NEWSLETTER

Department of Pottery Technology

VOLUME 13 - 1995

LEIDEN UNIVERSITY — THE NETHERLANDS

NEWSLETTER

DEPARTMENT OF POTTERY TECHNOLOGY

LEIDEN UNIVERSITY

VOLUME 13 - 1995

Address:
Reuvensplaats 4
POB 9515
2300 RA LEIDEN
The Netherlands

ISSN 0168-7913

CONTENTS

ERRATUM:
pp. 3; 53-79
Chartage = Carthage

In Memoriam JAN KALSBEEK

Jan Kalsbeek, who pioneered with Henk Franken in the study of ancient pottery techniques, died on the 7th of March 1996.

From 1961 until 1978 Jan Kalsbeek worked with me on the analysis of pottery excavated at tell Deir Alla in the Jordan Valley in Jordan. I had learned to recognize ancient pottery from Palestine when I was a member of the Jericho team under the leadership of the Late Dame Kathleen Kenyon and from studying the publications of the Tell Beit Mirsim pottery by W.F. Albright. There I had found the technical report on the Iron Age pottery by Kelso and Palin Thorley, of which few seemed to have grasped the consequences for typological pottery studies. I decided that I wanted a similar study of my own excavated pottery and, as the financial position of universities in those days were rather good, it was not too difficult to get a post for a technical assistant. Jan Kalsbeek was recommended because he was known as a professional sculptor, potter and art painter as well as for his exellent methods of teaching handicrafts at schools.

In the early fourties Jan Kalsbeek took training courses in horticulture and as he was in the countryside he managed to escape from forced labour in Germany. After the war he decided that he wanted to be a sculptor and he followed art courses in the Hague in sculpture, painting and pottery making. He married Tineke Kramers, the daughter of professor Kramers, an Arabist at Leiden University, and established a studio in Oegstgeest. There he made sculptures for a number of public buildings in several towns in Holland. But he probably was at his best when teaching art, analysing the work of students and showing them how to improve their results.

When I was employed by the university and working on the pottery from the excavation, it soon became clear that the archaeologist and the professional ceramist were talking different languages with little mutual understanding. Kalsbeek saw ancient pottery as the product of a craft and tried to understand ancient craftmanship. He produced information and ideas that could not be found in archaeological pottery studies. He started to test his ideas by making replicas of ancient pottery and analysing the problems that cropped up in the process. Thus he demonstrated that understanding the work of the ancient potter was a prerequisite for all typological work on ancient pottery.

The amount of fresh information about pottery that Kalsbeek produced necessitated a rethinking of the archaeological approach to pottery studies. In the light of his work the existing methodology seemed to be too limited and impressionistic to be reliable. Describing the shape of pots and quoting parallels were not enough for a proper understanding of the nature of ceramics, nor were they fit to produce information about the craft and its function in the ancient culture. As a result of long discussions between the two of us about the excavated pottery and about the potter's craft, I decided to publish on the ceramics from tell Deir Alla in the light of this new understanding of how to deal with pottery, with a chapter by Kalsbeek as an introduction to the manufacturing processes.

Jan Kalsbeek took part in several archaeological expeditions in Turkey and in the Jordan Valley where his many talents made him an exellent member of the team.

He retired early for health reasons and left Leiden to live in Friesland where he died, aged seventy three.

Zutphen, March 1996,
H.J. Franken.

INFORMATION

ANNUAL REPORT 1995

Research projects in cooperation with:

Leiden University/Department of Archaeology:

Indian America:

- Pre-Columbian pottery from Guadeloupe (Dr. C.L. Hofman).

Palestinian Archaeology:

- Pottery dating from the Bronze Age and Iron Age from Tell Deir Alla (Jordan) (Dr. G. van der Kooij);
- Pottery dating from the Bronze Age and Iron Age from the British Museum excavations at Tell es-Sa'idiyeh (Jordan) (Mrs. M.M.E. Vilders).

Theoretical Archaeology:

- Pottery from the *Riu Mannu* survey project (Sardinia) (Dr. P. van de Velde).

University of Utrecht/Faculty of Theology:

- Roof tiles and box tiles from Umm Qeis (Jordan) (Dr. K.J.H. Vriezen).

University of Hamburg/Department of Classical Archaeology;
University of Amsterdam/Department of Mediterranean Archaeology:

- Phoenician amphorae (Prof. dr. H.G. Niemeyer and R.F. Docter).

The Netherlands Institute for the Near East, Leiden:

- Islamic pottery from Tell Abu Sarbut (Jordan) (H.E. LaGro).

Municipal Archaeological Service, Gouda:

- Clay workability tests (R. Kok).

The Netherlands National Museum of Antiquities, Leiden:

- Pottery dating from the Transitional Period (5300 - 5100 B.C.) from Tell Sabi Abyad (Syria) (Dr. P.M.M.G. Akkermans and O.P. Nieuwenhuyse).

Soprintendenza Archeologica di Ostia and Museo dell'Alto Medioevo:

- Late Antiquity and Early Medieval pottery from excavations in Rome (Dr. L. Paroli).

Working Group on Mesopotamian Pottery:

- Pottery dating from the second millennium B.C. from Iraq (Dr. H. Gasche).

Fieldwork:

29/9 - 30/10 1995	M.B. Annis: *Riu Mannu* Survey (Sardinia).
10-17/10 1995	A. van As and L. Jacobs: *Riu Mannu* Survey (Sardinia).

Publications:

Annis, M.B. (1995), Economia di una produzione ceramica: ricerca etno-archeologica nell'oristanese. In: *Atti del convegno: 'La ceramica racconta la storia'*, Oristano: 295-329.

As, A. van and M.-H. Wijnen (1995), The Neolithic and Chalcolithic pottery from Ilipinar phases X-V: a technological study. In: J. Roodenberg (ed.), *The Ilipinar excavations I. Five seasons of fieldwork in NW Anatolia 1987-91.* Uitgaven van het Nederlands Historisch-Archeologisch Instituut te Istanbul LXXII, Leiden: 77-107.

As, A. van and L. Jacobs (1995), Archaeo-ceramological survey. In: S.E. Sidebotham and W.Z. Wendrich (eds.), *Berenike 1994. Preliminary report of the 1994 excavations at Berenike (Egyptian Red Sea coast) and the survey of the eastern desert.* Research School CNWS, Leiden: 45.

As, A. van, L. Jacobs and M.-H. Wijnen (1995), Archaeo-ceramological research: a contribution to the study of the development of early farming cultures in northwestern Anatolia. In: A. Lindahl and O. Stilborg (eds.), *The aim of laboratory analyses of ceramics in archaeology*. Kungl. Vitterhets Historie och Antikvitets Akademien. Konferenser 34, Stockholm: 63-75.

Lectures:

11/01 1995	A. van As: *Archeologische Ceramologie*; Archeologische Werkgemeenschap Nederland; Arnhem.
20/01 1995	A. van As: *Archeo-ceramologisch onderzoek; evaluatie van de bijdrage van het Instituut voor Aardewerktechnologie*; 4e Symposium Archeologie en Theorie (19-20 januari 1995); University of Amsterdam.
25/03 1995	M.B. Annis: *Cultureel erfgoed, toerisme en wetenschap*; Symposium Mediterraan Archeologische Discussiegroep: 'Te koop: Mediterrane Archeologie'; Amsterdam.
07/04 1995	A. van As and L. Jacobs: *Archaeo-ceramological research of the Department of Pottery Technology (Leiden University)*; Workshop 'The aim of laboratory analyses of ceramics in archaeology', April 7-9, 1995; Lund University (Sweden).
09/04 1995	A. van As and M.-H. Wijnen: *A contribution to the study of the development of early farming cultures in Northwestern Anatolia*; Workshop 'The aim of laboratory analyses of ceramics in archaeology',

	April 7-9, 1995; Lund University (Sweden).
26/04 1995	A. van As: *Archaeological applications of ceramic research*; University of Arizona, Tucson (USA).
05/05 1995	A. van As: *Techniques, context, scale, and organization of the pottery production in second millennium B.C. Mesopotamia*; 60th Annual meeting of the 'Society for American Archaeology' (SAA), May 3-7, 1995; Minneapolis (USA).
09/05 1995	L. Jacobs: *Over pottenbakkers, misbaksels en misverstanden*; Archeologische Werkgemeenschap Nederland; Leiden.

