decorative rows of knobs along the edges (Motif 2) which have been reported as well from Caliviny Island, Grenada (Bullen and Bullen 1968a). Besides, the low-quality complex-modelled geometric *adornos* consisting of three joined clay 'pillars' (Motif 3) are known from both New Sandy Bay, St. Vincent (Bullen and Bullen 1972: 66), and Pointe de Caille/Saltibus Point, St. Lucia (Friesinger and Devaux 1983).

Perhaps the most intriguing category of Plymouth ceramic features includes the simple-modelled triangular, trapezoidal, semicircular or 'horned' lugs showing combined incised/gouged and punctated designs, which are typically attached to the rims of mostly ovalish bowls of Form 1. These lugs suggest zoomorphic features, notably the heads, folded-up wings and tails of bats, indicating that the high-quality open bowls in question represent effigy vessels. A special iconographic symbol is formed by a round perforation, an incised circle or an elongated punctation in the centre of the lug. Interestingly, many contemporaneous Chicoid (Taíno) vessels from Hispaniola and Puerto Rico are provided with bat-shaped handles similarly showing centrally placed perforations (e.g., García Arévalo 1997). According to Pané (1999: 18-19), the Taíno believed that bats embodied the shades of the deceased who came out at night to feast on guava fruits. For them, bats and owls typically formed nocturnal images of death. They presumed that the deceased went to a remote island region ruled by a spirit, Maquetaurie Guayaba, which was imagined as a creature showing compound bat-owl features (Stevens-Arroyo 2006: 149-150, 232, 243). The Island Caribs held similar ideas (Boomert 2000: 448). Moreover, the Taíno were convinced that spirits in general lacked navels and that as such the souls of the dead can be easily distinguished from the living. It was pointed out by García Arévalo that the circular perforations in the bat-shaped Chicoid vessel handles allude to the presumed lacking of navels by the shades of the deceased, embodied as bats (Arrom and García Arévalo 1988: 51-52). This, clearly, can be taken to be the meaning of the centrally placed holes or incised circles on the lugs of the Suazan bat effigy bowls as well.

The question remains whether the striking similarity between the symbolism shown by the bat-shaped pottery vessels of the Greater Antilles and the Windward Islands can be attributed to direct contacts or to parallel developments deriving from the joint cultural heritage of the late-prehistoric Amerindian groups in both areas and beyond. Arguments can be put forward to support both explanations. As comparable simple-modelled triangular, trapezoidal, semicircular or 'horned' lugs symbolizing bats, associated with ovalish open bowls have been encountered in various complexes of the Arauquinoid series in Trinidad, the Orinoco Valley and the coastal zone of the Guianas as well (Boomert 1985, 2003), the origin of these effigy vessels is still quite enigmatic. Actually, they may even represent the outcome of stylistic influence from the mainland, just as the Suazan emphasis on anthropomorphic face designs which are similarly characteristic of the late-prehistoric Arauquinoid ceramics of the South American mainland

and Trinidad. On the other hand, as Allaire (1990) has pointed out, exotic-looking artifacts of probably ceremonial character showing strongly Chicoid iconographic features have been encountered at various Suazan Troumassoid sites in the Windward Islands, suggesting interaction between the Taíno and Suazan peoples which primarily operated at religious or esoteric levels. In the southern Lesser Antilles such objects are known from Dominica, Martinique, St. Lucia, St. Vincent and the Grenadines. Allaire believes that most of these artifacts form imitations or reduced models, i.e., were manufactured locally in the Windward Islands. On the other hand, it is quite possible that at least some of these objects represent actual exchange items which trickled down the Lesser Antillean archipelago to the south (e.g., Mol 2007). At any rate, they distinctly reflect the syncretic assimilation of foreign elements into the Suazan stylistic world.

Conclusions

Analysis of the ceramics of Tobago's Plymouth complex and their affiliations shows that the the Amerindian communities of the island formed a separate stylistic zone in the late-prehistoric Suazan Troumassoid interaction sphere of the southern Lesser Antilles. As study of the ancestral Golden Grove complex indicated (Boomert 2005), this special cultural position of Tobago dates back to early post-Saladoid times and is related to the mediating role, which the island may have played between the Windward Islands and Barbados on the one hand and Trinidad and the South American mainland on the other hand. Typically Cayo or Island Carib pottery elements are hard to find in Tobago although a few ceramic features associated with the Plymouth complex at least suggest some influence from this ceramic series.

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Notes

1. Floral investigation of the woodland sheltering much of the Great Courland Bay site indicated that a remarkable number of plant species known to have been used for medicinal or otherwise curative or practical purposes by the Island Caribs in the Windward Islands during the contact period are to be found in the area of the site (Kameneff, 1999: 6-7).

2. The name King Peter's Bay is a honorific toponym called after a Carib Indian who lived with his family in this area in the 1760s (Boomert 2002).

3. Further abbreviated as LRC and GCB, respectively.

4. Detailed fabric examination of a sample of potsherds from the Great Courland Bay site was undertaken by Loe Jacobs of the Ceramic Laboratory of the Faculty of Archaeology, Leiden University, under the auspices of the project 'Mobility and exchange: dynamics of the material, social and ideological relations in the pre-Columbian insular Caribbean' directed by Professor Corinne L. Hofman (see Jacobs 2007).

5. Asphalt deriving from underwater seepages offshore southeast Trinidad occasionally washes ashore on the leeward coast of Tobago; it was formerly used for medicinal purposes and burning in lamps as well as by fishermen for caulking their canoes (Boomert 2000: 31).

6. Although clearly a cultural trait dictated by a long-lived tradition of pottery making, surface scratching may have had a distinctly functional aspect. Deep, overall scratching enlarges the surface of a vessel and, consequently, it results in more rapidly warming up of the vessel's contents during heating (Rice 1987: 138).

7. Lumps of red and yellow ochre have been found at both LRC and GCB. A boulder encountered at an undocumented Tobago site, showing a group of ten cup-shaped cavities on one face and a second group consisting of two pits on another side, is kept in the TM.

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CONTEMPORARY TRADITIONAL POTTERY IN CENTRAL AND SOUTH MEXICO. ON COLONIAL TECHNICAL INTRODUCTIONS AND THEIR ASSIMILATION

Gilda Hernández Sánchez

Abstract

Today in Mexico there exists several traditions of pottery manufacture still using ancient methods. In some regions, pottery technology, form and function are very similar to that of pre-Hispanic times. In others, potters use various techniques introduced after the Spanish conquest of Middle America in A.D. 1521, and the pots appear different to those of pre-colonial times. Since the sixteenth century Mexican pottery traditions have changed with differing intensity and due to different reasons; however, it seems that the changes have mainly occurred in vessel shape and surface finishing rather than in the conceptualization of the pottery practice. Presented here are two cases of present-day traditions from Central Mexico that show that transformations in pottery manufacture since pre-colonial times have been more superficial than they look.

Introduction

In ancient Middle America pottery was used in domestic contexts for cooking, serving, storing and transporting, and also played a major role in ritual activities as offerings, ritual equipment, service ware for feasting, and even divine objects. Although the Spanish conquest of Middle America in A.D. 1521 had profound impact on the native civilisations and created new social systems in which both the indigenous and Spanish worlds coexisted and influenced each other, pottery retained its importance. Certain forms and decoration patterns disappeared; others were transformed as a result of newly introduced techniques, ideas and consumption patterns. Still others remained virtually the same.

Today in Mexico there exists several pottery manufacturing traditions spread throughout different regions. In some places, as in the Mixtec Highlands in South Mexico – far from urban centers and difficult to access-, pottery is still produced that is closely related to that of early times in technology, form and function. In other areas, like the valleys of Central Mexico – with big urban settlements –, potters use several techniques introduced after the Spanish conquest, and the pots appear different to those of pre-colonial times. Since the sixteenth century pottery traditions have changed with differ-

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ing intensity and due to different reasons. However, it seems that the changes have mainly occurred in vessel shape and surface finishing rather than in the conceptualization of the pottery practice. That is, the changes have been more superficial than they appear at first view.

Presented here are two cases of present-day pottery traditions from Central Mexico in order to explore changes and continuities in the manufacturing processes since colonial times. The first is Amozoc, in the Valley of Puebla, and the second Metepec, in the Valley of Toluca (Figure 1). Both are towns specialised in pottery production close to big urban centers. At first glance the pots made there do not look similar to those of the pre-Hispanic tradition.

