NEWSLETTER
Department of Pottery Technology

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A KNAPSACK FULL OF POTTERY

ARCHAEO-CERAMOLOGICAL MISCELLANEA
DEDICATED TO H.J. FRANKEN

UNIVERSITY OF LEIDEN — THE NETHERLANDS

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DEPARTMENT OF POTTERY TECHNOLOGY

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on the occasion of his seventieth birthday.

July 4, 1987

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PREFACE

This issue of the Newsletter Department of Pottery Technology, University of Leiden is dedicated to Prof. Dr. H.J. Franken on the occasion of his seventieth birthday. Dr. Franken retired in 1984 as Professor of Palestinian Archaeology and as Director of the Department of Pottery Technology. Fortunately, his retirement has not led to the end of his research. He still comes everyday to the Institute in order to study and prepare for publication pottery which was excavated at Jerusalem by his former teacher, the late Dame Kathleen Kenyon.

Henk Franken, in collaboration with the potter Jan Kalsbeek, developed new ways of studying the pottery from the excavations at Tell Deir ᶜAllā in Jordan. They have pioneered, in Holland and abroad, numerous aspects of technical-analytical pottery research. When one considers the length of time that Henk worked on Bali, where he gained a detailed background of anthropological concepts, it is not surprising that his technical approach to ceramics led to the inclusion of anthropological material into archaeological pottery studies. It was due to his stimulating work and his foresight, that the Department of Pottery Technology was established at Leiden.

This issue of the Newsletter Department of Pottery Technology contains contributions from his pupils, colleagues and friends as an expression of gratitude for all his work.

A. van As

Ted LaGro
Dick Noordhuizen

IRON AGE POTTERY FROM JERUSALEM - A PRELIMINARY CLASSIFICATION OF THE POTTERY FOUND IN TWO CAVES DURING THE 1961-1967 KENYON EXCAVATIONS

Introduction

In this article the preliminary results are published of an investigation into the pottery found in two caves in Jerusalem during the 1961-1967 excavations of the late Dame Kathleen Kenyon. After her untimely death, fieldrecords and sherds of part of these excavations (squares A) were transferred to Prof. dr. H.J. Franken of Leyden University for study, in cooperation with M.L. Steiner.

Part of the pottery was studied by a study group. This material consisted of sherds found in two caves: cave I in sq. A/XXVI) and cave II in sq. A/XXII[1]. These were selected for the following reasons:

- During the excavation of the caves all sherds were retained, resulting in enough material for some statistical studies.
- The excavator considered these caves as favissa's[2], because of the large number of more or less complete pots found (Kenyon 1974: pl. 53 and 58) in these sealed off areas, the many human and animal figurines in cave I, and the location of the caves adjacent to what she considered to be a sanctuary. A further investigation of the pottery found in these caves might give new information concerning the way these two caves have been used.
- The result of this investigation might contribute to the understanding of the relationship of these caves with the surrounding deposits, which was still a stratigraphic problem.

The study could only be based on sherd material since the whole or nearly complete pieces of pottery were given to I. Eshel for publication and distributed between the participating organizations after completion of the excavations. Drawings and descriptions, which are partly available, do not give enough information regarding that material to be taken into consideration in this study. However a comparison between the results of this study and the information which could be deduced from the drawings and descriptions will be given below.

In this article the preliminary results of this study, resulting in a tentative classification and a statistical analysis will be published.

We thank M. Vilders for her work as a member of the study group.

Material available

The sherd material available in Leyden consisted mainly of rims. Bases, although present, were not taken into consideration. In general no clear relationship could be established between an individual base and a rim, and the number of bases available was too small for a typology of the bases themselves. Therefore, the classification of the sherd material in the caves is based on rims only.

In total 1191 rims were available from cave I and 332 from cave II. Most sherds were too small to provide sufficient detailed information on other aspects than shaping and finishing of the rim itself. A number of sherds, 26 from cave I and 36 from cave II could not be classified according to the system described below and were, therefore, not included in the computations and diagrams.

Analysis

In the analysis of the pottery, the following characteristics were recorded, as far as the size of the sherds permitted.

Diameter:
Measurements, externally, were taken at a two centimeter interval.
Thickness:
To give an impression of the overall thickness of the vessel, the thickness was recorded in millimeters at about 2 centimeters below the rim. This measurement is only an indication, due to the variations in wall thickness within each vessel. Some pottery fragments were too small to take measurements at the indicated place.
Angle:
The angle of a vessel is defined by the angle between the wall of the sherd and a horizontal base line (see Orton 1980: fig. 2.8). The angle was recorded at an interval of 10 degrees.
Slip:
To determine whether a piece of pottery had a layer of slip is difficult. The layer might have flaked off or disappeared in the course of time or the layer which is observed might in fact be self-slip.

The identification 'slip' in this article means a positive identification of an applied layer of slip. Occasionally, when the inside of the vessel was covered with slip, also the top of the rim and a small portion of the outside of the vessel were slipped. Sherds with this feature were categorised as having 'inside slip'.

In general the slip, when applicated, had the same colour as the vessel itself (i.e. red or reddish)[3]. Other sherds had a somewhat dark-red colored layer.
Burnish:
There was a great variety in the burnishing of the vessels, which ranged from total burnishing to just some streaks of burnishing at irregular intervals.
Clays and fabrics[4]:
Of all the sherds studied a fragment was pinced off and studied under a binocular, 30 times magnification. No detailed

chemical or mineral analysis of the sherd material is available as yet. We used a limited number of clearly visible phenomena to differentiate between fabrics. This resulted in a small number of groups which were usually easy to identify. The results of a detailed study of the material composition of the fabrics of the Iron Age Jerusalem pottery and the implications of these results for a division of the pottery into fabric-groups will be published in the forthcoming publication of Franken and Steiner (see References).

Rim equivalent:

This indicates the percentage of the rim represented by the sherd. Establishing this percentage is only possible in combination with the possibility to measure a diameter. As it turned out, a diameter could only be established when at least 7 % of the rim was represented (see Orton 1980: 164-167).

Classification

For the description of the classification of the pottery the data of both caves were taken together, since no clear differentiation between the two caves could be observed.

After a general description of each class of vessel(5), there are drawings of some sherds representative of the vessel class, tables, and diagrams representing in a graphical way the different characteristics of the sherds used in the analysis. Diagrams are only given, when they clearly demonstrate a trend in the data and if the number of sherds is sufficient. In every diagram the number of sherds which could be measured is indicated with N.

Bowls class 1

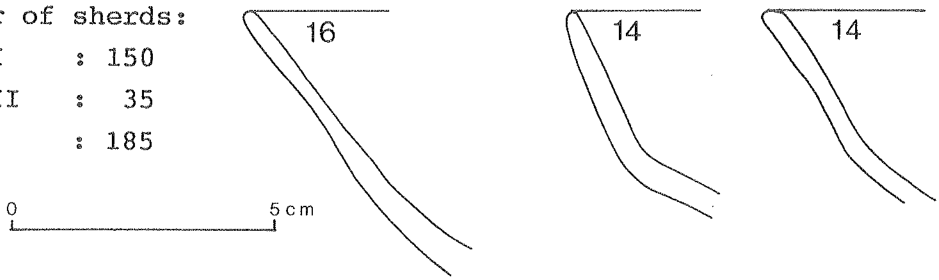
The rim becomes thinner towards the top and is not rounded off or profiled. Some sherds were large enough to observe that the lower part of the bowl had been scraped. This type was not burnished, and no slip had been applied. The angle is about 50°-70°.

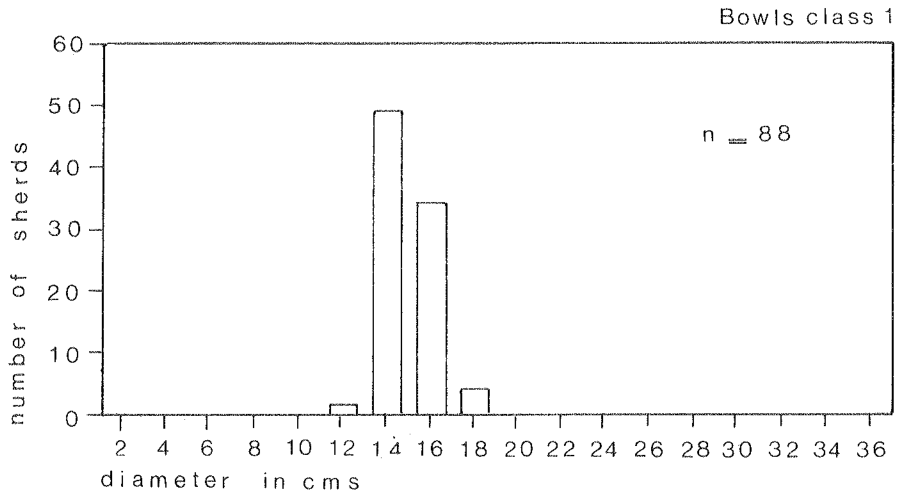
number of sherds:

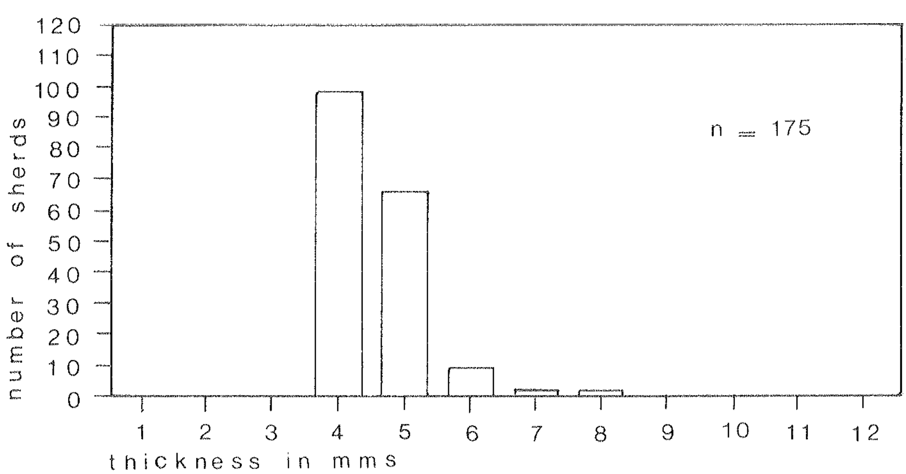
cave I : 150

cave II : 35

total : 185





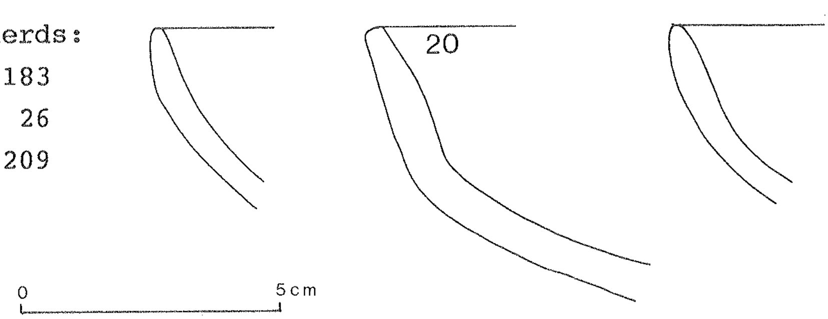


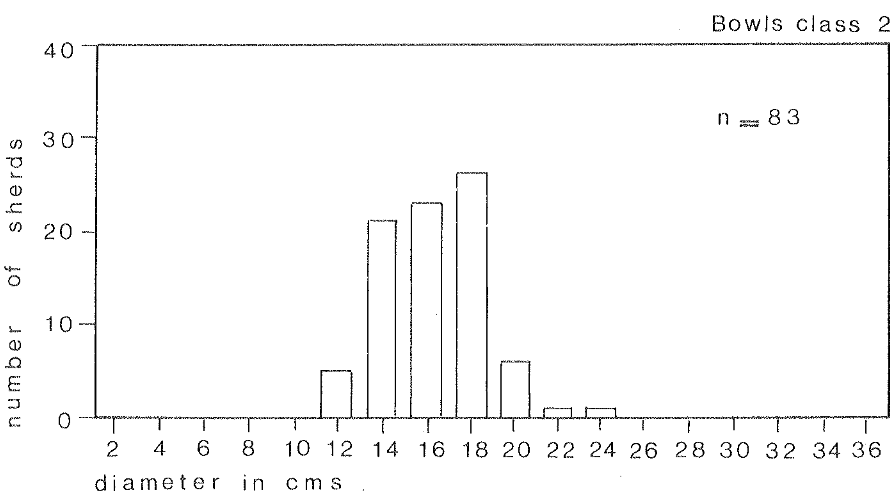
<u>Bowls class 2</u>

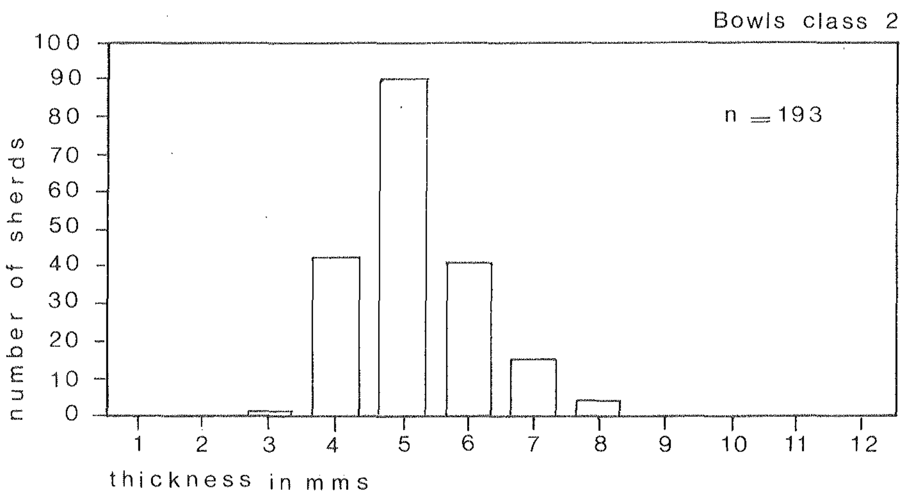
Rims of this class have an even thickness. The top is rounded off without resulting in a clear profile. The angle varies from 40° to 80°, with a peak by 60°-70°.

	burnish	slip
none	52.5 %	46.8 %
inside	47.5 %	50.2 %
outside	0 %	0 %
inside and outside	0 %	3.0 %

number of sherds:
cave I : 183
cave II : 26
total : 209





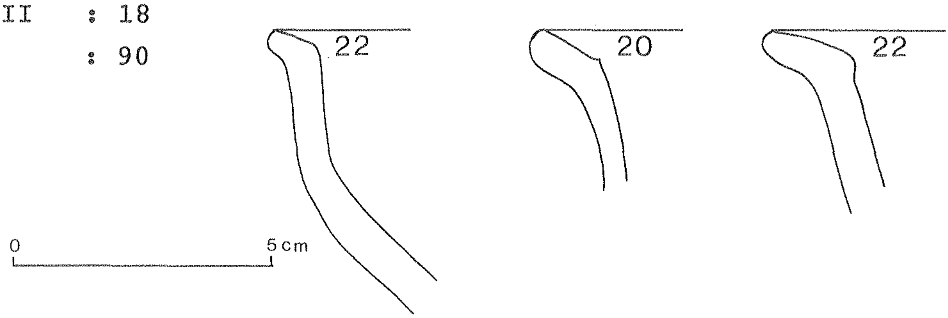


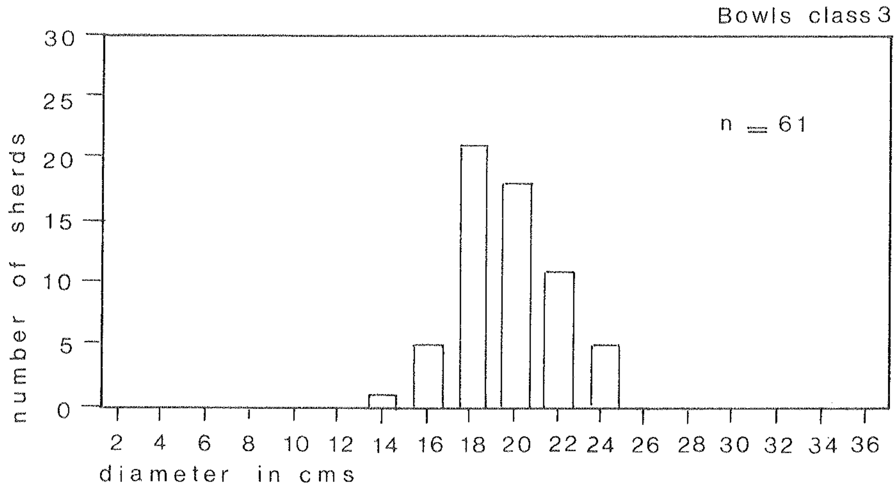
Bowls class 3

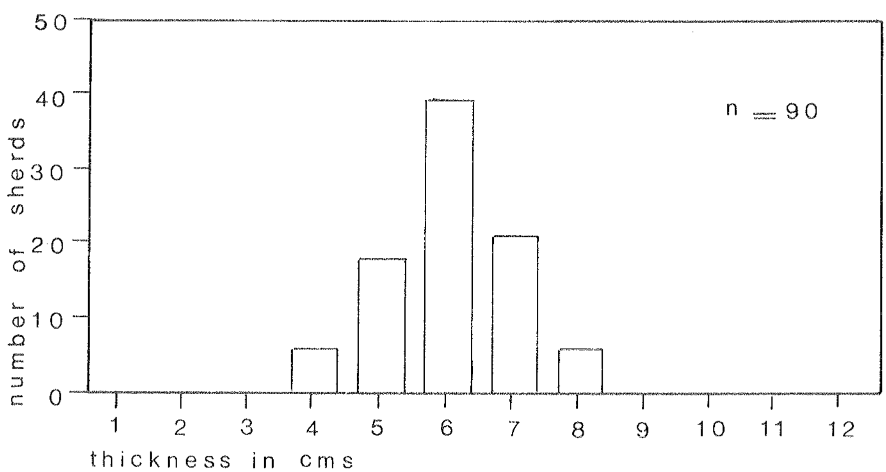
The rim has an even wall thickness and is profiled by pushing down the top part of the rim towards the outside, which did not result in a thickening of the rim itself. The angle is 50°-70°.

	burnish	slip
none	26.1 %	35.6 %
inside	73.9 %	62.2 %
outside	0 %	0 %
inside and outside	0 %	2.2 %

number of sherds:
cave I : 72
cave II : 18
total : 90







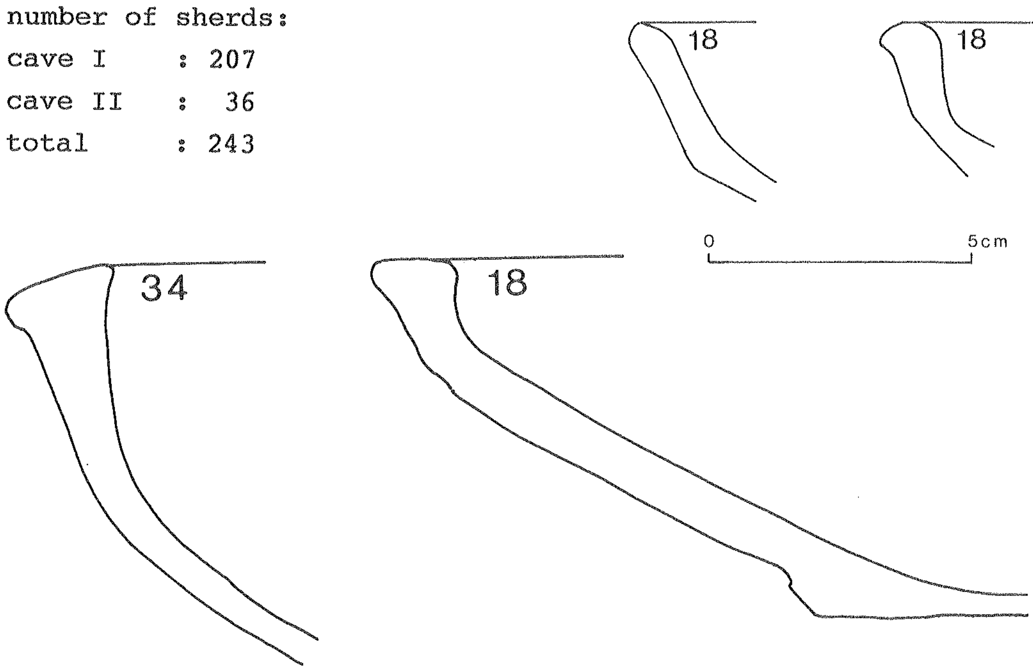
Bowls class 5/6

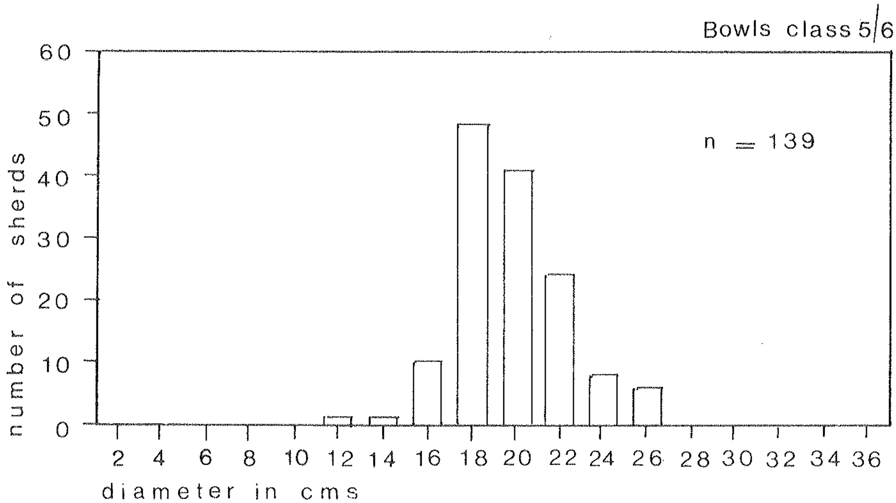
The rim of this class thickens gradually towards the top. This was done by pushing clay upwards along the wall towards the rim. There is no clear profile, although the rim itself thickens slightly outside and inside, which could have been done intentionally to strengthen the rim. The angle varies between 40° and 80°, with a peak at 50°-60°.

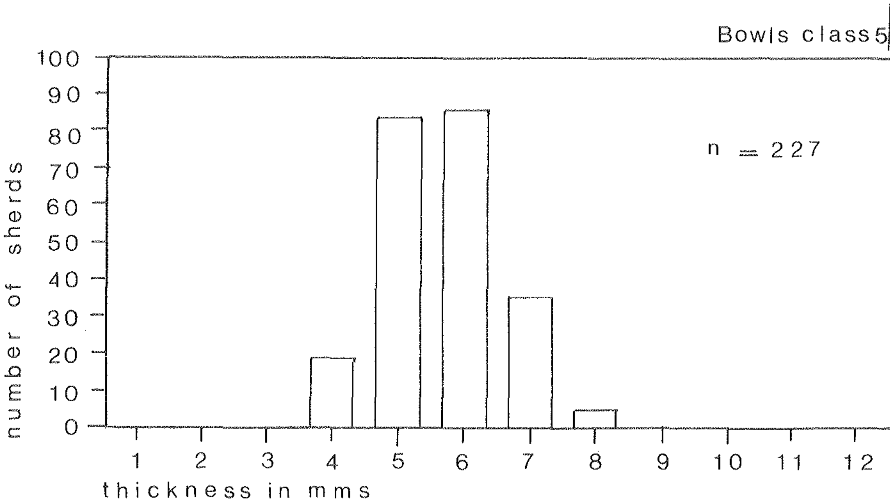
	burnish	slip
none	28.0 %	37.8 %
inside	67.1 %	57.6 %
outside	0.8 %	0.4 %
inside and outside	4.1 %	4.2 %

number of sherds:

cave I	: 207
cave II	: 36
total	: 243





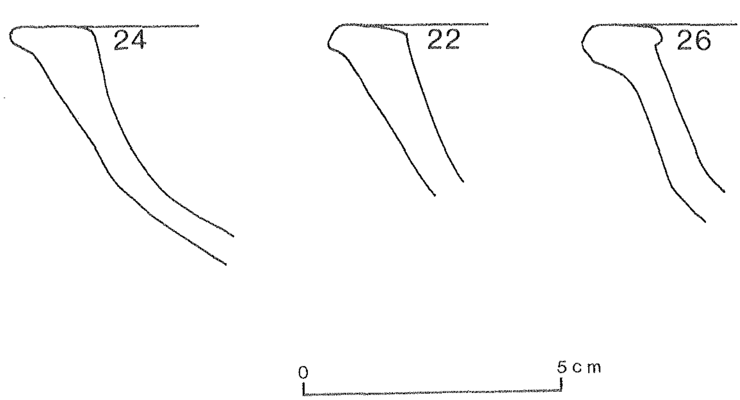


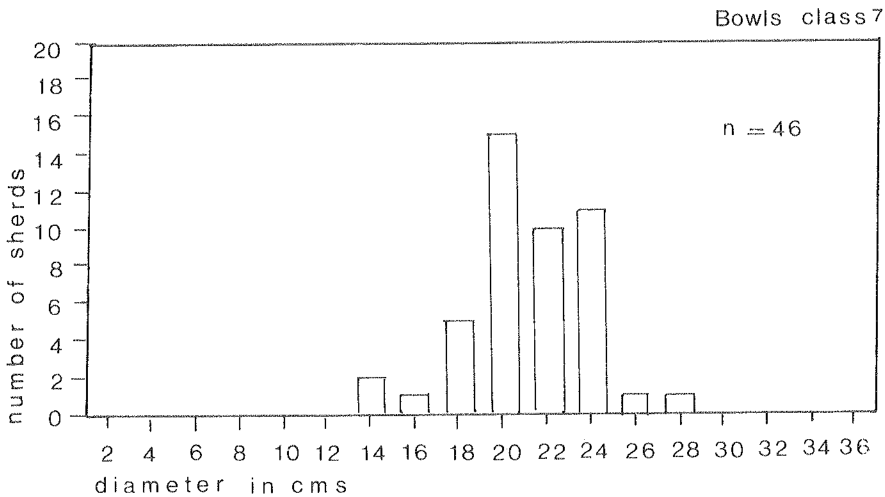
Bowls class 7

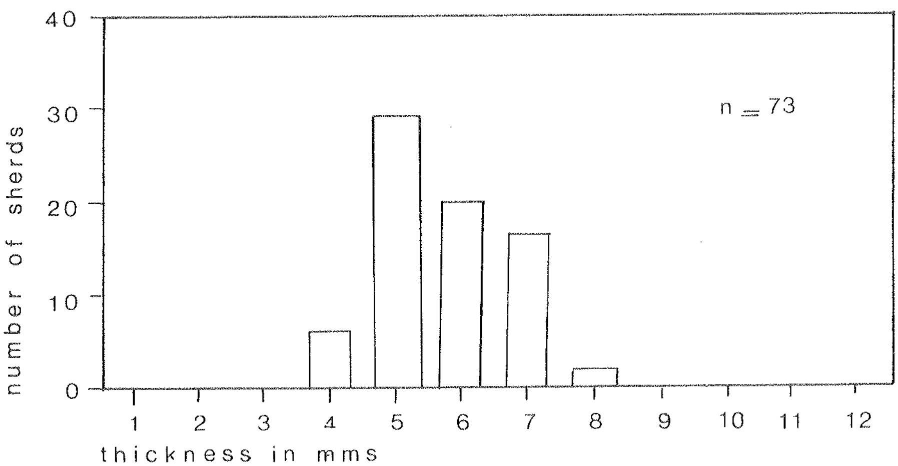
Like bowls class 5/6 the rim gradually thickens towards the top. But besides being pushed up, the clay was also pushed to the outside, resulting in a clear profile. The angle varies between 40° and 90° with a main concentration at 50°-70°.

	burnish	slip
none	14.8 %	56.7 %
inside	75.7 %	36.5 %
outside	0 %	0 %
inside and outside	9.5 %	6.8 %

number of sherds:
cave I : 51
cave II : 23
total : 74



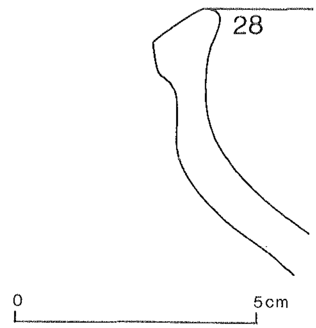




<u>Bowls class 8</u>

This class has a thickened rim, the clay having been pushed to the outside and downwards to a much further extent than was the case with bowls class 7. Usually, the lower outside edge of the rim was given a finishing treatment, so that a thick rim, forming an integral part with the wall, was obtained. The angle is between 50° and 100°, with a clear concentration at 70°-80°.

	burnish	slip
none	16 %	62 %
inside	82 %	18 %
outside	0 %	0 %
inside and outside	2 %	0 %

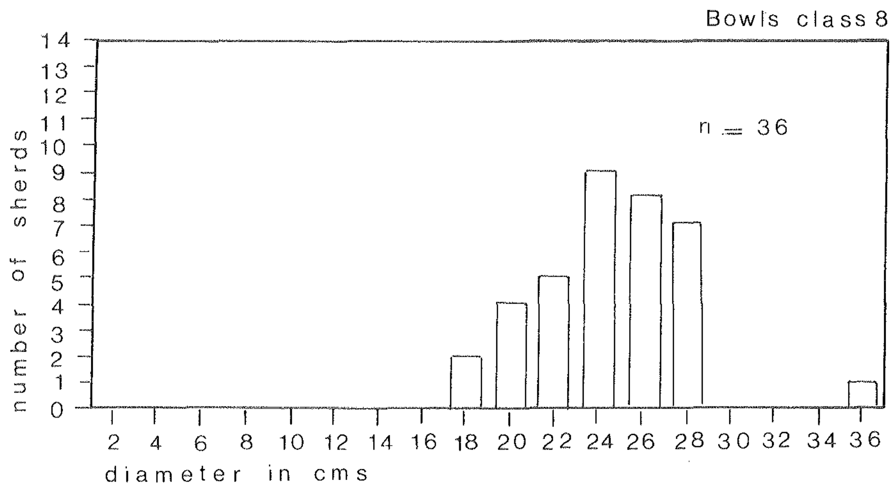


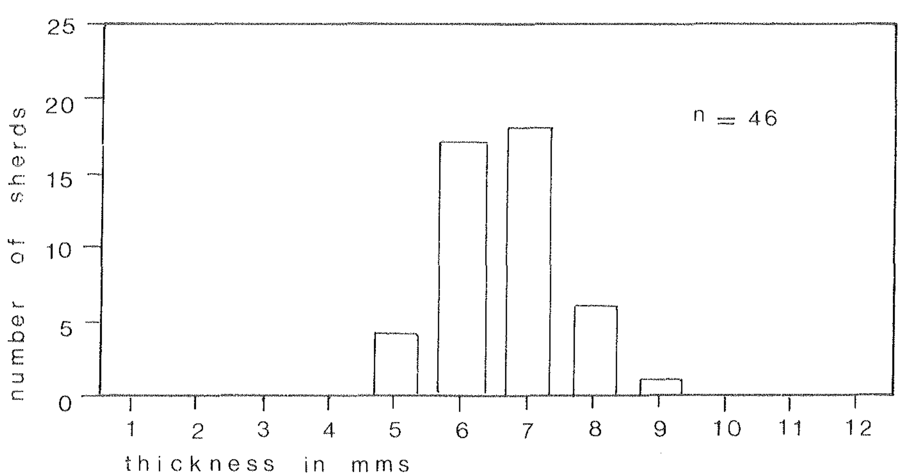
number of sherds:

cave I : 36

cave II : 14

total : 50



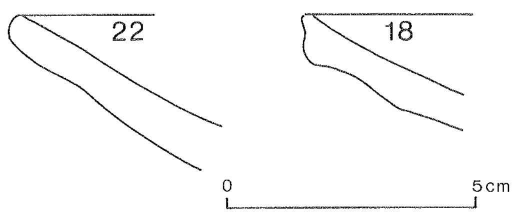


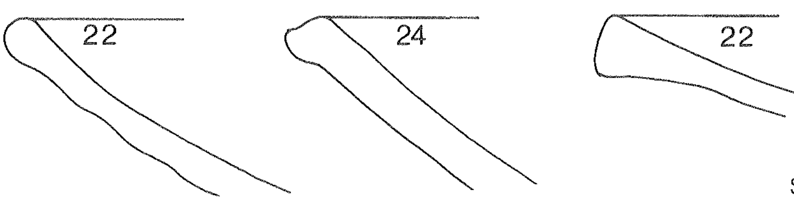
Saucers

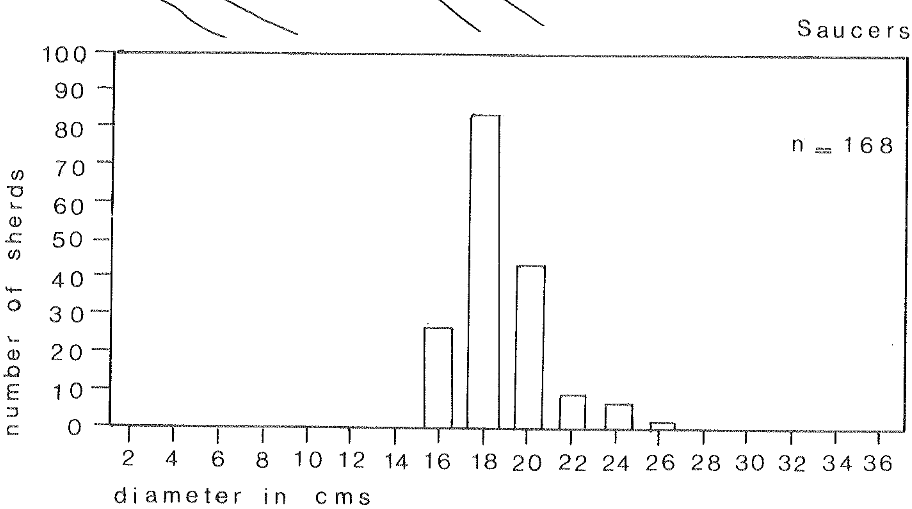
Flat dishes with an even profile of the rim. Sometimes the rim was slightly pushed downwards and was given a finishing treatment. The few base-sherds show that occasionally scraping, resulting in a low disc base, did occur. The angle varies between 10 ° and 40°, 20°-30° being the most frequently occurring value.

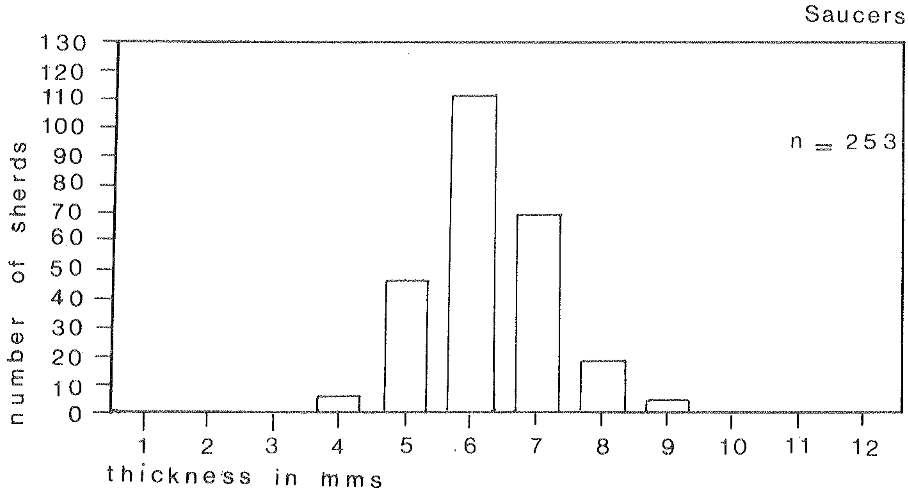
	burnish	slip
none	59.0 %	54.1 %
inside	39.8 %	45.5 %
outside	0.4 %	0 %
inside and outside	0.8 %	0.4 %

number of sherds:
cave I : 199
cave II : 67
total : 266







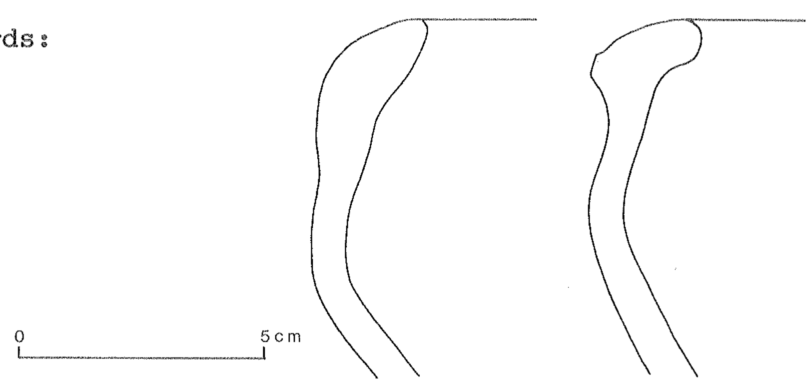


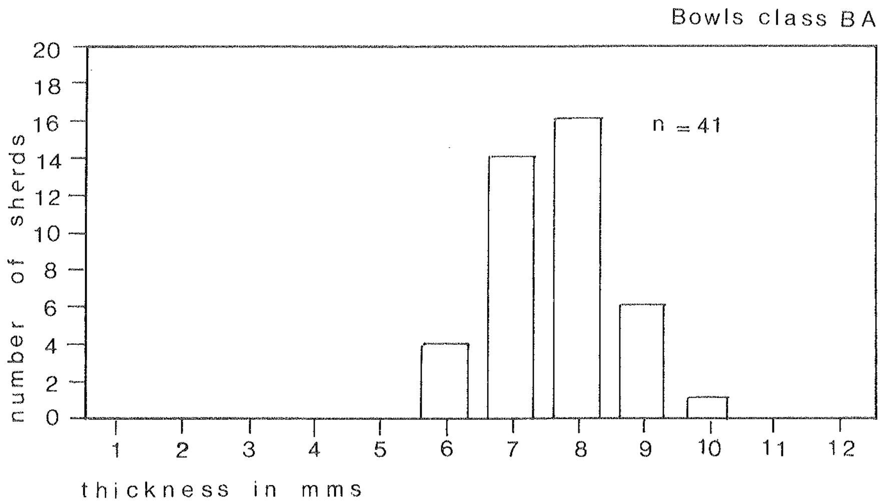
Bowls class BA

The rim was made the same way as bowls class 8: by pushing the clay downwards to the outside a thick rim was created. The diameter of this class of bowl however was much larger, about 34 centimeters.

Sherds of this class were found in cave I, many of them only fragments and too small to measure all characteristics. Therefore, only a diagram of the thickness is given. The angle was about 80°-90°, but very few angles could be measured. No slip was applied; all bowls except one were densely burnished on the inside.

number of sherds:
cave I : 52
cave II : 0
total : 52



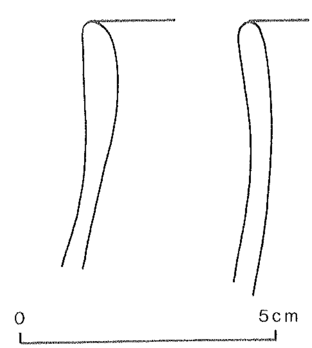


Jars

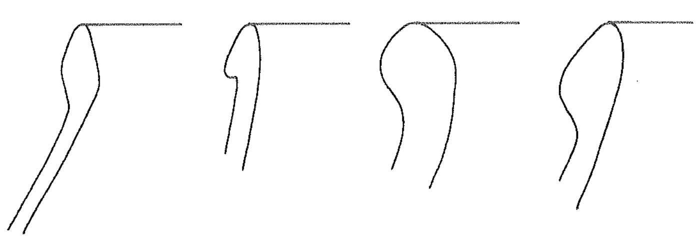
The great variation within this class in the diagrams of diameter and thickness indicates that this vessel-class in our preliminary classification is not a homogeneous group(6).

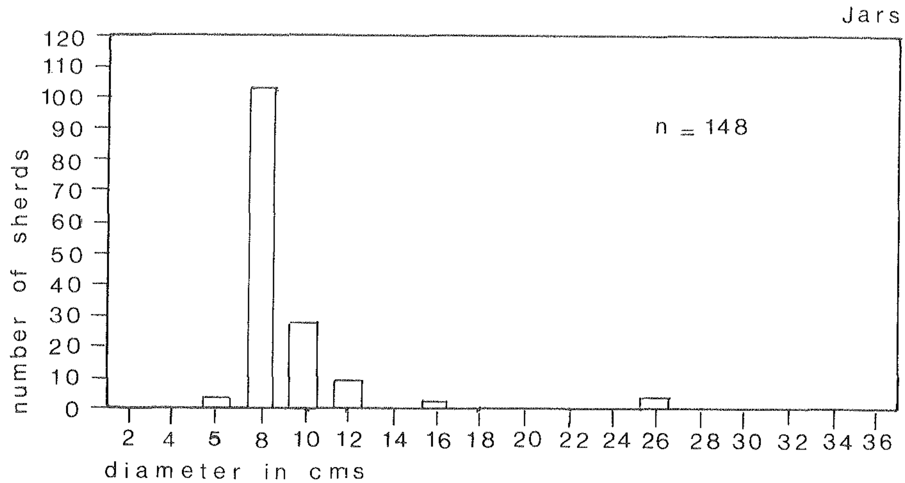
A further refinement of this class, resulting in some sub-classes will be made, when more sherds have been studied.

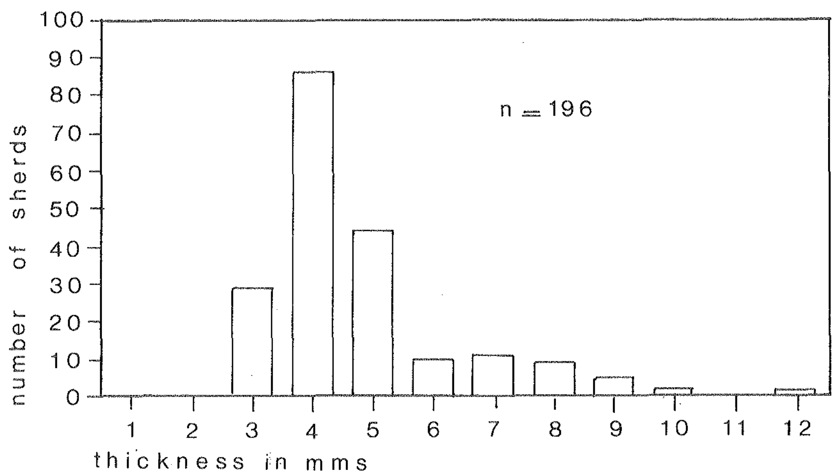
	burnish	slip
none	95.5 %	99.0 %
inside	1.5 %	0.5 %
outside	1.5 %	0 %
inside and outside	1.5 %	0.5 %



number of sherds:
cave I : 142
cave II : 56
total : 198



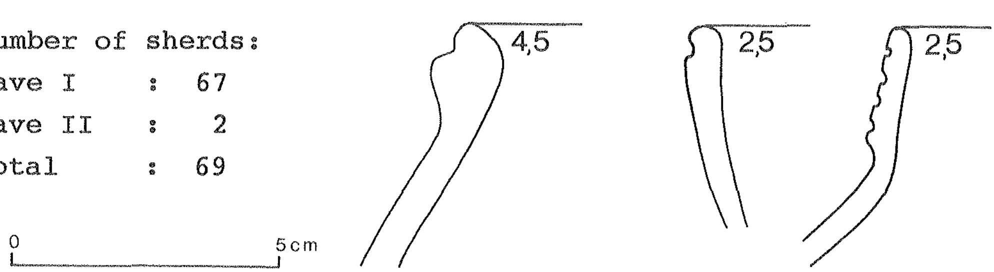


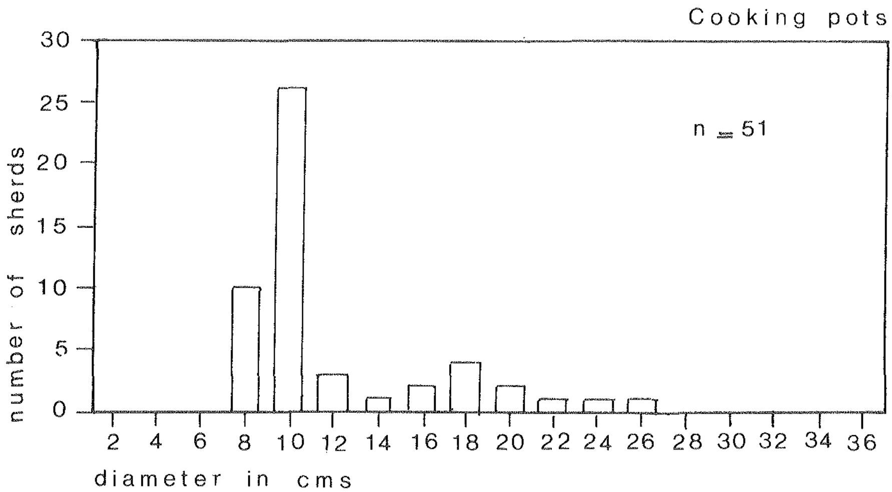


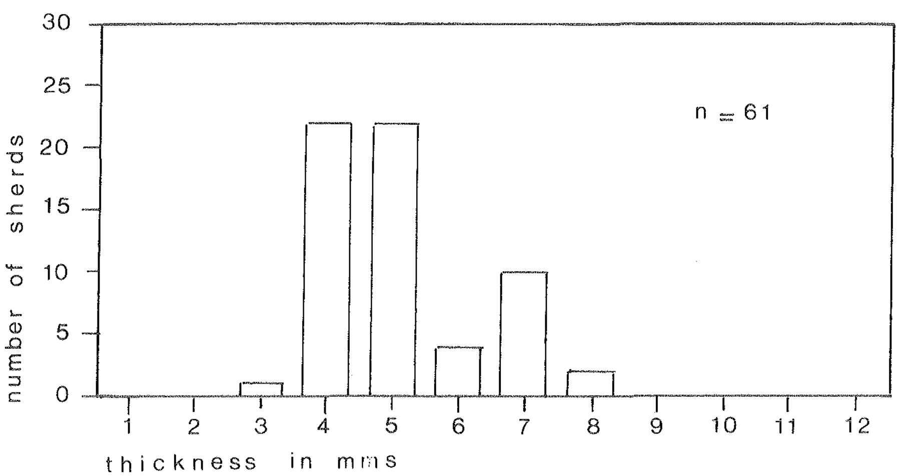
Cooking pots

The diagrams show a wide variety as regards thickness an diameter and indicate at least two possible sub-classes (7).

number of sherds:
cave I : 67
cave II : 2
total : 69

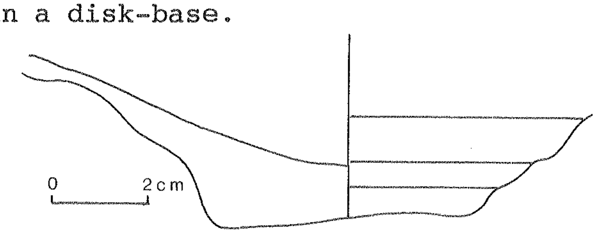






Lamps

Owing to the small number of sherds found, little information could be recovered regarding these lamps. A few bases show that they were thrown from the cone and sometimes were scraped, resulting in a disk-base.