Guest lecture:

13/12 1995	Dr. David Adan-Bayewitz (Bar Ilan University, Israel): *Common pottery from Roman Galilee.*

Visitors:

13-30/03 1995	Dr. Ian Edwards, Deakin University, Burwood, Victoria (Australia).
26/04 1995	Prof. dr. Zeidan Kafafi, Yarmouk University, Irbid (Jordan).
13/12 1995	Dr. David Adan-Bayewitz, Bar Ilan Universtiy, Ramat Gan (Israel).

Visitor's grants for study at the Department of Pottery Technology:

- Hamed Salem (Birzeit University): PEACE program;
- Nabil Qadi (Yarmouk University): bilateral agreement between the Yarmouk University and Leiden University; until 15/02 1995.

Two symposia on archaeological ceramics:

In 1995 the Department of Pottery Technology has attended two symposia on archaeological ceramics. The first symposium, entitled *The aim of laboratory analyses of ceramics in archaeology*, was held at Odengården in Northern Scania in April 1995. The symposium was sponsored by the Royal Academy of Letters History and Antiquities and the Philip Sørensen Foundation. The theme of the symposium was of interest to archaeology, archaeometry, ethnoarchaeology and in particular to ceramology. The symposium stressed the need for broad studies of ceramics in both archaeological and ethnographic contexts in order to reconstruct the relations between raw materials, handicraft, use of the products and the social setting. Papers were presented by Frederick Matson, Gerwulf Schneider, Andrzej Buko, Mike Tite, Yastami Nishida, Leon Jacobson & T.N. Huffman & W.A. Westhuizen & H. de Bruiyn, Abraham van As & Loe Jacobs & Marie-Hélène Wijnen, Rose M. Cleary, Ian Whitbread, Yuval Goren & Eliezer D. Oren & Rachel Feinstein, Alan Vince, Ann Mac Sween, Ole Stilborg, Olivier Gosselain & Alexander Livingstone-Smith, and Simiyu Wandibba. The papers read and discussed during the symposium have been published in honour of Birgitta Hulthén, ass. prof. emer.: A. Lindahl and O. Stilborg (eds.), *The aim of laboratory analyses of ceramics in archaeology*. Kungl. Vitterhets Historie och Antikviters Akademien. Konferenser 34, Stockholm 1995, 172 pp. ISBN 91-7402-258-X.

As an answer to the need of closer collaboration between ceramologists *The Society for Archaeological Ceramology (SAC)* was formed.

On May the fifth, during the 60th annual meeting of the *Society for American Archaeology* (May 3-7, 1995), a symposium was held on 'Ceramic production in the Ancient Near East: Investigations of production context, scale, organization, and their interpretation'. The symposium was organized by Louise M. Senior (University of Arizona). The symposium focused upon an assessment of the potential universality of Costin's (1991) ceramic model (see C.L. Costin 1991, Craft specialization. Issues in defining, documenting and explaining the organization of production. In: M.B. Schiffer (ed.), *Archaeological Method and Theory* 3: 1-56). Caveats and footnotes were added to the work which was considered from the perspectives of greater Mesopotamia and the Levant. Papers were presented by Eric E. Klucas & Louise M. Senior, Elisabeth Carter, J.P. Dessel, Nicholas Kouchoukos, Geoff Emberling, Robert C. Henrickson & Pamela Vandiver (scheduled but not presented), Louise M. Senior, Abraham van As, Bonnie Magness-Gardiner & Steven Falconer, and Judith Franke. Cathy Costin and Gil Stein were discussants.

(PRELIMINARY/INTERIM) REPORTS

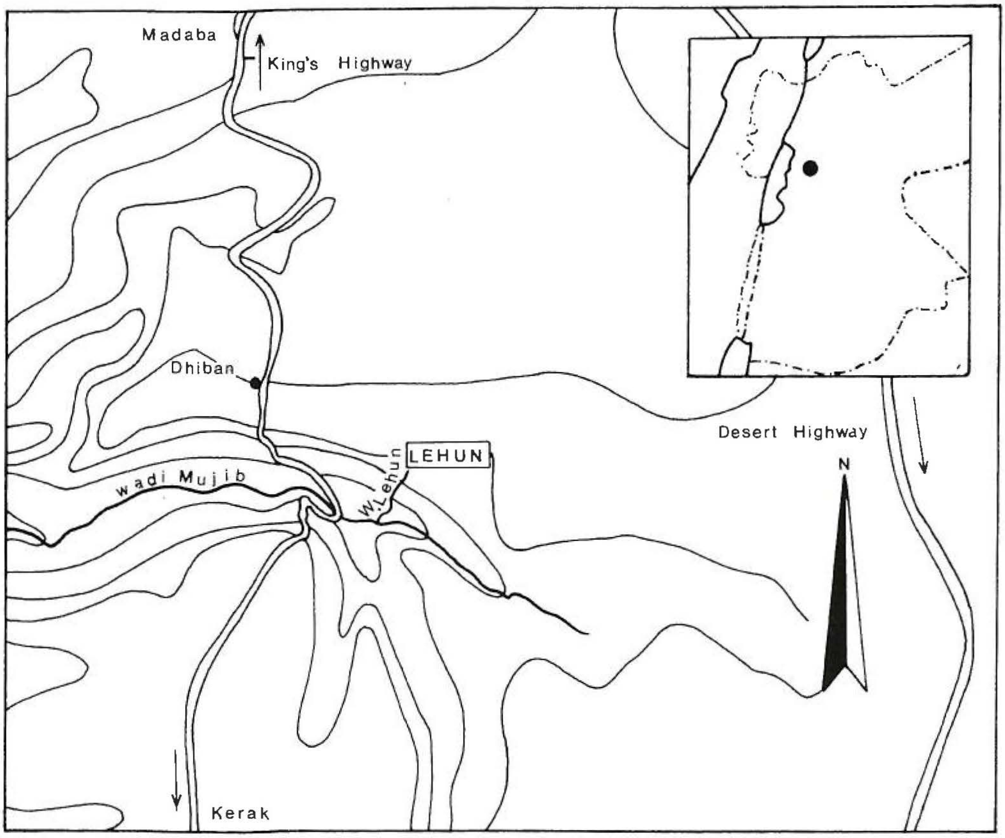


Fig. 1. Map showing the location of Lehun (Jordan).

A. van As
L. Jacobs

AN EXAMINATION OF THE CLAYS PROBABLY USED BY THE ANCIENT POTTERS OF LEHUN (JORDAN)

As part of a joint project involving the Royal Museums of Art and History in Brussels and the Department of Pottery Technology (Leiden University), clay samples have been investigated from the direct surroundings of the ancient site of Lehun (Jordan)[1]. This investigation involved 1) testing the workability and the firing behaviour of the clay samples for pot-making techniques and 2) macroscopic examination of the non-plastic inclusions in the clay samples and in the pottery excavated in Lehun. The results made it possible to form an idea of the clays probably used by the potters of Lehun during the various periods of habitation (Early Bronze Age - Islamic Period).