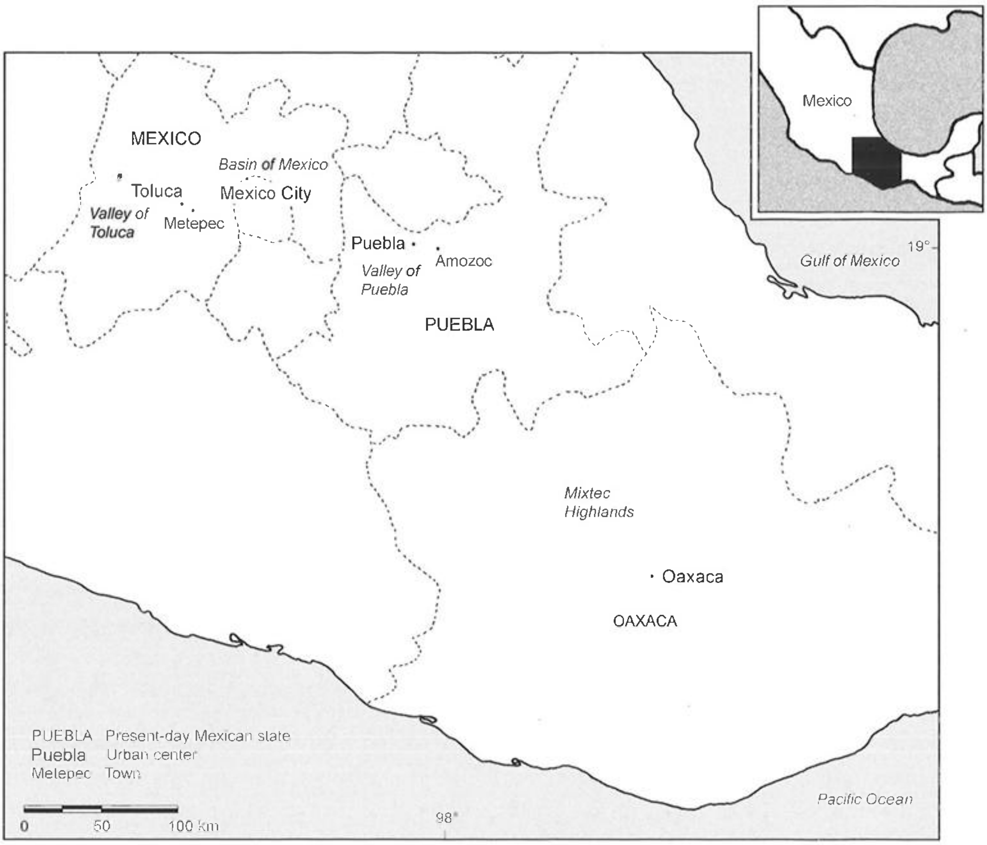

Figure 1. Map of Central and South Mexico showing the cities and pottery towns mentioned in the text.

Conceptualization of a pottery tradition

Studies of traditional pottery assume that artisans do not have a single or typical response to cultural contact. In Mexico, several decades of research in contemporary pottery communities, like Tzintzuntzan (Foster 1967), Tonalá (Katz 1977) or Acatlán (Lackey 1982), show that potters deal in different ways with new technologies, ideas and consumers. An approach to the foundations of pottery traditions of Sander van der Leeuw is a useful scheme to explore the effects of introductions and changes in pottery. He convincingly argues that it is not nature but culture which is the main constrain on pottery manufacture tecniques. That is, neither raw materials nor tools determine the method of manufacture, rather it is the conceptualization that the artisan has of the pottery tradition (van der Leeuw 1993: 241, 256).

According to van der Leeuw (1993: 257) the conceptualization of a pottery tradition is composed of three fundamental aspects: (a) the topology which the potter brings to bear on his dealing with shapes. For example, whether they are seen as horizontal, vertical or as a transformation of a sphere; (b) the partonomy which the potter applies to the shape, for example, what are considered the basic entities of which the pot is made: a number of coils, two or more pot segments, and (c) the sequence in which the vessel is made. For example, from bottom to top or viceversa.

Topology, partonomy and sequence are fundamental conceptual elements of any pottery tradition since they underlie the ways in which a particular culture deals with the problems which it encounters in the material world (van der Leeuw 1993: 259). These three aspects are very resistent to change because they permeate very large areas of activity of a group of people, they are shared, and people are largely unaware of their existence. Moreover, given that they involve motoric habits and specialised gestures usually learned during childhood, they are very rooted in the potters and very resistent to change, as Olivier Gosselain (2000: 192) proposes in the case of contemporary African artisans.

Thus, the basic part of a pottery tradition, the conceptualization, tends to be resistent to new ideas, technologies and consumers. However, pottery also involves other aspects. Potters take decisions about clay selection, its extraction, processing and firing. These issues seem to reflect the interaction network of the potter, as Gosselain (2000: 192) puts forward, and accordingly they can be easily modified. Potters take decisions about vessel's shape, surface finishing and decoration as well. These are very visible and openly show potter's behaviour. This visibility influences his choices of techniques, which can be simply and often modified (Gosselain 2000: 191).

In situations of cultural contact, like the colonization of Middle America, the scheme of van der Leeuw provides a good basis to explore the nature of long-term change and continuity in pottery traditions. It furnishes insights into the effects of innovations on pottery conceptualization, on one hand, and on technology, morphology and decoration, on the other hand.

Mexican traditional pottery

Generally it is believed that pre-colonial Mexican pottery was strongly affected by three Spanish technical introductions: the potter's wheel, the two-chamber kiln and the glaze. Before the Spanish conquest, pottery was formed through the methods of moulding, coiling or pinching, or a combination. The wheel to form vessels was not known. Pottery was fired in open bonfires, or perhaps in simple one-chamber kilns.[1] To finish the vessel's surface slips amd paints were used. In some cases these additions to the surface were so highly polished that the vessel acquired a luster or glossy finishing, but glaze, a coating of glass melted in place (Rice 1987: 151), was not used.

Studies of contemporary pottery communities show that such European technical innovations had different effects on the pottery traditions of Middle America. Interestingly, during colonial and modern times, the potter's wheel was often not seen as an important technical advance (Foster 1960: 101; Katz 1977: 124-125), rather it was seen as a risk, because it was expensive and required new motoric habits. Moreover, the speed in forming and the standardization of the vessel's shape – considered the benefits of wheel throwed pottery – were already obtained using the traditional forming methods (Nicklin 1971: 39). Conversely, the two-chamber kiln was widely accepted by Mexican potters. Today it appears even in isolated and conservative pottery communities (i.e., Druc 2000: 82; Engelbrecht 1987: 217; Rendón 1950: 258). Its technical advantages, especially firewood economy, were easily recognized. The glaze, to impermeabilize and decorate vessels, was accepted in some regions, but not in others. Probably reasons for the rejection were the extra costs involved in the acquisition of glazes, and the bigger amount of firewood required to reach higher temperatures.

At present most of the traditional pottery communities in Central Mexico, like Amozoc and Metepec, use the two-chamber kiln and produce glazed earthenware pots. The wheel, however, may be not present or has only a secondary role. In contrast, in certain regions of South Mexico, like the Mixtec Highlands, wheel, glaze, and even kiln, are not used (i.e., Houben 2006).

Traditional pottery in Amozoc

Amozoc is a town of artisans located in the present-day Mexican state of Puebla, 17 km from Puebla, a city with over two-million inhabitants founded as a settlement for Spaniards in early colonial times (see Figure 1). Amozoc, together with many other towns in the Valley of Puebla, has existed since pre-Hispanic times. Its main craft is pottery for utilitarian purposes. Potters work in familiar workshops, most of them full time, and most of them are men although women and children relatives help in minor tasks. Usually the knowledge is transmitted in the family for generations. The most common vessels now produced are *cazuelas* (open mouth bowls with handles) for cooking, and *ollas* (jars) for cooking, containing and transporting liquids. Today the pots of Amozoc have a wide distribution; they are sold in Puebla, Mexico City, and in several regional markets of Central and parts of South Mexico. The vessels of Amozoc have found a niche in the present-day traditional Mexican gastronomy. They are used for cooking and serving typical Mexican food; accordingly they must look traditional (Figure 2). Surely, this is one of the main reasons that potters still use traditional manufacturing techniques, that young generations of artisans exist, and that workshops are well organized and allow one to earn a living.

The workshop of Juan Antonio Sánchez and family is a characteristic example of the Amozoc pottery industry. He and his four children elaborate mainly *cazuelas* and jars

Figure 2. A restaurant in the weekly market in Amozoc showing typical Mexican food served in traditional pottery from the same town.

Figure 3. Making the base of a *cazuela* by moulding in the workshop of Juan Antonio Sánchez and family in Amozoc.

Figure 4. Making the walls of a *cazuela* in the workshop of Juan Antonio Sánchez and family in Amozoc. Coils are applicated on the moulded base of the vessel to build the walls, then they are modeled and polished.

through moulding and coiling. In the case of the *cazuelas*, first they make the vessel's base with a mould, and then apply coils to create the walls (Figures 3 and 4). The vessel is stationary and the potter turns it very fast to model and polish its walls (Figure 5). Anthropologists call this procedure the orbit technique (Rice 1987: 133). Next, they elaborate the rim and then put two lateral handles.