Number of sherds:

cave I : 0

cave II : 19

total : 19

Clays and fabrics

After a preliminary study by Prof. Franken, the clays and fabrics involved were divided in two main categories:

The A clay, the material commonly used in the Jerusalem pottery, is a red clay which contains microfossils.

The B clay, which burns very pale brown to yellow and contains extremely fine calcite grains.

Given the non-plastic inclusions in the claybody, the whole fabric group looks like this:

A1: the A clay with none or very few non-plastics.

A2: the A clay mixed with chalk/calcite(8). The concentration, size and color of these inclusions varies greatly.

A3: the A clay with quartz grains.

A4: the A clay with both chalk/calcite and quartz-grains.

B1: the B clay, high concentration of fine calcite grains.

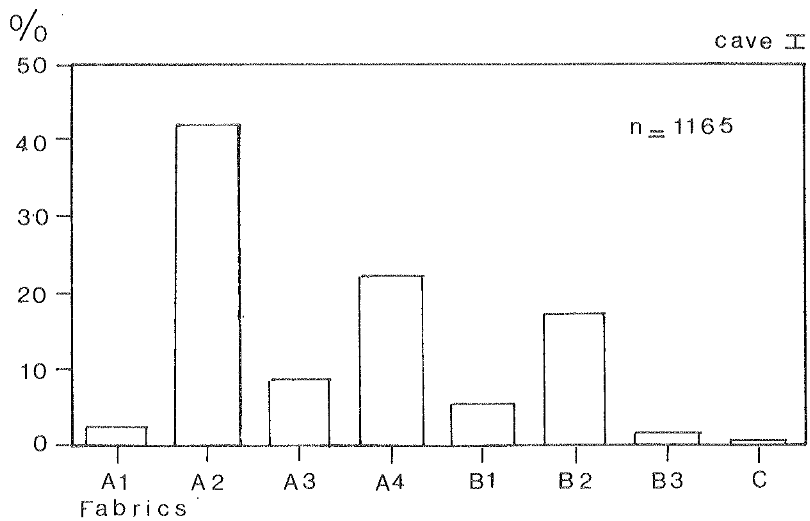
B2: B clay with a lesser concentration of the fine calcite grains possibly because of the mixing with an other clay.

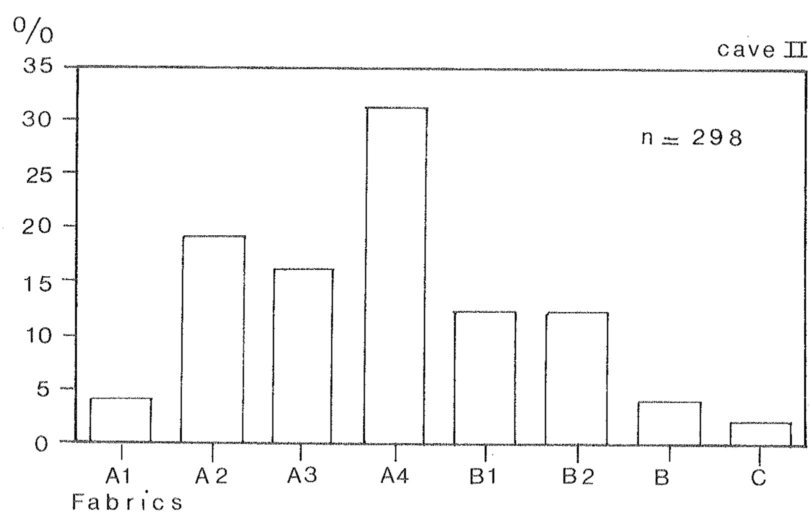
B3: like B2, with an inclusion of quartz grains.

C: unclassified material, all other fabrics.

The diagrams on page 19 show the distribution of the fabrics over the different classes of vessels for both caves. First the main subdivisions A, B and C.
The diagram on page 20 shows the whole range of distinguished fabrics.

In general both main categories A and B occur frequently, A being the most commonly used in nearly all vessel classes, especially pots and lamps. Cat. B, although present in nearly all classes has a strong association with bowls class 1 and class BA.

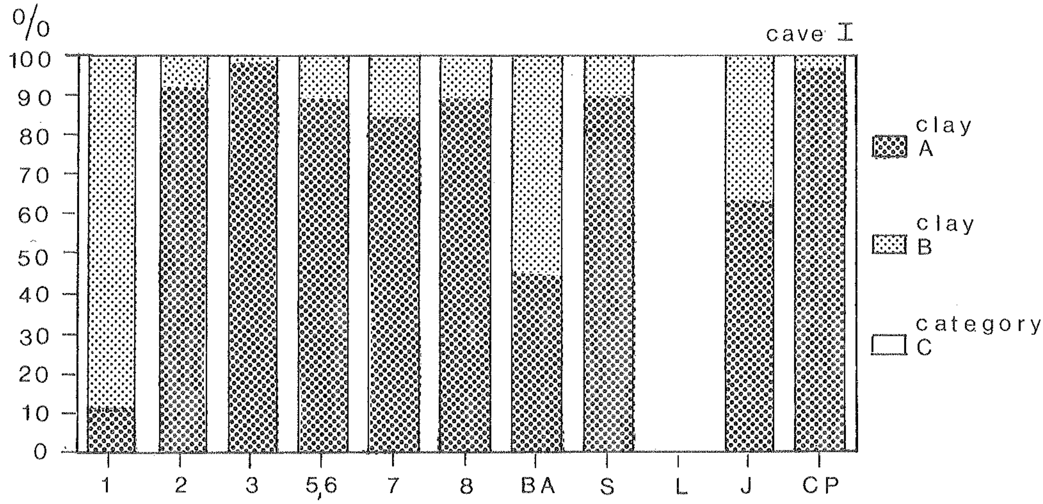


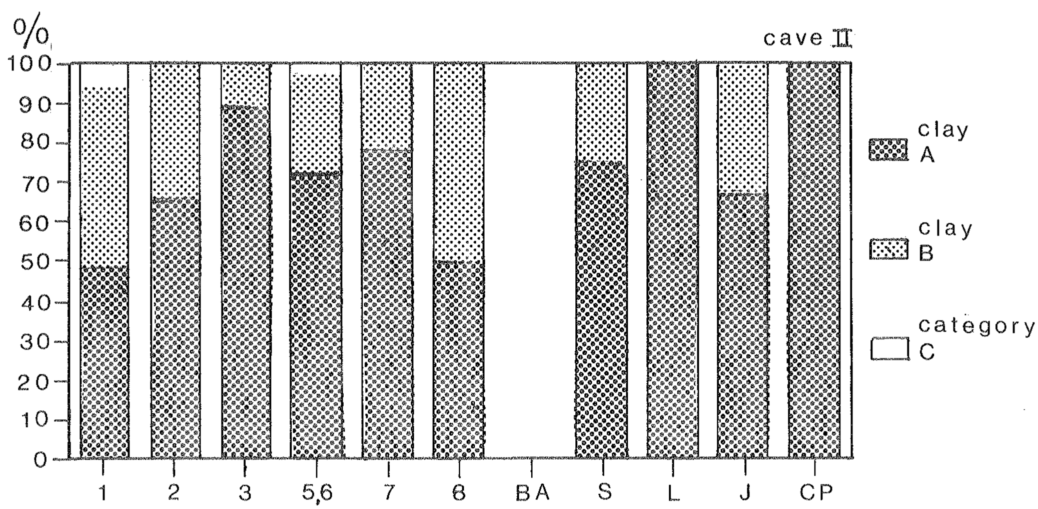


<u>Comparison of the pottery in both caves</u>

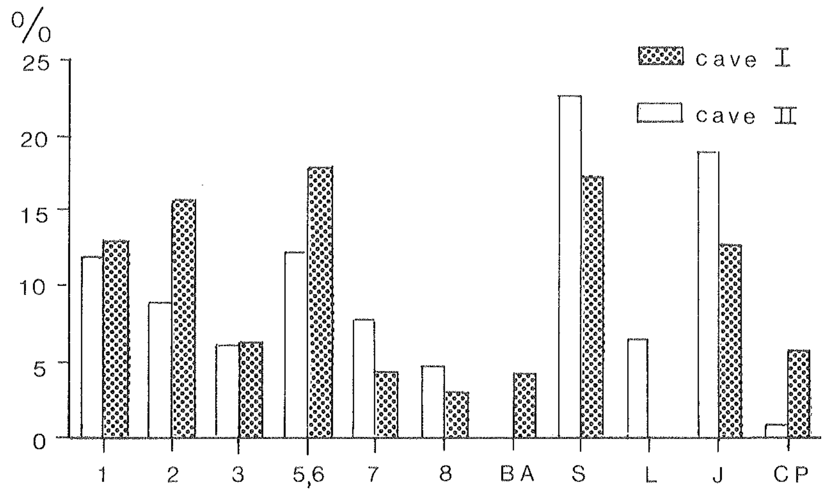
In the diagram on page 21 the frequency is indicated for each class of pottery.

Although differences can be observed some factors must be taken into account which may influence these differences. First of all the fact that no sherds of bowls BA were found in cave II and no sherds of lamps in cave I, while complete pieces of those classes were found in both caves, influences





the percentages in the diagrams. The diagram on page 22 (above) indicates the differences in occurrence of the bowls (classes 1-8 only) in both caves. On the whole, these differences are now smaller and bowls 1 and 3 now clearly occur less then in diagram, illustrating the whole range of pottery classes. Secondly the number of sherds available for cave II might prove to be insufficient to be used for a definite and constant indication of the frequency of the

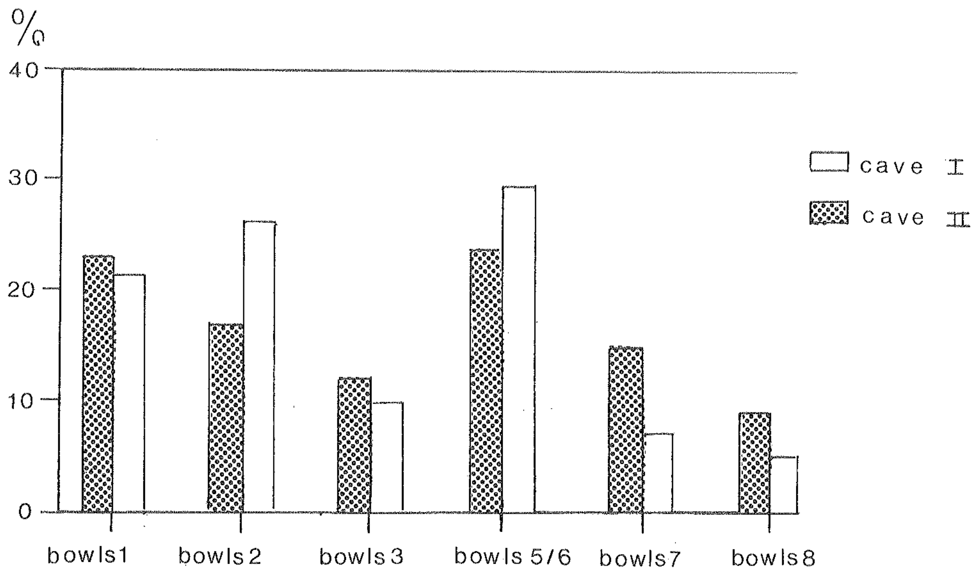


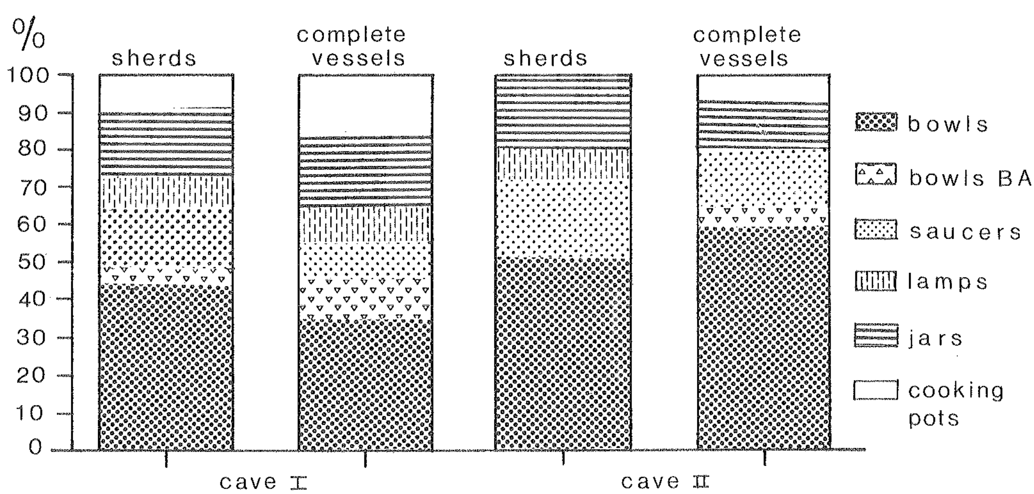
number of classes attested to. Also the fact that the pottery was found in caves must be taken into consideration because the different ways in which the caves may have been used, might have influenced breaking patterns and, therefore, the number of sherds into which a piece of pottery eventually broke. Therefore we do not know whether the differences observed are caused by chronology only.

A comparison of the (nearly) complete pieces of pottery in combination with the sherds is given in the diagram on page 22 (below).

Not every class could be recognized from the small drawings of the complete vessels. Therefore only the following groups were differentiated: bowls, bowls BA, saucers, jars and cooking pots.

More cooking pots were found in cave I, complete as well as sherds. Also more bowls BA were found in that cave. This class is thought to be a later development in the Jerusalem repertoire and this difference might therefore indicate a later date for the material found in this cave compared to cave II. In the diagram of the complete vessels the frequency of bowls class 1-8 is different from that in the diagram of the sherds. This shows that percentages of complete vessels





and sherds may not be used indiscriminately and that one cannot be used instead of the other. One must take into account the differences in percentages of sherds and complete vessels.

Conclusion

The sherd material studied represents a number of pottery classes, usually forming homogeneous groups with regard to diameter and thickness. In two instances the data show that a further subdivision is plausible. All classes occur in both caves and do not differ clearly in frequency. Only bowls BA are more frequent in cave I, being an indication for a possible later date for this cave than for cave II. A comparison with the pottery from the phases as regards class and frequency could not yet be made and therefore an indication for the use of the caves as favissa's is not yet possible.

Notes

1. See for published references regarding these caves the bibliography at the end of this article.
2. The suggested date for cave I is ± 700 BC. (Kenyon, 1968: 108) and for cave II ± 800 BC.
3. No color classification system, such as the Munsell Soil Color Charts, was used in the analysis.
4. "... the word fabric refers to the composition of the clay after the preparation by the potter ... .fabrics are distinguished on the basis of differences in the type, shape, size and frequency (both relative and absolute) of these inclusions (i.e. the inclusions in the clay body)". Schuring 1986: 159).
5. See for a detailed description of the pottery technology of the bowls Franken (1985).
6. Small jars, although present in the complete vessels collection, were not found in our sherd material.
7. One sub-class with a diameter of about 10 centimeters and a thickness of about 7 millimeters and a second sub-class with a larger diameter of about 18 centimeters and a thickness of 4 to 5 millimeters.
   See Amiran 1969: 230-231 e.g. Fig. 13,14 and 15-17.

8. No distinction was made between chalk and calcite, because at a high temperature calcite transforms into chalk.

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Hermann Gasche

REFLEXIONS SUR UNE ARCHEOLOGIE

La plupart des archéologues n'aiment pas qu'on les interroge sur "l'origine des choses": elle se dérobe presque toujours, voilée par un réseau dédaléen d'influences, de modifications, de progrès ou de décadences technologiques. Le récipiendaire de ces lignes, sans contredit, ne se range pas dans cette catégorie de chercheurs. Bibliste à ses débuts, sa participation aux fouilles de Jericho l'oriente vers l'archéologie, cette autre discipline qui engendre l'histoire. Mais la méthode qu'exige l'étude du discours écrit - ses inclinations personnelles aussi, sans doute - lui ont donné la rigueur indispensable, pourtant souvent délaissée dans la construction archéologique. J'espère qu'il me pardonnera de ne lui offrir que ces quelques propos, mais dont certains au moins, je le sais, rencontrent son approbation.

La valeur attachée au document écrit fut autrefois si grande qu'elle conditionna le début de l'Histoire à l'apparition de l'écriture. Pour sortir de l'impasse on "créa" la Préhistoire: il fallait bien trouver un terme pour cette interminable période, 400 fois plus longue que celle à partir de laquelle nous écrivons. Par la même occasion, la "vision historique totale" devint l'apanage des philologues même s'ils quêtaient, ça et là, un complément d'information chez les archéologues, relatif au "contenant", par exemple, de leurs grimoires.

J'aime à croire, aujourd'hui, que les habitudes d'esprit ont changé. Le document écrit, le témoin archéologique et plus encore, peut-être, toutes ces informations livrées peu à peu par les sciences dites auxiliaires - géomorphologie, paléo -géographie et -climatologie, archéo -zoologie et -botanique pour ne citer que les plus influentes - jouent des rôles complémentaires dans la reconstitution de cette extraordinaire aventure qu'est celle de l'homme à travers le temps et l'espace. Malgré de sensibles différences dans la qualité ou dans la nature de ces informations, on ne peut plus ignorer les liens profonds qui les relient. Dans aucune civilisation, voire dans aucun des phénomènes qui la caractérise , rien ou à peu près rien, pris isolément, n'est important. Ainsi, la date inscrite au bas du texte d'un titre de propriété, par exemple, n'est que rarement un témoin sérieux pour le cadre chronologique de la couche dont il provient; ce document, en effet, a pu être conservé jadis, comme aujourd'hui encore, très longtemps dans les archives d'une famille. Ce sont les transactions quotidiennes, ces "petits" textes moins attrayants et plus régulièrement éliminés, à l'époque déjà, des fonds d'archives qui produisent les informations les plus sûres dans ce domaine. Tout cela, évidemment, chacun le sait. Mais, hanté quelque peu par le repère chronologique, le fouilleur prendra volontiers pour argent comptant la première référence qui se présente. D'où confusions et fâcheuses lacunes.

A l'inverse, le document écrit peut être d'une irremplaçable éloquence. Tel ce texte réenterré depuis belle lurette dans les caves d'un Musée et qui nous apprend sans ambages qu'une belle poignée de rois méso-élamites épousèrent autant de princesses de sang cassite. Après plus d'un siècle d'études assyriologiques, il était temps qu'on nous apprenne enfin l'existence de ces mariages de raison entre les gouvernants des deux plus grandes puissances de l'époque. La parole est aux archéologues maintenant pour nous dire si cette noble descendance emporta quelques souvenirs mésopotamiens dans leurs dots royales.

Les exemples évoqués pourraient être multipliés à volonté. Ce serait sans intérêt. Ils suffisent à montrer combien sont complémentaires les données relatives à un même sujet, mais de natures différentes. L'attitude anachorétique n'est plus de mise dans ces métiers d'agrément que nous exerçons. Il est urgent que philologues et archéologues agissent de concert avec les géomorphologues en vue de restituer le système fluviatile et le réseau d'irrigation anciens: on comprendra alors mieux le fonctionnement de l'économie de ce pays. Et comment s'organisaient les échanges interrégionaux, nous évitant ainsi les inextricables contradictions qui jalonnent les reconstitutions actuelles d'un itinéraire ancien. Il faut que les archéologues et les philologues s'associent avec leurs collègues de la plupart des sciences naturelles pour dégager une image plus convaincante de cet environnement qui nous échappe ou presque. Il faut que les archéologues tentent de reconnaître la nature et les causes qui régissaient la sédimentation des dépôts qu'ils enlèvent. Et ceci avant de leur assigner une date, fixée souvent après avoir oublié d'établir les relations topographiques entre ces couches qui contiennent pourtant les seuls témoins physiques du passage de l'homme dans ces lieux. Par ailleurs, pour mieux intégrer leur découvertes, il faut chercher un but et un langage communs - différés dupuis trop longtemps - avec les chercheurs de ces disciplines dont le théâtre d'opération est un laboratoire.

Mais l'ensemble de ces enquêtes n'atteint qu'une partie de l'objet total de la recherche historique. Il faut y ajouter toutes celles, nécessaires et variées - mais dont je ne parlerai pas, car tout le monde les connaît - qui justifient l'existence même de l'archéologie et de la philologie. Pour le coup, je pratique ici une démarche que les anciens connaissaient déjà. Eux aussi ne parlaient pas, ou peu, de ce qui était connu de tout le monde et que nous aimerions bien, nous, connaître aujourd'hui. En somme, ils ne décrivaient tout simplement pas leur manière de voir et de sentir les choses. Je terminerai donc par cette vérité parfaite due à Jean

Bottéro: "aucun manuel de cuisine ne donne la recette de l'eau chaude".

Abraham van As

TOWARDS A CORPUS OF MESOPOTAMIAN POTTERY

Introduction

On April 29, 1987, the Working Group on Mesopotamian Pottery met in Ghent, Belgium. Those present included: M. Brandt (Eminence, USA); H. Gasche (Paris); McG. Gibson (Chicago, USA); B. Hrouda (Munich, West Germany); G. van Lerberghe-Voet (Louvain, Belgium); L. Jacobs and A. van As (Leiden, The Netherlands). The theme chosen for this meeting was centred around the composition of a corpus of Mesopotamian pottery (see van As and Tunca 1986). Below are a number of pertinent notes which were made concerning the meeting.

A corpus of pottery

A corpus of pottery is not an unknown phenomenon in archaeological literature. Such a corpus is usually composed of the so-called type corpus. This is, however, not identical to a true corpus, such as, for example, the "Corpus Vasorum Antiquorum", which aims at illustrating all the extant pottery from the Classical Age which is now housed in various collections throughout the world. The aim of a type corpus is to form the basis of a classification system which can be used to identify and illustrate the main types of pottery which are to be found in a particular area. Such a classification was carried out, for instance, by Sir Flinders Petrie for the pottery from Tell el Hesy (Petrie 1891). Petrie was one of the first archaeologists to realise the importance of pottery for dating purposes, and to this day one of the main purposes of composing a type corpus is the wish to establish dates (type chronology), and to indicate the geographical spread of certain pottery types.

The criteria for composing a type corpus: shape, function and technique

Many aspects determine the production and geographical spread of pottery. These points include: the raw material; the technique; the production type; the demand; the function; aesthetics; trade routes; the geographical and political situation, etc. In archaeology, a pottery type should ideally be composed of a group of pottery which belong together because all such factors are identical. In practice, however, it is extremely difficult to include all of these points when building up a type corpus. Most type corpora for pottery from the Near East, for example, are based only on the criteria of shape and function. All too often technology is considered to be a poor relation and only described with a minimum of details.

Shape and function

The most common criterion for the sorting of pottery is the shape. An example for a type corpus which is based on morphology is Duncan's "Corpus of Dated Palestinian Pottery" (Duncan 1930). "As in an index the first requirement is ready reference, so here all other considerations have to give place to a uniform system by distinguishing types. To this end, the order is from the most open forms, such as plates to the most closed forms, such as bottles" (from Petrie's Introduction to Duncan's study). For the denomination of his different categories Duncan used a terminology which indicates both the shape and the function of the pottery: lipped bowls; flat dishes; bowls which have a slope of below 45°; cooking pots, rounded, etc. In view of the close relationship between shape and function it is not surprising to find such combinations of morphological and functional denominations.

According to B. Hrouda, the German language has developed a clearly defined terminology as regards the function of pottery types, which can be used for archaeological pottery classifications: Teller; Schale; Napf; Schüssel, etc. D. Miller points out that B. Saraswati and N. Behura (1966) and J. Birmingham (1975) are of the opinion that function is the most influential aspect for determining, and constraining, the final shape of a piece of pottery. As such it should be taken as the most important starting point for the classification of ceramics (Miller 1985:52). In traditional excavation reports, however, determination of the function of a piece of pottery only serves to give the pot a label. Functional analyses are seldom carried out. Research into the causal relationship between function, raw material and shape, such as were carried out by V.P. Steponaitis (1984) and D. Braun (1983), are rare.

Some investigators, such as P. Delougaz, have attempted to give the morphology of ceramics a more objective and abstract character by introducing a geometrical approach (Delougaz 1952). Nevertheless, this type of classification system is frequently too detailed to be of use in comparative research.

An example of a more simple geometrical approach has been published by J.E. Ericson and E.G. Stickel (1972). Their classification system, which according to the authors will permit an international standardization of ceramic data, allows for an adequate, general cross-cultural comparison of vessel morphology. The reliability of this purely morphological classification system has been tested using twenty-five clay pots which were obtained from a store at Tijuana, Baja California, Mexico. The results of this test were favourable.

Technology

It is only of a comparatively recent date that the significance of technological-analytical studies of ceramics for the archaeological classification of pottery has been recognized. In her recent survey of the history of research into archaeological pottery from Palestine, Gloria London (1985) points out that "the publication of the Iron Age pottery of Tell Deir ^{c}Allā (Franken and Kalsbeek 1969) marked a turning point in ceramic analysis" (London 1985:65). Contrary to J.L. Kelso and J.P. Thorley, who in preceding years had been involved in the study of ceramic technology, Franken and Kalsbeek were concerned in their technological research with the chronological ordering of the material and in the question of the way in which the pottery represented a facet of ancient social organisation. "In the absence of a well-defined pottery typology for the upper Jordan Valley, a sequence was developed for the Tell Deir ^{c}Allā material based on manufacturing technique rather than on superficial stylistic criteria alone" (London 1985:65f.). The new aspect of the Tell Deir ^{c}Allā report lies in its emphasis on the testing of hypotheses and on the explanation of the method of pottery manufacture; the factors that contribute to variation of rim shape; fired clay colour, and to the selection of tempering material (London 1985:66).

Initially the approach by Franken and Kalsbeek was misunderstood and criticised. The positive reply by Paul Lapp constituted an exception (Lapp 1970). Criticism was particularly directed towards the usefulness of Franken's pottery presentation, as based upon a technological analysis, for comparative research. For archaeologists who do not have the special knowledge of the potter's craft, it remains difficult to insert their pottery into Franken's technological division (Dornemann 1983:41f.). Nevertheless, the work of Franken, as one of the pioneers in the study of pottery technology, has led to the general recognition that technological research into ceramics constitutes an indispensable condition for archaeological investigations.

Franken's work has not only been of influence to research within Palestinian archaeology. The Belgian Archaeological Expedition to Iraq, headed by Prof. Dr. L. de Meyer (Ghent, Belgium), found the work of Franken and Kalsbeek invaluable. So much so, that they invited Franken and Kalsbeek to study the Tell ed-Deir pottery. The resulting study of a small sample of second millennium B.C. pottery (Franken and Kalsbeek 1984), now forms the basis behind the idea of collaboration with the Department of Pottery Technology in order to produce a corpus of Mesopotamian pottery. It was with this aim in mind, that the Working Group on Mesopotamian Pottery was established in 1985.

At present there is no type corpus of Mesopotamian pottery which is based on technological research. However, a first attempt to compose such a type corpus for Jordanian pottery can be found in the exhibition catalogue "Pottery and Potters: 7000 years of ceramic art in Jordan" (Homès-Fredericq and Franken 1986). The Working Group has chosen to prepare an integrated morphological and technological corpus.

A morphological/technological corpus of Mesopotamian pottery

The deliberate choice has been made to prepare an integrated morphological/technological corpus of Mesopotamian pottery. The reason for doing so lies in the clear relationship between shape and technique. In general, shape can be explained by technological investigations (a reconstruction of the forming technique and an analysis of the raw materials). To make the corpus relatively easy to use, an attempt is made to build up a reference system in which the relationship between shape and technique is evident. Plans to present the pottery in technical categories, technical variants, and shape variants, as done by Franken (1969) and van As (to be published), have been abandoned. However correct the presentation based on technical divisions may be, the Working Group has taken into account the fact that form categories can be more easily understood and used by archaeologists who do not have sufficient knowledge of the potter's craft. At the moment the decision concerning how the main groups of the pottery corpus should be labelled remains irrelevant. Only at a later stage can a decision be made concerning the degree to which already existing pottery denominations (such as incorporated in the German terminology, as referred by Hrouda, or such as the geometrical pottery classification as suggested by Ericson and Stickel 1972), may be used for the corpus. Nevertheless, it has been provisionally agreed that the visual presentation of shapes should be based on a principle of progression from open to closed forms, and from small to large. The sequence of form categories, however, will be dependent on the results of technological studies and a decision will then be made as to whether a reference system will be set up and in what form.

Due to the complexity and length of time involved in setting up a corpus of Mesopotamian pottery as described above, the Working Group has decided that initially they will limit the general purpose of the corpus, and to carry out the

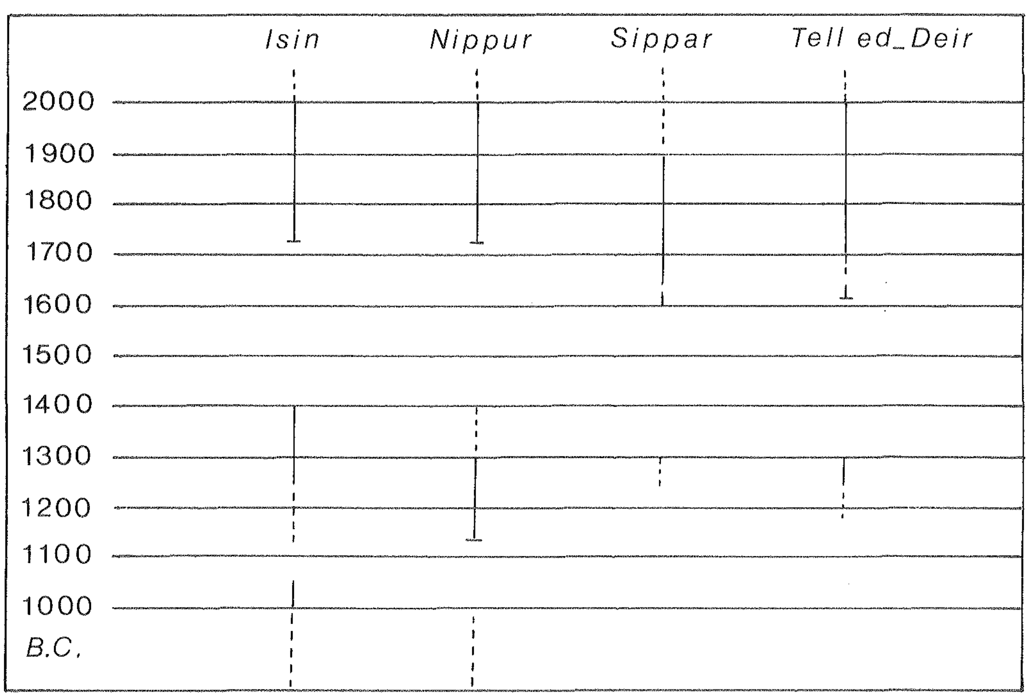

Fig. 1. Provisional distribution of pottery at key sites in the second millennium BC.

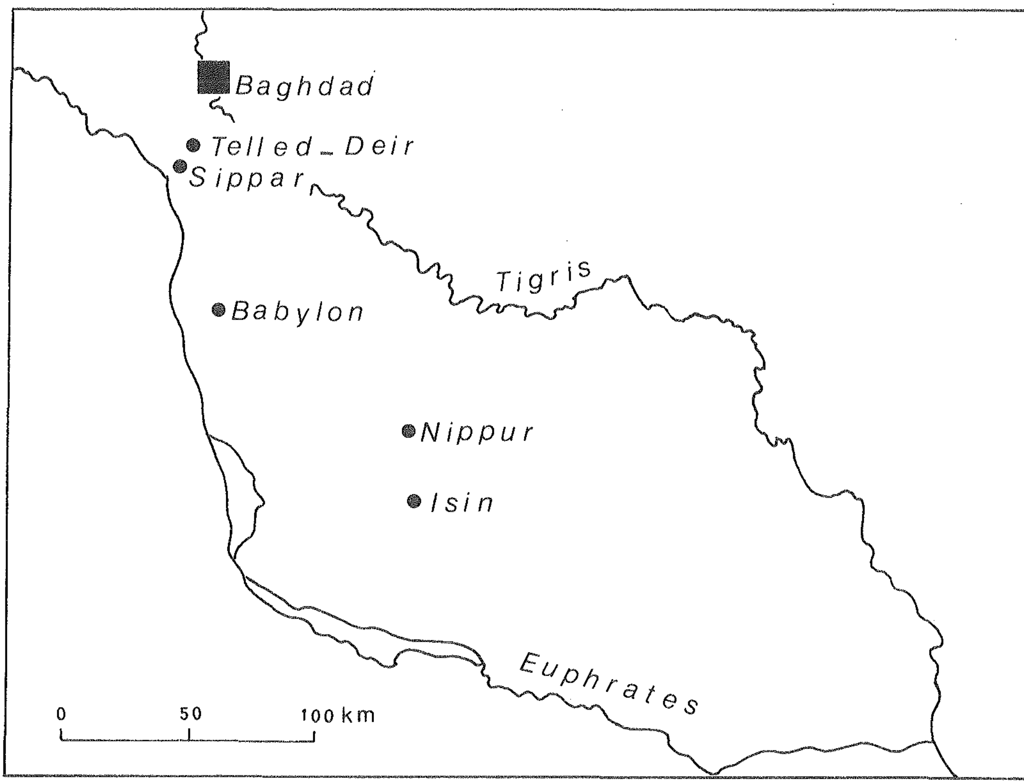

Fig. 2. Map of Mesopotamia.

necessary work in consecutive stages. It has been decided to concentrate on, at first, common types of pottery (these will be defined at a later meeting) from the second millennium B.C. with periods defined in terms of the middle chronology, which derive from Tell ed-Deir, Sippar, Isin and Nippur (Fig. 1 and Fig. 2).

The technological studies at Tell ed-Deir and research schedule for the near future

During the campaign of 1985 by the Belgian Archaeological Expedition to Iraq, a start was made on various technological studies which fit within the framework outlined for the preparation of the corpus (van As and Jacobs 1985; van As 1986). These studies were continued in 1986 (van As and Jacobs

1986).

Until now these studies have been concentrated on the following points:

1. A reconstruction of the form techniques found in a sample collection from second millennium B.C. pottery from Tell ed-Deir.
2. A macroscopic analysis of the non-plastics in the pottery referred to in point 1.
3. Refiring tests with the pottery referred to in point 1.
4. Analysis of clay samples from Tell ed-Deir and its surroundings (workability tests).
5. Reconnaissance activities of second millennium pottery from Sippar and Isin.
6. Visits to pottery and brick kilns north of Baghdad.

The results of this field work are at the moment being processed at the Department of Pottery Technology. Separate articles on form techniques and raw materials are in preparation.

During the meeting of the Working Group on Mesopotamian Pottery the following research schedule for the near future was agreed upon:

a. Technological research at Tell ed-Deir: (continuation of analysis of previously excavated second millennium material, and of recently excavated material) (October, November 1987).
b. Technological research at Nippur (American expedition, Oriental Institute, Chicago) (October, November 1987).
c. Technological research at Isin (German expedition, University of Munich) (April 1988).

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Abraham van As
Loe Jacobs

SECOND MILLENNIUM B.C. GOBLET BASES FROM TELL ED-DEIR - THE RELATIONSHIP BETWEEN FORM AND TECHNIQUE

Introduction

Among the collection of second millennium B.C. pottery from Tell ed-Deir, Iraq, the goblets constitute a remarkable sub-group(1) (Fig. 1). They are either tall, slim beakers with a small base, or rather squat, wide beakers with a larger base. H.J. Franken and J. Kalsbeek, in their study of a small sample of second millennium B.C. pottery from the same site, have drawn attention to the forming techniques of these beaker shaped pots (Franken and Kalsbeek 1984: 83-88). The goblets were made on the pottery wheel. In most cases it could be ascertained that they were produced from a cone. The study by Franken and Kalsbeek, and further research of a larger sample by the present authors within the context of the preparations for a morphological-technological corpus of Mesopotamian pottery (see this Newsletter, pp. 29-38), have demonstrated that the bases of the goblets show certain details which are of importance with regard to their method of manufacture. These details will be discussed in this article(2). The reconstruction of the forming technique, partly construed on the basis of the interpretation of the aforementioned details, was verified experimentally with the help of a clay-body the structure of which was comparable with those used in antiquity(3). The object of study is the question to what degree the shape of the bases can be explained on the basis of the applied forming-techniques.

Some factors which determine the shape and technique

The shape of the bases and the manufacturing techniques of the goblets are determined by the following variables:

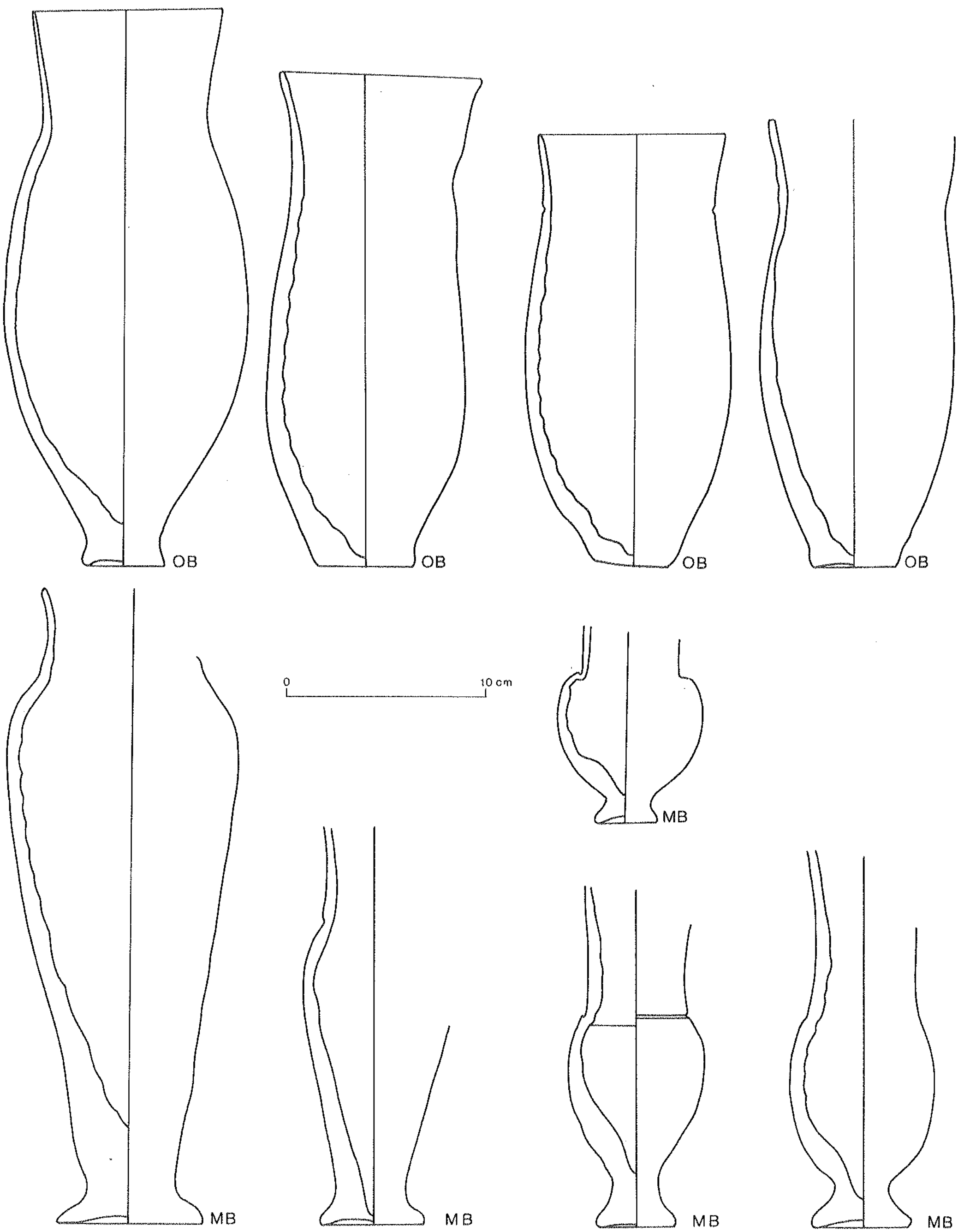

Fig. 1. A selection of Old-Babylonian (O.B.) and Meso-Babylonian (M.B.) goblets from Tell ed-Deir.

1. The height of the base on the inside.
2. The place where the constriction is the narrowest.
3. The height on which the beaker is cut off.
4. The possible finishing off of the base.

Narrow beakers:

It is not easy while producing the goblets which taper downwards to determine the height of the inside of the bases. This is necessary in order to create, after further forming and finishing off, a base of the correct thickness. Ideally, the narrowest constriction of the base should occur at approximately the same height as, or somewhat lower down than the level of the inside of the base. In such a situation the opportunity for producing the correct thickness of the base when cutting the pot from the cone is maximized.

The beakers were cut off from the cone in the area of its narrowest constriction. The thickness of the base was determined by the height of the cut with regard to the level of the base on the inside. A thick base was created when the goblets were cut off at a low height (as regards the level of the base on the inside). Such a base could not dry in an equal manner. This created shrinking tensions, whereby cracks could appear (Fig. 2: B2). When the goblets were cut off at a high level, a very thin base was made (Fig. 2: C1). Such a weak base could easily crack, even with the smallest shrinking tensions, which always occur.

There are two further causes for cracks forming in the base, as regards the applied techniques of manufacture. Firstly, the technique whereby constriction is applied from below (Fig. 2: E,F), easily causes cracks. Secondly, the cracks can be caused by slip which is left behind on the inside of the base when turning, and which could not be removed because the goblets were in general too narrow. No traces were found of the removal of the clay slip from the base. During the drying process the bases were thus wetter then the remaining part of the goblets.

Finally, cracks in the goblet's base may also be explained by reference to a limited drying strength of the applied clay, which caused a limited resistance against the formation of cracks during the drying process.