Lehun

Location of the site

The ancient site of Lehun is situated on the Wadi Lehun (Fig. 1; see opposite). The Wadi Lehun runs from the upland plain of Diban in the north to a small plateau in the south, from where it falls along a 500 m, steep escarpment into the Wadi Mujib. The Wadi Mujib, also known as the "Grand Canyon" of Jordan (ca 51 km in length) presents a steep fall from east to west, and flows into the Dead Sea. In biblical times, the Wadi Mujib (the river Arnon) formed the natural boundary between the kingdom of Moab in the south and the Amorite, later Israelite, sphere of influence in the north.

Habitation phases

Since 1979 important archaeological remains from the various habitation phases of Lehun have been excavated by the Belgian Archaeological Expedition under direction of prof. dr. Denyse Homès-Fredericq (Fig. 2).

At the eastern edge of the small plateau an eroded burial ground was excavated. A few bones mixed with over 130 specimens of often undamaged pottery were found. This assemblage dates from the Early Bronze Age I.

So far, no remains of the Middle Bronze Age have been discovered. Around the end of the second millennium B.C. and the very beginning of the first millennium

Newsletter of the Department of Pottery Technology (Leiden University) 13, 1995, 14-25.

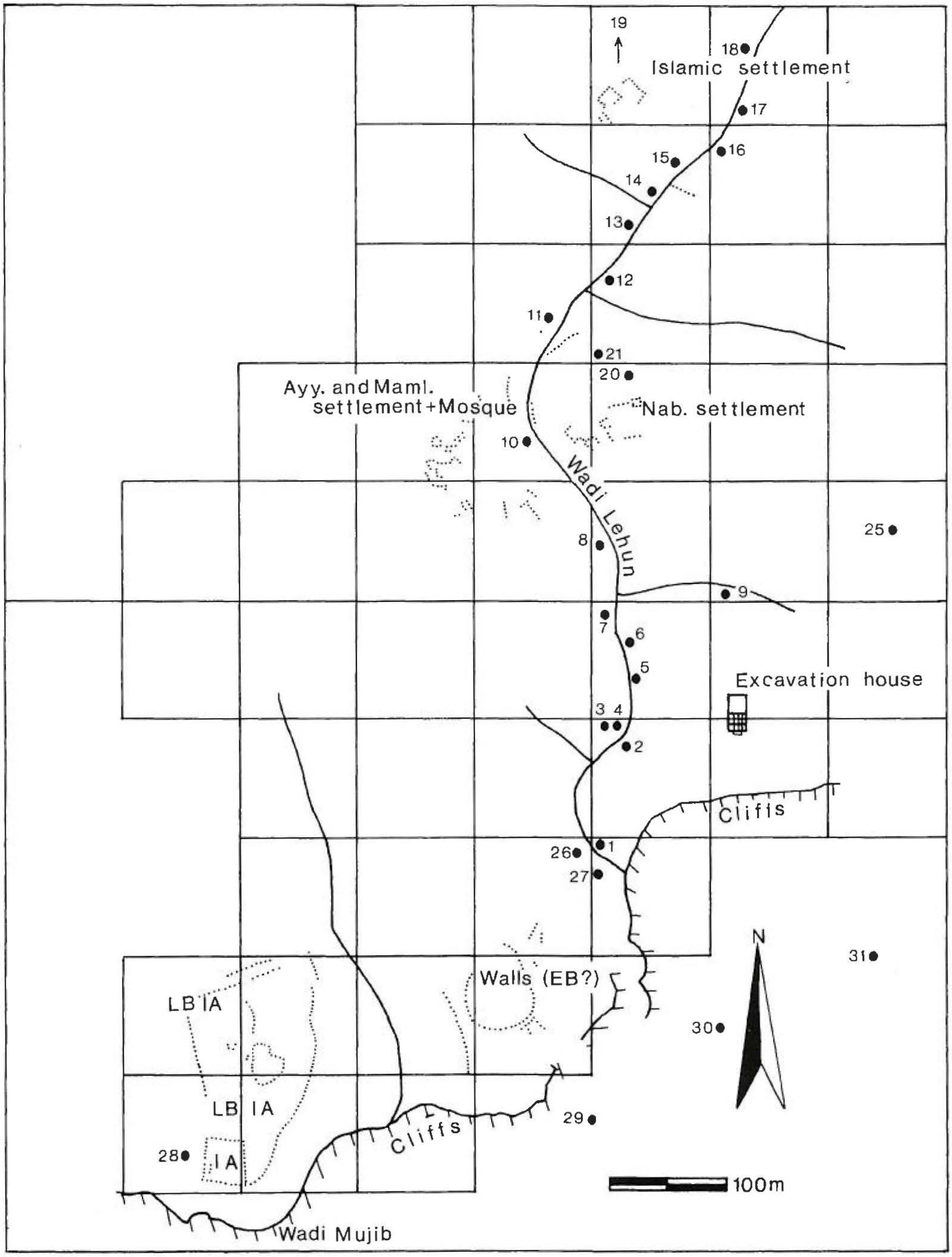


Fig. 2. The ancient site of Lehun and direct surroundings: excavated areas and location of the clay samples.

B.C. Lehun was - according to the excavator - a frontier fortress. The pottery found within the fortress is typical for the Late Bronze Age and Early Iron Age.

One of the most attractive remains from the Nabatean period still standing is a small temple. The ceramic fragments found in this temple date from the first century A.D.

The last important habitation phase is represented by a building and a mosque, dating from the Umayyad and Mamluke periods respectively. Here, only a few small potsherds were excavated.

At present Lehun is a small village with ca 100 inhabitants.

The pottery

In preparation for the exhibition *Pottery and Potters - Past and Present. 7000 Years of Ceramic Art in Jordan* in Brussels, Tongeren, and Tübingen (1984, 1985, 1986), the Department of Pottery Technology investigated the pottery excavated in Lehun. This research was mainly focused on the reconstruction of the shaping techniques. Fabric analysis was carried out on a limited scale. The results of the technological investigations were published in the exhibition catalogue (Homès-Fredericq and Franken 1986). The following is a short summary.

The manufacturing techniques

Early Bronze Age

The pottery was handmade

1. by pinching a small ball of wet clay in the hand ("thumb" pots);
2.. by shaping a base in a little hole made in the hard soil which was lined with fine dry organic material. To this was fixed a coil of clay which was pressed into the shape of a rim (vessels with convex bases);
3. by using a mould (vessels with convex bases);
4. by shaping a flat base on a flat and porous surface. Next, the wall was made of coils of clay. This technique was used for making large storage jars.

Late Bronze Age

The pottery was made on a turntable. At the beginning of the Late Bronze Age most pottery received an overall thick white-firing slip which served as a base for iron oxide painted decoration. Later, the slip layers became thinner and the occurrence of lime included in the clay increased. After firing at more than 825°C the surface of the vessels was broken open and the decoration was destroyed. As a consequence the finished vessels had a pock-marked appearance. By the end of the period the potters no longer decorated their pots. The pots became heavier and more clumsy in shape. Many pots were lopsided. One could say that at about the end of the 13th century B.C. the art of pottery was at its lowest ebb.

Iron Age

Although there was little material available, it could be established that the potter's wheel was used during the Iron Age.

Nabatean Period

The majority of the sherds are representative of smooth or ribbed common ware, but beautifully painted fine ware with walls as thin as egg-shells were found too. This fine painted ware was thrown on a fast wheel, shaved to its desired thinness and painted when bone-dry. For the manufacture of this egg-shell thin, painted pottery a special type of fine clay was required.

Islamic Period

Only a few small fragments of glazed and handmade pottery were excavated. The handmade pottery with an overall painted geometric decoration strongly suggests African influence.