Some potters in Amozoc, like Juan Antonio Sánchez, use the flying wheel. However it has only a secondary role. Sometimes it is used to polish the vessel's base when it is still on the mould (Figure 6). Or on occasions the artisans put the vessel's base on the wheel, after it has been removed from the mould, and form the vessel's walls with coiling, turning the wheel to polish them. A number of potters in Amozoc can actually form small vessels using the centrifugal force of the wheel, but it is not common and it is not preferred by potters.

The family Sánchez specialises in the production of *cazuelas*, in particular in the enormous exemplars for *mole* or *carnitas*[2] (Figure 7), although they also elaborate smaller

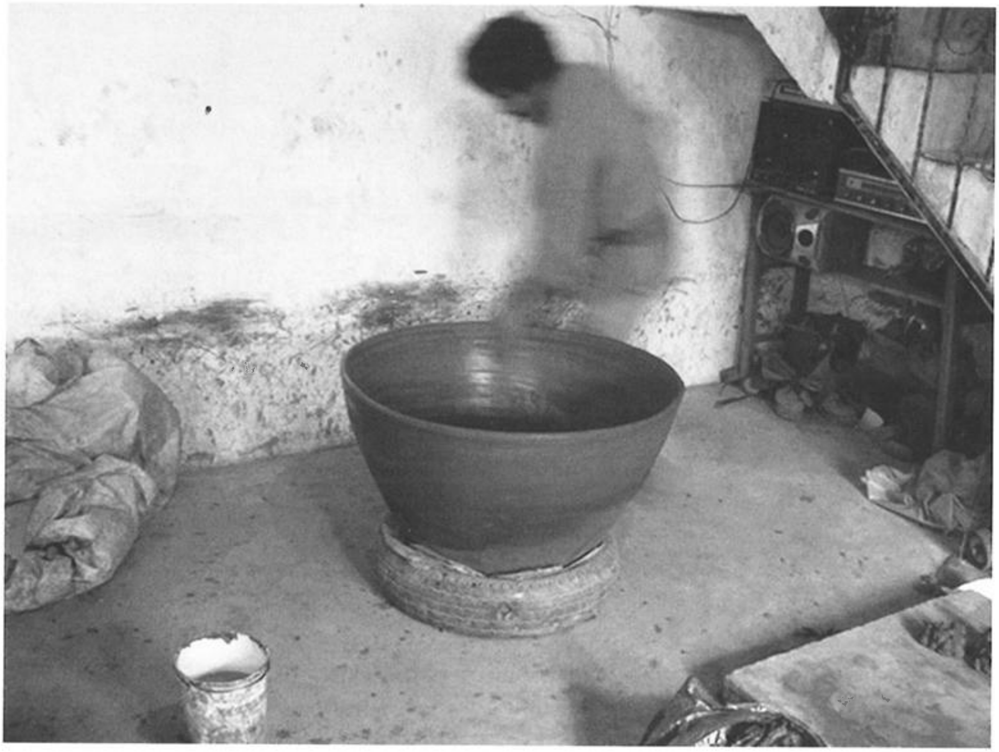

Figure 5. Polishing the walls of a *cazuela* in the workshop of Juan Antonio Sánchez and family in Amozoc. The vessel is stationary and the potter circles it very fast to model and polish its walls.

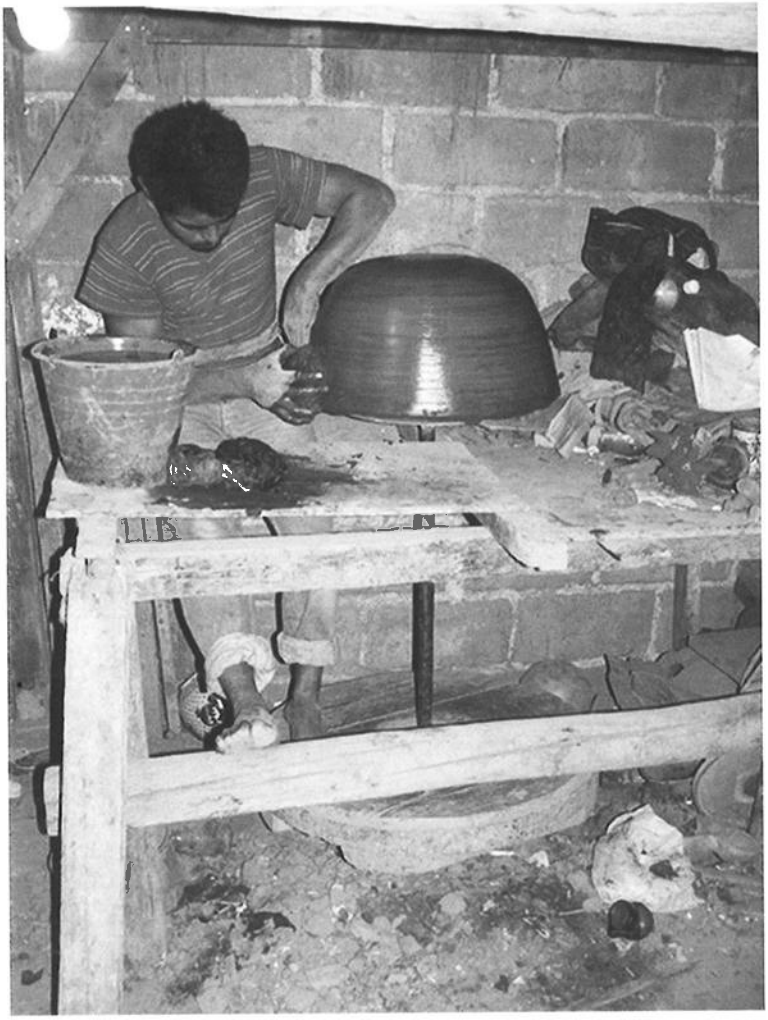

Figure 6. Some potters in Amozoc, like a son of Juan Antonio Sánchez, use the flying wheel, but it has only a secondary role. Here it is used to polish the vessel's base when it is still on the mould.

cazuelas (Figure 8), jars in several sizes, and occasionally special objects ordered by customers. According to the potters, vessel shapes have not changed during the last years, although their sizes have been a little bit modified in response to consumer preferences. The present-day *cazuela* shape does not derive directly from the pre-Hispanic tradition, rather it has certain similarity to sixteenth century Spanish cooking pots, also called *cazuelas* (McEwan 1992: Fig. 2).

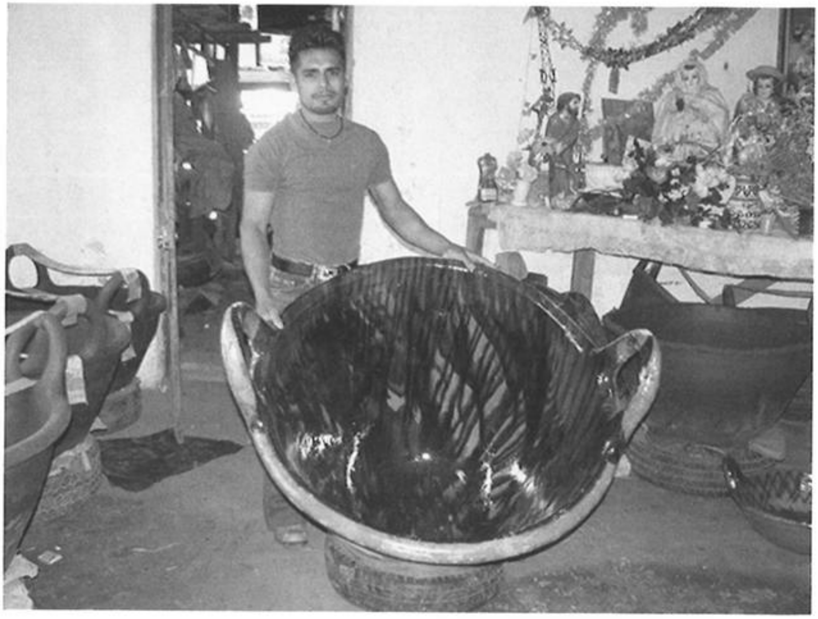

Figure 7. A son of Juan Antonio Sánchez of Amozoc shows a *cazuela* for *mole*. It is the biggest pot they produce.

Figure 8. Several sizes of *cazuelas* elaborated in the workshop of Juan Antonio Sánchez in Amozoc.

Pots are fired twice in a two-chamber kiln. Dried vessels get a first firing, and after cooling they are glazed and fired for a second time. All the pots elaborated in the workshop have a clear lead oxide glaze on the interior. Often they are also decorated with hasty lines or curves in black glaze (Figure 9). These decorations do not have precedents in the pre-Hispanic tradition of the region.