Because cracked bases were regarded as undesired, the cracks were subsequently repaired, or measures were taken to prevent these cracks. To do so, the cracks were filled in with a specially prepared substance, consisting of clay mixed with organic material. The same substance could also be applied in advance, in order to prevent the cracks. Because the organic fibers keep the clay together, the resistance against cracking at that place was also strengthened. Another method included the addition of extra clay with organic fibres to the clay of the base before raising the walls. In this way cracks were prevented also if the base was cut off too low. This method has been described as "preventative strengthening", as the base was strengthened before it could start to crack.

Below a presentation will be given of the observed situations:

The drawings show certain initial situations, indicated by the letters A, B, C, etc.(4). A number of variants were made by cutting the goblets off at various levels and finishing the bases in various manners. These are indicated by the signs A1, B1, etc. These various bases, which sometimes only differ marginally, belong technologically to a limited number of categories.

In order not to suggest a definite correlation between the shape of the base and the rest of the goblet, only the base fragments are depicted, rather than the complete vessels. The illustrations are of typical examples and have been presented in order to give an indication of the manner in which the bases were made. The technological classification of the ceramics is based on manufacturing techniques. This classification will be integrated with the archaeological form categorization in the final corpus of Mesopotamian pottery, in order to clarify the relationship between form and technique.

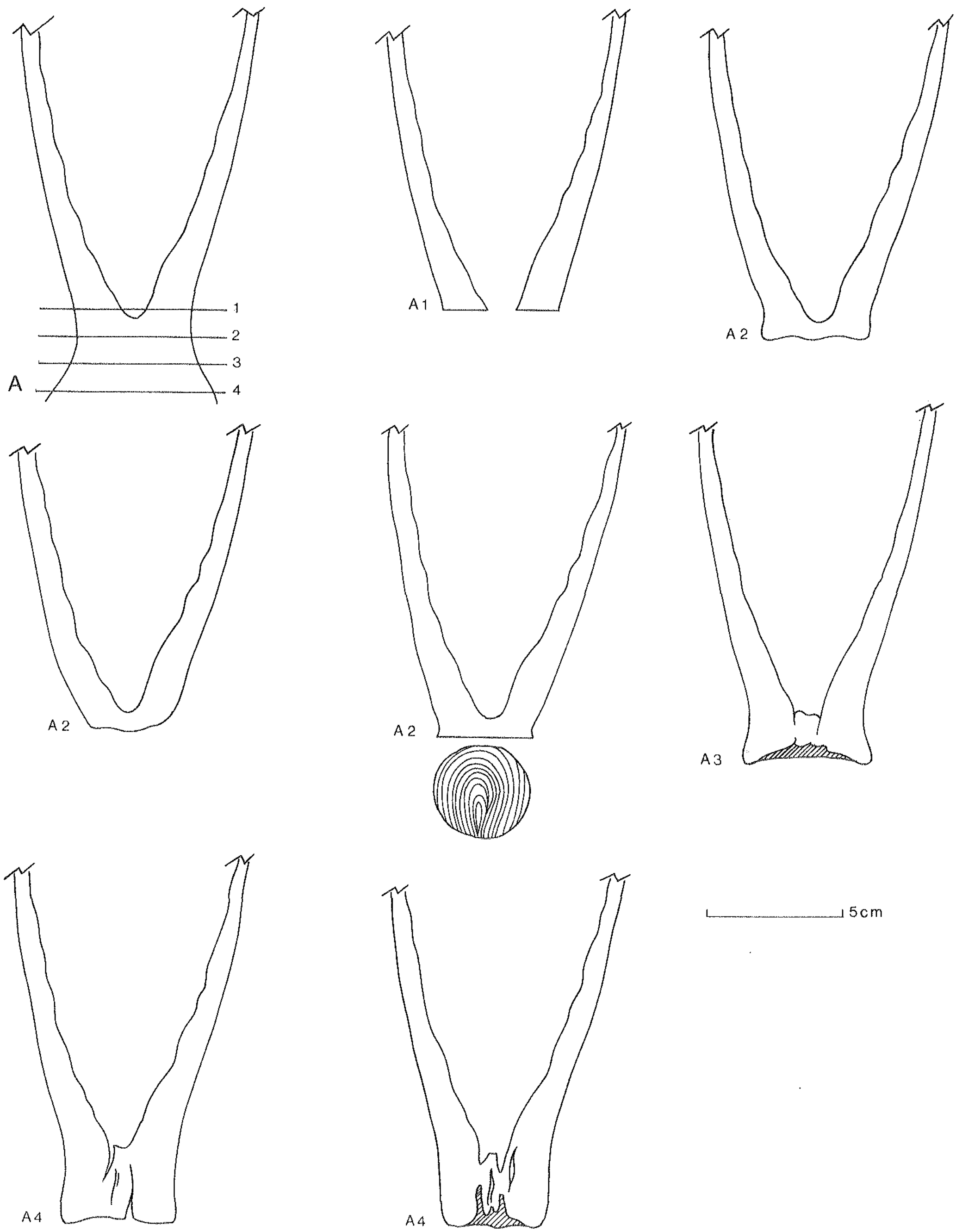

Fig. 2. Filling in of cracks.

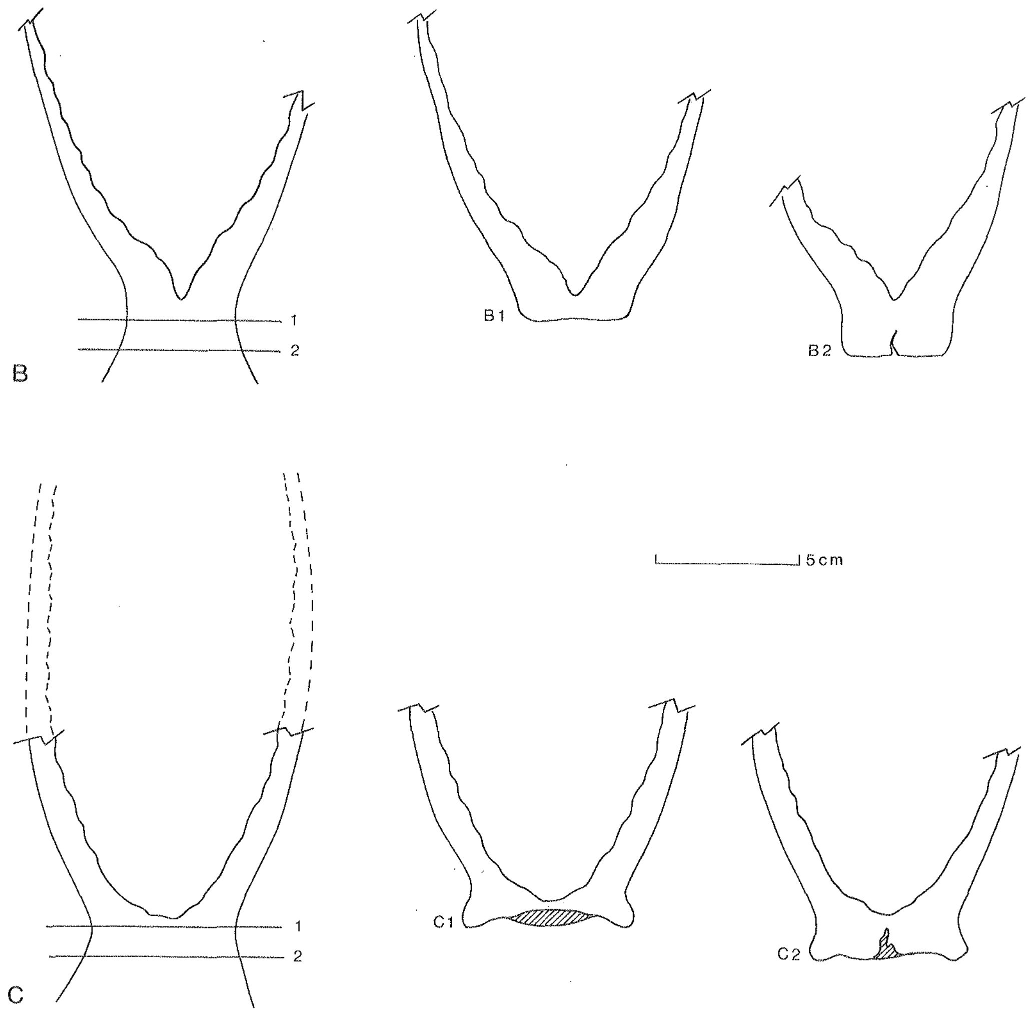

Fig. 2 (cont.). Filling in of cracks.

I. Filling in of cracks (Fig. 2)

The height of the narrowest constriction is somewhat lower than the height of the base on the inside (Fig. 2: A,B,C).

Height of cut:

- Hole in the base. The position of the wall means that a good, adhesive filling-in material is almost impossible (Fig. 2: A1).
- Correct (Fig. 2: A2,B1).

- There are possibilities of cracks forming in the base during the drying process or a weak spot which during the finishing of the base was strengthened with clay which is tempered with organic material (Fig. 2: A3,B2,C1,C2).
- There are chances for cracks in the base; if so, these can be covered over afterwards (Fig. 2: A4).

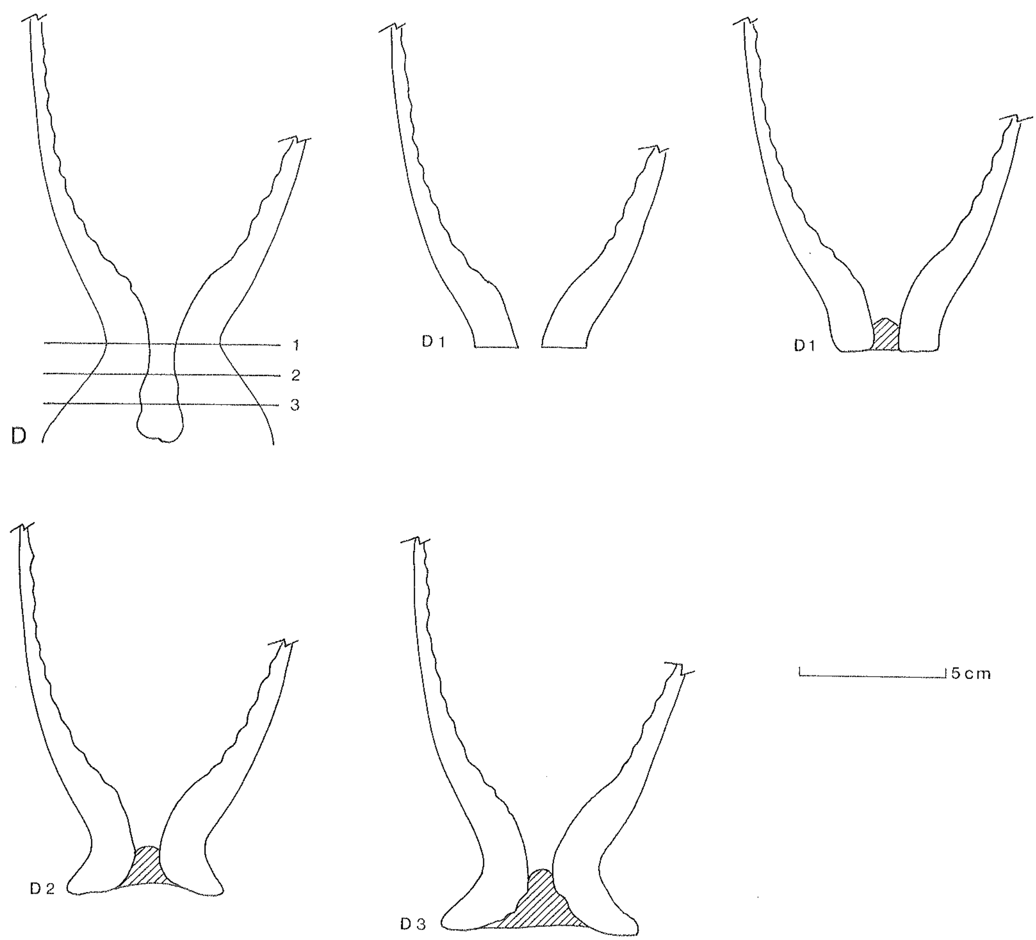

Fig. 3. The creation of a hole in the base which can easily be filled in afterwards.

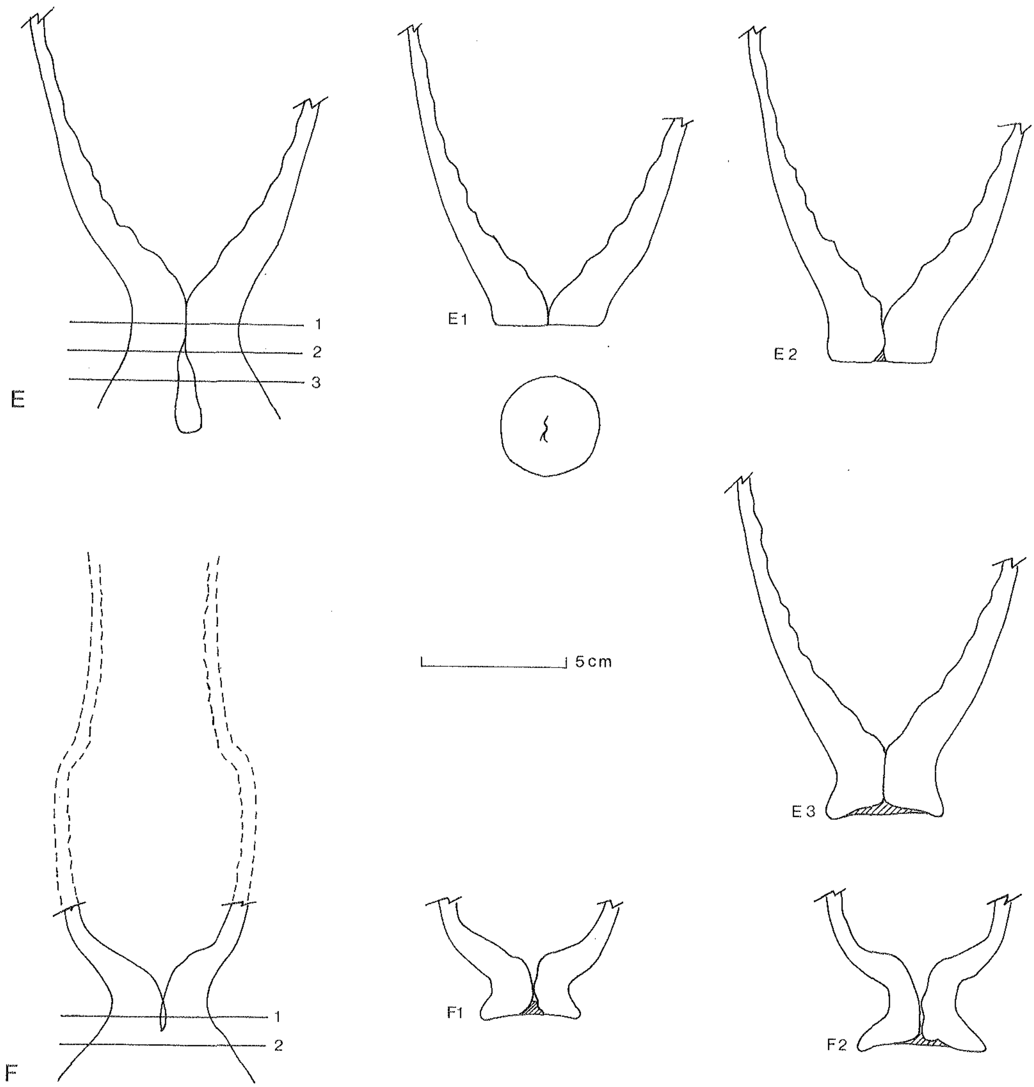

Fig. 3 (cont.). The creation of a hole in the base which can easily be filled in afterwards.

II. The creation of a hole in the base which can easily be filled in afterwards (Fig. 3).

The height of the narrowest constriction is above the inside of the base. A hole is created with all heights of cuts. This hole is filled in afterwards with clay, which is tempered with organic fibres (Fig. 3: D,E,F).

Height of cut:

- Hole. The position of the wall means that a good cohesion of filling-in material afterwards is almost impossible (Fig. 3: D1).
- Hole which is filled in afterwards (Fig. 3: D2,E2,F1).
- Hole which is filled in afterwards (Fig. 3: D3,E3,F2).

III Preventative strengthening (Fig. 4).

The height of the narrowest constriction is similar or somewhat lower than the inside of the base. In order to prevent cracks when cutting off too low, extra clay which is tempered with organic fibres is added to the clay of the base before raising the walls (Fig. 4: G,H,I,J,K,L).

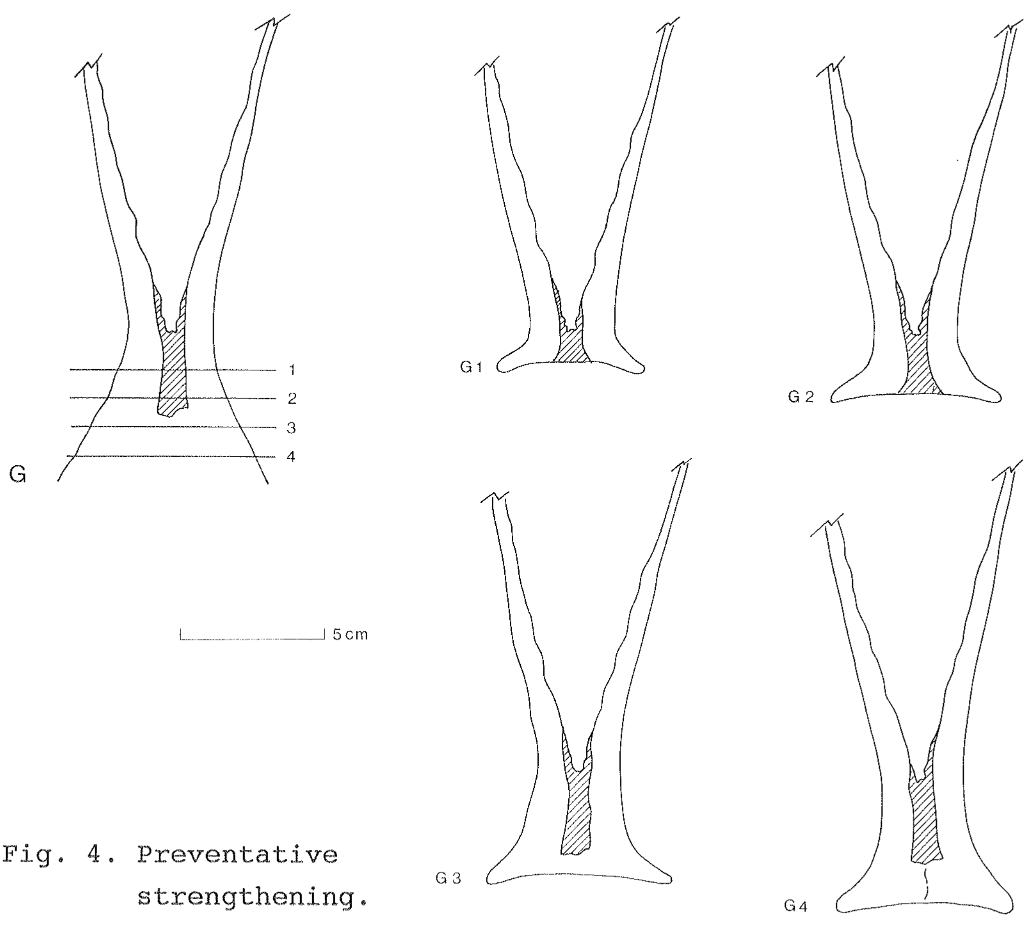

Fig. 4. Preventative strengthening.

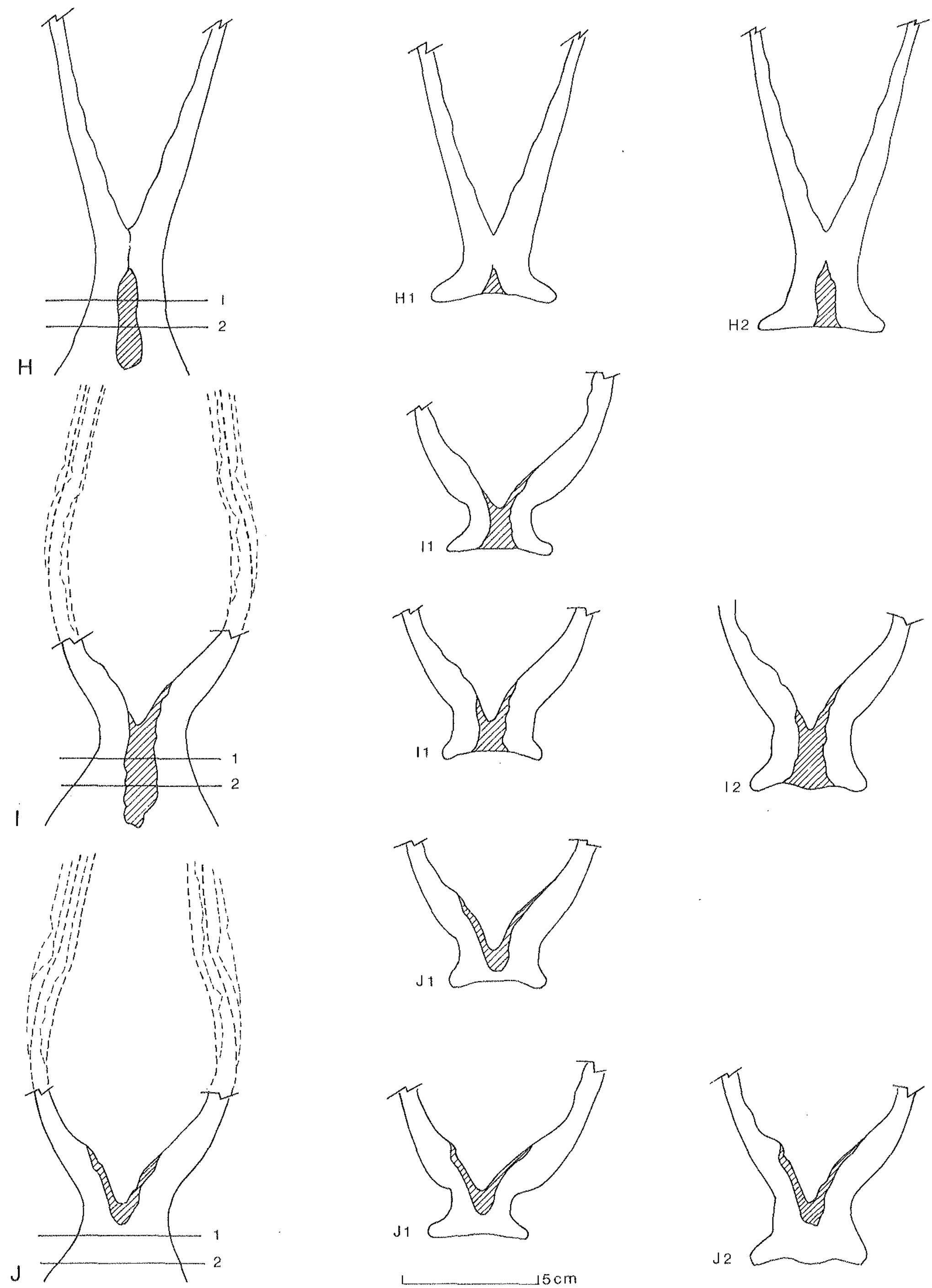

Fig. 4 (cont.). Preventative strengthening.

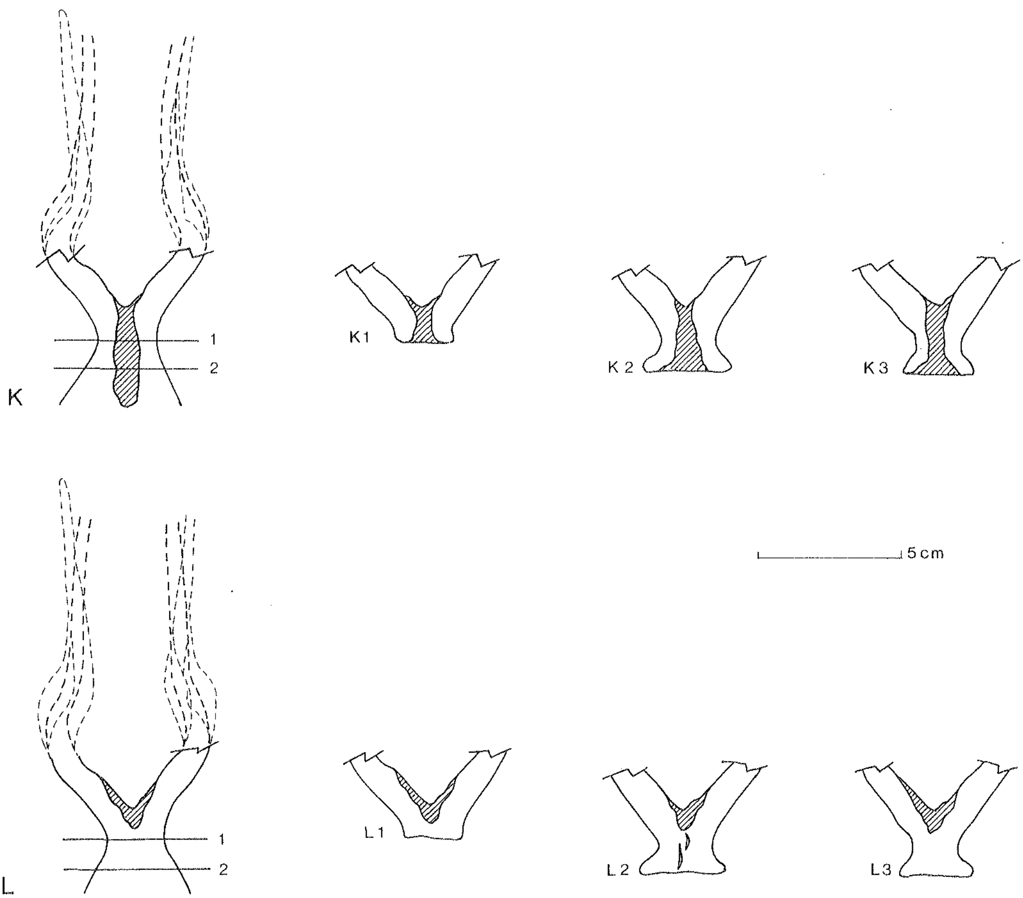

Fig. 4 (cont.). Preventative strengthening.

Height of cut:
- Correct (Fig. 4: G1,H1,I1,J1,K1,L1).
- No chances to develop cracks because of the "preventative strengthening" (Fig. 4: G2,H2,I2,J2,K2).
- No chances to develop deep cracks because of "preventative strengthening" (Fig. 4: G3,G4,L2).

Wide goblets (Fig. 5)

When making the wide goblets, the determination of the base thickness was not a serious problem. These beakers are so wide and/or squat that a hand can reach to the bottom of the goblet

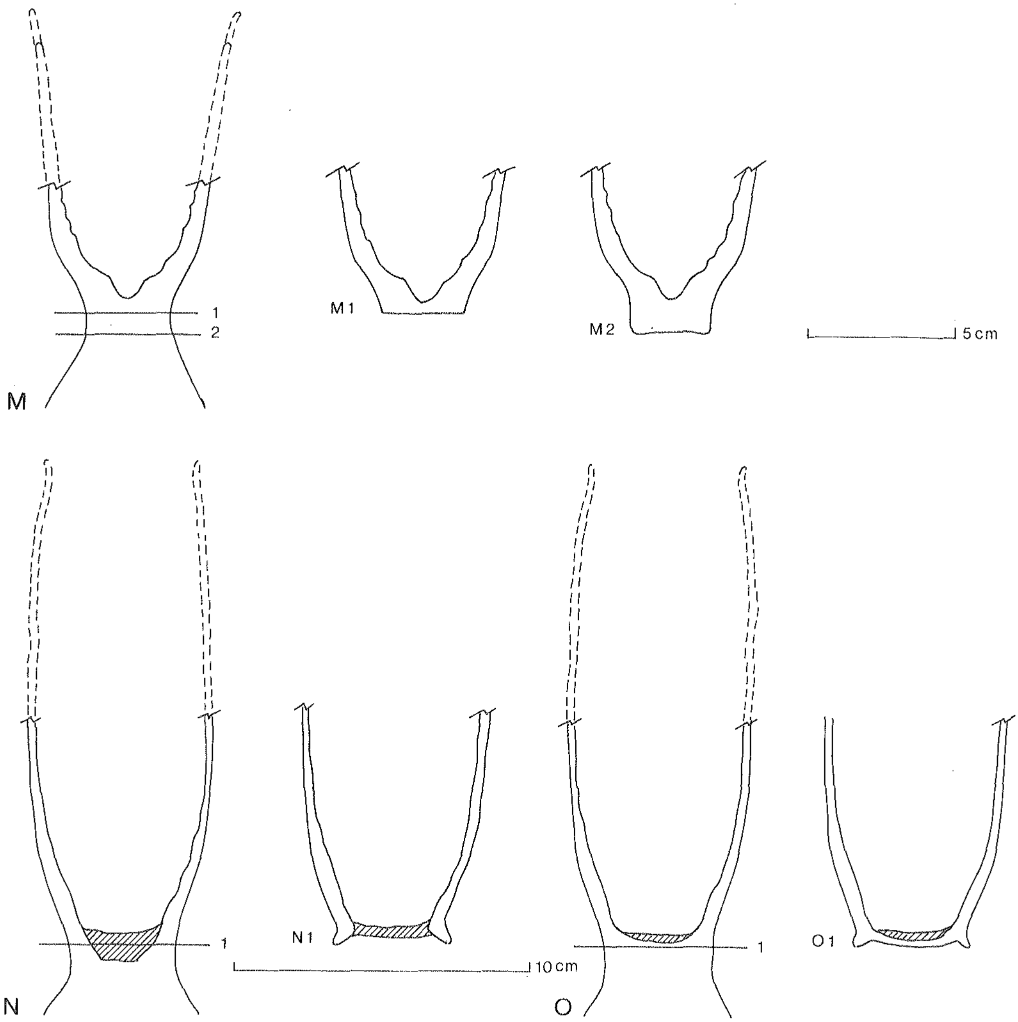

Fig. 5. Wide goblets.

during the whole process of shaping. The thickness of the base with these beakers is therefore normally correct.
The following points were identified:

- The height of cut could easily be detected; the base had the correct thickness. Excessively thick bases do therefore not occur within this category (Fig. 5: M1,M2).
- The large diameter of the base meant that the cohesion powers of the applied clay decreased, and therefore its

resistance against cracking. As a result cracks could easily occur during the drying process[5]. The clay of the base was therefore strengthened with clay tempered with organic fibres at an early stage or after the raising of the wall (Fig. 5: N,O).

In certain cases the bases of the beakers were cut off, allowed to dry to leather hard, and then finished off with the fingers or with the palm of the hand. In this way the shell-shaped pattern, which was left behind by the twisted thread, was smoothed away. In addition, certain bases were found which had pinched or turned feet.

Conclusions

As a conclusion it can be stated that the points raised in A1 (Fig. 2), and D1 (Fig. 3) were not desirable. By cutting off too high, a hole in the base was created. A satisfactory filling-in afterwards was almost impossible because of the position of the wall. The potter tried therefore to prevent these situations by cutting off somewhat lower, although this did not (always) prevent a hole occurring in the base. These, however, could afterwards be filled in (Fig. 2: A3,A4,C2). This technique, however, is hampered by the risk that the base while drying could crack again. Thus, potters may have sought for ways in order to integrate the extra tempered clay more satisfactorily into the base. Method D (Fig. 3), whereby care was taken to make a hole in the base which could easily be filled in, may be an example of this search.

From the point of view of the potter's craft, the preventative method (the addition of extra clay with organic fibers, before raising the wall) would seem preferable. The filling-in material is, in such cases, more satisfactorily integrated into the lower part, than when it is applied afterwards.

At this stage we can give no answer to the question whether the various techniques discussed in this paper were used simultaneously, or not. If we accept that the potters would have had to look for an answer to the problem of the cracking, then it can be suggested that certain preventative techniques were developed, but probably at a later stage than the others. The impression is gained that the preventative strengthening was specially applied in the Meso-Babylonian (Kassite) Period. This observation will be further tested during the next excavation campaign.

Notes

1. The second millennium B.C. pottery repertoire from Tell ed-Deir dates from the Old-Babylonian (Palaeo-Babylonian) Period and the Kassite (Meso-Babylonian) Period.
2. The manufacturing techniques of these goblets will be discussed in greater detail elsewhere (van As and Jacobs, in preparation).
3. Clay samples were collected in the vicinity of Tell ed-Deir, which were later used for these experiments.
4. Here the most frequent initial situations and its variants have been presented. In the illustrations Old-Babylonian and Meso-Babylonian (Kassite) fragments have been given without dates.
5. In this respect, beakers with a limited diameter of the base have a more convenient shape. This could be a reason behind the fact that, in most cases, the size of the base was limited.

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Josine Schuring

TERRA SIGILLATA AFRICANA FROM THE SAN SISTO VECCHIO IN ROME: ASPECTS OF FABRIC CHARACTERIZATION; A PRELIMINARY ASSESSMENT*

The interest and cooperation of the Department of Pottery Technology in the study of the pottery from the San Sisto Vecchio in Rome goes back many years. It is therefore a great pleasure for me to contribute to a collection of papers written in honour of Henk Franken who initiated me into the study of the technology of pottery production. I would like to present here the preliminary results of the study of one aspect of the terra sigillata africana which have been found at San Sisto Vecchio, an aspect which forms the very basis of every project of this department and to the study of which it contributed itself.

Terra sigillata africana, or African Red Slip ware, was produced from the late first to the seventh century A.D. in North Africa. The main centres of production being located in modern Tunisia. The first scholar to make a distinction between the various fabrics of terra sigillata africana was Waagé, who was working on the pottery from Athens in the early 1930's. Working on the pottery from Albintimilium in the late fifties and early sixties, Nino Lamboglia initiated in the West the study of these products in a systematic manner. He laid the foundation for the distinction in the main lines of production which are still in use today and he began a type series. In the late sixties and early seventies other scholars have made major contributions. For example, amongst others there is Andrea Carandini, who, amongst many other things, added extension and refinement to Lamboglia's basic division. Carandini based his distinctions on the finds from Ostia. Similarly, Jan Willem Salomonson who was the first to grasp the cosmopolitan dimension of this production by combining the results from scholars in the East and the West, and who contributed important studies in relation to the decorated wares. Finally mention should be made of John Hayes who not only made a major typological study by making comparison between finds from both East and West, but who also succeeded in distinguishing yet an other major production line. In the recently published monograph on the terra sigillata chiara (Atlante 1981), edited by Andrea Carandini, we come across an A production, subdivided into A1, A1/2 and A2; an AD production has been distinguished, having relationships both with the A production and the D production (which itself is subdivided into D1 and D2, each with an early and later phase). The C production is today subdivided into C1,2,3,4 and 5, whereas a CE production possibly precedes the E production. The main lines of production reflect in part geographical and in part chronological differences. If, however, we closely scrutinize the differences and alleged relationships between the main lines of production, and even more closely between the many subdivisions, we cannot escape the conclusion that whereas fabric composition and slip quality are often very important, and sometimes even decisive in making distinctions or observing relationships, these same elements do not appear to be objectively defined. The descriptions of both fabric and slip quality are based on macroscopic observations, mostly cited from Hayes' 1972 publication, with the exception of a small number of thin section analyses made and published in Ostia I. As a result, these descriptions are insufficiently objective, difficult to transfer and as a consequence of the comparative nature of many of the criteria (for example, more or less coarse, more of less glossy), they are difficult to apply. Since Lamboglia laid the foundation for the subdivisions, and since additions and refinements, all dating to the late sixties, early seventies, many changes have occurred in particularly the technical means which are used to characterize a ceramic material and in the accessibility of these technical means to the archaeologist. Characterization and thus definition of the fabrics is of major importance since it cannot only supply the rather subjective traditional division with a more objective foundation, but it is also essential to make either chronological distinctions within one main production, or to distinguish between contemporary production. In combination with a study of manufacturing techniques - in the widest sense of the word - it may bring to light possible changes and adaptations over a period of time, for example in the way of different choices that were made concerning the type of raw materials used; different treatment of the same materials, etc. Further research into both fabric and manufacturing techniques may also provide starting points in the study of the mode(s) of production. Finally, fabric characterization is indispensable in establishing provenances. Another question, however, is: how should these fabrics be characterized? A major problem is the extreme uniformity in much of the geology of North Africa. As a result of which most raw materials and hence fabrics come within the same range of non-plastic inclusions. This uniformity has led David Peacock to conclude that, in the matter of establishing provenances, the petrological method - analysis of thin sections - has been taken to its limits, and chemical analyses are necessary. A project has been started at the Chemistry Department, Manchester University, where finds are analysed by means of Neutron Activation Analysis (NAA) with a view to setting up a data bank with the "fingerprints" of different production centres (Fulford/Peacock 1984, chap. 2, p. 12).

Site identification, however, is not the aim in the study of the sigillata africana from San Sisto. Rather, this study tries to contribute - within the quantitative and qualitative limitations of the collection - to our knowledge of the technological and socio-economic background to this branch of pottery production in North Africa, as well as to an objectivation of the traditional subdivision currently in use.

Instead of taking recourse immediately to one of the most refined analysis techniques currently used in fabric characterization - NAA - simpler methods were tried out first, each of which have proved to be of different value in reaching the aims given above. However, an offer of the chemistry department of Manchester to analyze some fragments and run the results against their databank, was most gladly accepted, as it might provide the best check on the results of the simpler characterization methods used. The results were, however, not available while this paper was written.

PROCEDURE

Selection of fragments:

111 Fragments were selected for the fabric characterization study. Making use of the superficial descriptions of the fabrics and attributions of particular shapes to particular productions, as published in the Atlante, the selection comprised 5 fragments A1(or 1/2), 1 A1/2, 1 A1/2(or A2), 16 A2 fragments, 10 AD, 10 D1; 24 fragments D2, 6 D; 17 fragments C1, 15 C2, 4 C3, and 2 C5. Chronologically these fragments cover a period of six centuries.

Choice of characterization methods:

Optical properties: the outward appearance of a fabric can be studied: a) by the naked eye, b) by making use of a stereomicroscope and c) by analyzing thin sections. In this project, the fabrics were studied firstly without the use of lens etc., and then through a stereomicroscope (50x). The criteria for division used were: type (not diagnostic); quantity; size; size-distribution and shape of the non-plastic inclusions, and finally texture of the matrix. Thin section analysis was not performed since no identification problems were expected, and while matters like frequency, size, size-distribution and shape could very well be studied by making use of Secondary Electron Images (SEI's) i.e.

photographs taken using a Scanning Electron Microscope (SEM; these were available for some of the groups).

A physical property, porosity: the porosity of a ceramic material is to a very great extent influenced by two factors: firing temperature and composition. Both amount and size of non-plastics; size and shape of the clay particles and the way in which they are stacked together, and chemical composition of the mass since this influences the measure of fusion between particles when the mass is heated, determine porosity (Grimshaw 1980: 813). This offers an opportunity for classification since one of the two factors involved, firing temperature, can be standardized. When fragments are refired at different temperatures above their original firing temperature, porosity curves are obtained which may show different patterns, reflecting different changes in porosity. These patterns may reflect different compositions.

Chemical composition: the obliging cooperation of the ECN in Petten and the Chemistry Department of Manchester University has made it possible to use three different techniques in order to obtain information on the chemical composition of the fabrics. With the use of a SEM combining X-ray microanalysis apparatus working with an Energy Dispersive System a standardless quantitative analysis of all elements with atomic weights equal to or higher than sodium present with c. 0.5 % or more could be obtained. Two applications are possible and both were used. Firstly, the electron beam can be used to scan an area of the specimen which will result in quantities which are averages of the composition of both the matrix and non-plastic inclusions. Secondly, the electron beam, with a diameter of 1-2 micron, can be concentrated on one spot in the matrix providing information on the composition of the matrix area only. This device is therefore also extremely useful in the analysis of slips and glazes, to which purpose it was also applied in the study of the sigillata africana from San Sisto. The elements which could thus be quantified were Na, Mg, Al, Si, K, Ca, Ti and Fe. In order not to exceed the limits of hospitality and funds these analyses were limited to a number of fragments belonging to the A, AD and D production, whereas only one fragment of the C-production was analyzed this manner.

Neutron Activation Anaysis was performed on a larger number of C-production fragments.

THE RESULTS

Optical division: the results of the fabric division based on optical characteristics of all 111 fragments are fairly straight forward, be they very time consuming to obtain. As was to be expected, differences were very small. Nevertheless, 14 different groups could be distinguished, as could a number of unicae. A summerizing description of the groups has been given in the table on page 60. Apart from quartz, all of the fragments contained hematite in small amounts. Most of them also contained small particles of limestone. Only when either of these inclusions were present in a particularly striking way was their presence noted.

Division based on porosity: after firing temperatures had been determined for 66 fragments by refiring chips at temperature intervals of 50 °C it could be established that by far the most current firing temperature had been between 1000 and 1050 °C. To obtain the porosity curves 109 fragments were refired at 1100, 1150 and 1200 °C. The results of the porosity measurements were grouped by running procedure Cluster as available in SPSS/PC^{+}. Since the units of measurement of the variables were the same, the data were not weighted. Both Ward's method using Squared Eucledian Distances and Complete Linkage with City Block or Manhattan Distances were used. The resultant groupings were practically the same, but the graphical representation of the clusters by way of a dendrogram proved unsatisfactory for Ward's method in that

FABRIC GROUP	NUMBER OF FRAGMENTS	TRADITIONAL PRODUCTION(S)	STEREOSCOPIC OBSERVATIONS	
			QUARTZ INCLUSIONS	MATRIX
1*	13	D(2),D1(3), D2(8)	++ $\leqq$ 0.05mm subang. + 0.1-0.15mm subang. --0.3-0.9mm s.round.	compact, many rounded pores
2*	7	D2	++ $\leqq$ 0.05mm subang. ++ 0.1-0.15mm subang. -- 0.3-0.8mm s.round.	very irregular, many rounded pores
3*	18	A1/2(1),A1/2/ 2(1),A2(9),AD, D1(2),D2(1), D(2)	- $\leqq$ 0.05mm subang. ± 0.1-0.15mm subang. ± 0.3-0.5mm s.round. -- 1mm rounded	compact, many rounded pores
4*	16	A2(5),AD(6), D1(1),D(2), D2(1)	+ $\leqq$ 0.05mm subang. + 0.1-0.15mm subang. + 0.3-0.5mm s.round. - 1mm subang+s.round.	very irregular, many rounded + oblong pores
5	2	A2	++ $\leqq$ 0.2mm subang. -- 0.3mm subang.	compact, many rounded pores
6	2	A1 (1/2?)	++ $\leqq$ 0.1mm subang. ± 0.3mm subang. -- larger + limestone	compact, few pores
7*	5	A1(1/2?)(3), D1(1),D2(1)	++ $\leqq$ 0.05mm subang. + 0.1-0.15mm subang. + 0.3 subang. -- 0.5mm s.round. ±/+ limestone	spongy
8	5	C2	± $\leqq$ 0.05mm s.round. -- c. 1mm s.round.	compact, many small pores
9	4	C2	- $\leqq$ 0.05mm s.round. -- 0.15mm subang.	compact, many oblong pores
10	3	C2	+ $\leqq$ 0.05mm s.round.	compact
11	3	C2	- $\leqq$ 0.05mm s.round. -- 0.15mm angular	less compact than 9
12	16	C1	+ 0.01-0.15mm subang. - 0.2mm subang.	compact, many oblong pores
13*	3	C3	± $\leqq$ 0.05mm s.round. - 0.1mm s.round. -- 0.2-0.3mm s.round.	compact, many rounded pores
14	2	C5	+ $\leqq$ 0.2mm subang.	compact, many rounded pores

Fig. 1.
Fabric division based on optical characteristics: a summerizing description.

almost no separations were made visible. Only by going step by step through the different stages of clustering and drawing a line were the joining of cases was thought undesirable, were acceptable groupings obtained. The resultant dendrogram of City Block Measure and Complete linkage was much more readible in this form. Averages of values at different temperatures of the various groups are given below. A rather disturbing result is that C-production fragments, which even in the hand specimen could never be mistaken for A or D-products. sometimes showed porosity patterns similar to these products.