The fabric

The fabric analysis was carried out by using the binocular microscopy method. Only the Early Bronze Age yielded sufficient material for this analysis. The sherds contain grains of limestone, calcite, and/or mudstone. In some cases quartzite, siltstone, haematite, or basalt were found.

The production location

According to van der Leeuw (1977: Table 1) and Peacock (1982: 12-51), specific combinations of variables concerning the economy and technology of pottery production are typical of the various modes of production (household production, household industry, workshop industry etc). According to their models, handmade pottery is typical of household production. The manufacture of the pottery by the women of each household is occasional and primarily for own use.

The use of a turntable is one of the characteristics of a household industry. Peacock (1982: 8) describes this mode of production as "potting for profit". Part-time potting has become an important source of supplemental household income. "Pottery not only has use value but acquires exchange value as well and is made for someone outside the immediate environment" (Rice 1987: 184). In the household industry we see the first steps towards craft specialization.

The pottery thrown on the wheel is typical of vessels produced by a (individual/nucleated) workshop industry. The pottery, intended for sale on the market, is manufactured by craftsmen. Full-time potting forms their main source of subsistence.

The above implies that the Early Bronze Age pottery from Lehun has most probably been manufactured locally. It also implies that both the pottery made on a turntable (Late Bronze Age) and the pottery thrown on the wheel (Iron Age) was not necessarily made in Lehun. It could have come from elsewhere. Since a specific clay only occurring near Petra was required for the manufacture of the fine Nabatean painted ware, this egg-shell thin pottery had certainly been imported into Lehun (cf. F. Zayadine in Homès and Franken 1986: 185).

The examination of the clay samples

In order to obtain insight into whether the potters in Lehun could have used the clay resources in the direct surroundings of the site a "comparative consumer survey" was carried out.

The area surveyed for clays suitable for pottery production encompasses the Wadi Lehun and its direct surroundings, and the Wadi Mujib directly below. The area was surveyed intensively. The selection method in the field included the crumbling of lumps of dry clay. Since short clay - unlike plastic clay - breaks easily, we were able to determine whether a clay sample was too sandy for use. During our selection in the field it was obvious that the quality of the clays in the Wadi Mujib did not differ very greatly from each other. After selection in the field, 31 clay samples (28 from the Wadi Lehun and direct surroundings and three from the Wadi Mujib) were taken for further research (Fig. 2).

The investigation method used on the clay samples consisted of workability tests, an investigation of the firing behaviour, and fabric characterization. The research was mainly carried out in the dig house of the Belgian Archaeological Expedition in Lehun. With the help of Mr. Hamed Salem (Birzeit University) some supplementary research was executed in Leiden. The results are given in Table 1 (see also Fig. 2). A short commentary follows.

The workability

The workability tests were carried out in order to establish the behaviour of the clay samples for pot-making. The workability is based on the following aspects, all relating to the plasticity: the relative plasticity, the cohesive strength, the resistance to deformation, and the linear shrinkage after drying, each after bringing the clays to optimal plastic condition.

After adding water and soaking the clay, the relative plasticity of the clay samples was established. Then, the cohesive strength was tested by means of the potter's 'pigletstail' test (Fig. 3). By pressing plastic coils of clay of a certain length and diameter into flat bars, the resistance to deformation was judged. Finally, the linear (in one direction) shrinkage after drying was established by measuring the average shrinkage of four test bars made of each clay sample. The percentage of linear

Sample no.	shrinkage after drying	workability	% total shrinkage after firing at 750°C	fabric
1	6	+0	6	+
2	5	+	5.5	±
3	3	±	3	-
4	6.5	+0	7.5	+
5	4	+	4	-
6	4.5	±	5	±
7	5.5	+	6	+
8	5	±	5.5	-
9	6	±	7.5	+
10	4.5	+	5	±
11	5	+	5	±
12	5	+	5.5	±
13	6	+	6.5	±
14	4.5	±	4.5	+
15	7	+0	8.5	+
16	6.5	+0	8	±
17	5.1	±	6	+
18	5	+	6.5	±
19	7	+0	9	+
20	3	±	3.5	±
21	4.5	±	4.5	-
22	4.5	±	5	±
23	6.5	+	8	+
24	5.5	+0	6.5	+
25	5	±	6.5	+
26	8	+0	10.5	+
27	5	+	6	±
28	8	+0	8	+
29	7	00	6.5	+
30	6	00	6.5	+
31	7	00	6.5	+

Legend

Samples, nos. 1-28: Wadi Lehun and direct surroundings.
Samples, nos. 29-31: Wadi Mujib.
Workability, based on the relative plasticity, the cohesive strength, the resistance to deformation, and the linear shrinkage after drying:

	±	moderately suitable for hand-forming techniques;
	+	suitable for hand-forming techniques;
	0	suitable for turning (turntable) ;
	00	suitable for throwing (wheel).
Fabric:	-	bad, because of too many and/or too big grains of limestone;
	±	usable; moderate quality because of grains of limestone;
	+	okay (sometimes sporadically small grains of limestone).

Table 1. Analysis of the clay samples after selection in the field: workability, firing behaviour, and fabric.

Fig. 3. Testing the cohesive strength by means of the potter's 'pigletstail' test'.

shrinkage after drying varied between 3% and 8%. Most samples were around 5%. This is normal for clays judged as reasonably plastic (suitable for handforming techniques).

Based on the results of the workability tests, the clay samples from the Wadi Lehun and its direct surroundings could be considered to be (moderately) suitable for handforming techniques or suitable for the use on a turntable. All clay samples from the Wadi Mujib were suitable for throwing on a fast potter's wheel.

The firing behaviour

The colour of the dry natural clays varies between light brown (7.5YR 6/4), light yellowish brown (10YR 6/4), very pale brown (10YR 7/4), and light brownish grey (10YR 6/2). The grey colour is caused by carbon present in the clay. Surface clays tend to contain carbon, for instance introduced by the roots of plants.

The test bars were fired in a specially designed portable test kiln (Fig. 4) in seven hours up to 750°C[2]. This temperature was maintained for 30 minutes. Next, the burner was shut off and the kiln was closed to cool off. Since the atmosphere in the kiln varied from oxidizing to neutral, the test bars became spotted like much of the

Fig. 4. Portable test kiln for use in the field.

Early Bronze Age pottery from Lehun (Fig. 5). The colours of the oxidized parts range from 2.5YR 6/6 (light red) to 2.5YR 6/8 (light red). The neutrally fired parts showed colours ranging from 7.5YR 7/4 (pink) to 7.5YR 6/4 (light brown). In a very few places there were still some dark colours caused by incomplete combustion of the carbon: 10YR 6/4 to 5 (grey). Sample no. 20 showed the lightest colour in the neutral zone (10YR 8/3 - very pale brown).

The fabric

The fabric characterization was executed by binocular examination of the fresh breaks of the test bars made of the clay samples fired at 750°C for 30 minutes in an oxidizing/neutral atmosphere.

The majority of the test bars produced a rather good fabric, as is required for the manufacture of pottery. All clay samples include a greater or lesser number of grains of limestone and calcite. The colour of the calcite varies from dark grey to almost white and partly transparent, dependent on the carbon included in it. Since the firing temperature did not exceed 750°C the calcite crystals, under neutral conditions, remained intact. Furthermore, a few quartzite inclusions were found.