A brother of Juan Antonio Sánchez, Clemente Sánchez Romero and his sons also have a pottery workshop. They specialise in the production of jars of different sizes. They make the base and the neck of the jar with moulds (Figure 10); then they connect both parts, and after a while smooth the junctures. Next, they make the rim, and attach lateral handles. The wheel has the same secondary role as in the other potters family. The Sánchez Romero also glaze their vessels and decorate them with hasty black lines (Figure 11), and fire them twice in a two-chamber kiln. Their jar's shapes are only in broad terms comparable to those of pre-Hispanic times.

Today vessel shapes and decorations in Amozoc are different from that of pre-colonial pottery. However, the conceptualization of the pottery tradition seems to remain

Figure 9. After the first firing, vessels are decorated with hasty lines of black glaze, as is shown in this image of the workshop of Juan Antonio Sánchez in Amozoc. Then they are covered with a clear lead oxide glaze, and fired for a second time.

Figure 10. Moulds to make the base and the neck of jars from the workshop of Clemente Sánchez Romero and family in Amozoc. They make the base and the neck of the jar with moulds; then connect both parts, smooth the junctures, make the rim and attacht lateral handles.

Figure 11. After the first firing, the family Sánchez Romero of Amozoc decorated their jars with hasty lines of black glaze. Then they are covered with a clear lead oxide glaze, and fired for a second time.

analogous to that of ancient times. In the pre-Hispanic period in Central Mexico cooking vessels were also elaborated through moulding and coiling. Accordingly, vessels were almost cerainly conceived in similar terms as today. The partonomy and sequence of the present-day vessels seems akin to that of ancient vessels. For example, pre-Hispanic jars from the Valley of Puebla were also made with two horizontal moulds connected in the middle of the vessel's body.

Traditional pottery in Metepec

Metepec is a town of artisans located in the present-day Mexican state of México, 7 km from Toluca, a city of 500 000 inhabitants founded in pre-colonial times, and only 60 km from Mexico City (see Figure 1). Metepec is one of many settlements that have existed since pre-Hispanic times in the Valley of Toluca. The main craft of the town is pottery for utilitarian and decorative purposes. Besides cooking, serving and transporting vessels, they also produce figures, imitations of archaeological pieces and the famous trees of life[3]; the last two dedicated to the tourist market. Potters work in familiar workshops, most of them full time. Generally they are men although women and children relatives sometimes help in minor tasks. Pottery knowledge is transmitted in the family for generations. The most common vessels produced are *cazuelas*, but also jars and *comales.*[4] At present the pots of Metepec have a wide distribution; they are sold in Mexico City and other cities of Central Mexico, and in the weekly markets of the region. Like in Amozoc, vessel production supplies cooking and tableware for the traditional Mexican gastronomy. Also as in Amozoc, potters are aware that consumers want typical pots elaborated in the traditional manner. Probably this is the main reason that the pottery tradition is still alive, that the knowledge is still transmitted to young potters, and that family workshops produce the whole year and allows one to make a living.

Patricio Ramírez Carrillo and his family are a characteristic example of the potters of Metepec. He and his two sons have a workshop to produce *cazuelas*. First, they make the vessel's base with a mould, and then apply coils to create the walls (Figures 12 and 13). The vessel is stationary and the potter circles it very fast to model and polish its walls. Next, they elaborate the rim and then attach two lateral handles. Potters normally decorate the rim of *cazuelas* with finger impressions (Figure 14). Patricio Ramírez, like many potters of Metepec, does not use the flying wheel. However, there are a few in town who use the wheel to polish the walls of small vessels.

Pots are fired twice in a two-chamber kiln, like the one used by the family Torres Carrillo, another familiar workshop in Metepec (Figure 15). This kind of kiln was introduced to Mexico during colonial times. It has on the bottom an extra chamber for firewood. Dried vessels get a first firing, and after cooling they are glazed and fired for a second time.

The Ramírez Carrillo family specialise in the production of *cazuelas* of different sizes for cooking and serving, although they occasionally elaborate special objects and figures ordered by customers. Normally they produce sets of cazuelas of five different

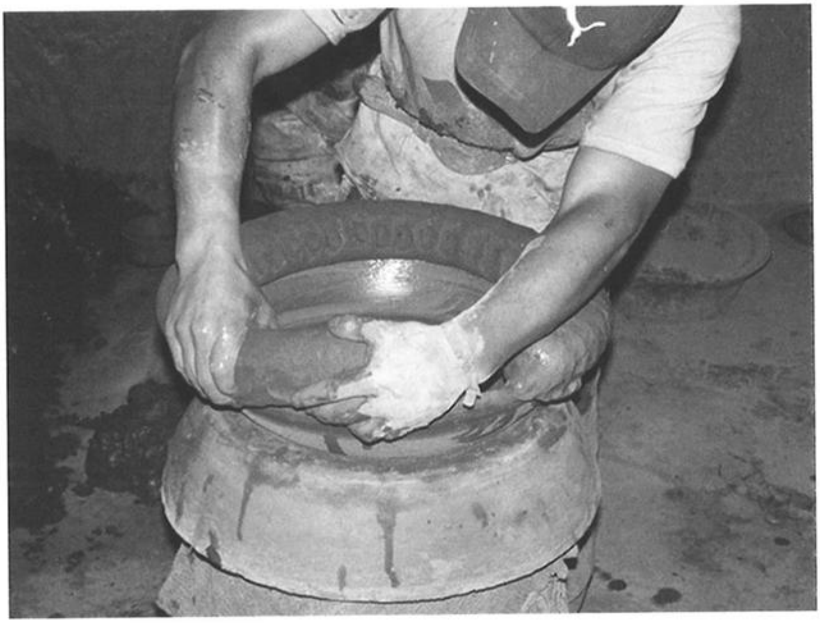

Figure 12. A potter of the family Ramírez Carrillo of Metepec makes the walls of a *cazuela* by applicating a coil on the vessel's base made by moulding.

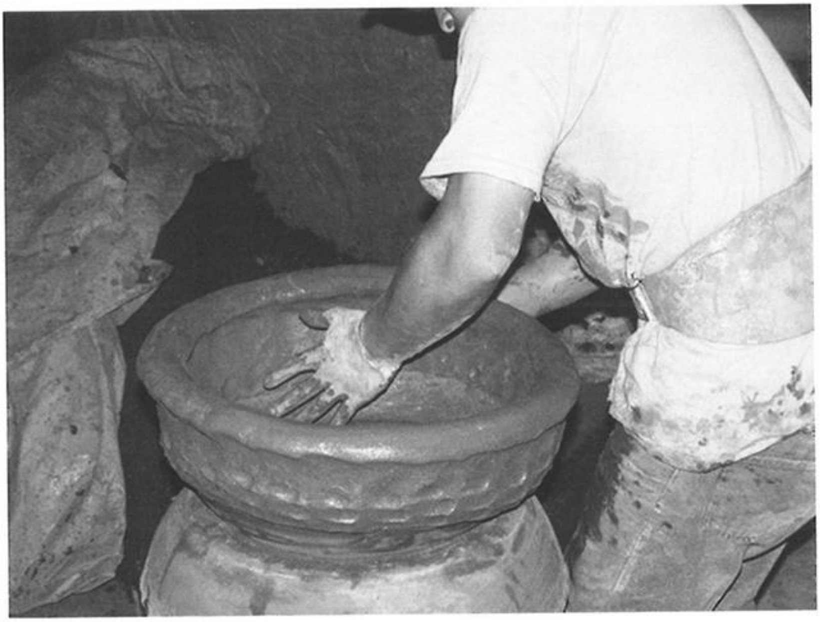

Figure 13 After the application of a coil on the *cazuela*'s base, a potter of the family Sánchez Carrillo of Metepec models the vessel's walls.