OPTICAL	POROSITY	CHEMICAL
1 (13)	L a-c (5), O b-d (5), M (1) N (1), <u>unicum</u>	III (1), IV (3)
2 (7)	D (2), E (2), F (2), <u>unicum</u>	III (2)
3 (18)	G c-e (8), H a-b (6), O a/d (3)	II (1), IV (3)
4 (16)	L a-c (5), O b-d (5), D (4) H b (1), M (1)	II (1), III (1), IV (2)
5 (2)	G a, K b	-
6 (2)	B	-
7 (5)	C (4), A d (1)	I (2)
8 (5)	G e (3), H b (1), N (1)	-
9 (4)	K c	-
10 (3)	K a	-
11 (3)	H b (1), K c (1), O c (1)	-
12 (16)	A a-d	-
13 (3)	G a/d, <u>unicum</u>	<u>unicum</u>
14 (2)	K b-c	-

Fig. 2. Average porosity values at different temperatures.

<u>Division based on chemical bulk analysis</u>: also the results of the chemical bulk analysis of 19 fragments were grouped with the help of cluster analysis. This time some weighting

was introduced. Clay is an aluminium-silicate containing other elements, but in much smaller quantities. As they are present in the highest concentrations, these two elements also showed the widest spreads. As a consequence these elements, which are probably less diagnostic, would carry greatest weight in determining distances (=differences) between different sherds. To overcome this problem cluster analysis was performed using their ratio Al/(Al+Si) rather than the absolute values. This ratio still reflected the relative amounts of the elements Al and Si, but their spread contributed less to the distance measure, thus giving greater weight to the other elements which had probably greater diagnostic value. Again both Ward's method using Squared Euclidean Distances and Complete linkage with City Block measures were used, resulting in the same groups, of which averages and spreads are given below. Whereas differences between groups II, III and IV are minor, group I and the one C3 fragment are clearly different.

GROUP	I	II	III	IV	
NUMBER OF FRAGMENTS	2	2	5	9	1
TRADITIONAL PRODUCTION(S)	A1 (1/2?) D2	D2	AD,D1(2) D2(1)	A1/2(1),A2 (3),AD(1), D1(1),D(1) D2(2)	C3
Na_2O	0.0	0.0	0.0	0.0	0.0
spread					
MgO	0.8	0.4	0.4	0.4	0.4
spread	0.7-0.9	0.4-0.5	0.2-0.5	0.3-0.6	
Al_2O_3	9.1	14.9	11.7	13.8	19.0
spread	7.9-10.4	14.9	9.3-13.5	12.0-16.1	
SiO_2	71.4	69.8	75.3	71.1	63.3
spread	70.5-72.4	69.5-70.2	72.3-79.7	67.8-73.4	
Al/(Al+Si)	0.11	0.18	0.13	0.16	0.23
spread	0.10-0.13	0.18	0.10-0.16	0.14-0.19	
K_2O	5.2	5.2	3.9	4.2	4.0
spread	4.7-5.8	5.2-5.3	3.1-4.7	3.8-4.6	
CaO	4.1	0.9	1.0	1.2	1.3
spread	4.0-4.3	0.8-1.1	0.8-1.4	0.9-2.0	
TiO_2	1.1	1.5	1.1	1.2	1.7
spread	1.1-1.2	1.5-1.6	1.0-1.4	1.1-1.5	
FeO	7.9	7.1	6.5	8.1	10.4
spread	7.8-8.0	6.9-7.4	5.6-7.1	7.5-9.0	

wt% normalised to 100%

Fig. 3. Division based on chemical bulk analysis.

<u>Division chemical spot-analysis</u>: Eleven fragments were analyzed for matrix and slip composition, each in two spots. The resultant quantities, however, often showed wide spreads for one element in one fragment, indicating that they were inhomogeneous in composition. Experimentation with clustering of results of both spots together; each spot separate; averages of both spots; either with Al/Si ratio's or absolute quantities, resulted each time in different groups, thus making the results useless for this purpose, but not to others.

DISCUSSION

Unfortunately, the three different ways of characterization result in groups which are often not the same. In the table below the results are brought together.

GROUP	NUMBER OF FRAGMENTS	TRADITIONAL PRODUCTION(S)	AVERAGE POROSITY VALUES			
			TEMP.X	TEMP.1100 °C	TEMP.1150 °C	TEMP.1200 °C
Aa	6	C1(5), D2(1)	8.2	0.1	1.5	27.0
b	4	C1	10.3	0.2	1.1	27.0
c	5	C1	9.8	0.8	3.1	27.0
d	2	A1(1/2?),C1	13.6	5.8	0.6	27.0
B	3	A1 (1/2?)(2) C1	8.6	2.6	14.0	24.2
C	4	A1 (1/2?)(2), D1(1),D2(1)	13.2	8.6	1.6	15.1
D	6	A2(1),AD(1), D2(3),D1(1)	12.8	11.6	10.7	9.4
E	2	D2	16.4	14.8	13.3	11.5
F	2	D2	13.0	14.2	13.2	14.0
Ga	2	A2,C3	6.1	4.7	2.7	4.4
b	2	D1	9.7	4.8	2.9	5.4
c	3	D,D1,D2	8.3	3.9	2.3	6.3
d	4	A1/2/2 (1), A2,(2),C3(1)	8.5	3.1	2.0	2.9
e	5	A2(2),C2(3)	8.6	3.3	2.0	4.7
Ha	5	A2(3),AD,D1	7.0	4.4	3.3	2.5
b	4	A2, C2(2),D2	10.1	4.4	2.9	2.0
Ka	3	C2	5.1	0.8	0.2	6.0
b	2	A2,C5	4.4	2.2	1.2	2.9
C	6	C2(5),C5	8.7	0.6	0.5	1.0
La	4	A2,AD,D1(2)	11.5	9.2	8.6	7.1
b	2	A2,D2	9.7	8.1	7.5	6.7
c	4	A2,AD,D,D1	11.7	8.0	7.2	6.0
M	2	D,D2	10.3	8.7	5.2	8.2
N	2	D2,C2	7.4	4.4	2.1	9.8
Oa	4	A2,AD(2),D1	7.6	6.2	5.5	4.7
b	3	AD(2),D2	11.3	6.4	5.8	5.2
c	3	D,D2,C2	10.4	6.3	4.6	2.5
d	5	A2,AD, D2(3)	10.0	6.2	3.3	3.9

Fig. 4. Three different ways of characterization.

Where does this leave the archaeologist? Of major importance now is for the archaeologist to: first reconsider his objectives; second to realize the significance of the resultant groupings, and third to investigate what contribution each method has to make to these objectives, both separately and in relation to each other.

One of the aims is to contribute to a more objective classification of the fabrics than the one which is presently in use, and which is based solely on macroscopic observations. In this repect this study seems to confirm in outline the main distinctions presently made. To some extent it also confirmed the alleged relationships between the A, AD and D productions. As long as attributions to either of these main production lines are meant to be no more than a first chronological and geographical demarcation, the results do not give any reason for renouncing the traditional division. However, where the many traditional subdivisions are concerned, a greater degree of precision appears to be necessary, since many of these subdivisions need to be further divided. Other purposes to which fabric characterization can be used are site identification and, most important in the study of the sigillata africana from the San Sisto, it can contribute to a better understanding of the technological, and to a much lesser extent, the socio-economic background of this production. In this respect a division based on optical properties is essential. Since the outward appearance of a fabric is determined both by the composition of the raw material and the treatment by the potter, and by firing temperature and firing atmosphere, thus the optical properties may give us information concerning both provenance and technology. As such, both type, frequency, size and size-distribution, and shape of non-plastics are of importance. In the matter of provenance, however, the archaeologist is always confronted with the problem whether differences in composition reflect differences in clay sources, variation in one clay source, different workshops or the different treatment of the same raw material.

Porosity influences many properties of a ceramic product, like absorption, spalling resistance, conductivity, mechanical and chemical erosion, refractoriness and strength. All of these properties are of importance to both the client and the potter since they determine, in part, the attractiveness of the product to the customer and consequently, the potential profit for the potter. Lower porosity has, in general, a positive influence on many of these properties. As explained before, porosity is influenced by both composition and firing temperature, both of which, to a certain extent, can be influenced by the potter. As such, porosity can be used to give information about natural and cultural aspects of the product. From the table above, however, we have to conclude that this property does not always have the same classificatory value, since whereas the optically distinct groups 7 and 12 are clearly distinguished and thus confirmed, the optically distinct groups 1 and 4 are put together. From a technological point of view, i.e. porosity as a function of degree of sintering, this property proves to be of greater interest, as will be explained below.

The results of the chemical bulk analysis are again unsatisfactory from a classificatory point of view. Whereas the optically distinct group 7 is indeed distinguishable from the others, chemical bulk analysis puts together such texturally different groups as 1 and 4, which seems undesirable since it does not take into account differences in size, frequency and frequency distribution of the non-plastics. Although they do not distinguish satisfactorilly, the results can, to a certain extent, be used to explain results from the other characterization methods used, and in particular porosity patterns.

Although there is no reversible relationship between the optical distinctions made and the porosity pattern within these groups, most optically distinct groups do show a trend in their porosity values.

Fabric 1: the fabric composition in this group has, in combination with a firing temperature of predominantly 1000-1050 °C (8x) (1x 950-1000 °C, 1x > 1050 °C), resulted in a moderate to high initial apparent porosity, which in 10 instances slowly decreases with a rise in temperature. In three instances an increase can be noted at 1200 °C due to incipient bloating. Except for a change in colour even a temperature of 1200 °C appears to be well withstood. The distinction made by the chemical bulk analysis (1x group III, 3x group IV), cannot be evaluated technologically, nor archaeologically. NAA might indicate whether the increase in porosity at 1200 °C observed in some fragments reflects minor compositional differences.

Fabric 2: the composition of this fabric has, in combination with a firing temperature of 950-1000 °C (4x) and 1000-1050 °C (2x), resulted in an initially high to very high apparent porosity which decreases very slowly at every temperature rise. In two instances a slight or minor increase is observed at 1200 °C, a temperature which, in the absence of any signs of overfiring, appears to be very well withstood.

Fabric 3: the composition of this fabric has, in combination with a firing temperature of 1000-1050 °C (11x) (950-1000 °C 1x, > 1050 °C 1x), resulted in a moderate, initial apparent porosity which slowly decreases with rising temperatures. In seven instances porosity starts to increase at 1200 °C. This temperature is very well withstood except for a change in colour. Chemical bulk analysis places three of the four samples analyzed together into group IV. One sample is separated (group II). Its relatively high KaO content might explain, through its fluxing action, the not insignificant rise in porosity at 1200 °C, resulting from incipient bloating. But see below.

Fabric 4: in combination with a firing temperature of 1000-1050 °C (6x) (900-950 °C (1x), 950-1000 °C (1x), > 1050 °C (1x)) the composition of this fabric has resulted in a moderate to high initial apparent porosity which slowly decreases at every temperature rise. Only in one instance does the porosity start to increase at 1200 °C, a temperature which, in general, appears to be very well withstood. Four samples were chemically analyzed and the results fall into three different groups (II, III, IV). This time the high KaO content of the other member of group II did not result in an increase in porosity.

Fabric 5: the composition of this fabric, in combination with a firing temperature of 1000-1050 °C, has resulted in a low to moderate initial apparent porosity, with a slow decrease at every temperature step and an increase at 1200 °C. Contrary to the first four groups this fabric does not withstand a temperature of 1200 °C but shows signs of severe overfiring.

Fabric 6: the composition of the two fragments that make up this group has resulted, in combination with a firing temperature of 950-1000 °C, in a moderate to high initial apparent porosity which decreases rapidly at 1100 °C, shows signs of overfiring at 1150 °C in combination with a major rise in porosity, and is severely overfired at 1200 °C, again accompanied by a major rise in porosity.

Fabric 7: the composition of fabric 7 has resulted, in combination with a firing temperature of 950-1000 °C, in an initially high apparent porosity with only a small decrease at 1100 °C, followed by signs of overfiring at 1150 °C accompanied by almost zero porosity, and finally in overfiring and high porosity. Chemical bulk analysis clearly distinguished the two samples in this group. The relatively high KaO and CaO contents of this group (bulk analysis 5.25 % and 4.15 % respectively; spot analysis 6.6 % and 3.95 %

respectively), are, through their fluxing action, probably responsible for the relatively early signs of overfiring

Fabric 8: the composition of fabric 8 has, in combination with a firing temperature of 1000-1050 °C, resulted in an initially moderate apparent porosity which slowly decreases at 1100 and 1150 °C, but which rises in four out of five instances at 1200 °C. At this temperature many blisters occur on the surface of the fragments.

Fabric 9: the composition of fabric 9 has, in combination with a firing temperature of 950-1000 (2x) and 1000-1050 °C (1x), resulted in a moderate initial apparent porosity which decreases until almost nil at 1100 °C and remains at this level. At 1200 °C the surface shows blisters and discolorations.

Fabric 10: fragments in this group have initially a low apparent porosity which decreases to almost nil at 1100 °C, remains at this level at 1150 °C and which next rises at 1200 °C. At this temperature the surface shows blisters.

Fabric 11: in combination with a firing temperature of 950-1000 °C, the composition of the fragments in this group has resulted in an initially high apparent porosity which decreases rather rapidly at increasing firing temperatures. Contrary to groups 8-10 no blisters appear on the surface at 1200 °C.

Fabric 12: the composition of this group has resulted, in combination with a firing temperature between 900-950 °C (1x), 950-1000 °C (1x) and 1000-1050 °C (1x), in a low to moderate and high initial apparent porosity. At 1100 °C all the fragments are already overfired and have almost nil porosity left. The porosity increases a little at 1150 °C at which temperature all the fragments are severely overfired. Refiring at 1200 °C was not performed. In order to avoid missing values when running the cluster procedures, a value of 27 % was chosen for this group at this temperature, in accordance with other, severely overfired fragments.

Fabric 13: the composition of this group has, in combination with a firing temperature of 950-1000 °C (1x) and 1000-1050 °C (2x), resulted in a moderate initial apparent porosity which decreases moderately rapid and which next increases at 1200 °C. The surface shows blisters and pimples at 1200 °C. Chemical bulk analysis clearly sets apart the one sample from this group.

Fabric 14: in combination with a firing temperature of 950-1000 °C and 1000-1050 °C respectively, the composition of the two fragments in this group has resulted in a low to moderate initial apparent porosity which decreases to almost nil at 1100 °C, it also remains at this level at 1150 °C in order next to slowly increase again at 1200 °C. No blisters occur on the surface at 1200 °C.

The above observations gain in archaeological interest when the "traditional" division is integrated. If we consider the A1 (1/2?) production as represented at San Sisto, it becomes apparent that the 5 fragments fall in groups 6 and 7. Both these are groups which, as has become apparent from their porosity patterns and change in outward appearance, have much lower vitrification points than the other clays used in the A, AD and D production, and are fired, accordingly, to somewhat lower temperatures. As the chemical analyses have made clear it is likely that this low vitrification point can be explained by the relatively high KaO and CaO contents, elements which are both strong fluxes. The fluxing action of KaO begins already at 750 °C, whereas CaO only begins its fluxing action at 1100 °C.The one A1/2 fragment was not refired in order to preserve enough of the fragment for chemical analyses. This fragment corresponds in both optical characteristics and chemical composition with part of the later A2 and D production. The only published parallel to the one A1/2 (or A2) fragment was in A1/2. The optical characteristics of the fabric of the San Sisto fragment and its chemical composition, however, fit in with later A2, AD and D products (group 3). Two fragments attributed to the A2 production were made of a clay body (fabric 5) with a higher vitrification point than the bodies used in the A1 (1/2?) production, but lower than that of the bodies used for the majority of the A2 production, as represented at San Sisto, i.e. fabrics 3 and 4. Both these fabrics proved to be well able to withstand the increasing firing temperatures, and had equal or somewhat lower KaO content and much lower CaO contents. The majority of the AD fragments were to be ascribed to these same groups, i.e. 3 and 4, and each group also contained a number of D-production fragments. Fragments from shapes ascribed to the D-production also occur in other groups, while both groups 1 and 2 consist of D-production fragments only. Also, group 7 contains, apart from three A1 (1/2?) fragments, two D-production fragments. Next to these, seven D-production fragments appear to be unicae. If we summerize the data, we may note that the study of a number of fragments represented at the San Sisto suggests that in the earliest phase of the production - A1 (1/2?)-clay bodies were used with low vitrification points. The two (?) A1/2 fragments present correspond more accurately with the later A2 production fragments which - in the sample - appear to fall essentially into 2 groups, 3 and 4. The latter groups also contain most of the AD fragments and part of the D fragments. This suggests the continual use of the same clay body over a period of several centuries, but this may not, without further evidence, be taken to imply continued activity of the same workshops. In contrast, the D-fragments differ widely in composition which might, but not necessarily, indicate the activity of more and new workshops. This would be in keeping with the fact that at this moment terra sigillata africana is believed to have reached its widest distribution.

A similar trend may also be discernable with regard to C-production. In the earliest phase - C1- a clay body is used with a low vitrification point, which results in overfiring at an early stage. The C2 production, which becomes active shortly after, and remains active much longer than the C1 production, is represented by a number of different compositions which have partly low, but never as low as the C1 products, or somewhat higher vitrification points. Signs of overfiring become visible only at 1200 °C. The different compositions might, but not necessarily, reflect the activity of different workshops. The few fragments C3 and C5 also only start overfiring at 1200 °C.

It is now necessary to try and establish whether the trends visible in the study of a limited number of fragments can be confirmed when studying a much larger number of fragments. If this proves feasible we may be confronted with the first changes - adaptations? - in the manufacturing process at the initial moment of increased production. A change for which we might supply a technological explanation. The first products - A1 - are, in general, considered to be aesthetical superior, coming closest to their Gaulish predecessors in their quality of gloss (Atlante, p. 19). As several studies have started to make clear, gloss quality is influenced by the chemical composition of the slip, the texture of the slip, the firing temperature, and the chemical composition of the body of the fragment (Tite et al. 1982, Maggetti et al. 1982, Maggetti 1986 (unpublished)). In particular a high CaO content in the body is favourable for a high gloss. Indeed the Arezzo, Lyon and later Lezoux samian products are always characterized by the very high lime content of the paste (Picon et al. 1970, 1971). It is precisely this high CaO content which seems to distinguish the A1 (1/2?) fragments from the later products. However, this same high CaO content is thought to be the cause of the relatively early overfiring of these products (see also Picon et al. 1970, p. 211 note 11). What might have happened, is that the potters preferred to limit their risk of misfiring by chosing clays which were almost impossible to overfire, but that this decision was taken at the cost of the gloss quality.

Note

* A full report on the terra sigillata africana from the San Sisto Vecchio is in preparation and will be published in Bulletin Antieke Beschaving (BaBesch).

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... In that old potter's shop I stood alone with the clay population round in rows. ...

Leendert van der Plas
Jan van Doesburg

HEAVY MINERALS AND FELDSPARS IN POTSHERDS

Introduction

Potsherds from numerous excavations generally contain feldspars and heavy minerals, either in the pottery-body or in the temper or in both. Some sherds are rich in these minerals, others poor. The mineralogical composition of such fragments may provide information about the nature of the body and of the temper. It can provide information about the origin of the body; whether the material has been found locally or at some distance from the settlement; whether the material or the ware has been imported.

Both feldspars and heavy minerals can be studied in thin sections of potsherds with the help of a petrographic microscope. Generally, the amount of heavy minerals and even of feldspars in a thin section is not large enough to allow a quantitative analysis. Therefore, it is useful to concentrate these minerals and to study them with specific methods.

The disintegration of sherds

In order to concentrate both feldspars and heavy minerals from sherds, the sherd must be disintegrated in such a way that the individual mineral grains are not broken but only separated from the ceramic matrix. Here, a variety of problems may be encountered. Ceramic products from various periods, regions, and cultures not only differ in the nature of the raw material, but also in the treatment of the clay before shaping, in the various ways in which the products are formed and in the firing techniques used. The disintegration of earthenware, fired below 1000 °C, is generally rather easy. The disintegration of stoneware or soft porcelain is difficult if not impossible due to the presence of glass in the body. Another, rather difficult material is the body of true terra sigillata, because of the careful preparation of the calcium-rich unfired body through a cleaning process causing a dense well sintered sherd even at low firing temperatures.

Disintegration of ceramic bodies for concentration of minerals is performed in a number of ways. The material may be carefully ground to a size of not less than 5 mm. The resulting granules are treated with concentrated nitric acid in order to solve the ceramic matrix, material smaller than 0.01 mm, and free the grains of sand size minerals. Another rather useful method, especially for porous materials, is water saturation (24 hours in boiling water) followed by repeated freezing in liquid nitrogen and boiling in water.

In the case of a study of Neolithic sherds from Hinheim (Bakels 1978; Westrate 1978; van der Plas 1986), acid treatment was used to concentrate feldspars. About 10 g of sherd is carefully ground and stirred for 15 minutes in 75 ml concentrated nitric acid (ca. 14.4 N). The acid is removed and the sample washed with distilled water until the supernatant liquid is colourless and clear. If the sample still holds fragments, the procedure is repeated. This first step removes a large amount of the matrix of the sherd as well as part of the iron oxides. Magnetite, Fe_3O_4, a result of firing in a reduced atmosphere is rather resistant and still present after this first phase. Therefore, it is worthwhile to establish its presence now; a beaker, with the sample is put on a magnetic stirrer with a small amount of water; magnetite is seen to move with the stirring magnet.

After this first treatment, the sample is freed of remaining iron oxide by treating it with a sodium dithionite solution. Formulas are among others given in van der Plas (1966: 259), or Begheijn (1980: 43). This procedure is repeated once in order to remove all the oxide. The sample is washed and brought in a beaker and a 0.5 N solution of sodium hydroxide is added untill the surface of the liquid is 50 mm above the bottom. The liquid and the mineral residue are thoroughly stirred and the suspension left to settle for four hours at 20 °C. The supernatant liquid is siphoned off and the procedure repeated a few times, leaving a residue free of particles smaller than 2_m.

The sample thus prepared is used for a concentration of feldspars of heavy minerals for further study.

The concentration of heavy minerals

The preparation of heavy mineral concentrates as well as the production of heavy mineral slides for study with a petrographic microscope is a well known procedure described in handbooks on sedimentary petrology, such as Krumbein and Pettijohn (1938) or Milner (1962). A few remarks on the special nature of heavy mineral concentrates of ceramic sherds suffice.

Heavy mineral concentrates of coarse ware are not too different from heavy mineral concentrates of sandy clays. The samples derived from fine-grained ceramics such as most early Neolithic pottery, made of loess or loess loam, tend to be very fine grained, with grains not larger than 100 _m. Consequently, minerals that are generally of a small size are more frequent than those normally encountered in the average heavy mineral slide of a sandy sediment. Such typical minerals are a.o., zircon and garnet. Therefore, the possible number of different species is smaller than normal, and the possibility to distinguish between different provenances is smaller also.

Heavy mineral concentrates of pottery are generally small, i.e., the number of grains in 10 g of sherd material is restricted. Therefore, the analyst has to work carefully in order to retrieve a sample large enough for counting. Samples from ceramic material of the Oss-Ussen excavation for instance (van den Broeke in preparation) sometimes hold less than 150 grains.

Finally, the method used for disintegration of the sherds may have removed a number of interesting heavy minerals. For instance, acid disintegration will solve apatite; some of the iron oxides and some of the carbonates are solved by using strong acids. The analyst has to be aware of these aspects of the various disintegration and cleaning methods he is using in sample preparation.

The concentration of feldspars

For the concentration of feldspars two different methods have been developed (van der Plas 1966). The first method is based on the density differences of alkali feldspars and plagioclases. This method is only efficient if the sample is rather feldspar rich. Moreover, the amount of sample has to be at least 0.1 g. It has one advantage over the second method "flotation" in that it is 100 % selective.

In a flotation cell minerals in suspension can be separated on the basis of differences in wettability of their surfaces. The selectivity of the process is enhanced through various additives. Presently, froth flotation of feldspar sands is one of the important industrial methods for the production of both quartz sand and feldspar for the ceramic- and the glass industry (Edelstein 1987). The method is not selective within the group of feldspar minerals but only separates feldspars from quartz and mica. Moreover, the method is not selective in an absolute sense but produces a concentrate, a "float" enriched in feldspars with respect to the residue, the "tailing". The restricted selectivity is not an important drawback because the X-ray diffraction analysis of the enriched float enables a sufficient characterization of the feldspar fraction of a sample for most investigations. If, however, a quantitative differentiation of the feldspar fraction is needed, either a subsequent staining (van der Plas

1966) of the feldspar grains in the float is necessary or the much more laborious heavy liquid separation must be performed.

Flotation of feldspars

Flotation of feldspars in the laboratory is generally performed in a Hallimond tube (Fig. 1); with some practice it can also be done in a glass beaker with a small amount of liquid. Furthermore, the method is efficient only with grains

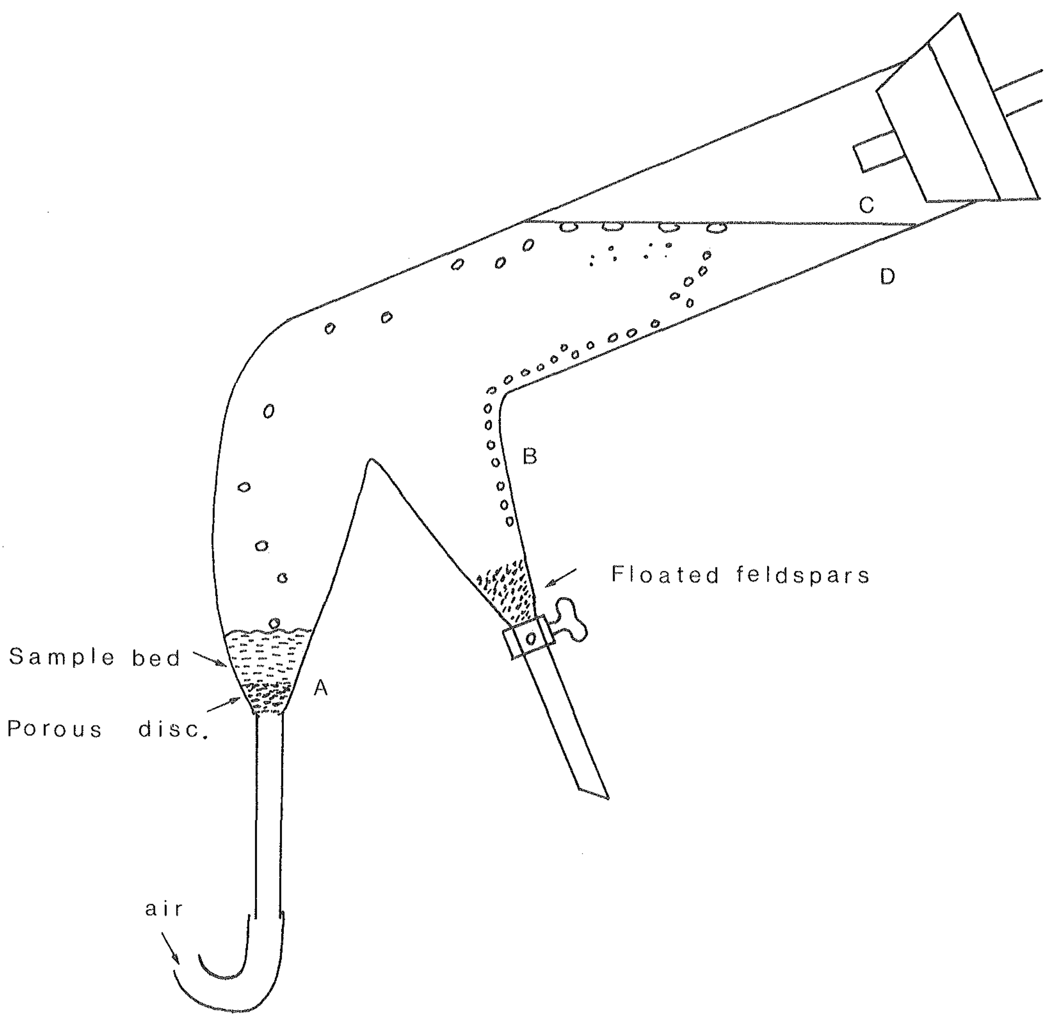

Fig. 1. Hallimond tube; the positions of the sample and the "float", the feldspar concentrate, is indicated.

larger than 50 _m. Therefore, the sample is passed over a sieve and the smaller grains are removed. The fraction > 50 _m is activated in a solution of HF at pH 2.3 for 15 minutes. The activated sample is than brought in a Hallimond tube (Fig. 1), connected to a container with either air or N_2 gas. The gasflow is preferably regulated with a needle valve. The Hallimond tube is filled with a solution of 6 mg/l dodecyl ammonium acetate (ARMAC C)[(1)] with an addition of a HF solution till pH 2.6 (3 or 4 drops of concentrated HF/ 100 cc) and a 1N HCL solution till pH 2.3. The pH values may be checked with indicator sticks. After conditioning for a few minutes the sample is floated for 2 minutes by opening the needle valve in order to allow a gentle gasflow through the sample bed. Both float (B in Fig. 1) and tailing (A in Fig. 1) are collected and used for subsequent X-ray diffraction. An example of such an X-ray analysis is given in Fig. 2.

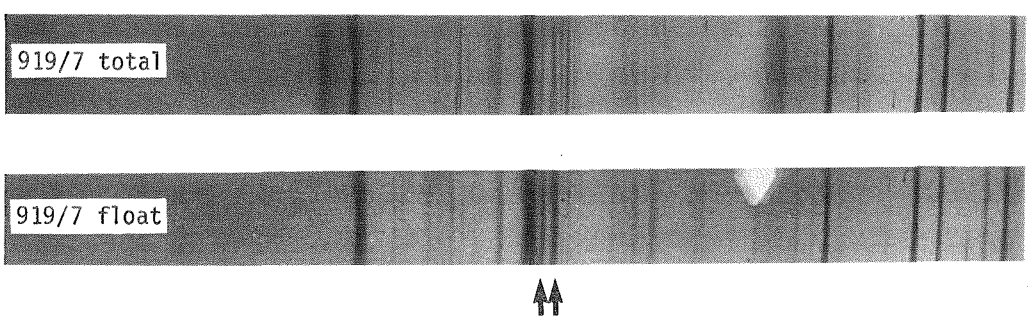

Fig. 2. X-ray patterns of the sandfraction of a Neolithic sherd (cf. van der Plas 1986), and of the feldspar concentrate, the "float" of this sandfraction.

The flotation method using a beaker is principally the same. The sample is immersed in the above flotation liquid in a glass beaker. The amount of liquid is approximately 10 mm above the bottom of a 250 ml beaker. After conditioning the liquid is gently swirled in such a way that part of the bottom is temporarily not covered by the liquid. Feldspar grains at the contact of the liquid with the bottom have the opportunity to attach themselves at the surface of the liquid and to remain at the surface. In order to separate the float from the tailing the liquid with the floating feldspars is gently poured in a second beaker. Because the flotation method is not strictly quantitative, the technique with a beaker, if expertly performed, is hardly less efficient than the use of the Hallimond tube. Information on the technical background of flotation is reported in Gaudin (1957), Fuerstenau (1962) and van der Plas (1966).

Heavy liquid separation of feldspar

Heavy liquid separation of feldspars is similar to the heavy liquid separation of heavy minerals. Differences follow from the observation that the density differences of feldspars and quartz, the other important mineral in the sherds, are rather small. Heavy liquids generally have a somewhat larger viscosity than water, causing the grains to settle more slowly. Therefore, the shape of the funnels used for heavy minerals is unsuitable. Favejee (1965) developed a funnel with steep walls that has been used eversince (van der Plas 1966). Another aspect of the feldspar separation with heavy liquids is the careful preparation of the proper liquids. Again Favejee suggested to use liquids made by mixing bromoform and decalin[(2)], two liquids with rather similar vapour pressure over a wide temperature range; thus the careful prepared liquids do not change their proper density over time. Procedures as well as the preparation of the mixtures of density 2.59, and 2.67 in order to produce an alkalifeldspar fraction < 2.59, an > 2.59 albite + quartz fraction < 2.67 and a plagioclase fraction > 2.67 are given in Doeglas et al. (1965) and van der Plas (1966). In case small grains of size < 70 _m have to be treated one may consider using a centrifuge method instead of funnels. Still funnels, although less efficient with small grains, produce useful concentrates if the analyst takes his time.

X-ray analysis of feldspars of pot fragments

Good X-ray patterns are obtained from powders with a grain size smaller than 10 _m; therefore, the finishing of the grinding of the feldspar concentrates is done by hand in an agate mortar. Powder thus obtained can be used both in a diffractometer or with a Guinier camera. Notwithstanding recent developments in diffractometer techniques, identification of feldspars as well as the study of structural aspects of feldspars is to a large extent still done with the Guinier camera and photographic recording. Especially, the problem of small amounts of sample is easily overcome with a Guinier camera.

X-ray patterns of feldspar concentrates as well as those of ground sherds show next to feldspar lines the lines of the omnipresent quartz and of mica (Fig. 3). Furthermore, the feldspar lines may belong to various mineral species. The

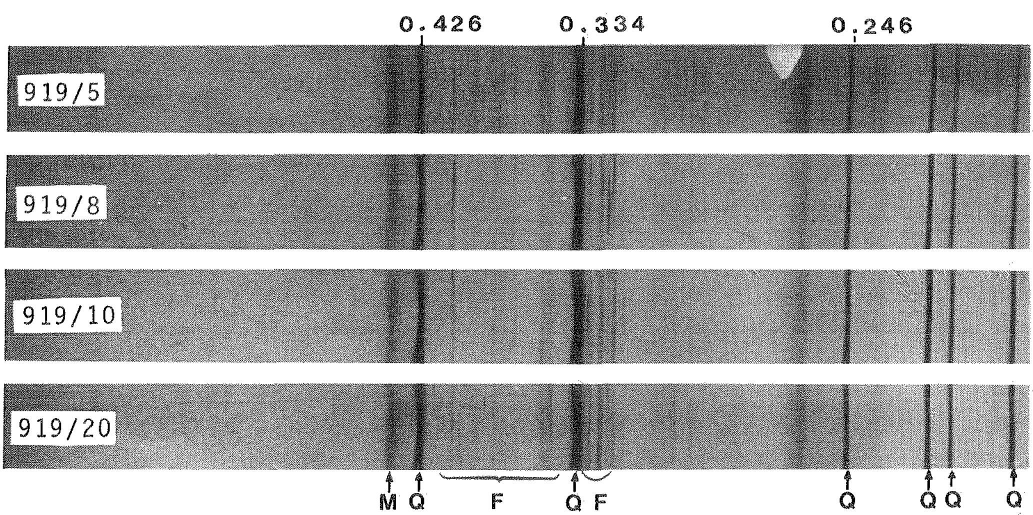

Fig. 3. X-ray patterns of the sandfraction of four Neolithic sherds (cf. van der Plas 1986). Both quartz and feldspar lines are marked.

group of feldspar minerals is rather rich in chemical varieties as well as in structurally different feldspars from volcanic rocks and from gneisses and granites (van der Plas 1966; Smith 1974). Finally, some alkali feldspars are submicroscopic lamellar aggregates of two chemically different species, microcline and sodic plagioclase, called perthites. Although, this situation seems rather complex, it offers an excellent possibility for the characterization of sets of sherds, either showing e.g., volcanic feldspars, or feldspars from metamorphic rocks or perthites or basic plagioclase.

For a routine analysis of a large set of sherds a simple identification method is prefered. Using only a few relatively strong lines of the X-ray powder pattern of feldspars it is generally possible to identify the various kinds of feldspar(s) present. The most conspicuous and strongest feldspar lines have d-values between 0.425 and 0.180 nm. An important feldspar line is the (201) diffraction line, enabling the discrimination between potassium feldspar and plagioclase. Pure potassium feldspar has a (201) line at ca. 0.424 nm, all plagioclases have at least 0.403 nm (Fig. 4).

In case the amount of feldspar in the sherd is not too small, the feldspar lines are strong enough for the determination of the chemical nature of the potassium feldspars. Potassium feldspars are hardly ever pure $KAlSi_3O_8$. Generally, there is an admixture of sodium and even some calcium in the chemical composistion. Orville (1967) and Whright (1968) published data on the chemical composition of feldspars. A regression line with correlation coefficient 0.997 derived from these data can be used to estimate the chemical composition. The percentage potassium feldspar, the Or %, is given in the following formula:

$$\text{Or}\ \% = 4823.2 * d_{201} - 1944.9$$

If perthites, unmixed alkali feldspars are present, two

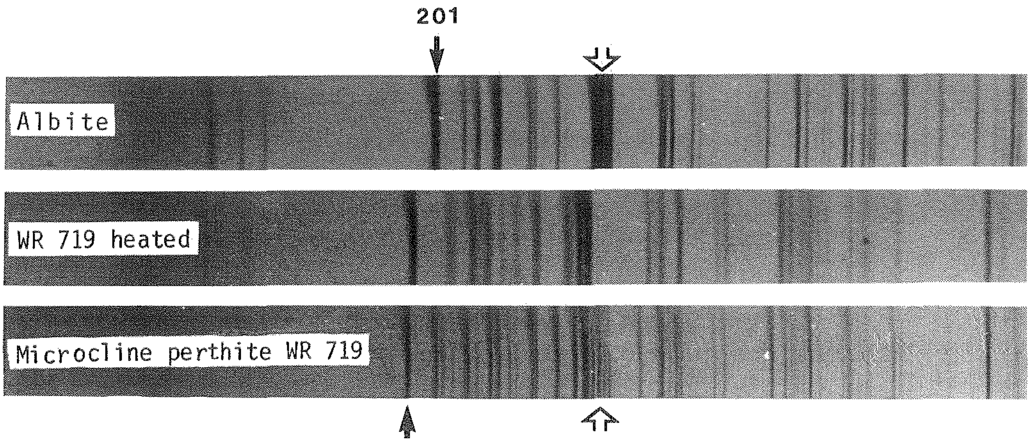

Fig. 4. The (201) diffraction lines of an albite and a potassium feldspar, a microcline, are shown. The middle pattern is the result of heating the microcline perthite.

d(201) lines close to each other are seen, one at approximately 0.424 nm, the other at 0.403 nm. The relative amount of both the plagioclase and the potassium feldspar share of the perthite can be estimated after heating the sample for a few hours at 1000 °C (Fig. 4), and measuring the position of the only one line that results from this heat treatment in the way just described. In Fig. 5, an X-ray photograph of a sample is shown before and after heating.

It goes without saying that the above perthite determination in potsherds is only possible if the pots have been fired for a rather short time at not too elevated temperatures.

Other well established methods for the identification of feldspars (Smith 1974; van der Plas 1966), are only possible in those cases where samples are available that are rather rich in feldspars. Such methods are less efficient with sherds.

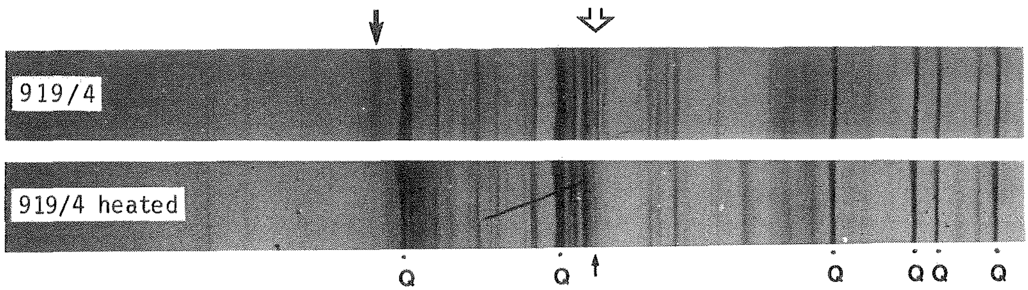

Fig. 5. The result of heating the sandfraction of a Neolithic sherd. The presence of perthite is indicated by the result.

Conclusions

The foregoing considerations and examples show that both feldspars and heavy minerals of potsherds can be studied with rather simple methods. Both the preparation of the mineral concentrates with heavy liquids or with flotation do not ask for elaborate laboratory equipment. The study of these concentrates with a petrographic microscope, an instrument that has to be present in an archaeological laboratory for the study of thin sections of sherds and of artifacts of stone, is not unlike the study of these thin sections with polarized light. Because, during such analyses, the nature of sand size minerals has to be determined also. Moreover, the skills of optical mineralogy are presently taught to a number of archaeological students.

The X-ray identification of the mineralogical composition of ground sherds as well as of mineral separates from these sherds is a somewhat more advanced technique. It needs an X-ray generator of a simple type, a Guinier camera and a dark room for the developing of the X-ray films. In addition, the X-ray room has to satisfy current safety regulations. If, however, the archaeologists can have some cooperation of a chemical or mineralogical laboratory willing to simply accept his finely ground powder samples and simply produce the films only, the measuring of the line positions and line intensities and the determination of the minerals present can even be done in the library.

Dedication

The authors want to dedicate this contribution to the study of ceramic objects of archaeological interest to Professor Dr. Henk Franken, who has been a lonely pioneer in the study of the production methods of pottery during his very active life. He emphasized the presence of traces of the potters' shaping methods on the pots. He tried to reconstruct the tradition of making pots in various cultures. He admired the potters skill, his knowledge of the use of proper clays for vessels with varying purposes and his knowledge of the technology of shaping, drying, finishing and firing. He asked the advise of studio potters on matters of technological interest and was among the first to employ such a studio potter in his laboratory. We wish him many more years with potters and pots.

Notes

1. A product of the Armour Industrial Chemical Cy, Chicago, products made by other chemical industries may have a comparable composition.
2. Decalin or decahydronaphtalene, $C_{10}H_{18}$, is a liquid with a density between 0.9 and 0.87 because of a mixture of (cis) and (trans) forms.

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Gordon Bronitsky

A COMPUTER-BASED SYSTEM FOR MEASUREMENT OF THERMAL PROPERTIES OF ARCHAEOLOGICAL CERAMICS

Introduction

The final product of pottery making is the pot, yet the subject of most archaeological ceramic study is the evidence of the failed pot, the potsherd. The ubiquity of potsherds at sites around the world gives rise to numerous questions about the use of ceramic vessels and their durability in use. Why do pots fail? Under what conditions do they fail? Are some pots more resistant to use-related stresses than others? To what extent can potters design vessels to meet specific anticipated stresses?

No single process is responsible for failure in all materials and under all conditions; rather, many different mechanisms can result in breakage. Factors affecting material performance include stress level, strain rate, previous history of the specimen, environmental conditions, and temperature (Kingery 1960: 52). As potters are well aware, the heterogeneous nature of ceramics means that different clays and tempers affect performance as well as manufacturing processes (e.g., Payne 1970 for Oaxaca; Rye 1976 and Rye and Evans 1977 for Papua and Pakistan, respectively).

Nonetheless, if archaeologists are to begin answering some of the questions posed above, it will be necessary to develop methods capable of assessing the relative performance of different materials and manufacturing processes under a variety of conditions simulating conditions of use. A major use of pots is in food preparation, and a number of archaeologists have attempted to measure vessel performance in terms of resistance to thermal schock, heat capacity, diffusivity and so on. However, there is often confusion about what exactly is being measured and how to measure it. A computer-based system developed at the University of New Mexico promises to measure a number of parameters accurately and at low cost. Before the actual system is presented however, it is first necessary to provide a theoretical background and definition of terms.

Ceramics and heat: theoretical background

Before we can discuss heat measurement, it is first necessary to understand what heat is. Broadly speaking, heat is any tranfer of energy (Jones and Schubert 1963: 622-624). Energy in the form of heat is transferred in three ways: radiation, conduction and convection. Heat transfer through conduction concerns us here. Conduction refers to situations in which the molecules of a substance are restrained from motion and energy transfer occurs through vibration, with one molecule transferring its energy to the next.

The physical factors that affect thermal shock resistance are specific heat, thermal conductivity, and the coefficient of thermal expansion (Jones and Berard 1972: 156).

Specific heat is the amount of heat energy that must be absorbed by a unit weight of material to raise its temperature one degree (Tweeddale 1973: 95). The two standard heat quantities in use are the British thermal unit (BTU) and the calorie; both are measured in relation to the specific heat of water. The BTU is the amount of heat required to raise one pound of water one degree Fahrenheit; the calorie is the amount of heat needed to raise one gram of water one degree Celsius. The related term, heat capacity, is of archaeological relevance in the study of thermal properties of ceramics. It is defined as the total amount of heat needed to raise the specimen temperature one degree. The relationship between specific heat and heat capacity is:

heat capacity of specimen = specific heat x weight of specimen

Heat capacity units are described in BTU/lb-°F or cal/g-°C (Tweeddale 1973: 95). Specific heat is usually measured with a calorimeter, which uses a known amount of water to absorb heat from a heated specimen placed in it. Heat capacity is measured by noting the temperature rise of a specimen of known weight. This temperature rise is then compared with the temperature rise of a sample of known specific heat and weight (e.g. water) heated at an identical thermal energy input (Jones and Berard 1972: 157).