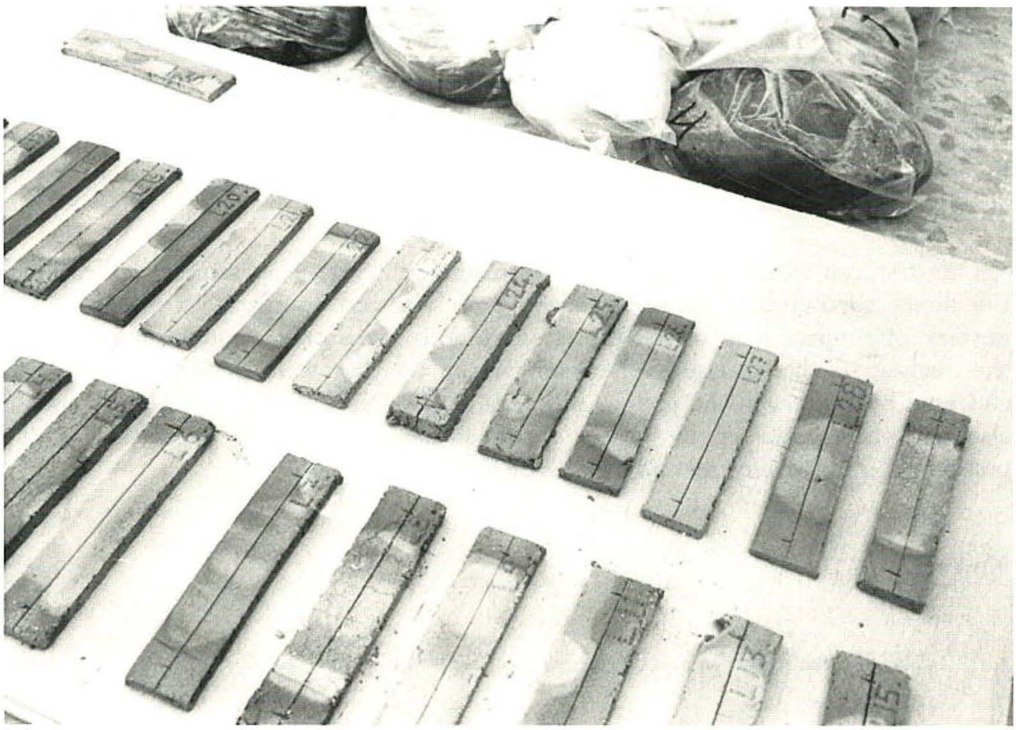


Fig. 5. Test bars after firing at 750°C.

Sporadically, mudstone was included. Apart for the calcite crystals and the quartzite inclusions, the shape of the grains was more or less rounded. The absence of large grains in about half of the samples can be explained by the method used in selecting the clay samples in the field (see p. 19). For the percentage total shrinkage after firing at 750° C, we refer the reader to Table 1.

Conclusion

The qualitative research into the clays from the direct surroundings of the ancient site of Lehun shows that they are by nature suitable for pot-making techniques. The potential clay resources for the potters could be found within a distance of ca 1 km around the site, i.e. within the first "threshold" of energy expenditure which is the "preferred" distance of procurement (cf. Arnold 1985: 34-49).

In the Wadi Lehun natural clays were found suitable for hand-forming techniques and for turning on a turntable as well. They could be used without any preparation. These clays are not suitable for throwing on the wheel. The comparison between the non-plastic inclusions in the clay samples from the Wadi Lehun and the fabric of the Early Bronze Age sherds shows that only angular grains of basalt were probably added by the potters.

In the Wadi Mujib clays were found perfectly suitable for throwing on a fast wheel. This means that even the pottery thrown on the wheel could have been made in Lehun. In order to obtain their clay, the potters had to go down into the Wadi Mujib.

Clay for a white firing slip, like on the Late Bronze age pottery, was not found near Lehun. If this pottery was made locally, the slip must have been traded from elsewhere.

Our research in Lehun shows that experimenting with clay samples collected in the direct surroundings of an archaeological site, and comparing them with the pottery of interest help define the effective and operational ceramic environment: the qualitative characteristics of ceramic resources that were probably recognized and used by potters in the past. Ideally, the composition of the clay samples should also have been matched by highly sensitive laboratory analysis with that of the pottery (cf. Adan-Bayewitz and Wieder 1992).

Notes

1. The research in Jordan was carried out from 10 to 18 October 1992.

2. The test kiln was especially designed for use in the field. It is a light weight portable kiln (total weight less than 7 kg, burner included). The atmosphere in the kiln varies from neutral to oxidizing. The flue through the centre of the kiln produced a neutral atmosphere. Near the exterior sides of the kiln was a zone of an oxidizing atmosphere, produced by the minimal amount of surplus oxygen able to pass through the high quality glass fibre blanket used as a cover of the kiln. The test bars were piled in such a way that one part of each test bar was in the oxidizing zone, the other in the neutral zone. This way, the colour development under different firing conditions of the several clays could be observed. The kiln was constructed in such a way that a good flue and a superb heat division were realized (downdraft type). Consequently, each test bar was fired at the same temperature. The test bars were fired at 750°C.

References

Adan-Bayewitz, D. and M. Wieder (1992), Ceramics from Roman Galilee: a comparison of several techniques for fabric characterization. *Journal of Field Archaeology* 19: 189-205.

Arnold, D.E. (1985), *Ceramic theory and cultural process*, Cambridge.

Homès-Fredericq, D. and H.J. Franken (eds.)(1986), *Pottery and potters, past and present. Seven thousand years of ceramic art in Jordan*, Tübingen. (original dutch version: *Klei bron van leven. Zevenduizend jaar pottenbakkerskunst in Jordanië.* Documenten van het oude nabije oosten - tijdelijke tentoonstellingen 3, Brussel, 1984).

Leeuw, S.E. van der (1977), Towards a study of the economics of pottery making. In: B.L. van Beek, R.W. Brandt and W. Groenman-van Waateringen (eds.), *Ex Horreo,* Amsterdam: 68-76.

Peacock, D.P.S. (1982), P*ottery in the Roman world. An ethno-archaeological approach,* London.

Rice, P.M. (1987), *Pottery analysis. A sourcebook*, Chicago.

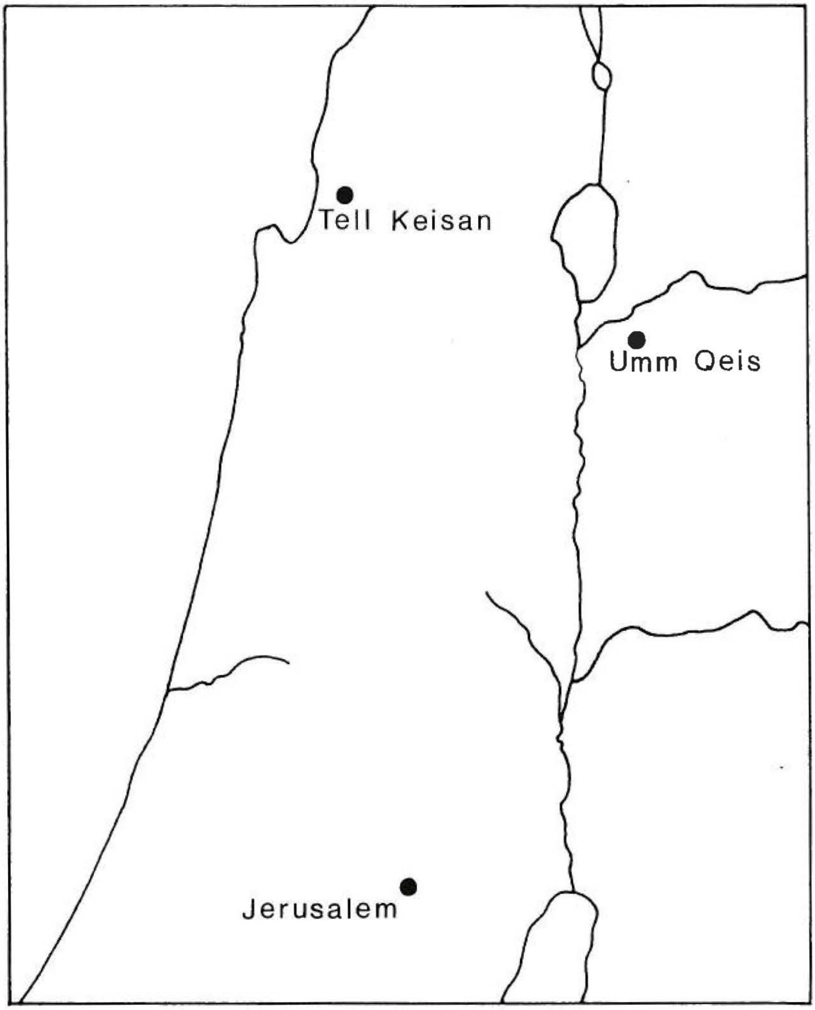


Fig. 1. Map showing the location of Umm Qeis (Jordan).