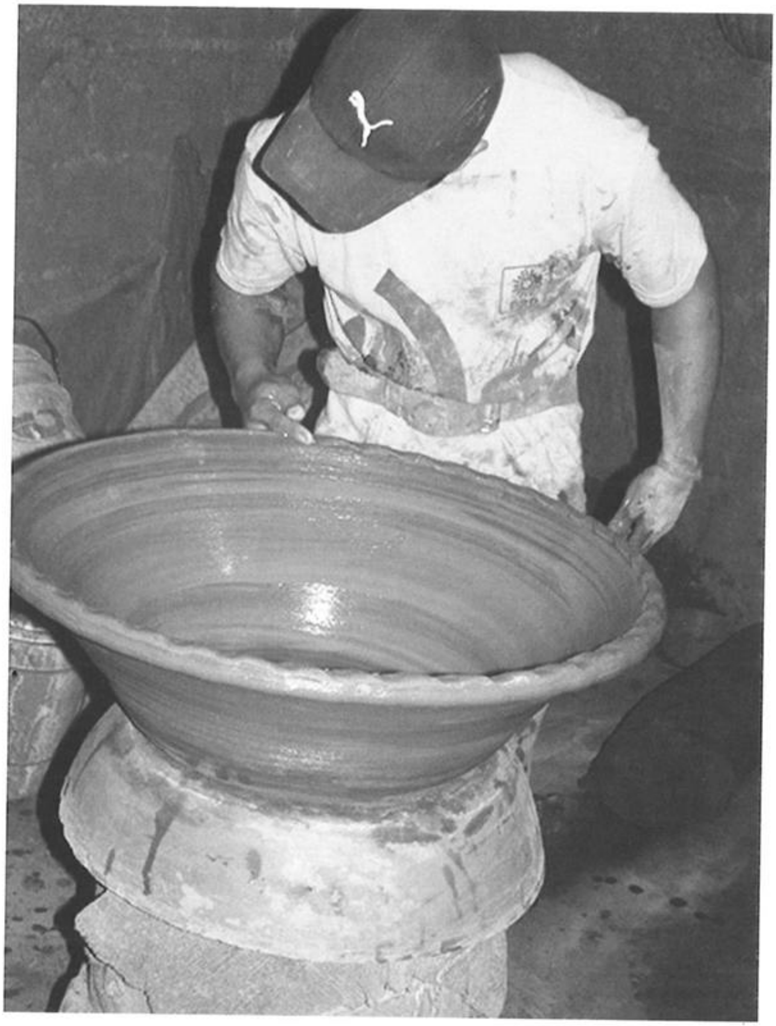

Figure 14. A member of the family Ramírez Carrillo of Metepec decorates the rim of a *cazuela* with finger impressions. The vessel is stationary and he circles it very fast to decorate regularly its rim.

sizes (Figure 16). The biggest one contains the other four, which are decreasingly smaller. This efficient assemblage of vessels increases the possible amount of vessels in the kiln and facilitates their storage and transport. The present-day *cazuela* shape does not derive directly from the pre-Hispanic tradition.

All the pots elaborated in the Torres Carrillo and Ramírez Carrillo workshops have glaze. Patricio Ramírez normally decorate his *cazuelas* with hasty lines and curves in

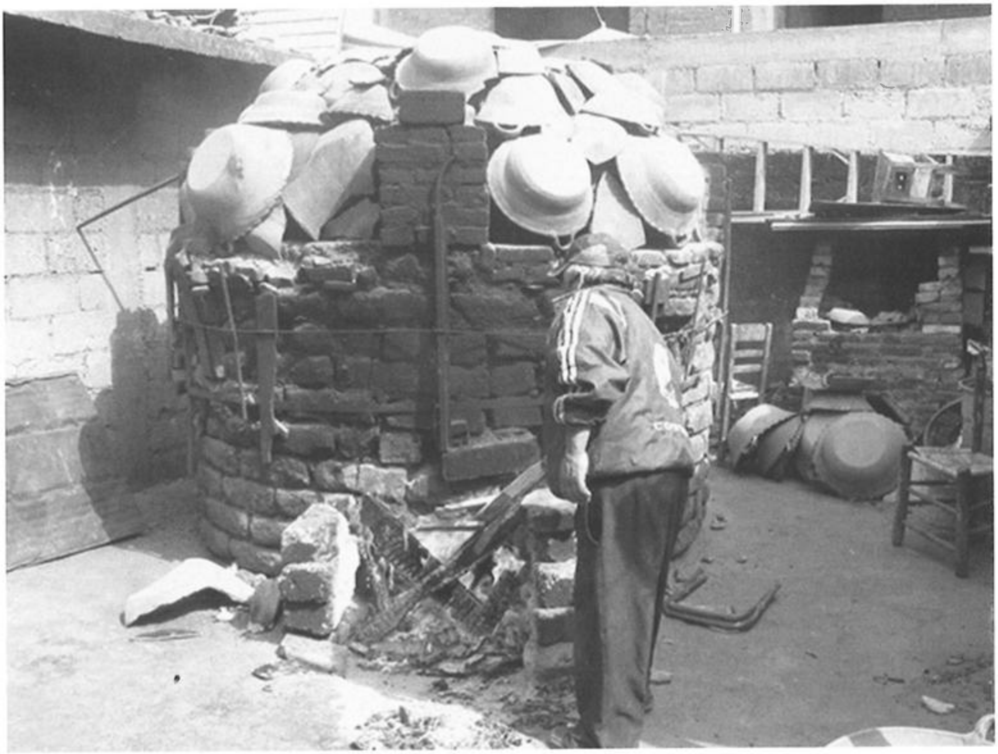

Figure 15. Pots are fired twice in two-chamber kilns, like the one used by the family Torres Carrillo of Metepec. The kiln has an extra chamber for firewood on the bottom.

black glaze. He also stamps their walls with geometric motifs with yellow paint (see Figure 16). Some of them may resemble pre-Hispanic motifs, but since they are simple lines and curves it is not possible to establish direct connections with ancient decorations. Next, the vessel's interior is covered with a clear lead oxide glaze. None of these decorations have precedents in the pre-Hispanic tradition of the Valley of Toluca or the neighbouring Basin of Mexico.

At present in Metepec, vessel's morphology and decorations are different to that of pre-Hispanic pottery. However, the conceptualization of the pottery tradition seems to remain similar to that of ancient times. In the pre-colonial period in Central Mexico cooking vessels were also elaborated through moulding and coiling. Accordingly vessels were almost certainly conceived in similar terms, as today.

Discussion

The well-know colonial introductions (wheel, kiln and glaze) differently affected the Amozoc and Metepec traditions of pottery, and the same occurred in other Mexican

Figure 16. The workshop of Patricio Ramírez Carrillo in Metepec normally produces sets of *cazuelas* of five different sizes. The vessels are decorated with hasty lines and curves in black glaze, and also with different stamped geometrical motifs in yellow paint. Next their interior is covered with a clear lead oxide glaze and submitted to a second firing.

pot-making towns. In principle, the throwing wheel for forming vessels could potentially change the conceptualization of the traditional pottery, since it influences the topology, partonomy and sequence of pots. However, it was not accepted by the great majority of Mexican artisans, as is evidenced by its still sparse present-day use in different regions (i.e., Druc 2000; Foster 1959, 1960: 101; Houben 2006; Katz 1977: 124-25). The kiln was adopted, although its technical possibilities mainly affected vessel decoration and production efficiency, but not its conceptualization. Also the glaze was incorporated in Central Mexico, but it basically had an effect on decoration and use, not on fundamental conceptual elements of the pottery tradition.

Thus, at first glance the pottery of Amozoc and Metepec has few elements of the pre-Hispanic tradition. However the changes in relation to ancient times have mainly occurred in vessel shapes, surface finishing and decoration, but not in their conceptualization. Vessels are still formed, as in the past, by moulding and coiling. Such combination of methods requires a constant manufacturing sequence, and consequently a constant idea about the topology and partonomy of pots.

Like in Amozoc and Metepec, today most of the pottery of Central Mexico is conceived in horizontal terms. That is, pots are made from horizontal parts, and the coiling is horizontally applied. Potters normally divide *cazuelas* in four horizontal sections (moulded base, coiled walls, modeled rim, and appliqué handles); and also jars are separated in four sections (moulded base, moulded neck, modeled rim and appliqué handles). This partonomy involves a constant sequence of manufacture. In pre-Hispanic times potters of Central Mexico made pots with a similar manufacture technique, as precolonial vessels show. Very probably potters had conceptions about the topology, partonomy and sequence of pottery similar to those of present-day artisans.

The idea that pots are made from horizontal parts is not generalized in Mexico. In traditional pottery communities in West Mexico today, as in ancient times, vessels are conceived in vertical terms. That means, pots are made using vertical moulds, and consequently the vessels are divided in vertical parts (i.e., Engelbrecht 1987: 213; Katz 1977: 164). This implies a different conceptualization of the pottery tradition, but interestingly it shows that in West Mexico pottery is still made using ancient fundamental concepts and that the changes have been superficial; as in Central Mexico.

The resistence to change of pottery traditions in Mexico, in spite of technical introductions, suggests that native artisans did not stop their work after the conquest. They continued working with the same technical knowledge and transmitted it to the following generations. They adapted vessel shape and decorations to the new ideas, techniques and consumers, but the basic principles that guided their relationship to the material world did not undergo big changes; at least in the case of pottery.

Acknowledgements

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Notes

1. Information about excavated pre-Hispanic remains of pottery workshops is very scarce (i.e., Winter and Payne 1976). Generally it is assumed that kilns were a Spanish introduction although it might be that they have simply not been found until now.

2. *Mole* is a typical Mexican feasting meal; it is a sauce of chilies, chocolate and other ingredients added to chicken or pork. *Carnitas* is pork meat cooked in oil.

3. Trees of life are colourful tridimensional earthenware trees with flowers, birds and human figures on the branches. They were once traditional and symbolic artefacts but now they are produced for the tourist market.