Thermal conductivity refers to the quantity of heat transmitted through a material per unit of time, per unit of temperature gradient in the direction of the flow, and per unit of cross-sectional area (Dodd 1967: 285); it basically is the flow of heat. It is important not to confuse thermal conductivity with thermal diffusivity, which is a measure of the rate of change of temperature when heat is applied; thermal diffusivity is measured as the "ratio of the thermal conductivity of the material to the product of the bulk density and the specific heat" (Dodd 1967: 285). Thermal conductivity is a measure of amount of heat transmitted per unit time, whereas thermal diffusivity is a measure of the rate of change.

Materials with high heat capacities generally have low diffusivity values; that is, they heat at a relatively slow rate (Tweeddale 1973: 95). Such measures have considerable archaeological potential for comparison of different wares and the efficiency of different shapes and materials. Studies employing these measures can provide considerable information for "reconstructing the potter's craft" (after van As 1984) from the perspectives of choices of materials such as tempers and clays.

Ceramic materials expand upon heating and contract when cooled. The amount of expansion depends on the original size of the specimen, the change in temperature, and the coefficients of thermal expansion (Jones and Berard 1972:

158). The coefficient of thermal expansion is a measure of the mean change in size of a test specimen which occurs between room temperature and some higher temperature; as a result, the coefficient depends heavily on the upper temperature value (Kingery 1960: 462).

Testing procedures: a computer-based system for archaeological studies of thermal properties

Recent developments in microcomputer-based sensing systems have made it possible to develop a system which can efficiently measure these properties of interest to students of ancient ceramic technology. Such a system exists in the Combustion Laboratory of the Department of Mechanical Engineering at the University of New Mexico, directed by Arthur Houghton III. The heart of the system is a Hewlett Packard 9816. Into this can be placed several temperature sensor A/D cards. The A/D cards interface the Hewlett Packard 9816 to the temperature sensors which are placed within the heating zone and/or attached to the samples. A relatively simple routine using an industrial control "BASIC" monitors the sensors. The shutoff of the heat source is controlled with a very accurate thermostatic device to govern temperatures of the heated zone. The sensors can be attached to the samples in a manner such that damage would not occur to the samples, although marks remain which could be removed with soap and water. The system would contain a real time clock for data monitoring time basing.

The software compares the sample sensors for rate of rise in temperature, rate of decay of temperature, maximum sample sensor temperature, length of time for heat transer from one side of the sample to the other, and values of expansion and contraction of either side of the sample during heating and cooling. Additionally, the temperature of the heating zone environment is monitored by at least two sensors to provide a reference point for all sample sensor data. The software controls the time of heating but not the temperature. In other words, temperature control of the heating zone is not done by the Hewlett Packard 9816, but the Hewlett Packard 9816 would have control over the application and removal of heat.

Relevance of thermal measurement studies

At the materials level, such a system can provide a rigorous assessment of ceramic performance in several thermal parameters for a variety of materials and a variety of wares. This assessment can in turn permit an evaluation of the extent to which vessel function played a role in temper selection. Such assessment is part of a growing concern with the broader socioeconomic context of the potter and the uses of pots as tools (Braun 1983). The interrelated mechanical analysis of clays and vessels can ultimately help us understand the choices and problems the potter faced. In so doing, more accurate assessments of ceramic technology and reconstruction of the potter's craft can be made, as we realize what kinds of clay were utilized, why they were chosen, and the kinds of manipulation required to arrive at the final product.

Answering these questions requires efforts from many disciplines in order to relate analytic approaches designed for commercial ceramics to archaeological pots, and to link laboratory studies with real-world sherds, vessels, and potters (see Bronitsky 1986 for a fuller review of this issue). The method outlined in this paper is just one approach to a complex problem. Clearly, however, the efforts of a variety of "high tech" specialists, working in conjunction with archaeologists, will be required to begin to understand the technical dilemmas, solutions and expertise of so-called "primitive" potters.

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Albert E. Glock

WHERE TO DRAW THE LINE: ILLUSTRATING CERAMIC TECHNOLOGY

Increasing awareness of the value of Prof. Franken's ceramic research demands that attention be given to illustrating the technological messages clearly impressed on the surfaces and sections of pottery in the sherd and pot drawings published in excavation reports. One can only infer from a review of pottery illustrations in Middle Eastern excavation reports that form and surface decoration are quite enough to satisfy chronological conclusions and rarely more. Missing from both surface and section drawings is data reflecting the selection of raw materials and the variety of forming techniques relative to different shapes and uses. From the section, carbon core and some "temper" types are impressionistically recorded in "ware descriptions". One implication is that technological information is not regarded as significant enough to record and therefore play a role in the interpretation of the excavation. Artifact drawing is, after all, a descriptive statement, a systematic interpretation, selection and recording of visible features deemed to be important evidence supporting both analytic and generalizing statements (Hope-Taylor 1966).

Picture the problem

The problem posed in this paper dedicated to Prof. Franken is the extent to which it is possible and useful in the presentation of pottery in an excavation field report to encode in the pottery drawings technological information. We have become accustomed to the forming sequence drawings in the pottery studies of Prof. Franken and his students (Franken 1969: 69-70); van As 1984: 138-140). There is frequent reference to the information on sherds, particularly bases and whole pots, as evidence of forming techniques and fabric characteristics. Only from the actual experience of handling excavated pottery does one know that such evidence actually exists. Since, however, little of the technological information contained on surfaces and none on the sections of sherds or whole vessels is ever systematically illustrated in the pottery drawings, it is necessary to blindly accept the word of the investigator that the evidence exists. I know of few efforts to illustrate in drawings the technological message found in sherd sections (Stevenson 1953: 67; see also Rye 1981: 61-85), and these not in an excavation report. M. Kirkpatrick's color drawings of Maya pottery (J.C. Gifford, 1973; J.C. Gifford and M. Kirkpatrick 1975), dramatic and informative as they are in reproducing texture and surface, reflect little or no detail in the sections.

Prof. Franken's (1971: 37-39) early autobiographic statements regarding the mystification resulting from traditional typological pottery classification systems in published excavation field reports apply as well to the presentation of technologically oriented pottery studies. It is a tribute to the catalytic force of Prof. Franken's pioneering efforts that such an issue can be seriously discussed. While I do not pretend to solve the problem, I do wish to present some ideas that might be profitably further developed to advance the communication of basic technical ceramic data published in excavation reports. I will first indicate how ceramic graphics can be perceived as a direct response to one's archaeological objectives. Second, I will describe and illustrate from our work on the reports of both the Ta'annek and Jenin excavations examples of methods to encode in drawings essential technological messages found on the surface and sections of representative pottery sherds and whole vessels. Conventional chronologies of this pottery from Palestine used to illustrate this paper locate the evidence from Tell Jenin in 32nd cent. B.C. and the 12th cent. B.C., that from Tell Ta'annek 26th to the 24th cent. B.C.

Drawing your intention

The following discussion is an attempt to stimulate efforts to present ceramic data more fully in graphic form. The chief benefits are twofold: 1) increased precision in comparing what is illustrated with what another excavator may have in hand, and 2) the presentation of evidence for reconstructing diversity in regional ceramic traditions, workshops or production units. This in turn facilitates, for example, studies of inter-site exchange systems and intra-site functional diversity. On the grounds that the rules and systems employed in a particular archaeological project are related to the research aims of the program I am not suggesting that ceramic illustration any more than classification systems be standardized in details, unless by a strange turn, the entire discipline agrees on the objectives for ancient ceramic studies produced by archaeological excavations in a specific region.

By the time an excavation report has been written the data has inevitably been selected and refined to match the biases and preconceptions of the investigator. The assumption that it is possible to present raw data as uninterpreted fact is an illusion. Description is always interpretation. It is therefore necessary to be explicit about a) the purposes of the excavation as the basis of data selection b) as well as methods of data retrieval and management. As a case in point, all the pottery excavated from a Middle Eastern site cannot appear seriatim in a report. It is therefore obvious that a process of selection is required to limit the data load. Selection is a function of one or more systems of classification generated by research aims. To cite an example of a generalized excavation aim infrequently actualized in the Middle East, the diachronic nature of deep tell excavation necessarily results in at least a relative chronology which permits a study of stability and change in a variety of social, economic and cultural events. It has been demonstrated

(Rice 1984) that the encoded traces of the processes of pottery manufacture on ceramic residues found in an excavation provide one important array of usable data relating to problems of environmental resources, foreign trade or demographic diversity (Bishop 1980; DeBoer 1982). The data are usually presented in alphanumeric form and represented graphicly only to the extent of reconstructed steps in the forming process. Valuable as that has been, the data on surfaces and in sections would visually amplify and more clearly communicate to the unbeliever the character and value of the technological information on the surfaces and sections of excavated pottery.

Initially there are three problems to be considered. First, in order to be prepared to systematically observe and record primary and secondary forming details it is useful to work with traditional potters. In Palestine this has meant male potters who mass produce on a fast wheel for commercial purposes and female potters who seasonally hand-build pots for domestic needs. Second, analysis of clays and non-plastics requires the assistance of a petrographer who prepares and reads thin sections of a significant sample. In the case of the EB pottery from Tell Ta'annek 64 thin-sections selected from 25 fabric families serve as the basis for the interpretation and visual representation of sections. A third problem is style of graphic representation. For detail to show, most vessels are best drawn 1:1 and printed at a scale of 1:3. Where sections are thin a vertical column drawn 2:1 may be used to illustrate the technological detail. Non-plastics are best distinguished by contrasting graphic conventions based on thin-section analysis and actual counts per average square centimeter. The decision that must be made on the size of non-plastics to be represented should be correlated with types recognizing that only types which include a range of sizes from large to small, are probably actual temper. Some make the dividing line between matrix and temper arbitrarily at 60 microns (Bishop 1980:49). Finally, how much of the data collected from surface imprint and section detail should be drawn? The answer depends on the stated aims of the ceramic presentation as a part of the excavation report. The following aims are suggested as a workable guide for the selection of ceramic evidence to be illustrated in an excavation report:

1. To determine the technological variability in the ceramic repertoire as a clue to the cultural diversity of potters' traditions.
2. To examine the continuity and discontinuity of systems of pottery production in order to examine the stability of cultural development in a region.
3. To clarify the possibility that there is a relationship between the selection of raw materials, forming techniques and pottery functions.

The types of data to be illustrated that will help meet these aims are the following:

1. Kinds of evidence that suggest forming technique: wheel, hand (coil, pinching), or mould and combinations.
2. Non-plastic type, size, density, distribution, orientation as evidence primarily of provenience and forming.
3. Color of fabric, extent and intensity of carbon core and edge as evidence of clay chemistry, firing technique and skill.

In this brief paper it is of course not possible to fulfill all of the expectations raised by these aims and observations. Rather, an effort will be made to illustrate some of the typical problems and possibilities inherent in the suggestion of more complete sherd/pot drawings sensitive to technological indicators.

Cogito ergo video

What follows is a brief review of some of the visible evidence on sherd/pot surfaces and sections that can be illustrated. My own sensitivity to evidence for reconstruction was learned in extended discussions with Owen Rye in the mid-1970's when we were working on the Ta'annek Bronze Age pottery. Many of his observations are now conveniently summarized in Rye (1981). The brief description of each of ten drawings which concludes this paper illustrates how only some of the range of attributes on unglazed low-fired pottery from Palestine might appear. The drawings were prepared by Ghada Ziadeh, an ethnoarchaeologist in the Archaeology Department of Birzeit University, West Bank. She also invented the symbol system.

The technological messages on sherds and pots are accompanied by noise and distortion. "Noise" may be due to accidents at the time of manufacture. If certainly identifiable "noise" need not be recorded. "Distortion" is due to events occurring during the use, reuse and long burial (Maggetti 1982: 122). The draughtsperson is, however, concerned to record the state of the evidence at the time of drawing so that some noise and distortion will inevitably creep into the drawing. More important is viewing the object as containing layered data reflecting the production sequence. On the surface this means traces of forming, finishing, decoration and firing. Production sequence is a conscious guide for both analyzing and representing the evidence. Since, however, each successive step in the production sequence tends to partially or completely mask the potter's previous action, the evidence for the final event tends to unduly dominate the picture. Nevertheless, the draughtsperson attempts to emphasize evidence in the order of the process of manufacture.

The kinds of evidence visible on pottery surfaces that are useful for reconstructing primary forming techniques include circular (slow wheel) and spiral (fast wheel) pressure ridges most clearly preserved on the interior of closed vessels. It is important to not be so schematic as to obscure the different effects (height of ridge, slope of spiral, disconnected grooves) of a fast and slow wheel or turntable. Not often recorded are the spiral lines on the inside base ending in a cone (fast wheel) or a flat spiral (slow wheel). Traces of coil construction are often very visible but rarely illustrated. Slight irregularities at the coil joins or variation in wall thickness are commonly visible on the surface as well in the section. The forming evidence coordinating section and surface used in interpretation can also appear in the drawing. A section may show a clustering of non-plastics at places where rolled coils had been joined. X-rays and xeroradiographs have been used to confirm the evidence of coil manufacture (Rye 1976; Alexander and Johnston 1982). Fracture lines are often along coil join points. The fracture lines of mended whole vessels as well as mere sherds which join should be shown. Even though break patterns are poorly understood, drawings indicating such evidence will be useful to a future researcher. The forming of a base or the attaching of a handle or spout often leaves visible process indicators. Bases formed on a mat or from a hump leave forming traces. Bases cut with a wire or string from a hump leave a whorl but rarely drag marks. Hand-formed bases and bodies which contain coarse non-plastics which often leave drag lines when scraped with a sharp-edged tool. Trimming or shaving with a knife results in a faceted surface. All such details if visible should be drawn. It should then be possible for the student of the ceramic industry of a region to infer the macro-technology from a close study of the pottery drawings.

Four attributes, if visible, are shown in the section: color, non-plastics, voids and carbon core. Fabric color is indicated by what appears sub-surface. Surface color is not illustrated. The density of fabric color is shown in the section, following the regular pattern of millimeter paper, by means of clustered or dispersed dots on the back of the drawing. The color combinations on the symbols chart in Fig. 1 summarize the actual experience in the ten examples. Where the range of color is from dark gray to red to pink the range density is easy to remember if we assume that the denser the dot clusters the darker the color, carbon cores being the darkest, though graded. Patterned color decoration on the surface, however, usually a reddish brown paint or slip is a slanting net pattern, also denser when the color is darker. Irregular dot patterns are used for shading.

Non-plastics are identified in cut sections. The type of non-plastics is represented schematically in three sizes on a 1:1 scale. Large is > 2 mm, medium is 2-1 mm, and small < 1 mm. If the size of a non-plastic type is consistently < 0.5 mm it is assumed here to be part of the matrix. Hopefully some day soon the classification of clays will be possible on the basis of major and trace element analysis. Identifying macroscopic features and schematic symbols for the seven most common non-plastics in the pottery illustrated in Fig. 1 are the following: calcite is diamond shaped, appearing to the naked eye as milky white (altered by heat) angular chunks; flint or chert as an elongated triangle, angular, dull lustrous, usually dark gray; limestone (chalk) is round or subround, appear white chalky; basalt is a black equilateral triangle, angular, dark gray and pitted; marly fragments with iron oxide are represented as a pentagon with interior slash lines, appear as angular, lustrous and red; grog is round or subround with slash lines inside, in cut section angular, soft; red, brown or black; and sand is represented by plus signs, rounded quartz grains coated with iron oxide. Density of sand correlates with the spacing of plus signs. If there is a preferred orientation it is indicated. However, in most cases illustrated here the orientation of voids or fissures reflect forming pressures more than non-plastics. Voids tend to be represented more or less as they appear macroscopically.

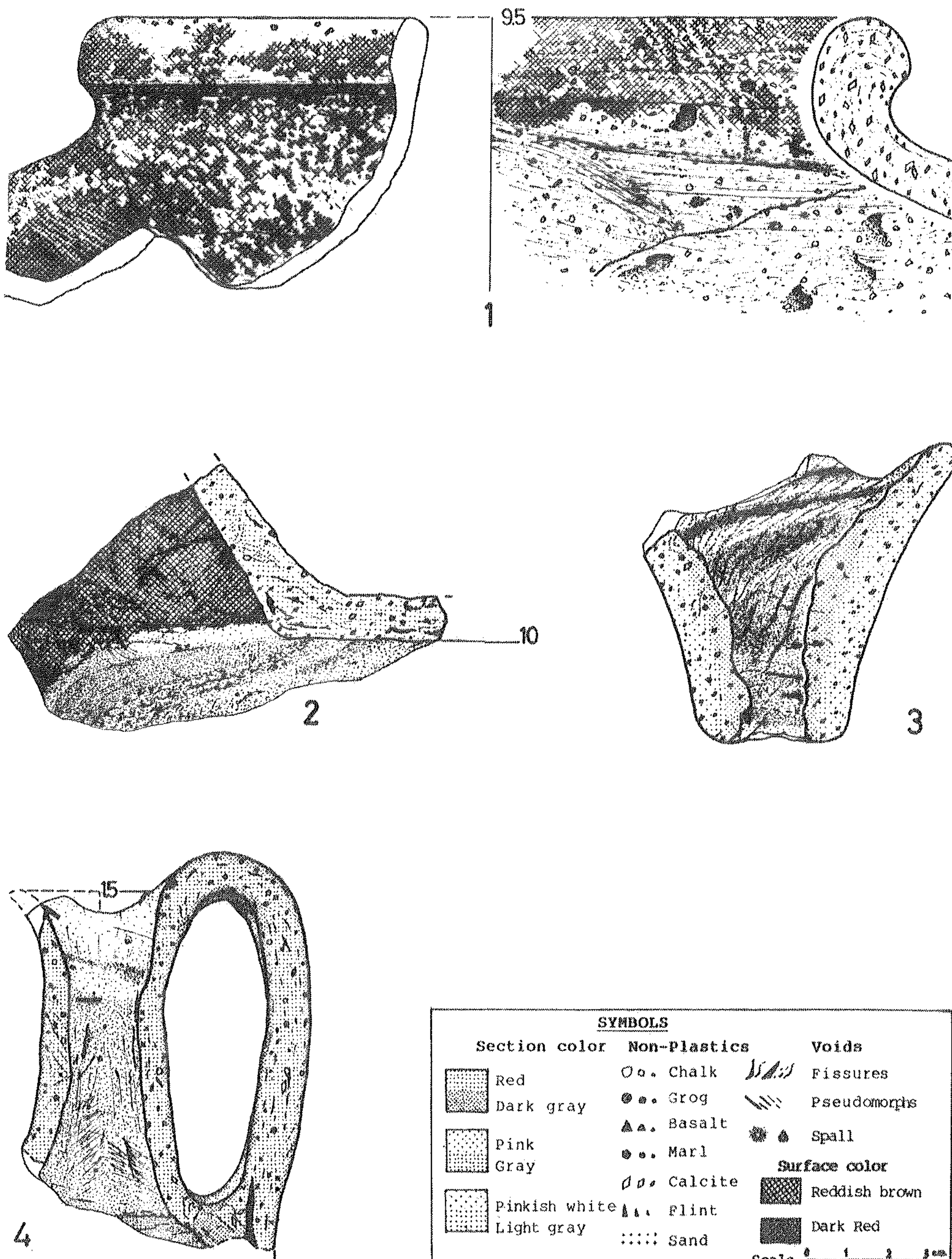

Fig. 1: 1-4. Potfragments from Jenin(1) and Ta'annek (2-4).

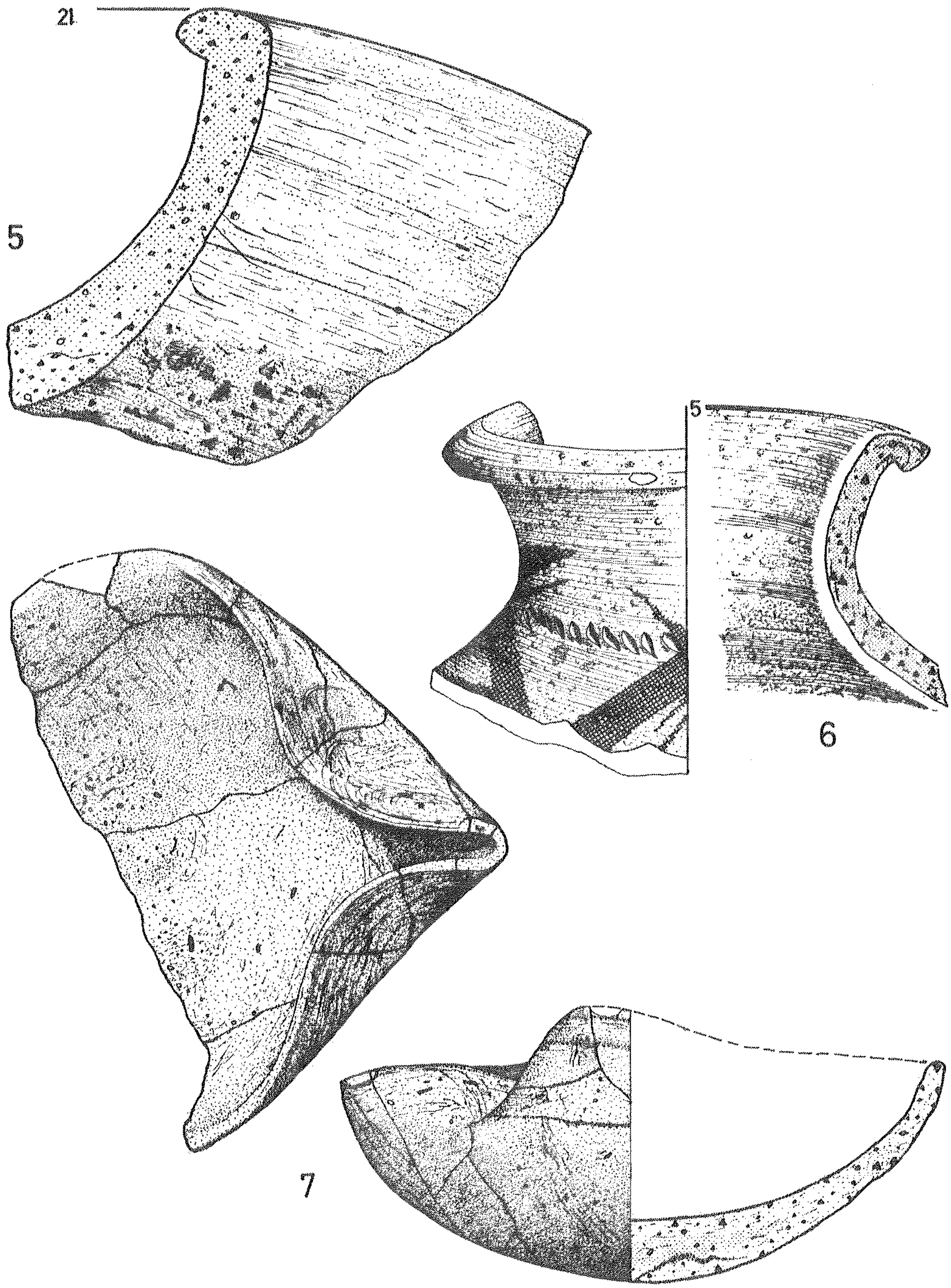

Fig. 1: 5-7. Potfragments from Ta'annek (5,6) and Jenin (7).

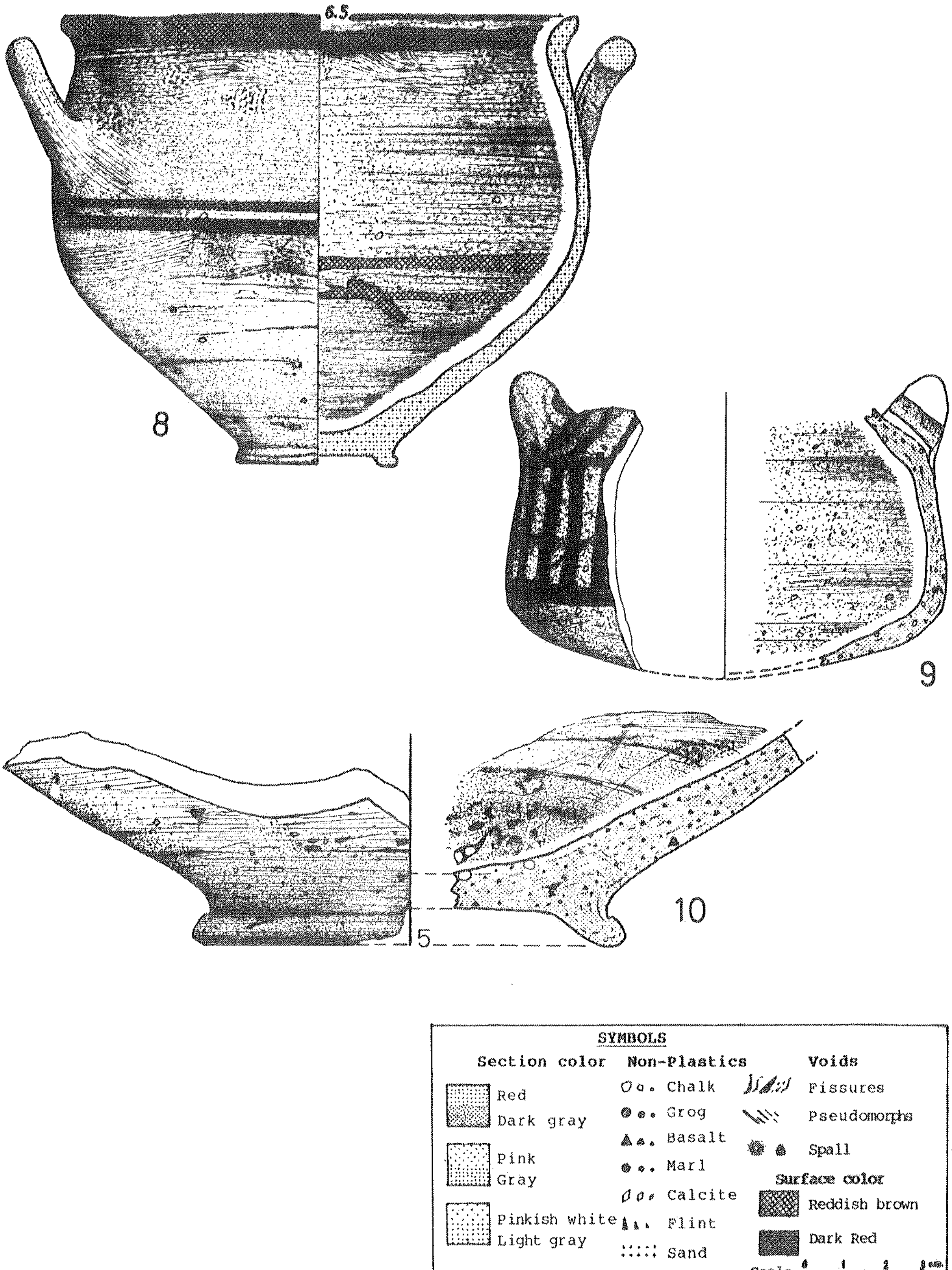

Fig. 1: 8-10. Potfragments from Jenin (8-10).

Finally, before closed vessels are mended it is obviously best to draw and photograph details of forming and finishing in the section and on the interior. Some of these observations are illustrated in the drawings (Fig. 1) described below.

Fig. 1: 1. Jenin. The exterior rim and shoulder of this large storejar is covered with shades of a much eroded yellowish-red paint which extends to the interior base of the rim. Where the paint has flaked many milky white non-plastics are exposed which in the section are clearly identified as calcite. Below the paint wipe lines from right to left and then left to right are less visible than on the interior. The line at the interior base of the rim marks where a coil was joined to form the thickened everted rounded rim. In section the fabric color is reddish yellow with a very light gray core in the rim. Voids in the rim bend with the curvature and are aligned with the body walls. The eruption of the non-plastics has pitted the interior (spalling).

Fig. 1: 2. Ta'annek. The body, base and section are visible in this drawing of a jar base. The clay disk which formed the base retains an untrimmed rough exterior surface. The fissures in the base section reflect vertical pressure to flatten the lean clay. It is likely that the body was built up with coils. At the point where the body begins the voids bend to the hand pressure forming and smoothing the turn. Red paint covering the exterior surface of the pink to buff fabric masks but does not completely hide traces of finger lines. Calcite and limestone are the dominant non-plastics.

Fig. 1: 3. Ta'annek. The section is of a stump-based jug. The broken line near the bottom indicates the location of a cap base which has broken away. The burnished red slip exterior is not drawn. The slanting deep finger-grooves spiral down to the base from right to left in a counter-clockwise motion. The

folds of a very plastic clay also slope in a similar direction. The section shows the fabric to be reddish yellow with a reddish gray core on the inside. The many small non-plastics are predominantly calcite.

Fig. 1: 4. Ta'annek. The sectional view of the tall neck and high loop handle of this jug contains more useful information than the exterior which shows a severely eroded burnished dark brown slip. The long neck was inserted into the body leaving a protruding join on the interior which has been recorded in the drawing. On the interior of the long neck the two finger-wide shallow grooves slant down from the upper left section. The lower depression resulted from joining the neck to the body while the upper groove was produced by pressure applied when joining the handle to the neck. Rolling a clay coil to form the handle caused the parallel orientation of the voids. The fillet inside the lower handle attachment retains a slight gray core and has left a vertical join void. The fabric is pinkish gray, the core light red. The non-plastics are predominantly limestone.

Fig. 1: 5. Ta'annek. Round bottomed bowls are often made in a mould requiring a parting agent which can leave traces on the base. The unsmoothed, rough sector of the lower exterior surface of this sherd contrasts with the smoothed upper two-thirds. A careful drawing of this sherd, showing its texture as well as the correlation of void and non-plastic orientation with the thickening in the section will provide the ceramicist with evidence to judge the implications of this imprint for reconstructing the forming technique. When first formed this heavy bowl would, to prevent collapse, necessarily remain in the mould or chuck until leather hard. The lower sector was not smoothed after being separated from the support form. The section of this sherd shows a clustering of non-plastics at the rim, mid-point and end of the preserved

sherd, probably locations of coil joins. The perspective of this drawing was influenced by Bonis (1979).

Fig. 1: 6. Ta'annek. Evenly spaced horizontal bands of fine-lined finger impressions on both interior and exterior surfaces suggest that a slow wheel was used to finish and perhaps to form this vessel. The many protruding but clay-covered non-plastics would have certainly created drag marks had a fast wheel been employed. The predominantly basalt non-plastics have been forced to near the surfaces by the centrifugal force of the wheel. The fabric color is red. The even edged carbon core is reddish gray.

Fig. 1: 7. Jenin. The drawing of this bowl lamp does not reveal all of its mysteries. The large number of basalt non-plastics protruding from both interior and exterior surfaces as well as pitting but no drag marks indicate it was hand formed and finished on a tournette. It is also possible that the surface eroded during long burial. A fingerprint remains from pinching the spout. In section the gray carbon core tapers to disappearing from the thick base to the thinner side walls. The carbon deposit on the spout is not shown.

Fig. 1: 8. Jenin. The very sandy non-plastic content of the reddish fabric of this early Philistine bowl indicates that it is exotic to the Jenin region. Pressure ridges are visible from half a finger below the rim interior to the base. Superimposed on the horizontal finger lines where the rim is folded out are several fingerprints which probably resulted from careless handling while drying, much as the indentation below the exterior paint line. The small ring base was added in a separate operation with a shallow band of clay thickening the join between base and body. The pink slip on the exterior under the paint is not shown.

Fig. 1: 9. Jenin. This is assumed to be a Palestinian imitation of a Mycenaean pyxis. The wheel formed pressure ridges are clear on the interior. The limestone non-plastics which predominate popped out (spalled) on the interior as well as from under the exterior pink slip which is not shown. Under the handle, which was not sectioned, are numerous straw pseudomorphs. The fabric in section is reddish yellow. The extensive gray carbon core has a sharp edge.

Fig. 1: 10. Jenin. Without the model of the methods of the traditional Palestinian male potter it would be difficult to interpret the traces of forming technique visible on this sherd. Most of the evidence on this base of a heavy bowl are explainable if we assume the following scenario: the potter forms a ring from a thick base on the top of a closed barrel-shaped vessel thrown from a hump. The fissure pattern indicates that the ring base is pressed outwards before being trimmed with a sharp-edged tool. After drying for a day the pot is reset base down on the wheel. The closed top is removed exposing the open interior which is now pressed out to form a bowl. Drag marks on the exterior and dunting on the interior base where finger lines indicate smoothing from the base center up the wall are due to some large basalt and limestone non-plastics.

Draw your own conclusion

The information load of these drawings increases the ability of the investigator to independently judge the value of statements made about the pottery in an excavation report. A good drawing is like a photo in at least one respect; it can be microscopically examined for detail. In order to be able to recognize the messages on the surface it is essential for a draughtsperson to have extended acquaintance with the work of a potter. In our case this means study visits with Palestinian potters producing unglazed vessels for domestic needs. In addition, consultation with a ceramic technologist and a petrographer increases awareness and precision of graphic statements. In any case, the drawn sherds should be able to communicate with the ceramic scholar enough technical information systematically presented so that he or she can interpret the data independently and judge the validity of the excavator's interpretation.

Apart from the limitations already mentioned the following investigations require further work: degrees of frequency of non-plastics need to be made more precise; the measured limits of macro- and microscopic data levels can be made more precise; fuller discussion of sampling and classification systems will indicate the number of such drawings required to adequately illustrate the ceramic assemblage of a site; more consideration of what kinds of technology can be usefully illustrated; finally, there is need for more experimentation in graphic representation of all types of ceramic material, including glazed ware. The considerable effort to improve the representation of lithic materials by drawing on enlarged photos (Sterud and Bohlin 1976) is an indication of the felt need to communicate more and better information in artifact illustrations.

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Ian Edwards

EARLY PYROTECHNOLOGY - NOTES ON INVESTIGATING ANCIENT AUSTRALIAN ABORIGINAL FIREPLACES

Introduction

The invitation to join in a workshop on Australian Aboriginal fireplaces and hearths at the Lake Mungo National Park in South Western New South Wales gave this writer, who is usually concerned with ceramic technology, a chance to consider the practicalities of attempting to study the scant remains of fireplaces ranging in date up to 30,000 years B.P.

Lake Mungo National Park is located within the Willandra Lakes Region which was a Pleistocene lake system originally fed by a former distributary of the Lachlan River known as Willandra Billabong Creek. The system is now dry.

The area covers about 6,000 square kms, of which about 1,000 square kms is made up of the dry basins of former fresh water lakes. During their fresh water phase, the shores of these lakes were host to homo sapiens. The remains of this human occupation has been discovered in the sand dunes of the shore line lunettes at the eastern ends of the lakes.

The outstanding archaeological discoveries include a 30,000 year old ochre burial site, a 26,000 year old cremation site (the oldest known anywhere in the world), the remains of giant marsupials such as the Procoptodon (giant kangaroo) and grindstones and mortars dated at 18,000 years B.P. which attest to one of the earliest seed grinding economies.

The Lake Mungo stone artefacts assemblage has now been accepted as The Australian Core Tool and Scraper Tradition (Bowler, Jones, Allen and Thorne 1970). This region has been used as pastoral holdings since about 1860 - sheep being grazed extensively both for wool and meat.

In seeking to elicit vital information from the eroded hearths in and near the sand dunes of the lunettes at Lake

Mungo one is faced with the obvious problem of investigating what the sun, rain, wind, bush fires and the passing animals, both grazing and native, have left for you.

Because of the difficulties involved in the investigation of the remains of these fireplaces this writer has compiled the following notes which he hopes will be of assistance to other investigators of similar early pyrotechnological events.

Lake Mungo

The hearths inspected at Allen's Plain (east of the famous sand dune formation called The Walls of China) were about one half to two meters in diameter. The termite (Drepanotermes perniger) nest fragments which had been used as hearth stones varied in colour from orange-red through grey-blues to charcoal black. The condition of the hearths and the hearth stones were consistent with the proposition that the "fire" was first lit, and then the hearth stones were placed into the blazing fire. The termite bed material which is high in silica would have been ideal for this as it would not readily shatter as the moisture present in the hearth stones turned to steam. The steam could readily leave the hearth stone because of the open porous texture of the termite nest material. Clearly the objective of the Aborigines was to use the ant-bed material as a heat bank either for cooking of for keeping warm.

Hearths using termite nest fragments have been dated from 4,500 B.P. down to the present whereas hearths using indurated sandy sediment have been dated as Late Pleistocene. Some other hearths dated in the Holocene period were found to have clay hearth stones and some carbonate nodules.

Other sites which were inspected for comparative fireplaces outside the Willandra Lakes Region were Lake Victoria, Lake Boga, Lake Mannoar as well as the Benjeroop Forrest. Of these fireplaces, those at Lake Victoria were similar both in age and type to those at Lake Mungo, whereas those at the other places were sites of large communal activity - presumably repeated camping and cooking as large mounds of ashy soil had developed. In the Benjeroop Forest one of these mounds was measured at sixty meters long. It was oval in shape and had an associated mussel shell midden. These mounds were of a more recent date than the hearths at Lake Mungo and had clearly been repeatedly used over long periods of time. The hearth stones used in association with these mounds were typically fist sized or smaller lumps of local sandy clay.

<u>Notes on hearths and hearth or oven stones</u>

I. What are we looking for when we inspect "hearth" or "oven stones"?

1. Evidence of any additions to, or removals from, the original "hearth stone" material, eg. was grass or sand added to the mixture or was sand removed. To check on this, compare the "hearth stone" mixture with the locally available "hearth stone" ingredients.
2. Is there evidence that the "hearth stones" were prepared by hand whilst the mixture was damp, or was the material used 'as gathered'? ie. do the hearth stones show the smooth rounded contours consistent with having been worked in the hands or do they show the irregular surfaces typical of lumps of clayey soil in the 'as dug' state.
3. To ascertain if any coatings have been added to the "hearth stones". (eg. a clay-like slurry with an organic filler such as grass or animal dung would burn out at temperatures of about 400 °C). The fired clay coating in this case would show the burnt out casts of the organic material.
4. To assess in the hand sample the fired colour of the "hearth stones", as an indicator of the extent to which they have been heated in a prevailing oxidizing or a reducing atmosphere, and to what extent there is any residual carbon or animal fat left in the "stones".
5. To seek to identify the composition of the "hearth stones" and note any significant changes to the minerals present

which might be important indicators of the temperature reached (Segnit 1979).

6. To investigate the extent to which any surface hardening has occurred in the "hearth stones" as a result of their interment in the soil (post-firing) and whether any organic materials have been preserved in the "hearth stones" as a result of the sealing effect of this hardening process.

II. What are the characteristics which make a good "hearth stone"?

1. If we assume that the "hearth stones" were used as a form of "heat bank", then good heat retension and sustained heat release over an appropriate period of time for cooking (eg. 1-3 hours) would be vital characteristics.
2. "Hearth stones" would need suitable physical and chemical properties to enable them to sustain the shock of rapid heating and cooling without disintegrating.
3. It is also highly likely that some soils, because they contain a suitable blend of clay and quartz sand, may well act as heat retaining "hearths" and "ovens" with or without the addition of "hearth stones".

III. Why do some clays, soils and rocks not make good "hearth stones"?

1. Dense clays do not allow the steam developed from the dampness and the chemically bonded water in the clay to leave freely as they are heated and so they disintegrate under the pressure of this escaping steam. The addition of "opening" materials such as dry grass and sand does overcome this problem.
2. Dense rocks and minerals with a high co-efficient of expansion and contraction often disintegrate on both heating and cooling and this would decrease their value as a bed of heat retaining "hearth stones".
3. Marly clays and rocks with a high percentage of calcium

minerals can present problems on heating and cooling, particularly at temperatures over 800 °C when clays with a high proportion of limestone or gypsum inclusions can disintegrate on cooling and/or be subjected to severe spauling.

IV. Colour variation in "hearth stones".

1. The colour developed in the "hearth stones" during firing is a permanent record of the degree of oxygen or lack of it present during the period of maximum heat intensity and the later cooling phase of the last fire to which they were exposed. Therefore and appraisal of any "hearth stones" based on their colour could give us a rough operational profile of the "hearth" despite the deflation of the "hearth" by wind and weather and any partial scattering due to disturbance caused by animals, providing of course that the "hearth stones" are correctly re-assigned to their own particular "hearth".

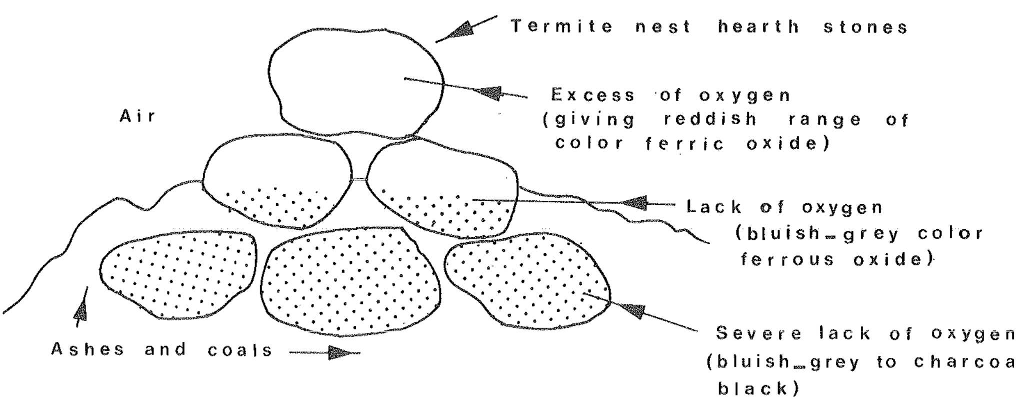

Fig. 1. Colour variation in "hearth stones".

2. It is recognized however, that if the fire is not rekindled after the cooking event that some of the partially burnt fats from the cooking may remain in the "hearth stones" together with impregnated carbon and therefore mask the colour developed during the heating phase. Later re-stoking

of the fire could also result in some modification to the fired colour of the "hearth stones" if their position in the fire is altered as a result of the cooking procedure and high enough temperature (approx. 600 °C) is reached in the re-kindled fire. The fired colour of the "hearth stones" will be the record of the prevailing atmosphere in the last campfire event in which whey were used.

V. Three major atmospheric zones in campfires are suggested by the colour of the termite "hearth stones" found in situ at fireplace sites:

1. An oxidizing atmosphere yielding bright orange-red coloured "hearth stones" (indicating the presence of ferric oxides).
2. A varying oxidation/reduction atmosphere yielding mottled reddish and bluish "hearth stones" (indicating the presence of ferrous and ferric oxides).
3. A reducing atmosphere yielding bluish-black "hearth stones" (indicating the presence of both ferrous oxides and carbon).

VI. What phases do we see suggested by the ethnographic evidence of the campfire "hearth stones"?

1. There were apparently three phases:
   a. Pre-heating phase - which included the initial starting of the fire and the placement of the "hearth stones" to enable them to reach their optimum operational temperature (30 mins - 1 hour).
   b. Cooking phase - the "raking out" of the fire to allow a rapid, partial cooling of the fire, the placement of the food on the "hearth" (made up of the "hearth stones" and coals) and the cooking of the food (1-3 hours).
   c. Cooling or re-kindling phase - after the first cooking phase when the fire either died out due to lack of fuel or was re-stoked with fresh fuel and used as a source of warmth during and after eating. Further cooking phases,

following immediately or some time later, would presumably have involved a repetition of this cycle.

2. Temperatures reached during these phases would have approximated those shown on the following graph:

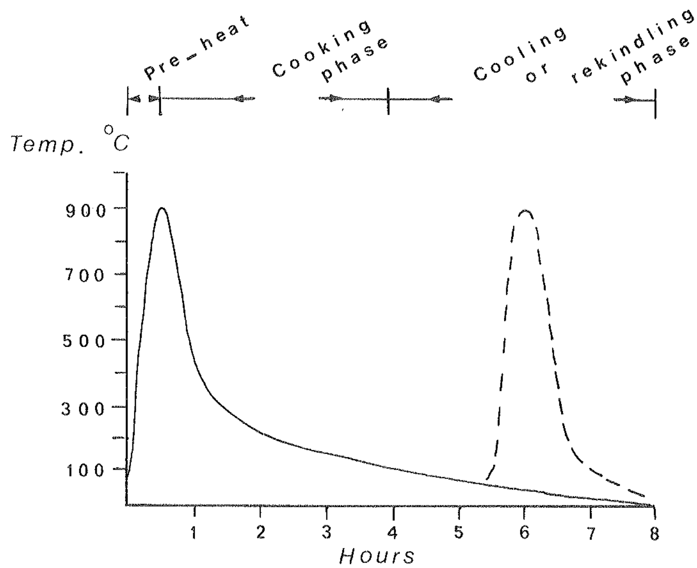

Fig. 2. Temperatures reached during the pre-heating phase, the cooking phase and the cooking or rekindling phase.