K.J.H. Vriezen

A PRELIMINARY STUDY OF THE BYZANTINE ROOF TILES (*TEGULAE* AND *IMBRICES*) FROM AREAS I AND III IN UMM QEIS (JORDAN)

In Umm Qeis (Jordan) a considerable amount of roof tile fragments belonging to a Byzantine church complex have been excavated by the German Evangelical Institute (Amman). The study of these tile fragments aimed at gaining a clear understanding of the different technological types, their provenance and architectural importance[1]. The technological study, carried out in cooperation with the Department of Pottery Technology (Leiden University), included both the macroscopical analysis of the ware and the reconstruction of the manufacturing technique. For the provenance study, a few clay samples from Umm Qeis and its direct surroundings have been analysed. In the following some of the preliminary results of the technological analysis are presented.

The site

Umm Qeis is located in the north-west of Jordan on a long mountain ridge between the valleys of the Yarmouk river on the North and the Wadi el-Arab on the South. Eight kilometres to the north-west is the shore of Lake Tiberias (Fig. 1; see opposite). Near the modern village of Umm Qeis lie the ruins of an ancient city, which have been identified as the remains of Gadara. Ancient Gadara figures in historical sources from the end of the 3rd century B.C. until the 8th century A.D. In the Roman period the city was a member of the Dekapolis and later it became an episcopal see.

During the archaeological campaigns of 1976-1979 and 1992 a church complex was excavated on the terrace situated at the bottom of the western slope of the Acropolis hill overlooking the Lower city (Fig. 2). This site was labelled Area I and consists of two church buildings. The larger of the two buildings is a memorial-church of the "centralised-type". The date of its construction is tentatively set at the second quarter of the 6th century. The second church of which only the northern half has been uncovered, is of the "basilica-type". It was built against the south wall of the first church, probably in the middle of the 7th century.

A street (a *cardo*) aligned with vaulted rooms runs along the bottom of the terrace wall to the west, part of which was excavated in 1977 and 1979. This site was labelled Area III.

Both church buildings and the rooms along the street were destroyed by an earthquake: presumably the earthquake of 749. The sites of Areas I and III were not rebuilt upon (Wagner-Lux and Vriezen *et al.* 1980a, 1980b, 1980c, 1993a, 1993b).

Newsletter of the Department of Pottery Technology (Leiden University) 13, 1995, 26-40.

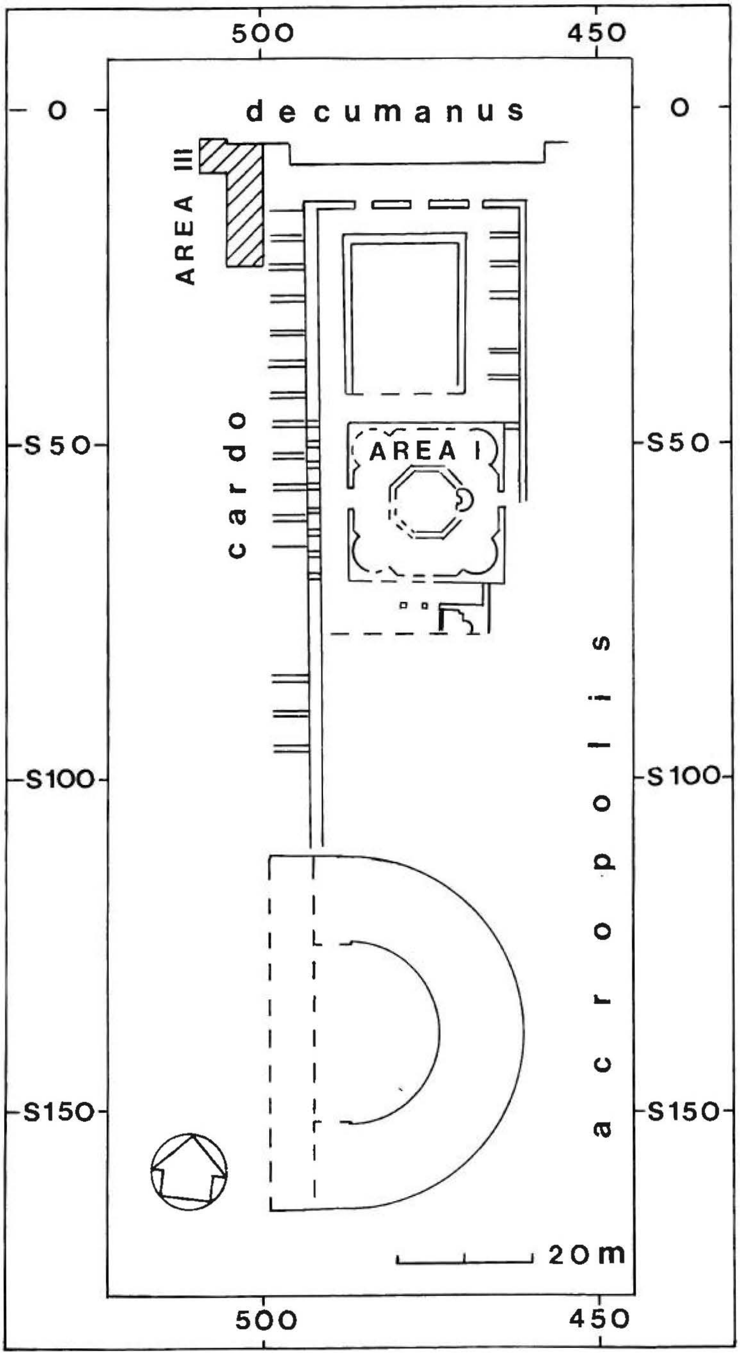


Fig. 2. Excavations in Umm Qeis: location of Areas I and III. The main street (*decumanus*) of the ancient city runs East-West, the *cardo* is a by-street.

The roof tiles

Basically, the roof tiles from Areas I and III may be divided into two types (Fig. 3):
- the *tegula*, a flat slab with flanged rims on the two long sides;
- the *imbrex*, a curved tile covering the seam between two *tegulae*.

There is a slight tapering on one of the short sides of the tiles to facilitate overlapping.

Both types reveal a wide variety of rim forms. A closer inspection of the fragments demonstrated that, despite the variety of rim forms, only a limited number of different wares and construction processes can be discerned. One construction process using different raw materials could result in various forms. The following is a typology based mainly on ware and manufacture[2].