4. *Comales* are large and thin plate-form earthenware objects that are put over the fire to cook *tortillas*, flat thin cornmeal cakes.

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CONTEXTUALIZING THE DESIGN MIND OF AN ANCIENT POTTER – A CASE STUDY OF THE RELIGIOUS CONTEXT OF ISLAM AND MING KENDI

FOO Check-Teck and TEO Khay-Chuan

Abstract

The design process should be of central interest to designers. Yet there is much mystery as to how the mind of a designer works in arriving at an aesthetically, innovative design. For many, the creative act is an intuitive one, springing out of the unconscious mind. Mind that brings to bear in the act of designing the influences absorbed from the environment both consciously and unconsciously. Even more interestingly, this articler investigates the influences on the design mind of an ancient potter in relation to a specific object, the kendi. In the process the authors traced the historical roots to the design of water vessels. Upon the basis of available evidence, the authors then argued for Islam as the major contextual influence on the design of this variety of crescent-shaped kendi.

Introduction

One of the most intriguing aspects of research into the history of design is in unraveling contextual influences. In particular, we investigate the impacts of the environment on the design of products and thus providing a contextualized understanding of the design process. Arguably before the design for any new product may be transfigured into its physical form – now as in the past – it had to be first figured in a person's mind. This question may then be posed:

From where does the concept for the design, especially one pleasing to the "man of taste" emerges from within the mind of the designer?

Interestingly, one of the early writers Herbert Reed on the art of designing products for consumers had attempted to answer this question as follows (Reed 1934: 38):

> "...I do not think there is any doubt that the average sensitive person, the"man of taste"would find the Chinese vase superior as a work of art. And that, I believe, is because its form has an appeal which cannot be analyzed, which is not intellectual, but intuitive or *unconscious...*" [*italics* added]

In his *Art and Industry*, Reed was comparing a sixth century (530 B.C.) and a Chinese porcelain vase of Sung period (A.D. 960–1279). Such an aesthetic design had to be already there, at least partially, as unconsciously embedded within the mind of its

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designer. For our case study of the Ming blue-and-white porcelain (*kendi*) it too had to appear as "thoughts" inside the mind of one or several ancient Chinese potters.

Our argument is that the influences of aesthetically pleasing design of products, especially those intended for religious purposes often embed within its form, some beliefs, values and practices of the particular religion. The design reflecting, say, those religious ethos, norms or symbols often unconsciously absorbed by the maker as part of the process in conceptualizing the product. In our example, we argue for the ancient potter to be most likely, a follower of the Islamic faith.

As far as the literature on the mind or the thinking of the designer is concerned, Lawson in *How Designers Think* (Lawson 1980: 131–147) had reviewed an interesting typology. The thinking types explored in relation to mind of the designer included inter alia behaviorism, the *Gestalt* school with its problem-solving orientation, the cognitive science paradigm and others including emphasizing convergence and divergence in the design thinking processes. Yet after having had devoted extensive efforts in deciphering the nature of the process, Lawson concluded:

> "Even now after some thirty years of working on design research, I realize that there is much I know about design from *practicing* the process rather than studying it. Perhaps this remains not only the greatest single failing but also the inherent fascination of the field. We have still not fully explained that most *magical* of all conjuring tricks, the design process." [*Italics added*].

The first author of this article too is under the same magical spell in seeking to understand the process in design. A process of embedding in the mind of the potter, cultural, religiously inspired concepts. In this case study the authors are investigating as deeply and specifically as possible all the detailed aspects in the design of a specific object. This is done as part of research in identifying critically important contextual influences that may be acting on the designing mind of the ancient Chinese potter in his exercising his craft in manufacturing these *kendis.*

What makes this search exciting is that our historical research revealed these kinds of objects to originate from India but used by a different religious order – Buddhism. The purposes of these objects remained however very much the same – the same religious purpose of ablution through water. Thus any changes in design are *not* due to changes for functional reasons.

Speaking experimentally we had instituted a control of a critical variable influencing design considerations – the functional considerations of a product. We anticipate, borrowing the words of Sparke for religion to be the primary "outside force" and of the object "manifesting" within its "context". Sparke (1986: xiii) had already put it so elegantly in *Design and Culture*:

> "...as a cultural concept design is determined by *the outside forces* that have shaped it and by the *contexts* within which it has *manifested* itself...." [*Italics added*]

Thus we argue here for *kendi* to be cited as the classic example, following Sparke of a design that as resulting from culturally, (religiously so, Islamic) concepts. Or as a restatement: a product that is in its conceptualization of design largely determined by *outside forces* but *manifesting* within its religious (Islamic) *contexts*. We turn to discuss religions as contexts as applied to our case study of the *kendi*.

Historical contexts of religion

Two major foreign religions that made inroads into early China are Buddhism and later Islam. Of the two Buddhism was earlier in making impacts on the Chinese consciousness or from the design mind perspectives, the unconscious through absorbing of the values, beliefs and practices of Buddhism. Some scholars had even suggested Buddhism to be introduced into China as far back as during the First Emperor of China, Qin Shi Huang. The longer the time the deeper and more entangled are the roots of religious influences.

The impacts of Buddhism on Chinese arts are well documented but relatively little is available on the impact of Islam on Chinese arts. Even though Islam was introduced much later yet the religion had an inherent, externally oriented dynamism. Thus by Sung, Muslims were handling external affairs of the country. Within the realm of arts and design, Islamic motifs began to trickle into pottery. Indeed Chinese potters began adopting Islamic motifs especially during the Ming dynasty period with the production of globally renowned blue-and-white ceramics for overseas and homeland markets.

Here we document by way of a detailed case study how Islam had radically transformed the design of a water vessel. It was introduced into China by Indian Buddhist monks for ablution during religious ceremonies. The design transformation was so evidently, so radical even dramatic that the impacts of external, *outside forces* had to be great. As shall be seen, key religious motifs were in the process incorporated into the design. It is thus meaningful for us as scholars to argue on the design roots for this specific breed of Ming blue-and-white ceramics: crescent-shaped, minaret-necked *kendis*.

In so doing we may better grasp the role of contextual forces such as the religion of Islam in shaping the art of designing or conceptualizing pottery or other related products. Through this process of exploration, we delve deeply into the mind of the Muslim Chinese potter as he took conceptually, motifs, shapes and forms as related to his own religious beliefs.

Most interestingly as in this case, the Muslim potter thereby achieved breakthroughs in terms of realizing a powerfully aesthetic design. As shall be seen, the end results of the religiously inspired design besides being highly innovative was at the same time, religiously, deeply meaningful. Next we explore the historical context of the Muslim Chinese potters.

Historical context of Islam

The golden age of Islam in China is during the Ming Dynasty (A.D. 1368–1644). Earlier, in the preceding Sung period, as mentioned earlier the Muslims were already well recognized by the Imperial Chinese authorities for the wide scope of their international contacts. Such recognition may be seen in the appointments made by the Imperial House. Muslims were appointed to leading positions, as high as the Director-General when China had dealings with external, overseas trading partners. Chinese worldview then was of their country as being at the center of the world and unsurprisingly they by themselves were not outwardly, globally oriented.

Another indicator of the high esteem enjoyed by the Muslims for their worldliness: Emperor Yongle chose the more outwardly oriented Muslim Admiral to lead an impressively huge Chinese fleet on naval expeditions, crossing seas and oceans to reach out to and explore the globe. This decision by Emperor Yong le was of some significance for he had been known historically to maintain personal ties with several ancient Middle Eastern states such as Samarkand. He is thus the key to the origins of the design of our crescent-shaped *kendi* (see for instance Khoo 1991: 9) (Figure 2);.

Now, in order to facilitate better communication and understanding with distant Muslim states, Emperor Yongle had to maintain within the city of Nanjing, a rather sizeable academy of Muslim language scholars. Aesthetic tastes, such as in choices of the colors, motifs or shapes had in China been influenced by the leading scholars of the day. Thus one plausible, if not perhaps the main source of influences on the design on any new, Islamic inspired ceramic art ought to also flow from these Muslim, Imperial Academy sdholars. And in particular for this chosen piece as case study, the design is austere, elegant and yet highly innovative. Furthermore as shall be seen in detailed discussion that follows, the artifact is so rich in Islamic symbolism.

Contextually, on common knowledge of the era, by the time of Ming rule, the integration of Muslims into the Chinese Han society was more or less complete. As may be expected, Chinese potters whether themselves Muslim or not, began to borrow shapes, designs and motifs from Islam for designing their ceramics especially if these pieces were made for the growing overseas clientele. By then too, the famed *Jin De Zhen* in *Jiangxi* province had already begun life as a center for ceramic production.