VII. General observations on aboriginal cooking fires

1. In these notes the Mungo Termite "hearths" are being taken as the 'classic' examples used to establish a basic explanatory model of how a "hearth" works. It is proposed that the carbonate nodules and other types of "hearth stones" will provide a set of variations of this working model.
2. It is proposed, that because aboriginal "pit oven cooking" provided an enclosed and controlled atmosphere which was heavily reducing and permeated with steam, and vapours from both the leaves with which the food was covered and the food juices present in the cooking meats, that it be considered as the other major variant of this model. A variant in which the "hearth stones" (if any) and the

surrounding soil will be carbon impregnated - a chocolate brown to blackish grey in colour - evidence of a very heavily reduced atmosphere.

3. However it is reasonable to expect that all types of "hearths", "ovens" and casual fireplace events which occur on soils which have a clay and/or ferruginous content will preserve a "ghost" of the event which may be investigated using a magnetometer. In other words all aboriginal cooking fires will leave a permanent record in the soil on which the fire was burnt and in the case of "hearth stones" being used - fired "hearth stones".
4. It should be noted that once one achieves the minimum temperature for cooking meat and vegetables, so long as one can maintain that temperature the food will eventually be cooked, even if it takes five hours or more.

VIII. Some questions for the investigator who is looking at aboriginal "hearths" and "hearth stones".

1. Is there any evidence of a pre-ceramic technology developing over the period during which these "hearths" were made and used? (ie. evidence of the aborigines mixing the ingredients and preparing "hearth stones" or shaping locally found ingredients (Coutts et al. 1979) or coating locally found rocks with other materials, and in particular varying the mixture, over time?)
2. Is it possible to establish a typology of "hearth stones" which could be used as a chronological tool?
3. Is it possible to reconstruct fireplace events from the observations and investigations which are currently being carried out, or do we need to develop some new approaches?
4. If there are no obvious technological advances, in ceramic terms (ie. heat as applied to clays and related minerals) represented in the hearth assemblages over the period in which they were used, could the investigator perhaps be looking in the wrong direction? Could the changes be more

in the area of diet, ie. with the side product of eating Drepanotermes perniger, being the production of fist sized lumps of ant nest which empirically proved to be a ready fabricated and potentially good heat retaining "hearth stone"?

IX. Conclusions.

1. The unfired "hearth stones" from the Willandra Lakes Region appear to have been harvested from the landscape to serve a function as a form of heat bank for cooking and related activities with little or no preparation by the aborigines.
2. That if Peter Coutts' proposition that some aborigines in the North Western region of Victoria did mix local clays with sand and shape their "hearth stones" (or heat pellets), is accepted, then this could be considered to constitute a satisfactory and practical example of a pre-ceramic technology. The current evidence however does not appear to support this proposition (Segnit 1979).
3. However, despite the fact that the aborigines appear to have had an extensive knowledge of fires, clays, and ochres, they do not seem to have taken the heat treatment and hardening of clays and related minerals any further and this would seem to be because they saw no advantage to them in applying this knowledge to the production of other types of fire hardened clay artefacts such as pottery.
4. The technology involved with cooking hearths and ovens would appear to have been partly about fires and the making or selecting of suitable "hearth stones" and partly about how to apply the quite considerable heat of the fire and the "hearth stones" to the food in a sufficiently controlled and not too destructive a manner. The aboriginal cooking technology then, was concerned with the problem of how to apply the quite considerable heat of the fire to the food in a sufficiently controlled but sustained way so that cooking and not undue burning resulted. The ethnographic

evidence suggests that the choice of fuel, the techniques of "raking out" the fire in preparation for cooking and the "wrapping" of the food to be cooked, were all important parts of the process.

<u>Suggested glossary of terms and explanatory notes used in connection with the description of aboriginal fireplaces and ovens</u>

1. <u>Fireplaces</u>: a "dilly bag" type word to cover the variety of fires lit by aborigines. Both casual fires without "hearth stones" lit for warmth and larger fires for communal cooking with "hearth stones" could be included. If used broadly it could also include pit ovens for cooking.
2. <u>"Fires viewed as a ceramic event"</u> is a statement made to alert those interested in aboriginal fireplaces that because of the quite considerable temperatures which can be reached in these fires (900 °C^{+}), in fact some permanent "ceramic" records can be left for us, in the form of fired clay "hearth stones" and the baked clayey earth underneath and surrounding the actual fireplace.
3. <u>Clay "hearth stones"</u> or <u>fired clay "hearth stones"</u> are fired materials found in aboriginal fireplaces which can be shown to be predominantly of clay.
4. <u>Clay pellets</u> or <u>fired clay pellets</u> could be used as terms to describe either the residue of larger clay "hearth stones" which have disintegrated during the life of the fireplace event or to small lumps of sandy clay put into the fire in the same manner as clay "hearth stones".
5. <u>Fire Zones</u> - The notion of zones in a fire is based on the final fired or burnt colour of clay and termite "hearth stones". The notion is that those which were heated in the presence of ample oxygen develop a bright reddish colour range (ferric oxides) whereas those lacking in oxygen develop a bluish colour range (ferrous oxides). Any "hearth stones" which are completely deprived of oxygen by being

completely buried in the <u>hearth</u> under the ashes and coals will develop a bluish black colour due to the additional impregnation of unburnt carbon. This carbon impregnation could reasonably be expected to reach its peak in the fireplaces and ovens where meat wrapped in leaves has been cooked and where the fire has not been re-kindled after cooking. This is because of the secondary burning which occurs when animal fats and vegetable materials drop down into the lower zone of the fire.

6. <u>Fire Phases</u> - The proposition is that there are at least three distinct phases in the life and operation of an aboriginal cooking fire.
   a. The first phase covers the initial lighting and burning of the fire and the heating of the hearth or oven and any "hearth stones" which are placed in the fire. Temperatures in the region of 900 °C can be expected during this vigorous burning stage. The temperatures reached during this phase are far too high for cooking.
   b. During the second phase the fire is 'raked out' and the temperature of the fire drops dramatically to about 300 °C. When the meat (wrapped in its own skin or covered with leaves) is placed on the "hearth" any further temperature drop is moderated by the heat retained in the "hearth" (in the form of the charcoal embers, heated soil and or "hearth stones"). The operational temperatures for cooking then fall in the 300 °C - 100 °C range. Three factors are operating in the actual cooking. The first is the temperature of the "hearth", the second is the length of time over which this temperature is applied and the third is the amount of steam generated within the food being cooked. This is the phase when the food fats (lipids) will impregnate "hearth stone" and related materials.
   c. The final phase is the cooling or dying phase of the fire during which the temperature slowly drops to the

generally prevailing soil temperature. If however the fire is re-kindled at this stage and taken up to the 600 °C^{+} range again for a prolonged period (2 hrs^{+}) re-oxidation of any areas of any "hearth stones" which are exposed in the "hearth" will occur and also many of the fatty food residues which have impregnated the "hearth stones" will be virtually burnt out.

7. Hearth, or fireplace is the area on which an aboriginal fire has been burnt.
8. "Hearth stones"- despite the possible ambiguity arising out of the use of the word "stones", I prefer "hearth stones" to any of the other descriptive terms being proposed for the diverse range of materials used as heat retainers in aboriginal cooking fires and ovens. Both of the terms, heat capacitors and heat retainers seem to me to be only describing the function which we are assuming that these artefacts carried out.
9. Oven - An oven basically differs from an open fire not only in being a pit dug wholly or partly into the ground but also in its operation, because it is an enclosed and therefore controlled atmosphere - which is high in moisture and low in oxygen. Heat loss would be minimized in this type of cooking event.
10. Pre-ceramic technology - Clay "hearth stones" are extremely important to the archaeologist, because if it can be shown that aborigines dug clay and mixed it with sand or any other ingredients and shaped the resulting mixture into balls which were later used as heat retaining "hearth stones", then we have a reasonable case for saying that the aborigines had a sufficient pre-ceramic technology which they chose not to take any further. It should be emphasized that the use of the term pre-ceramic is not being used in a pejorative manner ie. it is not indicating that the aborigines were primitive because they had not made pottery - conversely it is suggesting that

much of aboriginal technology was a superb adaptation to their environment and at times very sophisticated. It is proposed that their limits in technology with regard to fires were those of choice.

11. Prepared "hearth stones" - I see the need for some term to describe the type of "hearth stones" which Peter Coutts is proposing, ie. the intentionally mixed and hand moulded hearth stone.
12. Pseudo Vitrification - The prolonged interment of "hearth stones" from aboriginal fires in the ground may in some cases result in the sealing of the surface of the "hearth stones". Although there is currently some inconclusive debate about whether the sealing material is a form of carbonate, silica or other mineral, the resulting sealed surfaces can appear to be partially vitrified, this phenomenon is best described as pseudo-vitrification.
13. The fireplace "ghost effect" (or the remanent ghost features of a hearth) - When a fire is lit and used for cooking, the "ghost effect" of the event will later be recorded as an anomaly by a magnetometer as it traverses the fireplace area. The "ghost effect" could be invaluable to archaeologists investigating sites in which aborigines have camped, and where deflation of the fireplace surfaces have removed the obvious charcoal ash and or "hearth stones" as it allows the measurement of the remanent magnetism caused by the fireplace event.

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Gloria Anne London

REGIONALISM IN TRADITIONAL CYPRIOTE CERAMICS

Introduction

In dedicating this Newsletter to H.J. Franken, founder of the Institute of Palestinian Archaeology and the Department of Pottery Technology at the University of Leiden, we acknowledge his contribution to ceramic analysis and Near Eastern archaeology. In his publications, Franken invites archaeologists to approach pottery studies from the perspective of ceramic technology and to re-examine the significance of variation detected in the wares. Not since Kelso joined Thorley to study the Tell Beit Mirsim Iron Age pottery (Kelso and Thorley 1943) has an archaeologist collaborated with a potter to address questions concerning ancient ceramic technology and related sociological issues. In doing so, Franken and Kalsbeek pioneered a research strategy found in operation in an increasing number of excavations.

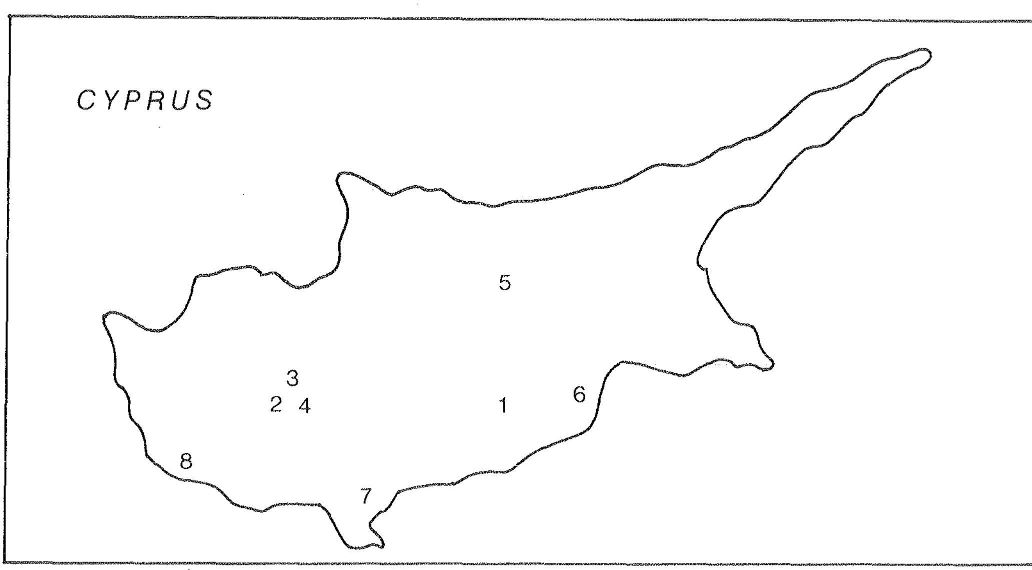
In 1975, a six month grant from the Ministry of Education and Sciences of The Netherlands, enabled me to study with H.J. Franken and J. Kalsbeek. With the help of Franken, I spent nearly one year experimenting with clay and making pottery(1) I can remember his consoling words as I removed from the kiln a bowl I had burnished, but due to a high firing temperature, lacked a sheen. Franken is always there to talk about history, to read manuscripts, and to listen. As a teacher, he stimulates students to explore new ideas and to question traditional explanations.

When Franken proposed that I examine the late third millennium B.C. Jericho material, excavated by Kenyon and stored in Leiden, he generously granted full access to the pottery and later requested that additional boxes be sent from England. This experience initiated my work on the contemporaneous Jebel Qa'aqir collection for my Ph.D.

dissertation (London 1985). Above all else, the approach fostered by Franken directed my attention to the study of manufacturing technique as fundamental for understanding the differences archaeologists detect in ancient pottery and that rather than describing the differences, the goal is to explain them.

Ceramic ethnoarchaeology in Cyprus

To better understand pottery production, ethnoarchaeological field work enables one to observe and record potters who use traditional technologies. The island of Cyprus provides an ideal setting for an ethnoarchaeological study of ceramics. Traditional potters work in four villages (Fig. 1) where they use red and/or white clays to shape cooking pots, jugs, jars, ovens, flower pots, incense burners,



Total area is approximately 9250 sq km

Fig. 1. Map of sites mentioned in the text showing the traditional pottery making centers at 1. Kornos, 2. Kaminaria, 3. Ayios Dimitrios, and 4. Phini: and the modern cities of 5. Nicosia, 6. Larnaca, 7. Limassol, and 8. Paphos.

pita plates, and decorated pieces. Accounts of the traditional industry in the work of Ohnefalscher-Richter (1913), Taylor and Tufnell (1930), Peridou (1960), Johnston (1974), Yon (1985), and Jones (1986) attest to its tenacity. Discussions with retired potters reveal that fifty years ago, men were actively involved in an industry currently dominated by women (London 1987).

Throughout a seven month field project, supported by a Fulbright Research Award, potters and non-potters responded to interview questions, but most of the work involved observing, recording, and quantifying all aspects of the ceramics industry, from clay procurement to product distribution. The majority of the traditional forms (80 % of the repertoire), are destined for local use whereas the indigenous population as well as tourists buy the small decorated pieces.

All 21 potters are aged 50 years or more and no young people are learning to work the locally available clays. One potter works in the village of Kaminaria, not far from Ayios Dimitrios where five potters live and produce traditional forms. In nearby Phini village, the two remaining potters use traditional techniques to create tourist-oriented wares. In addition to these Troodos Mountain communities, is Kornos village in the foothills south of Nicosia. The Kornos potters include ten members of a pottery cooperative and three private potters. Hampe and Winter (1962), who have provided the most detailed study of traditional potters in Cyprus, recorded two potters in the foothills west of Nicosia, at Klirou, but in 1985 the abandoned workshop was demolished.

The manufacturing technique

To record pottery production in detail, it is imperative to live in the villages full time. Three months in Kornos and six weeks in Ayios Dimitrios afforded the opportunity to observe potters at work and to collect quantitative data.

A basic manufacturing technique prevails in all villages, with minor differences in the fabrication of large versus small forms. Regardless of size, all pieces start as a solid cylinder of clay into which a hole is opened with the knuckles. To build larger forms (cooking pots, jugs, jars, ovens, and flower pots), potters add coils while rotating, with the hand or foot, the slow-moving wooden turntable which rests on the ground. For the small juglets and vases, the potters draw up the clay with a piece of wood or cane while pushing the turntable with the side of the foot. Initially, the bases are thick, but once the rims are sufficiently dry to support the vessel weight, the potters scrape away excess clay from the lower bodies.

Decoration involves stamped and incised patterns rendered with plastic combs, spliced cane stalks, and pointed tools. Thumb-impressed rims characterize flower pots. Vessels of all types are fired together in permanent kilns.

Regional differences in traditional Cypriote pottery

In contrast to the unified pottery manufacture, nuances in the technology reveal regional features. Many aspects of the industry attest to regionalism, including: clay types, decoration, terminology, repertoire, kiln construction, tools, and distribution techniques as well as territories.

Kornos potters work with red clay unlike Ayios Dimitrios potters who combine red and white clays which all derive from volcanic rocks. The Kaminaria potter uses red clay unless her husband acquires the white Ayios Dimitrios clay. Clay sources for the Phini potters were not investigated, but suitable clay abounds in Cyprus.

Nuances in the manufacture differentiate Kornos wares from those of all three mountain villages with regard to the order of handle and decoration application. In Kornos, all potters render the incised decoration prior to handle application, but the order is reverse in Ayios Dimitrios, Kaminaria, and Phini. Furthermore, in Kornos and Ayios Dimitrios, older pots reveal this to be a long-established dichotomy. One can easily determine whether the handle or decoration came first: handles applied after the decoration interfere and erase part of the incised pattern. As a result, a minor variation in the manufacturing technique serves to identify pottery from Kornos versus all mountain villages.

Decorations vary for each community. Ayios Dimitrios potters suffice with a zigzag of indvidually incised slashes, wavy lines (Fig. 2a), and jars are often undecorated. An abundance of decoration on pots and lids identifies Kaminaria wares (Fig. 2b) from all others. Potters elsewhere refrain from decorating lids and tend to limit incised patterns on pots to one or two bands in opposition to the Kaminaria surface treatment. Combed patterns characterize the Kornos and Kaminaria decorations, but in Kaminaria, the proliferation of the pattern identifies the maker and the community. Spliced cane tools create a rosette motif found exclusively in Kornos (Fig. 2c), as is the rolling devise used to produce a rouletted pattern (Fig. 2d).

Cooking pot lids and handles represent another regional stylistic difference. In Ayios Dimitrios, pointed handles prevail (Fig. 2a). The Kaminaria handle is a flat-topped decorated knob (Fig. 2b). Kornos handles are rounded, but each woman creates her own particular, individual form as represented by the two drawings (Fig. 2c,d). Finally, there remains the shape of the cooking pot lid: Kaminaria lids are convex whereas all others are concave.

Vessel names vary regionally as does the repertoire. Kornos lays equidistant from Nicosia, Larnaca, and Limassol and supplies an urban and rural clientele. Potters in Ayios Dimitrios cater more to the needs of rural rather than urban dwellers although their wares reach shops near Nicosia and Paphos. Given the different markets, the repertoires vary accordingly. Flower pots, rarely made in Ayios Dimitrios, represent 12 % of the Kornos industry. The opposite situation

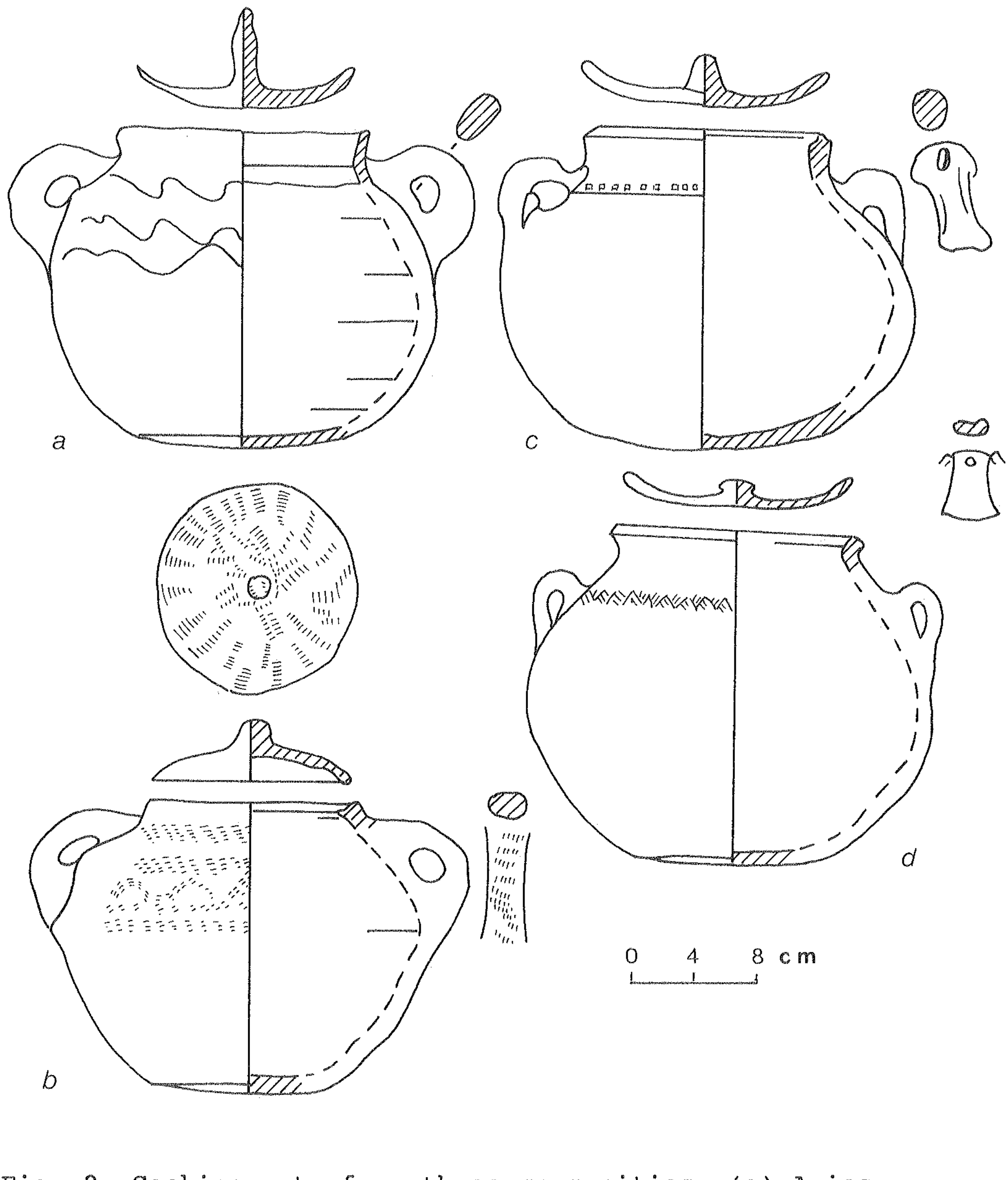


Fig. 2. Cooking pots from three communities: (a) Ayios Dimitrios, (b) Kaminaria, (c) and (d) Kornos.

applies for goat-milking pots which are still made at Ayios Dimitrios, but Kornos potters fabricate miniature replicas for decorative use. Furthermore, in the mountain villages, goat milk products create a demand for clay jars, a type that has almost disappeared from the Kornos repertoire (under 1 %), but constitutes 47 % of the Ayios Dimitrios output(2). Urban women, who less often prepare goat milk products, use glass and plastic containers. For the three forms discussed here, flower pots, goat-milking pots, and jars, geography and marketing dictate differences in regional repertoires.

Kiln and turntable construction vary between the mountain villages and Kornos. Square turntables at Kornos and formerly

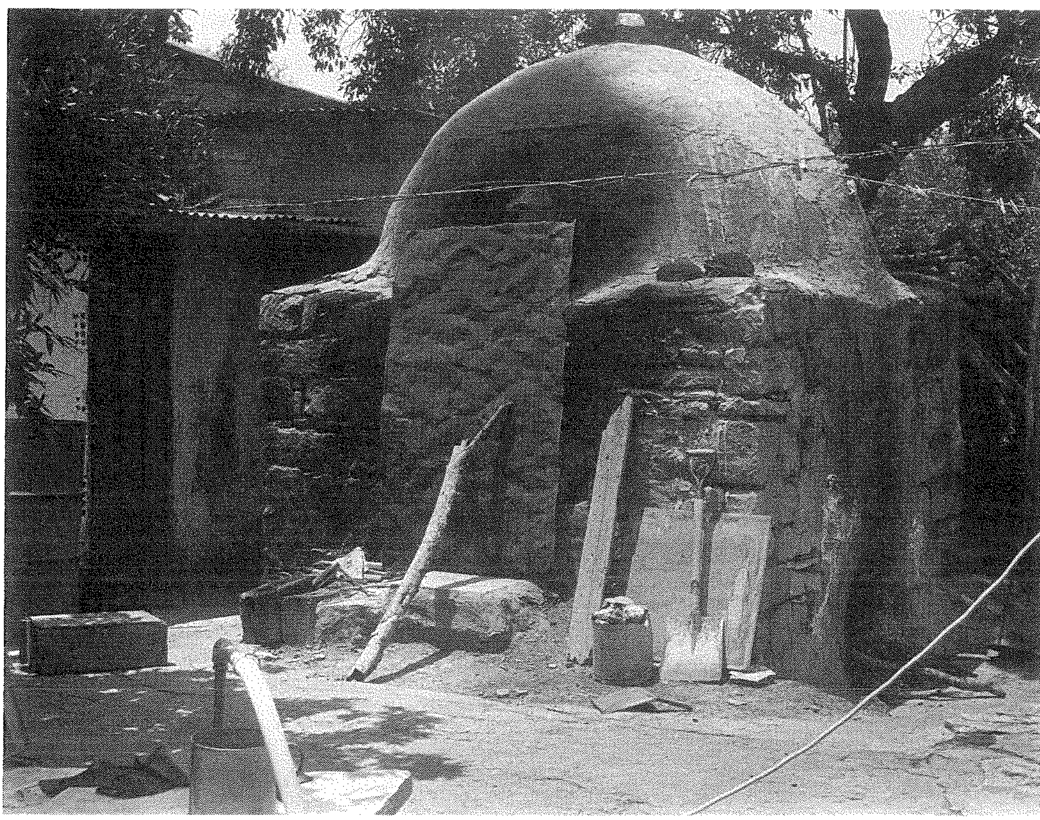


Fig. 3. A kiln at kornos owned by a private potter. The large side door, through which the pots are loaded into the kiln, is covered with a metal sheet supported by a part of a tree. To the right, around the corner, is the fire box from which wooden poles protrude.

in Klirou (Hampe and Winter 1962: Pls. 45-50), contrast with the round-headed turntables elsewhere. At Kornos, the square kilns have a permanent domed roof, unlike the round roofless kilns in the mountains. The permanent roofs on all four Kornos kilns require loading pottery through a side door (Fig. 3) closed with a wall of old bricks and sherds and sometimes covered with metal sheeting. On another side of the kiln, the fire box is placed on a lower level. In Phini, Ayios Dimitrios, and Kaminaria, three old kilns and five kilns in use are top-loading constructions built adjacent to a slope to facilitate loading and stacking through the open roof (Fig. 4). Circular metal discs and reused curved roof tiles cover

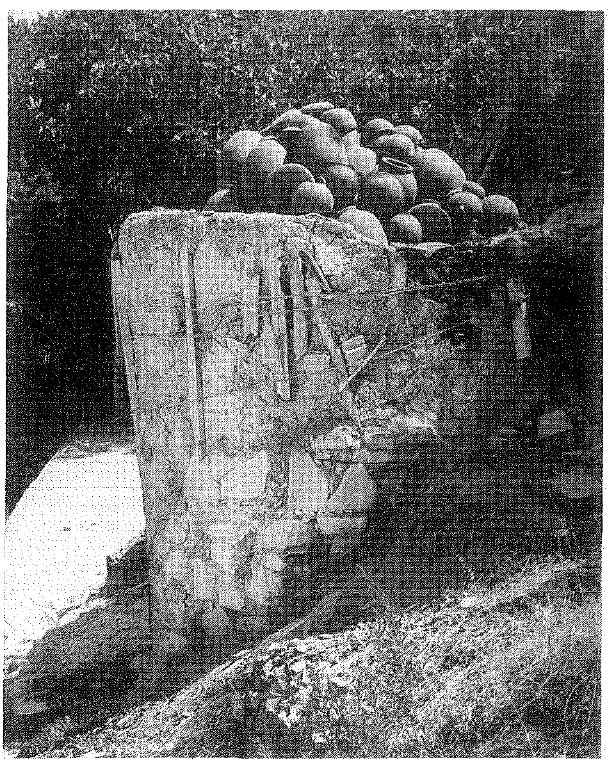


Fig. 4. An Ayios Dimitrios kiln adjacent to a slope for easy loading of pots from the top. Ash and charcoal are discerable in front of the kiln at the level of the firebox.

the domed pile of pottery on top of which pole are arranged which serve as fuel in addition to the wood burned in the fire box.

As for sales and distribution, shopkeepers drive to Kornos to buy kiln loads (200-300 pieces), but Ayios Dimitrios wares are distributed by truck drivers to shops and to individual customers. Formerly Kornos pottery reached the entire eastern part of the island and mountain wares served the western region. Today there appears to be less of a division as shopkeepers from the Troodos Mountains travel to Kornos to buy pots, just as Ayios Dimitrios pots are transported to Nicosia and environs. Communities west of Kornos and east of Phini, chose Kornos or Klirou wares.

Implications for archaeology

Regional differences in traditional Cypriote pottery made today imply that subtle distinctions in repertoire, manufacture, and decoration of ancient pottery might also reflect regional centers of pottery production. Variations in the incised decorations on contemporaneous Cypriote pottery do not reflect chronological distinctions, but serve to identify the work of each village and suggest that subtle differences in the designs on archaeological wares might betray a multiplicity of workshops of pottery producing communities.

Discrepancies in the repertoire between Kornos and the mountain villages are indicative of two lifestyles and markets: urban versus rural. This has implications for understanding the presence/absence of ancient pottery types at various sites. For example, in the Levant, the collar rim store jar is considered to have been a hallmark of the late second millennium B.C. rural Israelite community in the hill country. In contrast, the Canaanite ceramic repertoire of the lowland cities lacks the collar rim store jar except for isolated examples. Rather than attribute the jar to an ethnic group, its presence could indicate a lifestyle requiring large storage containers, i.e. a self-sufficient farming community in the hilly region. Canaanite cities would have no need for this type of container, just as Nicosia residents have no use for large ceramic jars in contrast with their rural counterparts. The diverse repertoires of the lowlands and highlands of ancient Palestine might well represent an urban/rural dichotomy and not the material correlates of two distinct ethnic groups, Canaanites and Israelites (London n.d.).

Conlusions

Long-term ethnoarchaeological field projects providing evidence of regionalism in traditional pottery, can have implications for explaining nuances in the manufacture and differences within contemporaneous assemblages excavated at different sites. To further understand the differences archaeologists detect in pottery, an analysis of the manufacturing tradition, as advocated by H.J. Franken, is an approach that plays an ever increasing role in the study of pottery and will result in a more complete assessment of past human behaviour.

Notes

1. The extension was made possible by a grant from the Maatschappij tot nut der Israëlieten in Nederland for which I am most grateful to Mr. Spyer.
2. These figures are based on a total of 1880 pots in Kornos and 686 in Ayios Dimitrios. As mentioned earlier, 80 % of the finished products belong to the category of traditional forms rather than tourist oriented wares.

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Rogier Bedaux
Diderik van der Waals

ASPECTS OF LIFE-SPAN OF DOGON POTTERY

Introduction

One of the main objectives of the ethno-archaeological investigations by a combined team of the State Universities of Utrecht and Groningen and the 'Institut des Sciences Humaines' at Bamako among the Dogon (Mali, West Africa; Fig. 1)(1) was the collection of data relevant to the archaeological interpretation of pottery. Professor Franken had already taken an interest in archaeological work in the Dogon area when the potmaking of the Tellem, predecessors of the Dogon in the area, was studied in his Institute (Bedaux and Lange 1983). For the ethno-archaeological project, he helped us to define data and materials related to Dogon pottery to be collected during the field work. We gladly offer to Professor Franken the following observations as to the use-life of Dogon pottery, along the line initiated by Foster (1960)(2).

The Dogon, still largely a traditionalist people numbering about 250.000, live in comparative seclusion on the sandstone tableland and along the escarpment of Bandiagara and on the adjacent Plain of Gondo, in the Southeast of Mali. Their territory is situated in the Savannah zone, almost on the verge of the Sahel.

Dogon society is tribal in character. They live in nucleated villages of about hundred up to two thousand inhabitants. In the villages, the extended families, living in one or more clearly distinguishable compounds, represent the basic productive units. They are grouped in lineages, which hold the productive land, divided among the families by the lineage elder. The council of the eldermen represents the most important decision making body in Dogon society, there being

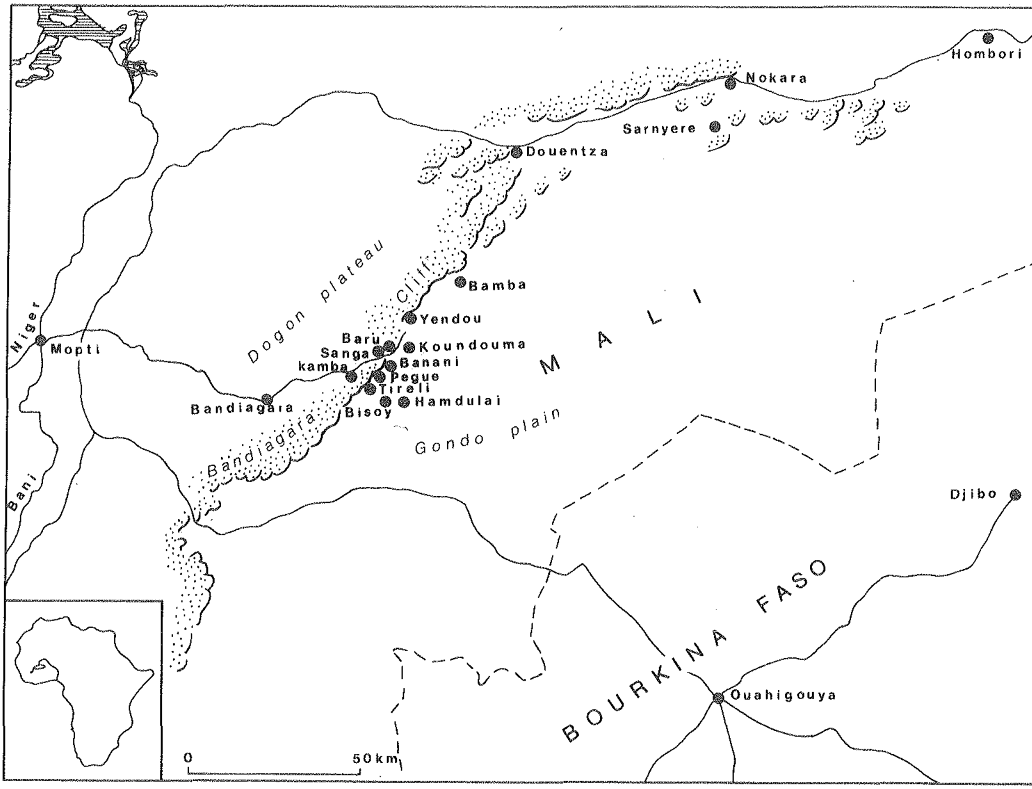

Fig. 1. Map of the Dogon Country in Mali, West Africa. (Drawing F. Stelling).

no authoritative higher level of integration.

Essentially, Dogon agriculture is of a mixed character, with crop growing as the central activity. Millet is the staple food, and also serves the brewing of beer by the Dogon woman (Fig. 2), beer being of paramount social importance. Its importance is in fact reflected in certain types of pottery.

A more complete description of the different aspects of Dogon potmaking and pottery is given by Bedaux (1986). Potmaking is an exclusively female activity(3). It is not evenly distributed over all Dogon villages. The availability of a suitable clay of good quality, as in Tireli, may play a role, but more important are taboos on potmaking in certain

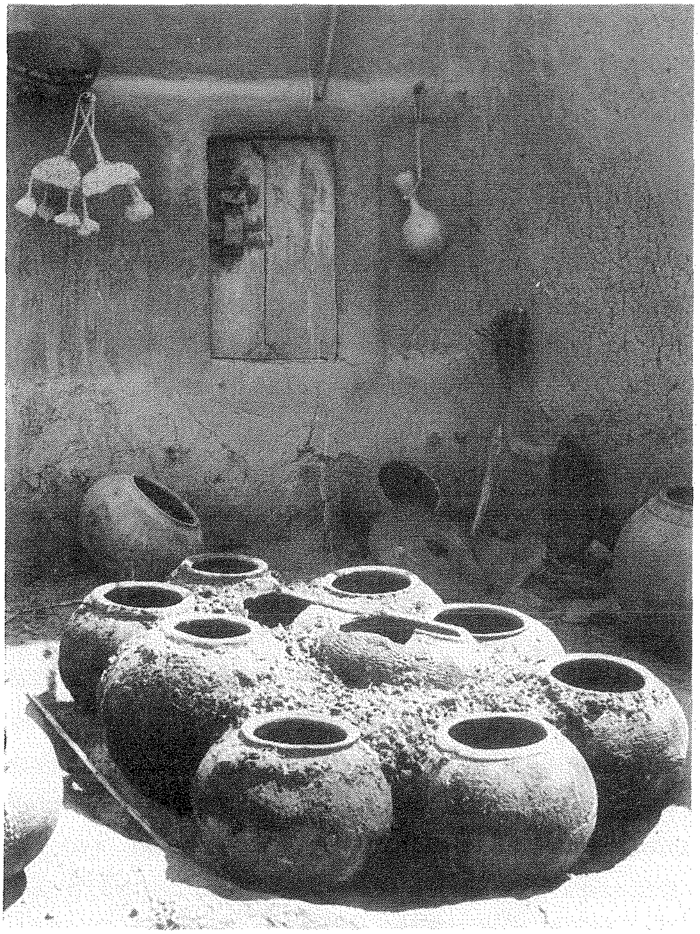

Fig. 2. Brewing in action: battery of ten dei juno (type 11). Note the beer fermenter (a file pouch) hanging to the left of the granary door. Sanga, 1975, compound 5-5 (Photo J.D. van der Waals).

villages (Sanga for instance). Potmaking is a dry season activity. Towards the end of the dry season groups of women combine to fire their ware jointly in communal, large, open fire pits, donkey droppings, chaff and stalks of millet and bark of trees serving as fuel. In principle, all women can partake in potmaking, and in some villages, like Tireli, most of them do. The pots they make not only serve the needs of their respective families. The women also sell their pots at the local market and at the markets of neighbouring villages, especially of those villages where potmaking is taboo.

On the data collected

In the paper already referred to, aspects of pottery life-span were briefly considered (Bedaux 1986, Tables 7-9). The data and the preliminary conclusions presented there require reconsideration. As soon as average ages of pots are being considered and data from different villages are being taken into account, conclusions may be distorted due to the fact that potmaking is not equally distributed over the villages. Pots registered in compounds at Sanga, where no pots are being made, have all been bought to be used, and it is unlikely that many pots will have been bought in advance. Therefore, new and unused pots are relatively rare in compounds of non-potmaking villages, and unfired pots will be altogether absent. In Tireli at the other hand, all pots which have not yet been fired and all pots which have been fired at the end of the dry season are being kept in the compounds. These include pots which are being stored to be taken into use in the future, and pots destined to be sold at a later date. All these pots have been registered and will tend to lower the average age. In the tables presented here as opposed to the tables presented in the earlier paper (Bedaux 1986) we therefore omitted from the record all pots which have been registered as new (i.e. unused), meant to be sold, or being in unfired condition.

The ages have been recorded on the basis of the indications given, sometimes upon mutual consultation, by the women of the compound in question. In some cases, these indications have been double-chequed at a second occasion, and proven to be reliable. We believe them to be fairly exact approximations. In illitterate societies without radio, t.v. and newspapers, where circulating information refers to a small world, apparently unimportant facts like the dates of acquisition of the pots they have in use, are well worth knowing for the women. Yet, we realize that the ages indicated will be more exact for the younger pots, whereas for the older pots the marges of exactitude will be generally larger. In relation to similar data obtained in the Fulani village of Be (North Cameroon), David (1971, 1972) arrived at comparable conclusions. Only in exceptional cases, for instance when a pot was acquired when the woman-informant took residence in her husbands compound, even the higher ages indicated can be taken to be precise.

All ages and median ages refer to the moment of registration. The aequivalent in archaeology would be found in sites destroyed by sudden catastrophy: the living floors of Pompei for instance.

<u>Median ages of types</u>

When pottery types can be connected with functions and functions are indicative of economic aspects of culture, the relative frequencies of pottery types in archaeological sites can be of importance in order to assess the relative importance of economic activities. However, in order not to arrive at entirely false conclusions, this will be possible only in cases where the relative life-span of the pots of the types in question can be estimated.

In Table 1A (after Bedaux 1986: Table 9), the median ages of pots according to types as registered in the compounds investigated are presented. In this table, unfired pots, new pots and pots meant to be sold are included. In Table 1B same are excluded. It is clear that the inclusion of these data has a deflating effect on the medians.

The variability within the various type groups of Table 1B has been compared with the variability between those groups by means of a Kruskal-Wallis test (Siegel 1956: 184). There is less than 0.1 % chance ($p < 0.001$; two-tailed) that these two

Table 1

Medium life-span of pots in use in 16 households of 4 villages in the Sanga arrondissement. A = inclusive of new (= unused) pots (N=87), pots to be sold (N=46) and unfired pots (N=53). B = exclusive of same.

Type, name.	A		B	
	N	Med.	N	Med.
1 woni/ni tonyo	10	2.5	6	11.1
2 tegeri	94	1.4	63	2.4
3 lajiry dei	12	3.2	10	4.5
4 joni	9	1.1	5	2.0
5 tegere	32	2.7	28	3.0
6 totonyi tegere	8	2.0	7	3.0
7 ninge dei	151	1.8	129	2.2
8 dei sire	163	2.5	146	2.8
9 pana dei	48	2.8	48	2.8
10 dei no	364	3.0	273	4.0
11 dei juno	122	3.7	122	3.7
12 dei dam	36	9.9	36	9.9
13 dei pogo	81	9.5	78	9.7
14 ibonu ogono	12	2.5	10	3.5
15 ogono neu	38	7.5	38	7.5
16 ogono seme	5	5.0	4	6.5
17 ogono du	12	1.3	6	4.0
Totals	1197		1009	

variabilities are similar, i.e. the various types have age distributions which show significantly less variability than the total group. The implication is that the age distributions of at least some of the various types will differ significantly between them. It is worthwhile to determine the significance of the differences between all the types with the help of the Mann-Whitney U-tests (Siegel 1956:116). On this basis, it was possible to make combinations of types for which the ages of the pots did not differ significantly from each other ($p < 0.01$; two-tailed). These combinations are the following for the types, compare Fig. 3):

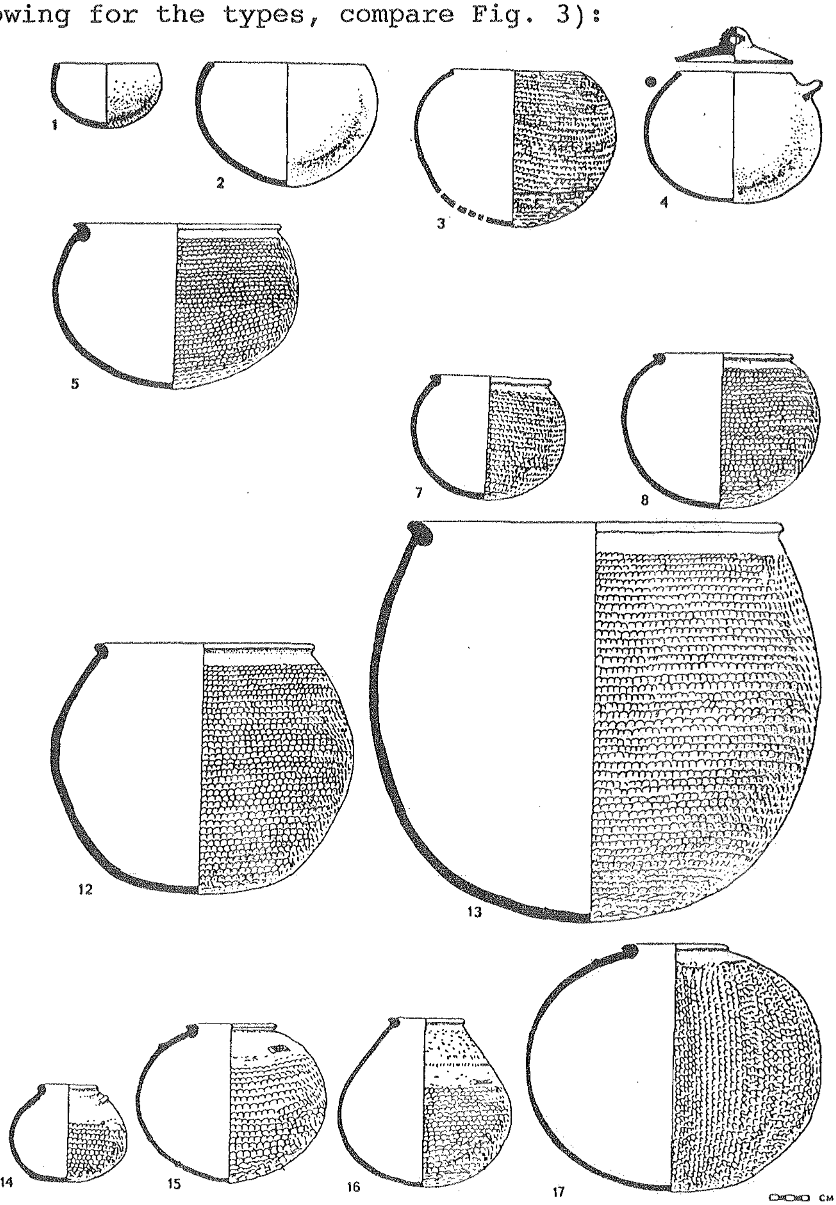

Fig. 3. A selection of types of Dogon pottery. Type numbers indicated (compare Table 1)(Drawing F. Stelling).