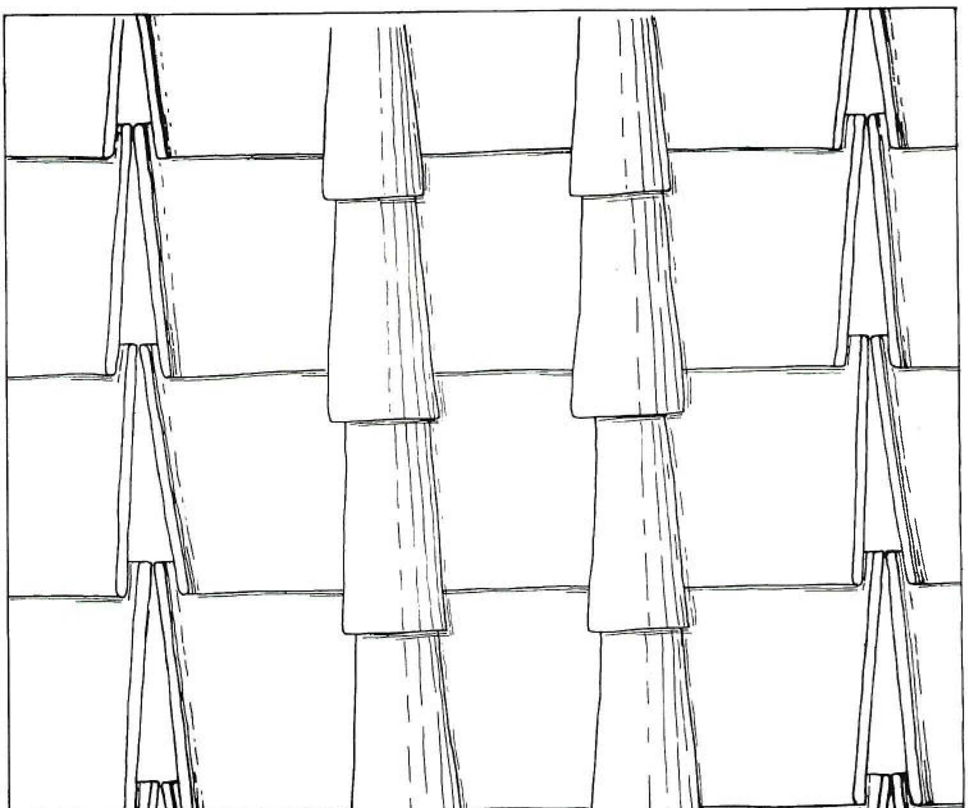


Fig. 3. Sketch: roof-covering of *tegulae* and *imbrices*.

The wares

The qualitative/quantitative analysis of the non-plastic inclusions has led up to the identification of fourteen ware types. If the types of low frequency (≤1.3% of the total repertoire) are not considered, seven ware types remain:

Type I	Characterised by a natural admixture of quartsite silt and angular and rounded quartsite and manganese grains of <1 mm and sporadical sand with gravel grains added.
Type II	Like type I. Type II, however, has more anorganic voids.
Type III	Characterised by a high percentage (22.5%) of non-plastics, almost exclusively angular basalt grains.
Type IV	Characterized by a high percentage of mixed temper of sieved rounded quartz grains (dominant) and basalt.
Type V	Characterised by a virtually exclusively sieved rounded quartz grain temper.
Type V2	Characterised by mixed temper of sieved rounded quartz grains (dominant) and lime.
Type VI	Characterised by a very pale brown/yellow firing clay with a very low percentage (4%) of non-plastics (quartz/lime).

Types I and II seem to be closely related; the temper added is characterised by the absence of rounded quartz grains. Types IV, V, and V2 seem to be related because of the presence of rounded quartz grains.

The ware types have been compared with the ware of four different clay samples: one from a clay deposit excavated in 1994 in an industrial area of ancient Gadara (clay A)[3]; one from a clay resource in the fields of Umm Qeis, still in use by local potters (clay B); one from Ain Umm Qeis (clay C); and one from the Yarmouk valley (clay D).

Type I shows the same characteristics as the sample of the natural clay resource from Umm Qeis (clay B). Type II seems to correspond to the excavated clay deposit (clay A). None of the ware types seems to correspond to the clay samples from the two natural clay resources at Ain Umm Qeis and in the Yarmouk valley (clays C and D).

It is surmised that ware types I and II may come from the Umm Qeis plateau itself: together they make more than 1/3 of the total repertoire. Possibly the basalt tempered type III (4.2% of the repertoire) is non-local. The basalt region mainly extends itself from eastern Galilee, the Golan heights upto Jebel ed-Druz. The wares, which are characterised by the admixture of sieved, rounded quartz grains, types IV, V and V-2, may originate from the area of a river bed or a seashore; they make almost half of the total repertoire. Type VI (8.7% of the repertoire), the clear coloured and almost untempered ware, is distributed over a far larger area than the region of Umm Qeis, as will be discussed below.

The manufacture

In the manufacture of the roof tiles, various construction processes may be discerned. Information on the tile manufacture from classical sources (Blümner 1879: 14f.,18,30f.) seems to be corroborated by observations on brick and tile making in more recent times (see for the Netherlands: Holwerda and Braat 1946: 104ff.). The manufacture of the curved tiles is well illustrated by Hampe and Winter in their study of tile manufacture in the Eastern Mediterranean (Hampe and Winter 1965: 26-29; Taf. 15,42,48f.,55). There, it may be seen how a lump of clay is pressed into a wooden frame in order to form a clay slab. Then the slab - still in plastic condition - is pressed over a more or less semi-cylindrical mould to form a curved tile, which is then laid out in the yard to dry. The inspection of the *imbrex* fragments from Umm Qeis showed that for all ware types except one (type VI), the same basic method of manufacture was used (Fig. 4). Traces revealing this process include: surface finishing on the upper side, in contrast to the surface of the lower side which is not finished but has remains of an anti-adhesive coating or a rippled surface still showing.

As for present-day production of *tegula*-tiles, I only know of the existence of industrial production using pressing machines. The manufacturing process of *tegula*-tiles excavated in Umm Qeis, however, may be studied with reference to the visible traces which the process left on the surface of the tiles (e.g. clay ridges, surface finish) and in the tile itself (e.g. air holes and folds), and may be reconstructed as follows. After a lump of clay was pressed into a wooden frame to form a slab, the two longer sides of the rectangular slab were curved up and folded over. The final shape of the rim depended on the position of the fingers and on the kind of tools used to press and finish off the flange (Figs. 5 and 6)[4].

Both the *imbrex* and the *tegula* show a notable difference between the items made of ware types I and II (Figs.4 and 5) and the items made of ware types III, IV, V and V2 (Figs. 4 and 6), as the latter are more carefully finished than the former and are therefore finer and show a wider variety of forms.

The tiles of ware type VI stand out, not only because of the ware itself, but also for their style of manufacture. Contrary to the *imbrices* already mentioned above, these *imbrices* were not pressed over a mould, but **into** a mould, resulting in a more angularly formed *imbrex*-tile, with finger imprints on the inside and a lack of surface finish on the outside of the tile (Fig. 7). Also the *tegulae* of ware type VI have a distinct form and show signs of a special surface treatment: both surfaces of the slab have been finished with a tool and using the fingers, the folded-over flanges are angular in section and continue a little around the corner on one of the short sides, whereas parallel to the opposite short side a clay coil is attached to the surface to form a ridge (Fig. 8). These tiles, in ware and in shape and in specific gravity (1.51 gr/cm^3), correspond to the roof tiles Type B from Tell Keisan (Landgraf 1980: 84-87). Therefore, these ware VI roof tiles are supposed to have a wider area of distribution, covering northern Palestine and northern Transjordan as well.