Also at about the same time, Muslims began to adopt Han names and even some of their customs. Customs are not in conflict or inconsistent with beliefs of Islam. However the Muslims must have retained the Islamic mode of dressing, one similar to what they are now dressed in. They must also be keeping to a strictly Islamic diet, for example, no pork. For the artifact to be detailed, we hypothesized the crescent *kendi* to be capturing and reflecting the aesthetics in design of this period in China – or at least, the preferences among leading Muslims within the community. For during this period, Islam was near or reaching its peak under Imperial favor.

Technological context

During the same Ming period, there was the intense and wide application by the Chinese potters of cobalt blue (cobalt-oxide pigment and also riches in iron oxide). Color in the case of ceramics is a critical design choice. An ingredient pivotal to the potter for realizing on porcelain what is now known as the world famous Ming blue-and-white under-glaze porcelain).

Despite its fame, it is still not as yet abundantly clear why this phenomenon blossomed *only* during Ming. Here we speculate on possibilities. For in terms of the availability of chemical technology, cobalt oxide had long been imported by the Chinese – albeit in small quantities –from as early as the beginning of Tang dynasty. Yet despite the luxuriant tastes of the Tang Han Chinese for colors, blue-and-white was not one of their favorites.

It was the Mongols of the Yuan Dynasty (A.D. 1271–1368) who were the first to import cobalt blue in large quantities from the Near East (cf. northern Iraq). This may be attributable to the widely held religious worship and beliefs of the Mongols in the Sky God – hence blue – as their heavenly protector. Contextually, it is likely the abundance availability of this critical resource that triggered the later, wider commercial exploitation of this color as the key design element of Ming blue-and-white, under-glaze ceramics.

Aesthetically pleasing, this must be one of the key design factors why many of these pieces were so sought after including connoisseurs from the Islamic world. Chinese under-glaze blue-and-white (as exemplified by Ming pieces) is argued by many to be China's greatest contribution to the art of ceramic. Pieces emerging out of China in the 14^{th}-15^{th} century made wide impacts globally across different cultures.

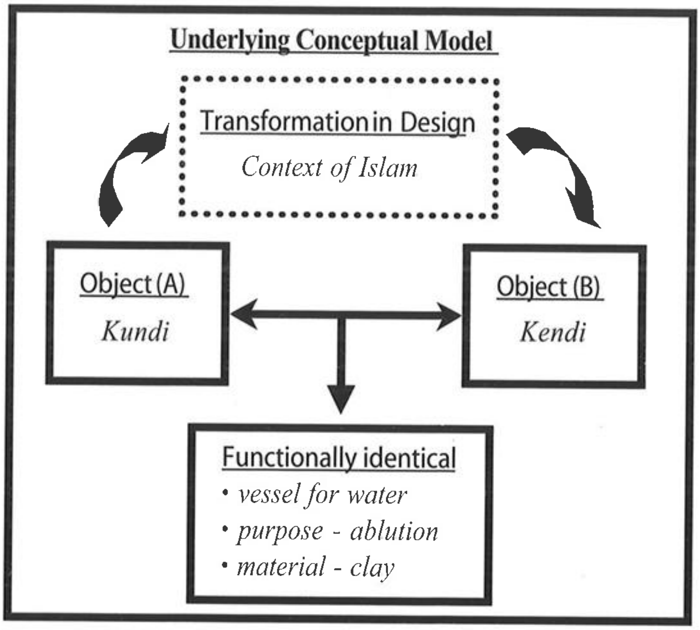

Figure 1. Underlying conceptual model.

On the technical side, to produce the blue-and-white, under-glaze porcelain, the Chinese potter first potted the body by applying white kaolin mixed with feldspar. After body is preheated to 900–1000° C, the enriched cobalt oxide treatment is then applied. Before firing at 1325°C in an oxidizing environment, a transparent, alkaline glaze was applied. Besides prototypes of Chinese origin, kilns like *Jin De Zhen* produced many Islamic influenced models. Of the available pieces, we selected one that in our opinion best capture and illustrate the transformation in design concepts due to Islam.

The case study: *kendi*

Our methodological approach may be conceptualized more generically as shown diagrammatically (Figure 1). Our focus is on the contrasting design features between two artifacts, object A as the originating piece and object B, the subsequent development. Most importantly, the functional purposes of these two objects had to the same. In our case, the function is as vessel for water to be used for ablution. Though less essential to our methodology, is in the similarity of the material that the objects were made (clay).

Figure 2. Crescent-shaped, minaret-necked *Kendi* decorated with flying phoenixes.

Our focus is on object (B): a Chinese Ming blue-and-white, crescent-shaped *kendi* (early 15th century; see Figure 2) with a minaret-like, tabular neck and a minuscule, onion-shaped spout is utilized here as our case study of Islamic influences on design. The *kendi* stands on four short legs and decorated interestingly with motifs. *Kendi*, a vessel for water used for purification purposes originated from the Indian *kundika* or *kundi* (object A as per our methodology) in Sanskrit (Wu 2002: 28). Indian Buddhist monks used the *kundi* for religious purposes as in the carrying water for cleansing. The design of the *kendi* in the shape as it stands, suggests the design to be one highly evolved from the original version.

The Collection of Dr and Mrs Foo

Ming dynasty, 16th Century,
Jing De Zhen ware, porcelain painted
in under-glaze blue
Height 19 cm, Length 22.5 cm and
Diameter 11 cm
Collection of Dr and Mrs CT Foo

Most interestingly this piece is a classic example of the fusion of Islamic ideals with the high art and advanced technology of Chinese ceramic making. The artifact reflects major Islamic symbolism of the crescent and the star and the minarets of a mosque. Overall, the shape of the *kendi* is that of a crescent moon. The stars sparkle as painted motifs just below the dome, at the top of the neck, what may also be described as the "blue-on-white diamond pattern". The shape of the centrally situated, dome minaret reminds the faithful of the call to prayers. Indeed, the twin ends of the crescent are conical in shape, again reflecting popular, alternative designs of minarets.

At the bottom are the motifs of sea waves perhaps reminiscent of the period of the seven great expeditions (A.D. 1405–1433) by Muslim Chinese Eunuch Admiral Cheng Ho. His father, a Muslim had done his pilgrimage to Mecca and thus Cheng Ho was more externally exposed than the average Chinese. His expeditions had brought about even further fusion of ideas from the overseas that influenced the Chinese arts. The Chinese fleet visited Muslim states including Malaysia and Sumatra among others. According to Menzies (2003), Cheng Ho had in fact sailed round the world and had reached the Antartica.

The motifs of similar flying phoenixes in pair are typically seen during the reign of Emperor Yung-le (A.D. 1403–1425). For an example, it is in the use of a pair of phoenixes where a stem-cup is decorated utilizing the same concepts (Macintosh 1994: 36). The phoenixes are painted exquisitely as these Imperial birds appear to be alert with their wings spread out as though still in flight. Arguably such motifs of flying phoenixes further reinforce the idea of exploration and travel under Emperor Yung-le. The phoenixes were flying amidst rolling scrolls of lotus and looping, tender stems with tre-foil leaves and leaf-buds. Such arabesque, spiraling of plant/flower/leaf/bud motifs is very much consistent with Muslim design preferences.

All these factors render this a valuable if not rare piece of Islamic influenced artifact from the hands of the famed Ming Chinese potters of the blue-and-white. The motifs of phoenixes clearly suggest this artifact to have been intended more for the upper, wealthier class of Muslims residing within cities of China with strong Islamic presence. The approach undertaken here is consistent with what Medley (Medley 1986: 178) had advocated as follows:

> "...Both the motifs and the manner of painting provide valuable keys for dating the vast quantity of 14th Century output which was intended primarily for the Islamic market..."

Next we discuss on religious influences.

How Islam transforms design

To be more specific, these elements were being transformed as a result of Islamic influences. As to the *speed*, *quantities* and *perceived quality* of this religious transformation in the design of porcelain wares to being Islamic may be discerned from Vainker (1991) who remarked as follows:

> "...Islamic tradition *quickly* revealed itself in the Jingdezhen wares..." [p. 139]
> "...China was producing *large* quantities of blue-and-white porcelain in Islamic shapes..." [p. 142]
> "...Gong Zhen and Fei Xian accounts of the voyages with Zheng He a Muslim contained remarks of the *high esteem* Jingdezhen blue-and-white wares were held in foreign country..."

For as mentioned earlier, one of the earliest designs of water vessels used for ablution as it is known in Chinese, *Sui-hu* was from the earlier Indian *kundi*.. This is depicted summarily in Figure 3 and each element shall be discussed in detail.

(1) Neck
The hypothesis here is the designer had borrowed the concept of minaret and utilized it in the shaping of the neck of the *kendi*. The minaret-like neck is given the central position of the artifact. This is particularly significant for Muslims as the mosque (as symbolized by the minaret) remains so central to their daily lives.