Types 1, 12, 13, 15, 16: median ages 6.5-11 years. Within this group of types with the highest life expectancy we find the largest types (12, 13), which are not usually being moved around and which often have a fixed position in the compound. Type 1, the smallest of all, concerns pots which often have a ritual function. Pots of types 15 and 16 are used only by women brewers to set apart the small quantities of "free" beer they owe to their husbands.

Types 3, 10, 11, 14, 17: median ages 3.5-4.5 years. Types 10 and 11 represent large pots only slightly differing in size, which are used for the brewing and storage of beer and for the carrying and storing of water (Figs. 2, 4).

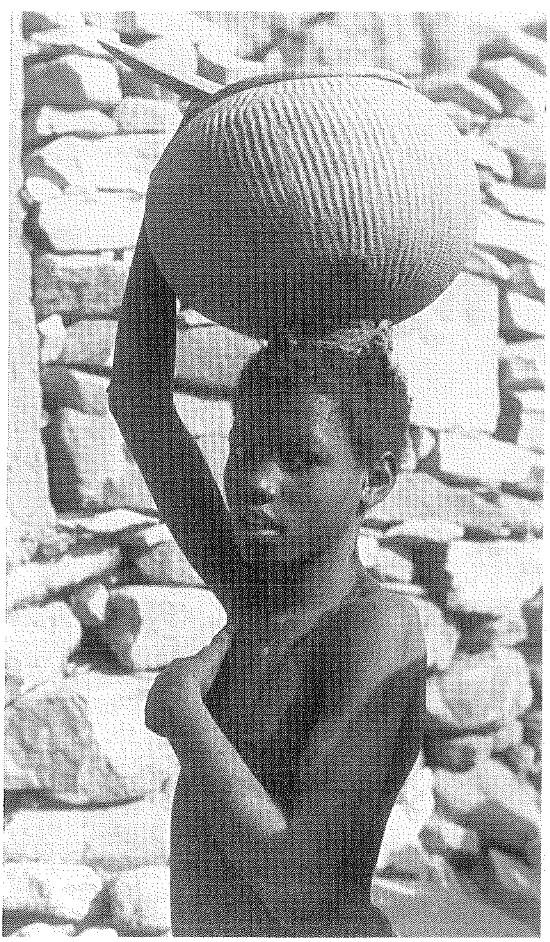

Fig. 4.
Dogon girl carrying water in a dei no (type 10) in Tireli, 1985 (Photo R.M.A. Bedaux).

Type 14 is a small pot, serving the drinking of beer by small boys. Type 17 represents the pots in which men carry water. Type 3 is a perforated pot for the preparation of couscous.

Types 2, 4, 5, 6, 7, 8, 9: median ages 2-3 years. This group of types of pots with the lowest life expectancy comprises practically all cooking pots (Fig. 5). Only types 5 and 6, large bowls, are used for storing, the watering of animals and washing.

The logic of these age groups is fairly convincing. Pots daily in contact with fire and constantly being moved around

Fig. 5. Cooking area in compound 1-16 at Tireli, 1983: pestles, inverted mortars, calabashes, baskets and cooking pots (in vulnarable position!) (Photo J.D. van der Waals).

have the shortest life-span; pots never put on the fire and only occasionally moved the highest. The intermediate group can be understood on the basis of the same criteria. Pots for brewing beer for instance are used on the fire, but generally only once per week. The rest of the time, they are set apart.

Median ages of pots in potmaking and non-potmaking villages

The question as to whether pots in non-potmaking villages are handled with greater care was also considered by Bedaux (1986; Table 8, p. 134): "It appears that in potmaking villages pots are easily being replaced. The median age for all types of pots per compound in Tireli, a centre of pottery manufacture, is between 1.2 and 3.7 years; for Sanga, where no pots are being made, these values are between 4.6 and 8.3 years, and for Banani, where pots are being made though on a limited scale, the values appear to be intermediate, between 3.3 and 3.9 years." These conclusions were based on age data which for Tireli included the unfired and unused pots intended to be sold on the market, deflating the medians for Tireli and strengthening the contrast between Tireli and Sanga beyond the effect of careful or careless handling.

It is worthwhile to reconsider these data when the distorting pots are omitted (Table 2). The contrast appears to be smaller, but is still obvious. The variability within the various compounds (Table 2) proved to be significantly lower ($p < 0.001$, two-tailed) than that between them by a Kruskal-Wallis test. With the help of Man-Whitney U-tests ($p < 0.01$, two tailed), four groups of compounds can be distinguished:

The first group, with the lowest median age of the pots from 1.5 to 2.5 years, consists of compounds in the potmaking villages of Tireli and Pégué (compounds 1-11, 1-13, 9-1), inhabited by well-known potters.

The second group, still with small median ages from 2.8 to 3.7

Table 2
Median life-span of pots in use in 16 households of 4 villages in the Sanga arrondissement, arranged according to compounds and villages. Unfired and new (=unused) pots and pots intended to be sold are omitted. Tireli and Pégué are active potmaking villages; Sanga is a non-potmaking village. In Banani pots are being made, but on a limited scale.

Village	Compound	N	Med.	Village	Compound	N	Med.
Tireli	1-4	9	3.2	Banani	8-1	58	3.9
	1-5	121	2.9		8-2	71	3.4
	1-9	20	3.7	Sanga	7-1	44	3.4
	1-11	30	1.5		6-1	100	4.7
	1-13	67	1.5		5-5	102	4.9
Pégué	9-1	110	2.5		5-4	21	7.0
	9-2	60	2.8		5-3	76	8.2
					5-2	41	6
					5-1	44	5.7
					Total	974	

years, also comprises compounds in Tireli and Pégué (compounds 1-4, 1-5, 1-9, 9-2).

The third group, with higher median ages ranging from 3.4 to 4.9 years is more composite. Two compounds (8-1, 8-2) are from Banani, a village with limited pottery production. Three compounds are from Sanga, but these are fairly atypical. One (7-1) is a smith's compound, the smith's wife being the only woman in Sanga entitled to make pots. The other two (5-5, 6-1) belong to people with an extraordinary position in the village (an official, a teacher).

The fourth group, with the highest median ages, ranging from 5.7 to 8.2 years, comprises four typical compounds from the non-potmaking village of Sanga (5-1, 5-2, 5-3, 5-4).

The conclusion as to a greater care in the handling of pots in non-potmaking villages seems warranted. The function of the pottery in the villages in question does not differ. Nor is there reason to assume major differences in quality between the pots in use in Sanga and the other villages. However, the fact that potters usually keep more or less defective pots for themselves might be of some influence. As to the two compounds from Banani in the third group, these both were compounds of women potters who almost only used their own ware. It is therefore difficult to decide in how far raw materials, the potter's skill or care in handling are the factors determining the age of these pots.

Differences of median ages of pots per type and per compound

It should still be asked whether pots of certain types are chiefly responsible for the above age differences between pots from compounds of potmaking and non-potmaking villages. Therefore we investigated the within-group and the between-group variability for the various compounds per type by a Kruskal-Wallis test. It appeared that at $p < 0.001$ (two tailed) only for types 10, 11 and 13 a significant difference exists between these two variabilities (Table 3). Differences which according to Man-Whitney U-tests are significant (at $p < 0.05$; two-tailed) combine only in part conformably to the groups defined in the preceding section. We may therefore conclude that the differences in life expectancy between pots from potmaking and non-potmaking villages are not systematic for all pottery types and that the above four groups are mainly caused by type 13 and, less clearly, by types 10 and 11. Differences nevertheless may be striking: for the dei pogo (type 13), the biggest of pots, a median age of 1.2 in a Tireli compound (1-11) contrasts strongly with the median age of 50 years in a Sanga compound (5-1).

Table 3
Median life-span of pots of the three types 10,11 and 13 according to compounds. New (= unused) pots, pots to be sold and unfired pots are omitted. Per compound, only in case N 5 pots of these types are taken into consideration.

Type:		10		11		13	
		N	Med.	N	Med.	N	Med.
Compound							
Tireli	1-5	31	3.3	12	3.5	11	2.7
	1-11					6	1.2
	1-13	11	1.4			9	4.7
Pégué	9-1	29	2.5	12	2.9		
	9-2	15	3.4	11	2.7		
Banani	8-1	17	4.6	7	4.2	5	9.0
	8-2	25	4.1	8	3.0		
Sanga	7-1	13	5.3				
	6-1	27	3.4	24	5.0	12	10.1
	5-5	26	4.5	14	3.5	10	17.5
	5-4	6	3.5	7	8.0		
	5-3	30	8.0	10	7.5		
	5-2	14	6.2	6	4.5		
	5-1	16	4.2	6	5.0	6	50.0

Median ages of pots in Sanga according to villages of provenance

As we have seen, nearly all pots in Sanga have been bought from potters of other, potmaking villages. In six Sanga compounds (compound 7-1 being excluded) 389 pots came from 14 different villages (Bedaux 1986: Fig. 5). It may be questioned whether the ages of the pots, arranged per type, from different villages differ (Table 4). Such differences might result from differences in quality, due to differences in raw materials or workmanship. The Kruskal-Wallis test indicated

Table 4

Median ages of pots of five types registered in Sanga, per village of provenance. New (= unused) pots, pots to be sold and unfired pots are omitted. Per compound, only in case N 5 pots of these types are considered.

Type:	7		8		10		11		12	
	N	Med.	N	Med.	N	Med.	N	Med.	N	Med.
Origin										
Yendouma			6	3.0	22	1.8	23	5.6		
Tireli	5	2.0	18	4.5	65	5.7	12	6.5	7	10.0
Bamba					6	5.8	11	5.0		
Banani	17	3.1	6	4.0	13	6.0	7	7.0		
Kamba			5	4.0			9	5.0	5	8.0

that, again only for type 10, the variability between the ages of pots, made by the same potter, was significantly less than that between pots, made by different potters ($p < 0.02$; two-tailed). With the help of Man-Whitney U-tests (at $p < 0.05$; two tailed) the pots from Yendouma (1.8 year) can be distinguished as opposed to those from Tireli, Bamba and Banani (5.7-6 years). Curiously, according to one informant from Sanga who was questioned as to the relative quality of pots from different villages, pots from Yendouma were said to be the heaviest but also the strongest, whereas pots from Tireli should be relatively light and fragile. A systematic difference in thickness of wall between pots from Yendouma and Tireli as suggested by the informant can in fact be demonstrated. But, apparently, thickness does not stand for strength. In the other types, no significant difference between villages could be demonstrated.

Median ages of pots, arranged per type and per potter

In order to investigate whether the skill of the potters and/or the quality of their raw materials are responsible for differences in the life expectancy of the pots they produce, we compared the pots according to types, per potter (Table 5). The Kruskal-Wallis test indicated that, again only for type 10, the variability between the ages of pots made by the same potter, was significantly less than that between pots, made by different potters ($p < 0.02$; two-tailed). According to Mann-Whitney U-tests (at $p < 0.05$; two-tailed), two groups can be discerned. One group comprises two potters from Tireli (1 and 16) and two from Pégué (56 and 57), with median ages ranging from 1.4 to 3.3 years. The second group comprises one potter from Tireli (14) and three from Banani (52, 54 and 55), with median ages between 3.7 and 4.6 years. We must point out that it is not certain that the age difference is in fact related to differences in quality due to differences in skill or raw materials. Since most of the pots concerned were recorded in the compounds of the potters themselves, and in consequence the potters were also the users of their own pots, part of the difference could have been caused by differences in care in handling them (cf. Bedaux 1986: Table 3).

Table 5
Median ages of pots of type 10 per potter. New (= unused) pots, pots to be sold and unfired pots omitted. Only potters from which 5 or more pots of this type were registered have been included.

Village:	Tireli			Banani			Pégué	
Potter:	1	14	16	52	54	55	56	57
N	11	19	5	17	10	13	20	13
Med.	1.4	3.7	3.3	4.7	3.8	4.0	2.6	3.1

Conclusion

Life expectancy of Dogon pots appears to vary considerably according to the closely related variables type and function, but also according to the circumstance whether pots are being made in the compound/village in question or not. Pots of identical type but from different origins in use in the same village appear sometimes to have different life expectancies. Whether raw materials, the technology of the potter, or her skill are to be held responsible is difficult to asses.

<u>Notes</u>

1. The project "Ethno-archaeological Research among the Dogon" is concerned with relations of material culture, in particular pottery, to other realms of culture. Research was made possible by grants of the Netherlands Foundation for the Advancement of Tropical Research (WOTRO) at the Hague and by the Society for Scientific Research in the Tropics (Trueb-Society) in Utrecht to the authors and to Dr. W.E.A. van Beek.

   The field work was carried out in three campaigns during the years 1983-1985 by a team consisting of Dr. R.M.A. Bedaux, Dr. W.E.A. van Beek, W.F. de Boer, Dr. B. Keita, Drs. A.G. Lange, Drs. F. Smits, Drs. M. Sypkens Smit and Prof. J.D. van der Waals.

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2. We greatly profited from critical remarks and suggestions for improvements, especially in relation to the statistics,

from our colleague Mrs. Dr. T.S. Constandse-Westermann.

3. Such in contrast to the Dogon of the outlying village Sarnyere (see map Fig. 1), where potmaking is an exclusively male activity (Gallay 1981).

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M. Beatrice Annis
Herman Geertman

PRODUCTION AND DISTRIBUTION OF COOKING WARE IN SARDINIA

I. Modes of production and of distribution (M.B.A)
II. The case of a workshop according to its administration (H.G.)
III. Epilogue (M.B.A.)

Introduction

The archaeological and ethnographic peculiarities of the production and distribution of ceramic cooking ware has been the subject of several discussions with our friend Henk Franken. We are therefore particularly pleased to have the opportunity to dedicate this study to him, as a sign of grateful homage.

The present article consists of two parts which differ in character. The first part is of an ethnoarchaeological nature in that its contents is derived on the one hand from information provided by potters, distributors and consumers, and on the other from the observation and recording of the material remains - workshops and objects - of the production of cooking ware that came to an end in 1973. The second part is of an ethnohistorical nature and consists principally of a systematic analysis, also supplemented with oral information, of the data contained in the administration of one of the two largest workshops of the production centre Pabillonis[1].

Part I. MODES OF PRODUCTION AND OF DISTRIBUTION

The production centre.

In Sardinia, Pabillonis, also known as sa bidda de is pingiadas (the town of the cooking pots), was, by antonomasia, the production centre of ceramic cooking ware from the 1920s to the 70s[2]. This medium-sized farming village[3] is situated in the central part of the plain of Campidano, on quaternary terraces and recent alluvial soils, flanked in the west by the mountains of the region of Iglesiente and in the east by the fertile hills of Marmilla (Fig. 1). The lush marsh-vegetation on the one hand, which before the land reclamations[4] characterized this swampy area, and on the other the clayey and muddy-clayey soils and the presence of maquis shrubs in the vicinity favoured the development of two small industries: basketry (Atzori 1983: 156-175) and terracotta production. The latter included cooking ware, tiles and bricks. These activities, whose importance to the economy of the village is testified from at least the last century (Frau 1979/80: 149-162; 400-446), enabled the population to compensate for the meagre yield of an agriculture which, even in recent times, was still based on archaic systems of a communal type (Le Lannou 1941: 188-199).

Modes of production

In the first half of the 1920s there were 13 workshops in a village with about 1800 inhabitants. These workshops belonged to two different categories: those with one wheel in which the master potter worked alone, assisted by an apprentice, and those with two wheels in which the master was not only assisted by an apprentice, but also by a helper trained in the craft. The main task of the helper, usually a member of the family, was to work at the wheel, while the apprentice was

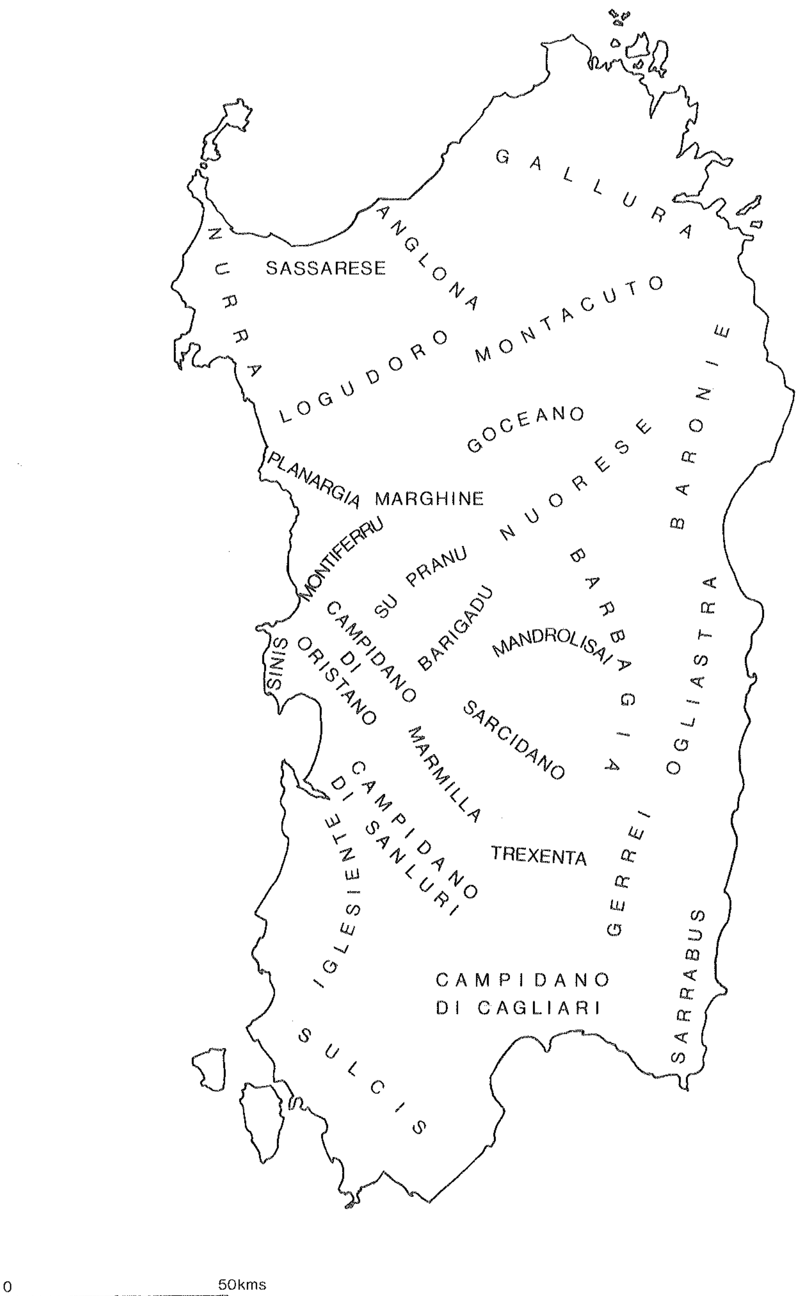


Fig. 1. Sardinia. The regions.
(Source: Atlante della Sardegna 1980, Tav.47).

responsible for the preparation of the clay. However, in the case of these more extensive workshops we cannot speak of a true division of tasks either. In both categories the potter's family cooperated and the workshop and the living areas formed a single unit.

The two categories of workshops reflect the different economic conditions of the owners. The smaller ones belonged to potters to whom the craft was more or less their only source of income, supplemented in the wet season by the money they earned as day-labourers in the fields. The larger workshops, however, belonged to masters who owned some land and livestock and therefore did not depend exclusively on the craft for their livelihood, although they could not manage without it either. Each workshop formed an independent operational unit in the sense that there was no form of joint cooperation in the supply and transport of the raw materials and fuel or in the practising of the craft. For the supply and transport of the raw materials, each master potter depended on landowners and the auxiliary services available in the village. This mode of production can be defined as a full-time male 'workshop industry of the rural type' (Peacock 1982: 9; 38-43) or 'village industry' (van der Leeuw 1977: 68-76).

The potters of Pabillonis and their small and middle calibre middlemen (see below) operated in a vast, scarcely populated territory. In 1921, Sardinia, with its total area of 24090 Km^2, numbered 859,000 inhabitants (that is, an average density of 36 per Km^2 against the average of 135 in Italy as a whole) distributed mainly in villages (Fig. 2). Approximately 60% of the active population consisted of farmers and shepherds (Fig. 3) living and working under archaic pre-industrial conditions. In the years following World War I the island began to partake in the national life from which it had been virtually secluded for centuries. (Brigaglia 1976: 313-321; Le Lannou 1941).

Archaeologically, the distinction between the two types of

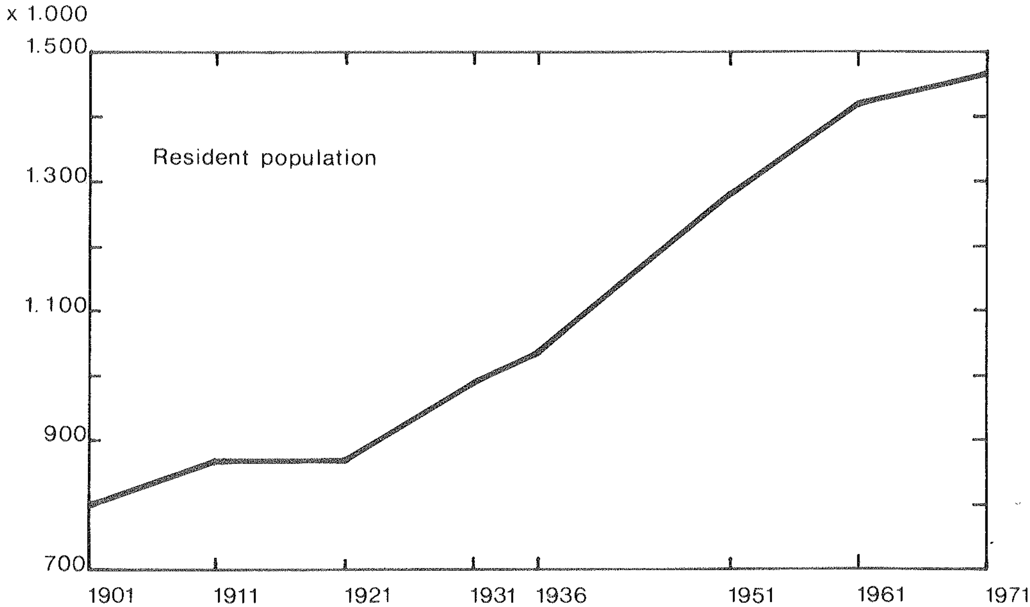


Fig. 2. Population of Sardinia according to the periodic census (Source: Atlante della Sardegna 1980, Tav.52).

Active population			Percentages of active population			
Census	x 1000	% pop.	Agriculture	Industry	Transports Commerce Finance Administration	Unemployed
1921	331	38.5	60	19	21	
1931	364	37.4	58	20	22	
1936	376	36.3	57	20.5	22.5	
1951	433	34.4	51	23.5	25.5	
1965	416	29.5	33	32	35	4.6
1971	401	27.8	25	33	42	5.2

Fig. 3. Active population of Sardinia 1921-1971 (Source: Brigaglia 1976. Atlante della Sardegna 1980).

workshops is not only reflected in the size of the area occupied, which, in the case of those with two wheels, is generally greater, but also in the traces left by the installation of the wheels. As far as the capacity of the kilns is concerned, however, there do not seem to be any great differences between the two categories. Both types of workshops had kilns of about the same size, but in the larger workshops the kilns were fired more frequently.

The independence of the individual workshops is reflected in their scattered distribution, in which no form of tight nucleation is observable.

The period 1925-1935 saw a crisis in the small workshops, five of which disappeared in these years. At the same time, however, the owners of two of the workshops with two wheels managed to acquire a third wheel (Fig. 4) and enlarged the capacity of their kilns by one and a half. Having succeeded in substantially increasing their property of land and livestock, these potters had become self-sufficient as far as the procurement of raw materials was concerned. Moreover, they no longer had to depend on auxiliary services and were even able to employ labourers in their workshops. In order to increase production in the wet season too (from November to April), they modified the traditional kiln, which had been updraught without a dome, by providing it with a dome.

The premisses of these changes are to be found in the growing integration of Sardinia with the rest of Italy which, along with the intensification of cereal cultivation and mining, led to an improvement of the living conditions of the population which in 1936 reached the number of 1,036,000 (Fig. 2). This fact is important with a view to the growth in demand (Arnold 1985/155-156) in that it was not due to an increase in birth- rate, but rather to a decrease in death-rate. If we add to this the policy of the government, which was directed at preventing emigration and stimulating

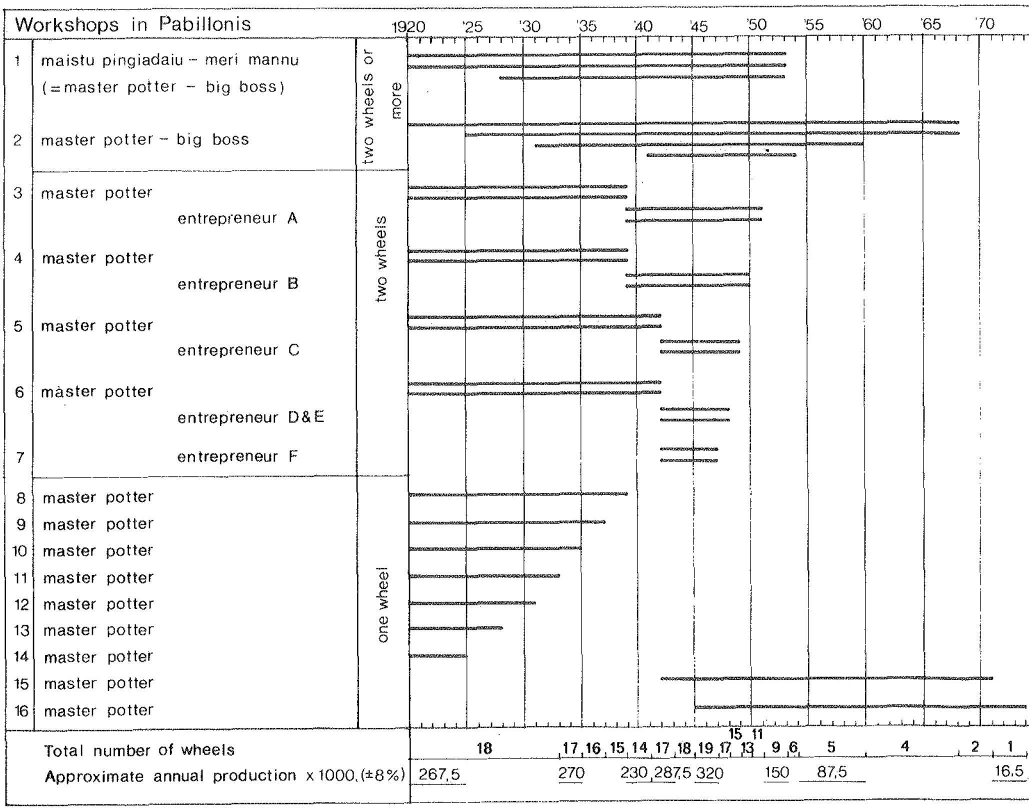


Fig. 4. Workshops and wheels at Pabillonis, 1920-1973.

marriage, and consider that in Sardinia each family traditionally constitutes a separate nucleus, we arrive at a considerable increase in family units which, moreover, could now allow themselves a higher standard of living than in the past. The population grew particularly in Campidano, Marmilla and Trexenta, all three areas of cereal cultivation, and in Sulcis and Iglesiente, which were mining regions. These areas are directly accessible from Pabillonis (Figs. 1, 8). Generally speaking, however, the villages of the entire western part of the island expanded, several becoming attractive markets for wholesalers and shopkeepers (see below). To be able to satisfy the demand for considerably larger quantities of pots which were required throughout the entire year, the workshops had to become more efficient[5]. This explains how some workshops that were capable of investing in technical equipment and could hire workers succeeded in strengthening their position, while those that were economically weaker and were incapable of keeping up the low prices resulting from the general crisis of that time (see Part II) disappeared. Some of these potters became labourers in the larger workshops, others chose to work in agriculture or mining.

Despite the continuous increase in population (Fig. 2), in the second part of the 30s there was a drop in demand, as is also apparent in the number of pots produced (Fig. 4). This seems to be related to the progress of the cultural integration with the mainland and the consequent spread of new cooking methods to which modern materials are more suited, such as enamel, aluminium and refractory clay ware. It should also be noted that this period was characterized by a strong increase in population in the three province capitals Cagliari, Sassari and Nuoro and, in general, by a greater flow of people from the peripheral areas to the more important centres[6].

During World War II, there was practically no fighting going on in Sardinia, but the island did find itself in an extremely isolated position. This, along with the fact that part of the town population moved to the countryside for fear of bombings, caused a sharp recovery of the demand. At Pabillonis a fourth wheel was added to one of the two workshops with three wheels (Fig. 4) and in both a second kiln was built inside in order to enable the potters to load and fire them indoors in the wet season while the heat could be used for drying (Hampe and Winter 1965: 73; Cuomo di Caprio 1982: 313-314; Peacock 1982: 39). In the meantime the surface area of these two workshops had been extended to include numerous rooms arranged around a court, whose functions reflected the two activities of the owner, namely potter and peasant. The two master potters were from then on called meri mannu (= big boss), which replaced the term maistu pingiadaiu (= master in cooking ware) which until then had been used for all workshop owners. The files examined in the second part of this article belonged to the workshop of a meri mannu.

In the meantime, in 1939/40, two small traders of the village had taken over two workshops with two wheels which had stopped or intended to stop production. Encouraged by the strong demand, four more entrepreneurs - none of whom were potters - followed this initiative during World War II (Fig. 4). In this new type of organization all the necessary means were supplied by the owners and the only task of the employees was to produce. In contrast with the situation in the family-run workshops and, to a certain extent, also in those of the two potters-and-peasants in which both members of the family and labourers were active, in these workshops the working hours and the quantities produced were fixed, there was a neat division of tasks and none of the employees was fully skilled in the craft. Two labourers, each assisted by a boy who prepared the clay, worked full-time at the wheel, while a third, also assisted by a boy, was responsible for the biscuit firing, the glazing and the second firing. If not as regards the scale of the workshop, but certainly as far as the exquisitely capitalistic management of the craft and the specialization of the protagonists is concerned, this organization can be defined as a 'manufactory' (Peacock 1982: 9-10). It is significant that the electric wheel was first introduced into this type of workshop.

From an archaeological point of view it is difficult to distinguish the workshops of the entrepreneurs from the family-run workshops that preceded them. In general, however, there are numerous traces of the changes that took place in the period 1920-1945, which are observable both in the production centre and in the area of distribution. During the war the number of wheels was reduced to 18 once again (Fig. 4) but they presented a more concentrated distribution pattern. The increase in the capacity of the kilns and the change in their typology are indications of greater efficiency in the technical aspects of the craft. This is also reflected in the spatial distribution (Hodder and Orton 1976) and in the standardization of the artefacts.

Figure 4 presents a schematic impression of the development described above. The approximate annual production of single pots was calculated on the basis of the total number of hours spent <u>effectively</u> at the wheel per year (which varies from one workshop to the other, depending on the mode of production) and on the basis of the daily production of a wheel, which also varies according to the type of workshop. The result obtained was verified on the basis of the average contents of the kilns and the frequency at which they were fired.

Modes and areas of distribution

At Pabillonis only pots and casseroles were produced (Fig. 5). This is in contrast with the situation at Oristano and Assemini, the other two important production centres of Campidano, whose ordinary production did not only consist of water jars, their product <u>par excellence</u>, but also included pots intended for other purposes (Annis 1985a). The distribution of the pots produced at Pabillonis covered almost the entire island where they were greatly appreciated for their resistance to thermal shock and thermal stress (Rye 1976; Steponaitis 1984), as well as for their light weight and the rationality of their shapes and sizes. The pots were sold both directly and via middlemen. Direct sale was not limited to the inhabitants of Pabillonis and of the villages in the

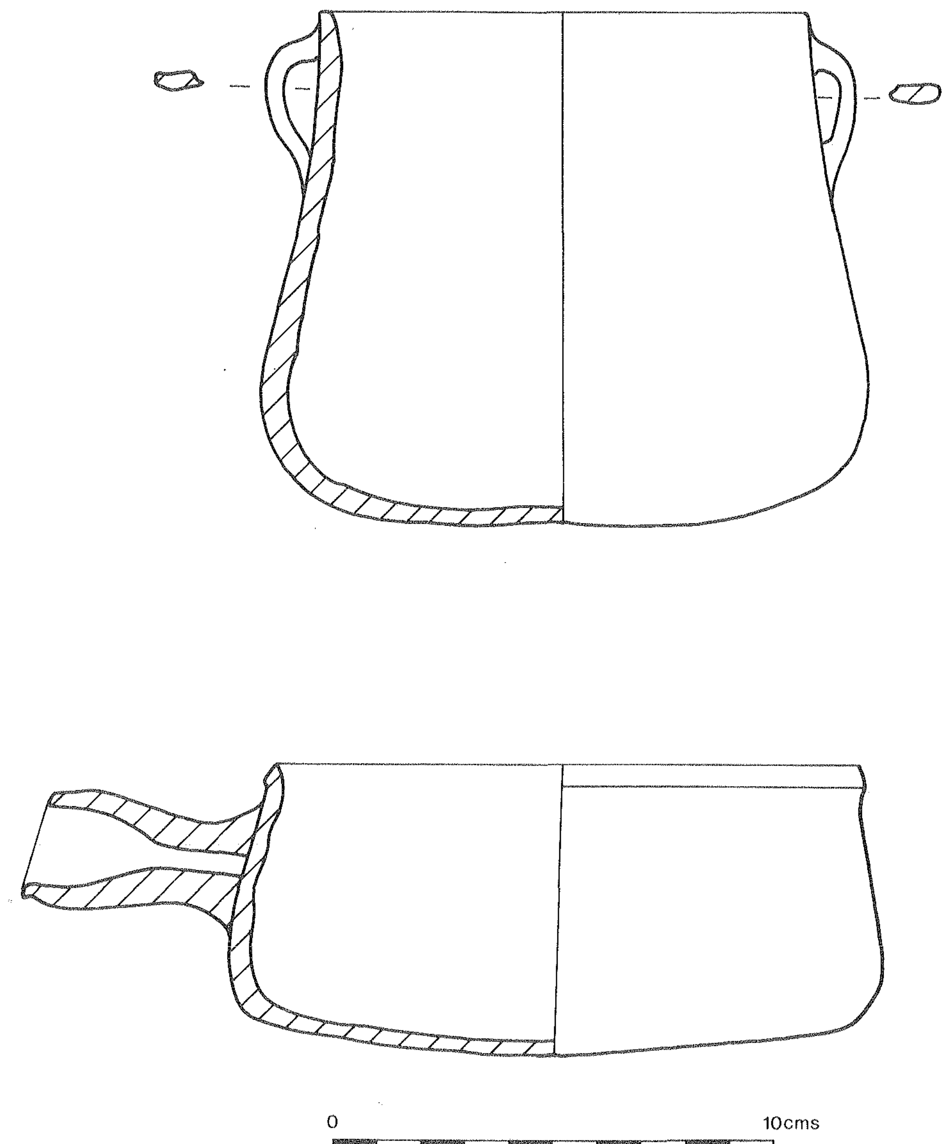


Fig. 5. Pabillonis, cooking pot and casserole.

immediate vicinity. Transhumant shepherds and the inhabitants of the mountainous pastoral regions, who used to descend to Campidano with their carts to buy cereals, also bought directly. The distribution proper, however, took place via middlemen, which is in keeping with the vastness of the area. The potters distinguished two different types of middlemen: inhabitants of Pabillonis and foreigners. For the latter the unit of sale was smaller and more expensive than for the inhabitants of Pabillonis(7). The foreign middlemen were generally shopkeepers of medium-sized and large centres but also traders who visited the Campidano seasonally to sell the products of the mountainous areas and then returned with a load of pots. For the middlemen from Pabillonis the unit of sale, sa cabiddada, consisted of eight pieces, that is, two sets of four, being either pots or pans, of four different sizes. For the foreign middlemen, however, the unit of sale was the set itself, that is, four pieces (see Part II). The shapes and sizes of the four pots were such that they fitted perfectly one inside the other, while the pans, having long handles, were paired off: the third pan was fitted into the first and the fourth into the second. These ways of stacking were functional in the kiln, during transport and in the kitchen.

The middlemen of Pabillonis were not all of the same calibre. The smallest quantities were purchased by a certain number of women (20-25) who distributed the pots by foot. These women, generally in pairs, bought wholesale to enjoy the advantage of the trade price. They stored the pots in their houses and usually went out to sell them on alternate days. Every day a group of these women left the village for different destinations within a radius of at most 20 Km, but more often 12-15 Km (Figs. 6, 7). On their heads they carried a basket containing una cabiddada e mezu (one and a half cabiddadas), usually composed of two sets of pots and one of pans. In the evening they returned to the village. This form of door-to-door distribution slackened in the winter months, but did not come to a complete stop. It was most intensive in the late summer, after the harvest had been sold (which is also when most weddings were celebrated) and in October and November, before the pigs were slaughtered (see also Part II and Fig. 14). The differences in the density of the distribution pattern (Fig. 6) are caused by various factors.

Fig. 6. Distribution of cooking ware by foot from Pabillonis: 1930-1950 (the size of the squares indicates the density).

The two best supplied areas are the hilly regions in the southwest (Iglesiente) and in the northeast (Marmilla). The former, a mining area, is characterized by few, but large centres of occupation; the latter is known for its fertile soil and is dotted with numerous small villages.

The decrease in the density of distribution is proportional to the distance from Pabillonis and to the elevation above sea level (Fig. 6). As regards the villages situated in the immediate vicinity of the production centre, they were not attractive markets for these women since, as already mentioned, they bought directly. The customers often paid for the pots in kind: oil, cereals, vegetables, flour, lard, and cheese, which the women then resold. Eventually the potter was paid (see also Part II).

The second category of middlemen consisted of itinerant merchants, between 25 and 30 men who transported the pots by horse-drawn cart (Fig. 7). Most of these did not own their means of transport, but hired them from peasants. The load, consisting exclusively of pots and pans, was carefully stacked in the cart with a soft marsh-herb (preimentu = filling), which abounded in the swampy surroundings of Pabillonis, being used as packing material. The load was held together by sa cerda, a mat woven of twigs and reeds (Angioni 1976: 162) which was placed around the load and protected the pots. A cart contained between 100 and 120 sets of four, which corresponded to the average capacity of a medium-sized kiln, in the proportion of 3 pots to 1 pan. The middlemen travelled to their furthest destination and on the way gradually unloaded the pots at the houses of acquaintances who granted them some room to store their pots and spend the night. The cart was then returned to Pabillonis while the middlemen started to distribute their goods by foot, making their way back to Pabillonis, following the route along which they had come and stopping off at the villages where they had left their goods. These men were away from the village for a

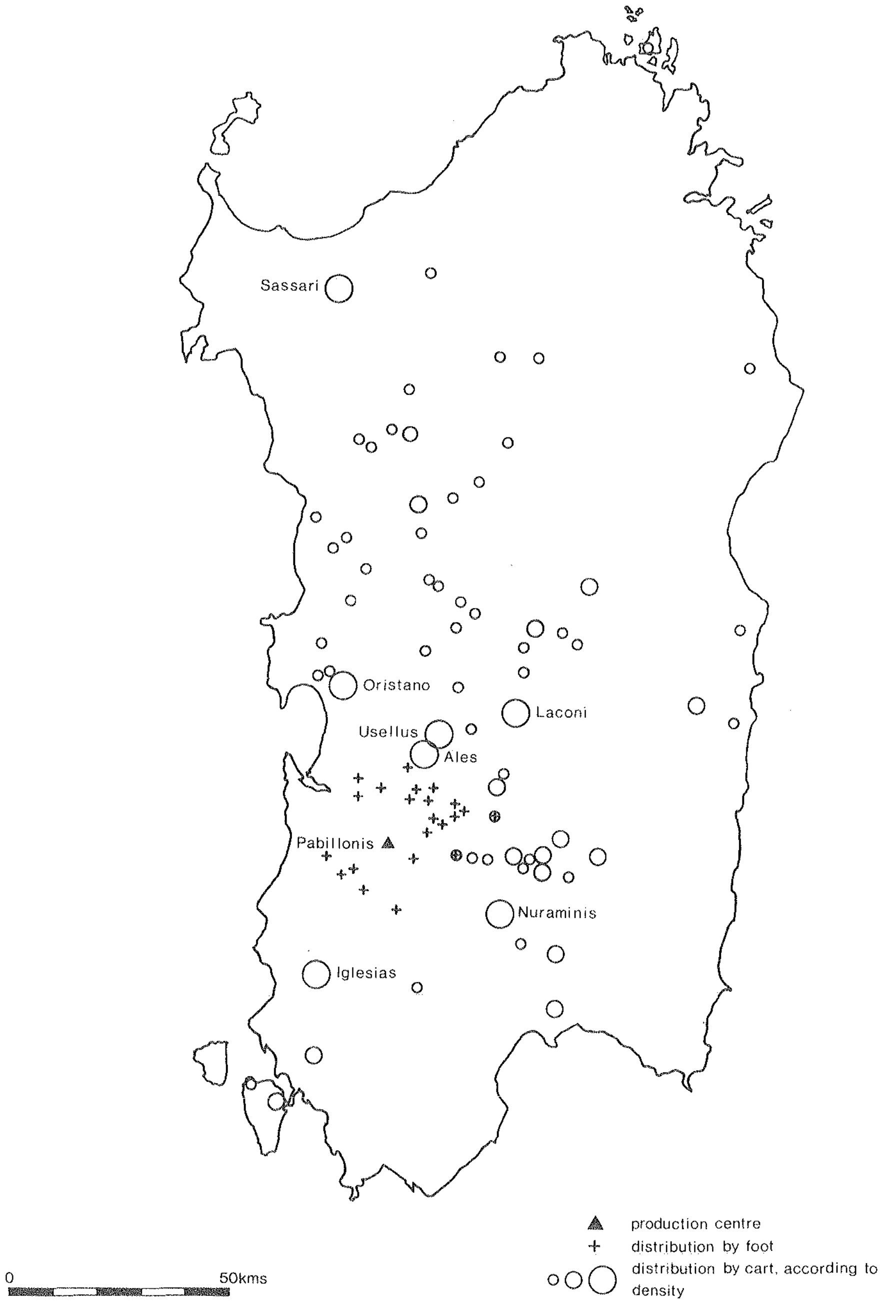


Fig. 7. Distribution of cooking ware from Pabillonis by foot and by cart: 1930-1950.