(2) Spout
In the case of the Indian originated *kundi*, the spout is in the shape of a cup-like, garlic head. Whilst the origins in the design of *kundi* are outside the scope of this paper, we may briefly theorize it to flow from an earlier religious practice. That is of using small cups to hold water for ablution. Instead of a cup, there is here instead a small, almost garlic-like shape spout for the *kendi* (see the photograph for a detailed view). Like the

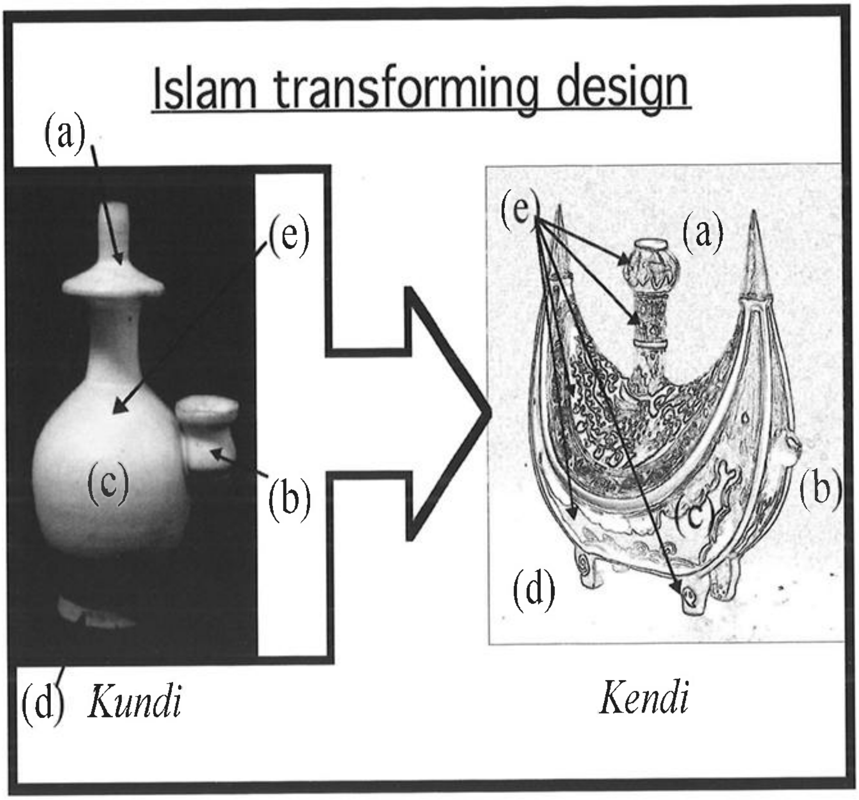

Figure 3. Islam transforming design.

kundi however, the spout of the *kendi* stayed on the side and at somewhere, mid-way in its height.

(3) Body

This is the most dramatic transformation due to Islam in terms of overall design concepts. Here arguably the Chinese potters were attempting to capture the shape of the crescent moon. One alternative explanation for the resulting design is that the resemblance to the horns of a bull.[1] It is an animal then frequently encountered in the fields of South East Asia then. Whilst this explanation is plausible, it fails to account for these other observations:

(a) Towards the ends of the crescent, they are indeed ringed and conical in shape. Indeed, as already documented, these blue-and-white (see for example, Yeo and Martin; 1978, p. 110)[2], these early Ming *kendis* are later capped and decorated with silver caps. These decorations are suggestive that the potters, working probably under the influences of Muslim scholars were trying to reinforce the resemblance of these to the towers. For towers were often seen along with the central minaret inside the compounds of the typical Mosque.

(b) The width between the two tips of the crescent is much too close for them to be representing the horn of a bull. Also the body of this particular piece is much too broad and resembles rather more the moon. Perhaps the very whiteness of the porcelain had reinforced the imagination of the potter into one of conceptualizing the crescent moon as a motif.

The only argument favoring the concept of the horn of the bull is in its four legs. Their presence suggests the remote possibility of these being legs of an animal.

(4) Legs
Instead of a foot rim in the case of *kundi*, the *kendi* had four short but stout standing legs. Even more interestingly, each of these had been decorated with curled motifs. What is the motivating factor behind incorporating legs as part of its design? Maybe, the potter simply wanted to bring out by lifting off the ground, the aesthetics of the underlying line of the curve of a crescent moon.

(5) Motifs
Finally, in sharp contrast with concept of emptiness (a Buddhist concept) as suggested by a plain white surface of the *kundi*, the Islamic *kendi* is richly decorated by motifs. These were painted with vibrant blue on the pleasing, white porcelain.

From our detailed case-study we now present a generic model on a process for investigating contextual influences on the mind of a designer.

A generic model

Theoretically, the design of an artifact may be influenced or constrained by contextual factors (see Figure 4) of religious, societal, technological and other origins. Thus a root object may be transformed in its design as a result of the designer or teams of designers who operated with these contexts. Our work explores the contextualizing of design. In our discussion, possible roles are highlighted – societal, cultural norms (color, Tang versus Ming), leadership (Emperor *Yongle*), religious beliefs (motifs), technology, resource abundance (enriched cobalt oxide mineral). Yet there are very few studies that provide insights on contextual influences using specific, representative artifacts. As illustrated through our case study, such a strategy may illuminate on the plausible origins of design concepts from the East.

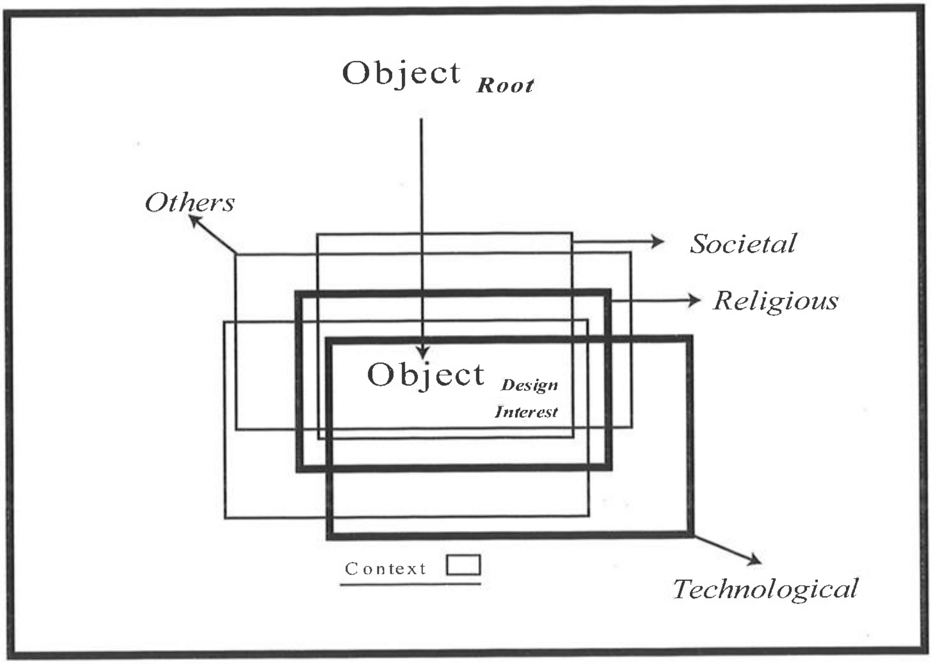

Figure 4. Contextualizing design.

This case study is intriguing for the design seemed to have originated from India, then absorbed into China along with the spread of Buddhism. Later, whilst the functional use of the water vessel remained unchanged, it was transformed by Islam into a radically design, one highly innovative. Even more interesting, such a make of crescent-shaped *kendi* (for another representative piece within China[3], see note [12]), then flowed out of China into South East Asia, the Middle East and back again into Muslim regions of India. As observed by Horey (1945: 13):

> "The exportation of porcelain from China never ceased throughout the whole of Ming period, rising to a flood in the middle of the 15th century and again from the middle of the 16th century onwards."

In the process, they were creating an evolutionary flow of design ideas for water vessels (ablution) over the centuries.

Now with the rise of China economically with strong manufacturing capabilities, we may yet be to trace yet another torrent of design ideas in the exports of Chinese manufactures. This time it is more likely to embed design ideas absorbed unconsciously from the West.

Notes

1. According to Khoo (1991: page 8), such early period Ming (15th to 16th centuries) *Kendi* with crescent-shaped body with tabular neck and tiny spout may have been made for the Islamic areas of the Malay-Indonesian Archipelago.

2. See plate 28 for a similar though smaller piece. It had been attributed to early Ming dynasty, (length 19 cms) but differently decorated. The metal spout, metal lid and metal covers on the piece were as explained by the authors to be later additions. According to the authors the piece as displayed was intended for the Muslim market.

3. A similar though later 17th Century Ming piece (H18 cm) although different motifs on the body (floral motifs) is featured in a recent 1998, Chinese publication (ISBN 7-80609-745-7) on page 204..

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