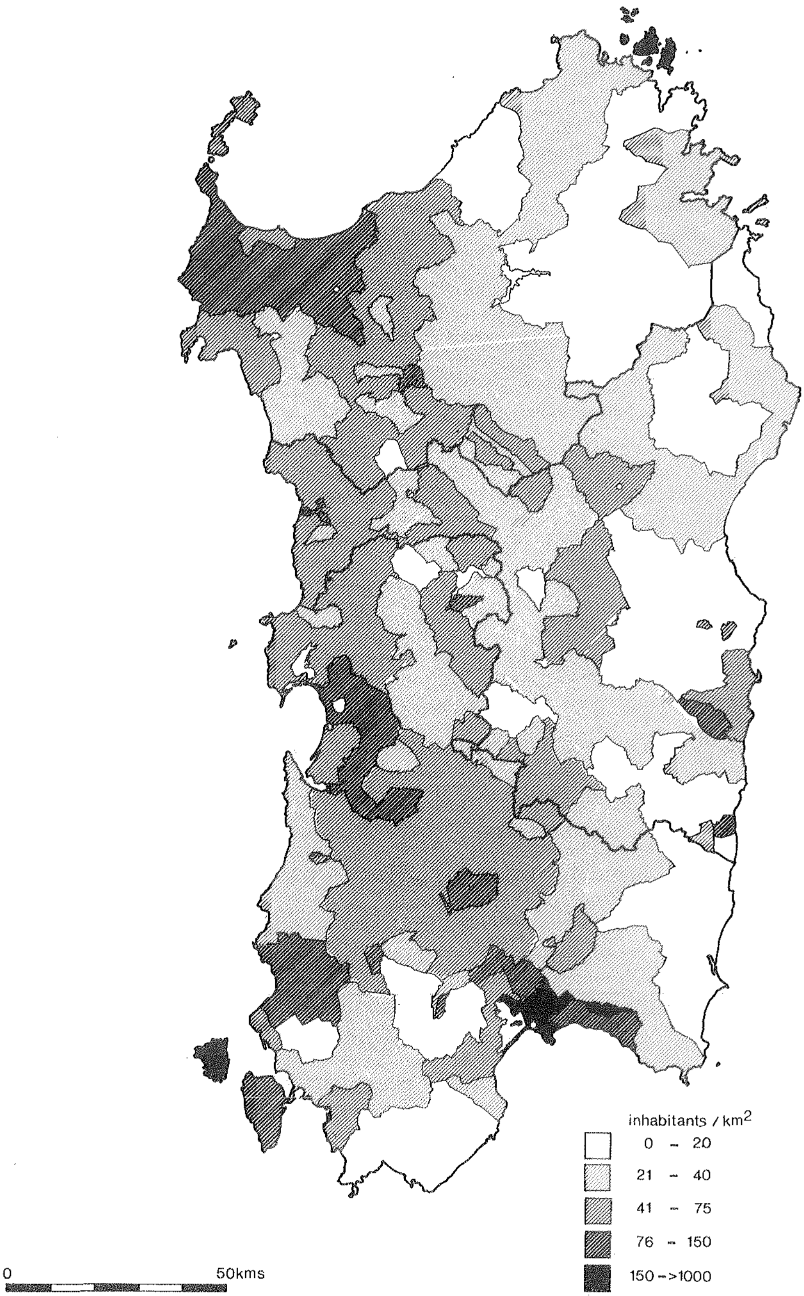


Fig. 8. Sardinia. Density of the population: 1936
(Source: Atlante della Sardegna 1980, Tav.55).

long time, often more than one month. Unlike the women who did this work alongside their domestic tasks, they worked full-time and could travel far. Apart from that there were no essential differences between the two modes of distribution. The men carried three sets of four pots and two of pans in knapsacks over their shoulders. Like the women, they also accepted payment in kind which they consumed in the periods that they were away from home and used to repay their hosts. They too paid the potter when the pots had been sold. Buying from the potter cabiddadas of eight pieces which they then sold by sets of four or by the piece, they made a gross profit of at least 100% (see also Part II). This mode of distribution knew seasonal fluctuations too.

The third category of middlemen consisted of a few wholesalers, also inhabitants of Pabillonis, who seem to have appeared on the market some time around 1925. They were both economically and socially superior to the other middlemen and had established depots in the central and northern parts of the island, from where they redistributed the ware to other middlemen (see Part II).

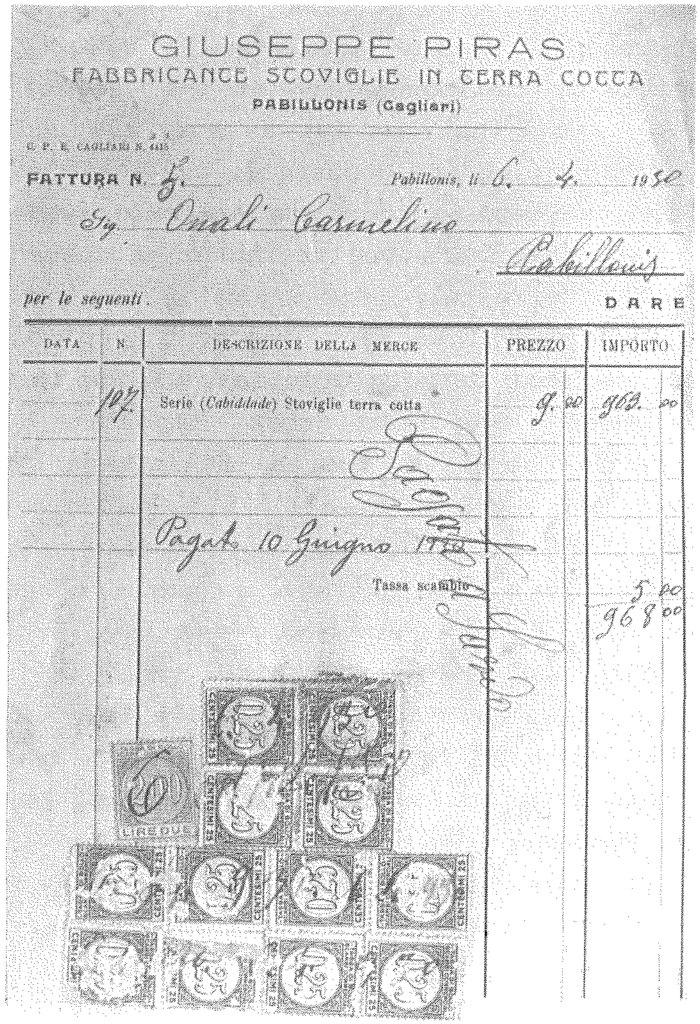
Distribution was therefore controlled mainly by the inhabitants of Pabillonis. During the war, however, foreign shopkeepers started to visit the village to buy pots or ordered them by post. In this context it should be noted that in these times of greatest need shopkeepers who, having come from far, arrived at Pabillonis to find that no finished pots were available, more than once contented themselves with biscuit ware (8). Archaeologically, this may prove an interesting fact.

For the transport of the ware both the wholesalers and the shopkeepers made use of carts which they either owned or hired. During the war and even more so in the years after, they also used trains or hired lorries. However, these means of transport were considered expensive and were used relatively rarely and by only few.

A comparison of the pattern of the distribution by itinerant merchants in the 30s and 40s (Fig. 7) with the average density of the population of the various regions in 1936 (Fig. 8), shows that, as far as both the radius and the density of distribution are concerned, the positive factors of the demand and the need of the distributors played a much more determining part than the negative factor of distance. This is in spite of the definitely poor state of the road system on the island (Brigaglia 1976: 320). The best supplied areas also appear to be the most densely occupied. Of the three province capitals, Sassari was the most important centre of redistribution in the north, whereas it appears that Cagliari and Nuoro were not supplied at all. It is not clear why Nuoro did not constitute a market. But as for the capital of the island, we know that Cagliari was a centre of distribution around the middle of the last century (Frau 1979/80: 162). That this was no longer the case in the period considered in this article (1920-1970) is, as we were informed, due to the fact that this port town imported terracotta pots from continental manufactures, in particular from Savona. Besides, new cooking methods and the corresponding modern cooking materials were introduced into this town earlier than elsewhere on the island.

Part II. THE CASE OF A WORKSHOP ACCORDING TO ITS ADMINISTRATION

Of one of the workshops at Pabillonis part of the administration has been preserved. The workshop belonged to Giuseppe Piras, fabbricante di stoviglie in terra cotta (manufacturer of earthenware cooking pots), as he called himself on his invoices (Fig. 9). The files contain the invoices recording sales to middlemen in the period 1930-1947 and the personnel and wages administration of the period 1940-1953.


GIUSEPPE PIRAS
FABBRICANTE STOVIGLIE IN TERRA COTTA
PABILLONIS (Cagliari)

FATTURA N. 7 Pabillonis, li 6. 4. 1950
Sig. Onali Carmelino
Pabillonis

per le seguenti DARE

DATA	N.	DESCRIZIONE DELLA MERCE	PREZZO	IMPORTO
	107	Serie (Cabiddade) Stoviglie terra cotta	9.00	963.00
		Pagato 10 Giugno 1950		
		Tassa scambio		5.00
				968.00

Fig. 9.

The invoices, almost 300, were filed in numerical order in three books. They by no means give a faithful impression of the daily production of the workshop. Invoices were only made out on delivery to wholesalers and itinerant middlemen and to shopkeepers from outside Pabillonis. Only rarely do we encounter the category of private buyers in this administration - to them the pots were sold without invoice. But the first group was not always provided with an invoice either, as appears from the conspicuous lacunae in the supplies to the individual middlemen. The most complete, or possibly rather the least incomplete, is the financial administration from the period January 1941 - April 1943. A sale of 8330 sets (33,320 pots) was recorded in these 28 months. Considering the capacity of the workshop and the number of employees in this period, the total production must have been about four times this figure. Nevertheless, when categorized according to types of middlemen and the periods of the year, the sales recorded present a clear picture of various phenomena.

Middlemen

In the period from which the invoices have been preserved (1930-1947), Francesco Fanari of Pabillonis was Piras' greatest customer. His first order he placed in 1931, together with Battista Montis, also an inhabitant of Pabillonis. They bought double the number of pots that was usually purchased at that time, namely more than 1000. Battista Montis had since long been active in the central districts Marghine and Goceano. Fanari entered into partnership with him and after Montis' death in 1936, he continued the business by himself.

The second greatest customer was Francesco Montis who from 1935 or an earlier date had been operating from a depot he had established in the northern county town Sassari and had turned into a redistribution centre in the northwest of Sardinia.

In addition to these persons, who operated predominantly as wholesalers, the invoices of the period 1930-1941 mention sixteen itinerant middlemen, nine men and seven women, also all inhabitants of Pabillonis. This category is lacking in the invoices from 1942-1944, which only mention deliveries to the depots of Montis and Fanari and to shopkeepers in towns and villages outside Pabillonis. We do not know why, in this period, invoices were not made out to itinerant middlemen, but possibly different administrative regulations applied in their case. From other sources we in any case know that they were active without interruption throughout this period (cf. above, page 167 and Fig. 7). The itinerant middlemen once again show up in the invoices from after the war; these then mention a total of ten persons, three of which were women.

In 1941 the first invoices were made out to shopkeepers and other traders resident outside Pabillonis, in the adjacent regions and also in the northern and central parts of the island where Montis and Fanari had established redistribution centres in their depots at Sassari, Anela and Macomer. Whether these shopkeepers from outside Pabillonis had already purchased pots from Piras before 1941, and if so on what scale, we do not know with certainty (see below).

The diagram in Fig. 10 presents a survey of the average buying orders of the various categories of middlemen. Owing to the incomplete character of the administration, we do not have information of a similarly precise nature on the frequency of the purchases. If we concentrate on those periods in which for one or more categories the administration is somewhat more complete, and also allow for some factors which will be discussed below (rate of turnover; seasonal influences), we arrive at the following picture. In the invoices of 1930/41

Middlemen	Period	Number of persons	Average buying order (expressed in single sets)
Wholesalers (Pabillonis)	1930/46	2	86/70
Itinerant middlemen (Pabillonis)	1930/41	9 men 7 women	94 74
Shopkeepers (elsewhere)	1941/43 1944/46	48 34	40 66
Itinerant middlemen (Pabillonis)	1945/46	7 men 3 women	60 24

Fig. 10.

intervals of four to eight weeks between purchases are normal in the case of itinerant middlemen. Their turnover can be calculated as at most 750 sets of four pots per year, with an average purchasing frequency of eight times a year. The women only rarely bought and worked alone, but preferably as a pair (see below). The annual turnover of a pair of women can be calculated as at most 1000 sets of four pots, purchased at a frequency of at most twelve times a year. In the period 1941/42 the wholesalers bought pots from Piras once a month on an average, with intervals of between two and six weeks; the invoices reveal a turnover of about 1000 sets of four per year. However, this picture of the wholesalers is incomplete. According to oral information, these figures should be multiplied by a factor 1.5 at least. As for the larger shopkeepers, who in the larger centres varied in number from three to six persons, the invoices mention no more than four to six purchases a year.

Spatial distribution (Figs. 11, 12)

As far as we can make out from the invoices, up to 1941 the cooking ware produced by Piras' workshop was distributed mainly by inhabitants of Pabillonis. Where they sold their merchandise is not apparent from the invoices, except in the case of the two wholesalers. Since his first appearance in 1935, Francesco Montis had the ware he ordered delivered at Sassari, for which he had to pay additional charges. In 1937 Francesco Fanari arranged to have his ware delivered at Bonorva where he had a depot. He too had to pay a higher price for this service. This phenomenon of increased prices is already observable on earlier invoices made out to Fanari. However, these mention his residential address and not the address of his depot.

In the case of deliveries to shopkeepers and any other persons from outside Pabillonis, the address on the invoice

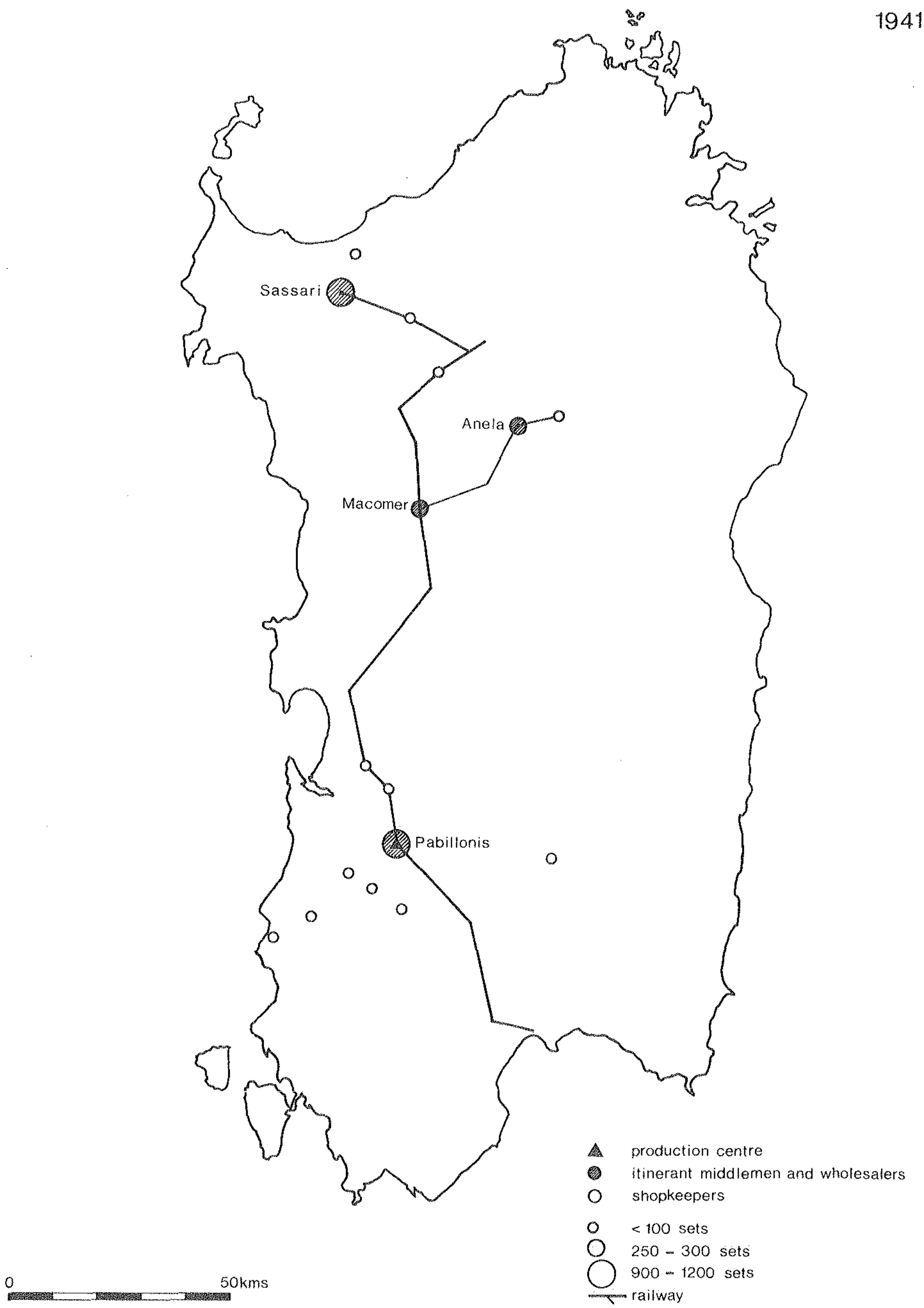


Fig. 11. Pabillonis, Piras workshop. Spatial distribution according to the invoices: 1941.

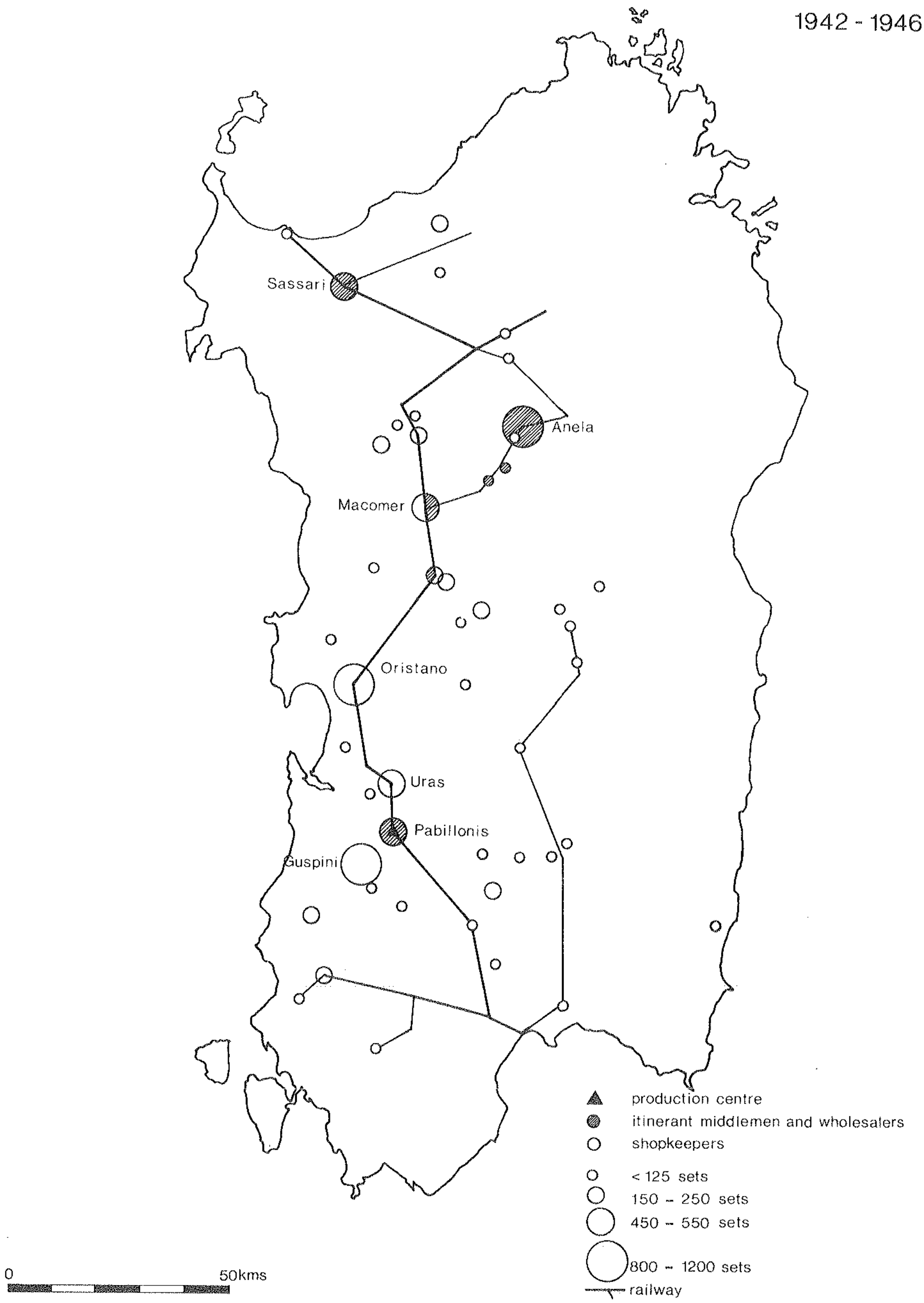


Fig. 12. Pabillonis, Piras workshop. Spatial distribution according to the invoices: 1942-1946.

indicates where the goods were sold. As already mentioned, this external category did not appear in the invoices until 1941, with only one exception, in 1937, to which exactly the same particular conditions of sale were applied as were uniformly applied to this category in 1941 and later (see below). This seems to indicate that it was not a new phenomenon. There are two possible explanations for the appearance of this group of customers in the invoices from 1941 onwards, namely the increased size and calibre of this category and stricter government control of freight traffic for third parties and of shop administrations during and immediately after the war.

However the case may be, the invoices from 1941-1946 show how each of the two categories of middlemen, viz. the internal and external ones, developed in this period. The years 1942/43 saw an increase in the number of shopkeepers purchasing from Piras. They came from all over the island with the exception of the east coast. This phenomenon seems to be due to the increase in demand resulting from the scarcities created by the war. The invoices also show that this same greater sales potential induced the wholesaler Fanari to set up depots at Ozieri, Bolotana and Abbasanta, in addition to the ones he already owned at Anela and Macomer. All these villages lie along the railway lines connecting Pabillonis to the northern part of the island.

The invoices show a partially different development in 1944-1946: in this period the number of shopkeepers scattered across the eastern and southeastern parts of the island increased, but in the northern, central and southern parts we observe concentration. Fanari's depot at Anela expanded to become the largest redistribution centre in the northern and central parts, flanked by Montis' depot at Sassari and by others in the regional centres Bonorva, Pozzomaggiore and Macomer. In the plain of Campidano, Oristano, Uras, Guspini, Flumini Maggiore and Serrenti had by that time become dominant redistribution centres, while the number of isolated selling points in the villages decreased. In the regions where most pots had always been sold, the boom of 1942/43 was therefore followed by selection and concentration.

The primary and secondary railway lines, as shown in Figures 11 and 12, seem to have been of importance to the redistribution described above. That this was indeed the case in the northern and central parts of the island, at least from shortly before the war, was confirmed by oral information: part of the merchandise was conveyed via this relatively expensive form of transport. In the southern part of the island, on the contrary, transport by rail hardly played a part at all: this region was supplied directly from Pabillonis by carts travelling along the east-west roads.

PIRAS WORKSHOP
1941 – 1946 : Distribution in percentages according to the invoices

	Centres of redistribution	Wholesalers and itinerant middlemen	Shopkeepers in towns and villages
Northern region	Sassari	11 (Montis)	4.5
Central region	Abbasanta Macomer Anela and others	14.5 (Fanari)	8.5
Southern region	a) Oristano and adjacent area		9
	b) Uras, Guspini and adjacent area		18
	c) Eastern area		7
Pabillonis production centre		27.5 (others)	
Total		53 %	47 %

Fig. 13.

The invoices provide no information on the quantitative distribution across the island before 1941. Insufficient invoices have been preserved from this period and, with the exception of the deliveries to wholesalers, these do not mention the destination of the goods. But, as already mentioned, even the picture that emerges from the invoices from the period 1941-46 (see Figure 13 and note 9) leaves a large part of the production and, consequently, the distribution out of sight. Certain considerations and oral information lead us to assume that the itinerant middlemen had a much larger share in the distribution than is suggested by the invoices. It would seem that in actual fact the internal middlemen were responsible for about 70% of the distribution (i.e. wholesalers 17%, itinerant middlemen 53%) and the external middlemen for 30% in this period.

Fluctuations in the yearly sales figures

A survey of the invoices per month reveals fairly regular fluctuations. The relatively large number of approximately 160 invoices that have been preserved from the period September

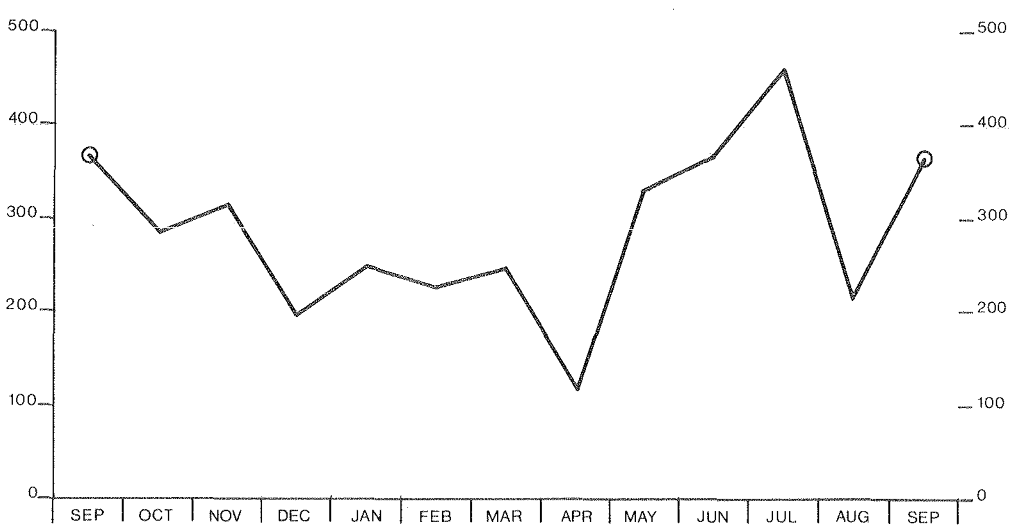


Fig. 14.

1940 - April 1943 enables us to express these fluctuations in a graph (Fig. 14).

In the months of May, June and July sales are high and, after a drop in August, they rise again in September, October and November. In the winter months sales are modest, but constant. April (and part of March) shows a conspicuous drop in sales each year.

It would seem that this picture is to be related to climatological conditions and the rhythm of the agrarian year. The drought of the summer, the shorter working days in the winter, and the wet spring had an effect on the production as well as the activities of the middlemen. The high season of agrarian activity and trade were the months of May, June and July, and September and October, after the clearing of the fields in August. The slaughter of pigs in November also created a demand.

On the whole, the production and sales figures of the high season and those of the low season were in the proportion of 3 : 2.

Payment of the invoices

According to the invoices, shopkeepers from outside Pabillonis paid on delivery, to the carrier or the railway company. The wholesaler Montis of Sassari paid 'within ten (or 15) days', presumably by Post Office Giro.

A different - and much older - regulation applied to the middlemen from Pabillonis, including the wholesaler Fanari. They received their goods on consignment and paid after they had sold them (a merce venduta), with a limit of three months. In 1930-1932 the date of payment was recorded on the invoices (cf. Fig. 9). This results in the diagram given in Figure 15.

The diagram suggests that the rate of turnover of the women was higher than that of the men. However, in actual fact this

Itinerant middlemen 1930/32	Buying order (single sets)	Average buying order (=n)	Term of payment in days	Average term of payment (= t)	$\frac{t}{n}$
men	92 – 132	118	26 – 65	49	0.4
women	60 – 100	79	15 – 33	24	0.3

Fig. 15.

was not the case, for the women always worked in pairs, a phenomenon that is also observable in several addresses on the invoices. Yet the figures recorded for the women may not simply be halved or doubled, because from oral information we know that the two women went out to sell the ware more often alternately than simultaneously. If we allow for this, and miss out sundays, we arrive at an average daily turnover per person for both the men and the women of three single sets of four pots. As for the women, this figure corresponds to the capacity of the basket they carried on their heads when they left the village for a day. The knapsacks of the men could hold five sets. Their daily turnover must therefore have been five sets rather than three. Men lost less time per day in travelling than the women who returned to their houses in the evenings, but calculation shows that for every four days of selling of the men there were three days of travelling (cf. Part I).

Sets and prices

The production consisted of cooking pots and pans, made in sets of four different sizes that could be fitted one inside the other (cf. Part I). The wholesalers and itinerant middlemen bought the pots in units of double sets (eight pots), which they resold in single sets of four pots. According to oral information from former middlemen, the selling price of a set of four was the same as the cost price of a set of eight, which means that the itinerant middlemen made a gross profit of 100%. But, depending on distance and other factors, and also in the case of the sale of half sets and single pots, the gross profit of the middlemen could rise to 150% or more.

As already mentioned, invoices made out to shopkeepers from outside Pabillonis became a normal phenomenon from 1941 onward. The shopkeepers did not buy double sets of eight, but single sets of four for which they paid two thirds of the price paid by the wholesalers and itinerant middlemen of Pabillonis for a set of eight. The shopkeepers in fact paid 133% of the 'internal' price. There seem to be two different causes of this phenomenon. On the one hand the invoices often state <u>pagamento all'arrivo della merce</u>. Apparently the merchandise was delivered to the shopkeepers, which would mean that the higher price could partly include transport costs. But, as appears from the invoices made out to Fanari and Montis, who had to pay at most 7.5% extra for transport, this accounted for only a small part of the higher price. On the other hand, as was pointed out in Part I, protection of the inhabitants of Pabillonis - both the consumers and the middlemen - must also have played a part. One of the consequences of this was that middlemen from outside could only buy the 'private' set of four, and at only a limited trade discount. The price they paid was in fact the same as that which, as appears from oral information, the wholesalers and some larger itinerant middlemen of Pabillonis charged when they resold their sets to smaller salesmen in other parts of the island. The only, but not irrelevant, difference was that the profit margin went to the producer himself.

During the war, the potters of Pabillonis began to regard the two categories of customers, the 'internal' and 'external' middlemen, as independent entities. The regular price increases (see below) were applied separately to the two categories, the ratio of the two prices fluctuating between 100 : 125 and 100 : 140. In other words, the old price ratio of 100 : 133.3 and the motivations behind it were no longer considered imperative.

As appears from the invoices, towards the end of 1942 the wholesalers Fanari and Montis were forced to buy single series of four at the 'external' price, be it a most favourable one. It seems that the workshops owned by the entrepreneurs (see Part I), which were not rooted in the tradition like the workshop of Piras and others, gave the impulse to this breakthrough. As a consequence of the peculiar market situation created by the war, the entrepreneurs, and apparently the others too, no longer regarded the difference in price as a fully justified protectionist barrier of 33.3% for external traders, but as an unjust discount of 25% for the internal group. Surprisingly, we observe the reverse a few months later in Piras' invoices: shopkeepers, particularly from villages not far from Pabillonis, were buying double sets at the internal price, collecting the merchandise themselves from the workshop. The wholesalers also returned to the internal price. After the war (1944-1947 and later) all categories bought double sets of eight at one and the same price. This reverse development is probably to be traced back to an initiative of the traditional potters. We were told that they regarded the entrepreneurs as 'disloyal intruders' and instead of making higher profits by acting as a homogeneous group, they obviously yielded to the protests of their regular customers and eventually decided to take competitive measures.

The invoices from 1930-1947 give a detailed picture of the development of the prices in this period. In 1930 the wholesale price of a double series of eight pots was 9.00 Lires. The crisis of the 30s reduced the price to 6.00 Lires in 1934. This was followed by a slow recovery, reaching the old price level in 1938 and then rapidly increasing due to inflation. Particularly during the war, the price was sometimes increased twice within one month and by July 1943 it had risen to 65.00 Lires, that is, 480% of the price in the autumn of 1940. The monetary reforms of the first year after the war quadrupled the price to 250.00 Lires in 1946/47.

The workshop and its employees

In addition to the owner, Giuseppe Piras, and one or two members of his family (his wife and daughter), a number of employees worked in Piras' workshop (Fig. 16). The books give detailed information on these employees and on their wages.
The following is of importance to us:

Officially, an employed potter already had fixed hourly wages and a working week of 45 hours before 1940, but reality was less rosy. The traditional daily wages of a fully trained employed potter were equivalent to the wholesale price of the cabiddada, one double set of eight pots. This system was maintained in practice and the official hourly wages were calculated by dividing the price of a double set by eight hours. However, the working day was almost always longer and the working week included the whole of saturday and sometimes part of sunday too. These facts we know from oral information only, because the records of the payments of social securities

Employees G. Piras	Jan. '40	Oct. '40	Nov. '42	Sep.'43**	1945/53
Potters	2*	3	3	2	3+ 1***
Apprentices	1*	1	2	1	1
Assistants	1	2	2	1	–

* These persons were employed troughout the entire period
** Also unrecorded temporary personnel
*** On a temporary basis

Fig. 16.

state working months of between 120 and 140 hours, while the official working time was already 195 hours.

In the autumn of 1942 the manner of calculating the wages was altered. The continual price increases, which sometimes followed each other weekly, were only much later, at most once every six months, followed by wage adjustments. In November 1942 this presented the opportunity to increase the daily wages, not to the latest wholesale price of the double set of eight pots, but to the current external price of the single set of four which, also from November 1942 onwards, was applied uniformly to all categories of middlemen, as explained above. In actual fact this meant a reduction in purchasing power of 33% which was, however, compensated by a reduction in the standard of production for employed potters from 20 to 15 single series per day. Again the initiative seems to have come from the entrepreneurs. Any pots the potter produced above this standard were paid for by the piece. In 1949 one skilled potter worked entirely at piece rates (un terzo netto della produzione, one third of the net produce) and by written agreement he abandoned all the diritti assistenziali (social securities) to which he had a legal right. We have reason to assume that this was not the only nor the first case of this.

The wages of the apprentice and of the potter's assistant were related to those of the potter. In 1940 both categories were paid 50% of the potter's wages; after the reorganizations of the autumn of 1942 this was 75 and 60%, respectively. The raise compensated for the fact that they were excluded from the possibility of overproduction.

Conclusion

Looking back on the above analysis of the files of Piras' workshop, two questions may be put: what could be deduced from this source and what not, and how does the information thus obtained relate to the oral information, our ethnographic source, and to the information derived from material remains, our archaeological source?

The files offer no information whatsoever on material and technical aspects of Piras' workshop. Had this workshop, which was closed down in 1967, not have been preserved along with its contents, there would have been no possibility of relating and verifying the quantitative and qualitative data contained in the files.

Only when combined with other information, particularly oral, but also of a material kind, did the following matters become clear:

- the protection of the local population by the application of different prices and conditions to external customers;
- the abolition, in November 1942, of the traditional system of wages and prices;
- the average rate of turnover of the middlemen. It must, however, be kept in mind that the information that the invoices appear to give on this matter is deceptive where the women are concerned, and that there is nothing in the invoices suggesting that men and women operated in different ways.
- the purchasing frequency of the middlemen and their yearly turnovers;
- the extent of the workshop's production. In this respect, the invoices are of only limited value. It is clear that the resulting figures are too low, but how much too low cannot be deduced from the invoices. This requires knowledge of the daily production of each wheel, of the output of the kilns and of the frequency at which they were loaded.
- the modes of transport.

On the other hand, however, the files provide independent data, several of which also confirm the oral and material information, on the following aspects:

- the social status of the owner and his mode of production (fabbricante);

- the economic level of the workshop and the part played by the government: Piras already had a Giro Post Office account in 1930; he paid turnover taxes; his administration was checked by officials.
- the relation between the course of business in the workshop and the general economy of Italy;
- the distribution by middlemen and the extent of the area of distribution. The information on the categories of wholesalers and shopkeepers is new. Besides, insight is gained into the different calibres of the middlemen, both categorically and individually, and into the modes of payment.
- the dynamics of the production: regression in the 30s; expansion in the 40s; but also seasonal influences;
- the division of tasks in the workshop and the hierarchy in the tasks and in wages;
- finally, the possibility of verifying the alleged total number of middlemen from Pabillonis by means of calculations based on the files.

In conclusion, we can state that the material data and oral information agree fairly well with each other. The written information contained in Piras' files presents lacunae and is at times one-sided. Because of this, and also on account of its explicit and detailed character, it deviates on more than one point. It confirms and supplements the material and oral information, but would have been the least suitable as the only source for the reconstruction of the pottery activities of Piras' workshop and of Pabillonis as a whole.

Part III. EPILOGUE*

In the production and distribution of the ceramic cooking ware of Pabillonis a series of changes took place in the course of years, which can be explained in the light of alterations in the social, economic and cultural contexts.

On the one hand, the growth of both the population and the economic welfare and the expansion of the villages resulted in an increase in demand and the need for greater productive efficiency. This affected the organizational forms of the production and the amount of technical equipment. In addition, the modes of distribution changed. These alterations became even more evident in the state of isolation in which the island found itself during World War II.

On the other hand, the profound social (Fig. 3) and cultural changes that took place in the period after the war led to the extinction of the tradition.

As for the causes of this extinction, it would seem that the spread of new cooking methods and the correspondent use of pans of different materials, that is, the specifically cultural factor, ranks first in both chronological and hierarchical order. Here a difference is observable with respect to the production of water vessels, where the use of substitutive materials came second on the chronological and hierarchical scale. This difference can be explained by considering the <u>function</u> of the water vessels which, even today, are virtually irreplaceable in the environment in which they are used (Annis 1984; 1985b).

As for the modes of production and their flexibility and respective <u>resistance</u> to the changed conditions of the post-bellic period, the capitalistic organization of the

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* This 'Epilogue' is in many ways a continuation of a discussion started in previous articles, in particular in the article published in number III of this 'Newsletter' (Annis 1985b), with whose contents I assume the reader is familiar.

entrepreneurs, which had developed on account of an accidental situation rather than as a result of structural changes, disappeared as soon as the situation had returned to normal. However, the simplest organizational form, that of a single potter assisted by members of his family, proved the most resistant (Fig. 4). The activity did not come to an end because of lack of demand, for in the 60s and 70s the demand was still more than sufficient for the three workshops that had remained active. In the case of the potter-and-peasant, the cause of the extinction was rather the impossibility of hiring labourers while, in the case of the 'individual' potters, it was the lack of successors. The jobs offered by the various branches of industry and the possibility of emigration were in every respect more attractive options.

The important part played by technology in a production is once again apparent here. At Pabillonis, every potter aspired to acquire the status of farmer. The potter's craft was a means to this end and, as such, of an implicitly temporary nature. Because of this, every effort was made to invest in ground and livestock, while the workshop had to bring in as much as possible and cost as little as possible (Arnold 1985: 228). Therefore, when the market changed between 1925 and 1935, only the economically stronger potters were able to offer a sufficient and regular production by expanding and adapting their technical equipment; the weaker potters were forced to abandon the craft (Fig. 4).

Expansion and adaptation of technical equipment, however, do not constitute innovation and are functional only for as long as the structures remain basically unchanged. The premisses of a true breakthrough which requires much from the potter (Franken and Kalsbeek 1975; Balfet 1973; Rice 1984) were lacking in the social and techno-economic environment of Pabillonis. Even when they had the opportunity to modernize their technology, the potters of Pabillonis continued to invest in ground and livestock instead of in, for example, machines to help them in the time-consuming and thankless preparation of the clay. This attitude is not only determined by the potters' low status; the techniques employed in farming, which was practised actively by every potter of Pabillonis, were also archaic. The developments at Assemini, however, show how the use of machines that are more in line with the ways of production of a true industrial society would in the first place have enabled the potters to continue the traditional production. Moreover, it would have enabled them to meet the subsequent demand for new products and would eventually have made the working conditions more acceptable to younger generations, thus ensuring the future of the craft.

Such an analysis once again reveals the important part played by the potters' working conditions in their reactions to the changes taking place. These conditions are in their turn determined by the type of context in which the production developed. At Oristano this is an urban context in which the guild opposed any form of progress; at Pabillonis a precarious and technically backward economy which, in itself, does not favour innovation; at Assemini, a prosperous village near the capital, however, we have an agricultural economy based on specialized crop cultivation (Le Lannou 1941: 240-247), which constitutes a techno-economic structure that is open to new developments.

On the one hand the <u>resistance</u> of the various modes of production appears to be proportional to their degree of complexity and, consequently, flexibility; on the other, the capacity of adaptation and <u>renewal</u> appears to be dependent on the techno-economic conditions of the production, which can be traced archaeologically. Such concepts may therefore prove useful in the interpretation of the dynamic processes in pottery production like those observable in the period of transition from Late Antiquity to the (Early) Middle Ages in Italy - the processes that constitute the starting point of this ethnoarchaeological investigation.

In the preceding pages the complementary part played by written sources and material evidence in the reconstruction of situations and processes has repeatedly been emphasized. The following lines are intended as a 'post scriptum' specially dedicated to Henk Franken.

In the village of Pabillonis a monument to the potter's craft has recently been erected (Fig. 17). This monument does not only show a pan and a casserole, but also a water vessel. Water vessels did not form part of the production of Pabillonis and indeed could not have formed part of it because, as one of the potters explained to me, the clay body (clay and temper) required for pans is quite unsuitable for water vessels. 'If the village officials had asked our advice,' the potter added, 'this mistake would never have been made'.

A monument, which is a source intentionally destined for posterity, passes down incorrect information. The mistake, however, can be corrected by a technological investigation of the products themselves, which are unintentional sources.

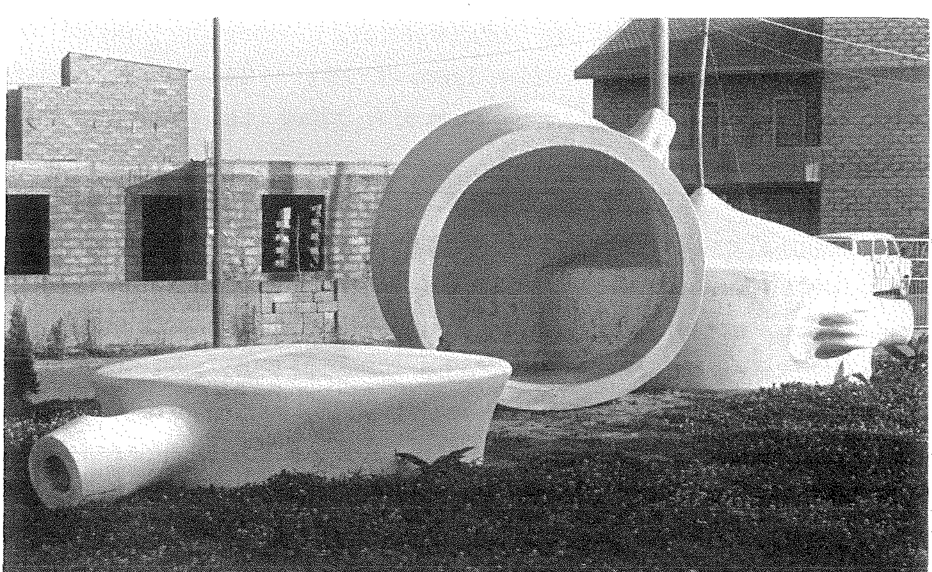

Fig. 17. Pabillonis. Monument to the potter's craft.

NOTES

1. Gli autori vogliono esprimere la loro gratitudine all'amministrazione comunale e alla popolazione di Pabillonis per la gentile collaborazione. In particolare la loro riconoscenza va alla famiglia Frau-Piras che con costante cordialita e ammirevole comprensione e sempre venuta incontro alle non poche è non lievi richieste degli autori.
2. The time range covered by this research on pottery production in Sardinia is 1920-1980. At Pabillonis, however, the activity came to an end in 1973.
3. In the 20s there were about 1800 inhabitants; in the 30s about 1900/2000; in 1951, 2539 and in 1971, 3100.
4. The land reclamation and re-allotment of the Guspini-Pabillonis territory (with an area of 34290 ha) was started in 1934 and was completed after the war. This included the canalization of the river Riu Bellu which did not have a proper bed and because of this regularly flooded the fields of Pabillonis (Le Lannou 1941: 311-314; Terrosu-Asole 1982: 1, 69-72).
5. As regards the life span of the pots, if treated with care, a pan that was used every day could last between about ten months and one year (David 1972; Arnold 1985: 152-157).
6. For the data on the population (figures, density and variations in density and residence) in the period 1920-1970, see Atlante della Sardegna II: 163-167, Tavv 52, 53, 54; 188-198, Tavv 63, 64, 65; 207-214, Tav 69).
7. We have evidence from around 1850 that the local government took measures to protect the interests of the village population (Frau 1979/80: 445).
8. This explains the occurrence of some invoices among the files of Piras' workshop on which the price has been reduced by 25%.

9. The sales percentage shown in Fig. 13 for Pabillonis does not relate to sales in this village and its immediate surroundings, which were supplied in ways that are not recorded in the invoices, but refers to the group of itinerant middlemen from Pabillonis who sold their pots all over the island. This category does not appear in the invoices from 1942-1944. To obtain an overall, at least approximate, impression of the sales figures, the recorded purchases have been corrected in the diagram in accordance with the development of the figures in the invoices made out in 1942-1944 to the two other categories of wholesalers and shopkeepers.

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