An even larger area of distribution can be assumed for a type of roof tile not yet mentioned: viz. the tiles made of ware type VII. They constitute only 0.1% of the

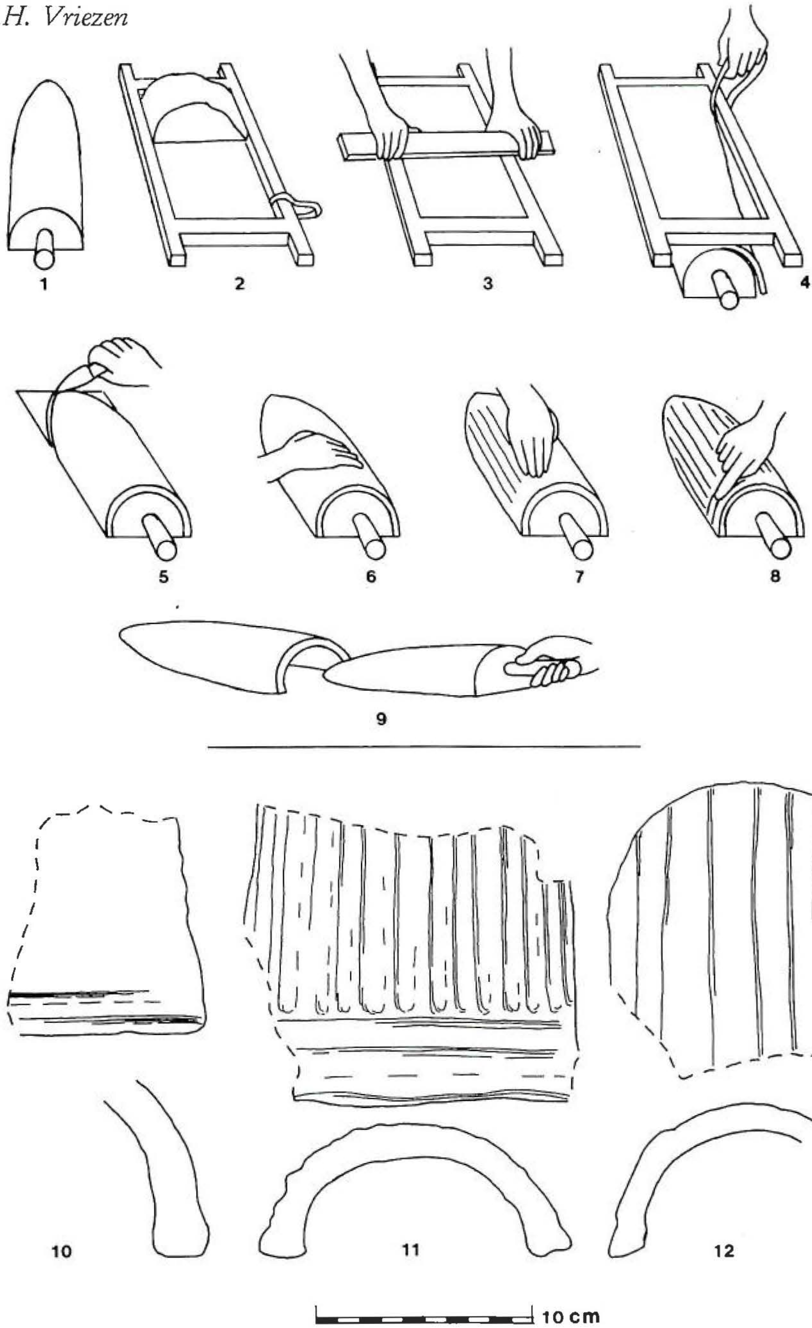


Fig. 4.
Imbrex- manufacture: ware types I and II (1-6,9); ware types III-V and V-2 (1-9). Semi-cylindrical mould (1); pressing a lump of clay into a wooden frame (2-3); cutting the clay slab free from the frame and pressing it over the mould (4-6); finishing the *imbrex*-surface (7-8); removing the mould (9); *imbrex*-fragments ware type I/II (10) and ware types III-V (11: wide opening; 12: tapering end).

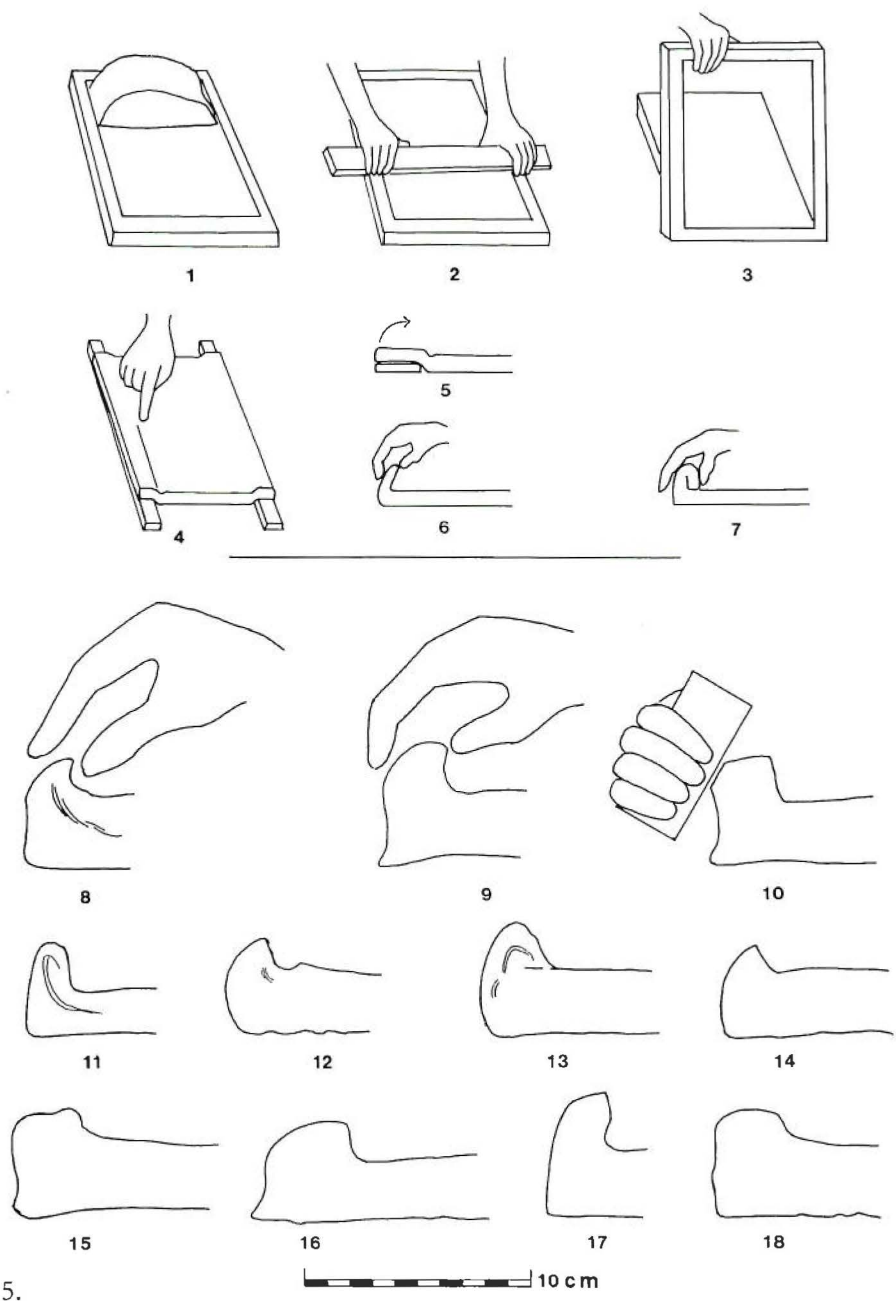


Fig. 5.
Tegula-manufacture: ware types I and II. Pressing a lump of clay into a wooden frame and smoothing the upper surface (1-2); removing the frame (3); preparing the folding of the rim (4-5); folding over the rim and finishing the flange (6-7); *tegula*-fragments and the finishing of their flanges (8-18).

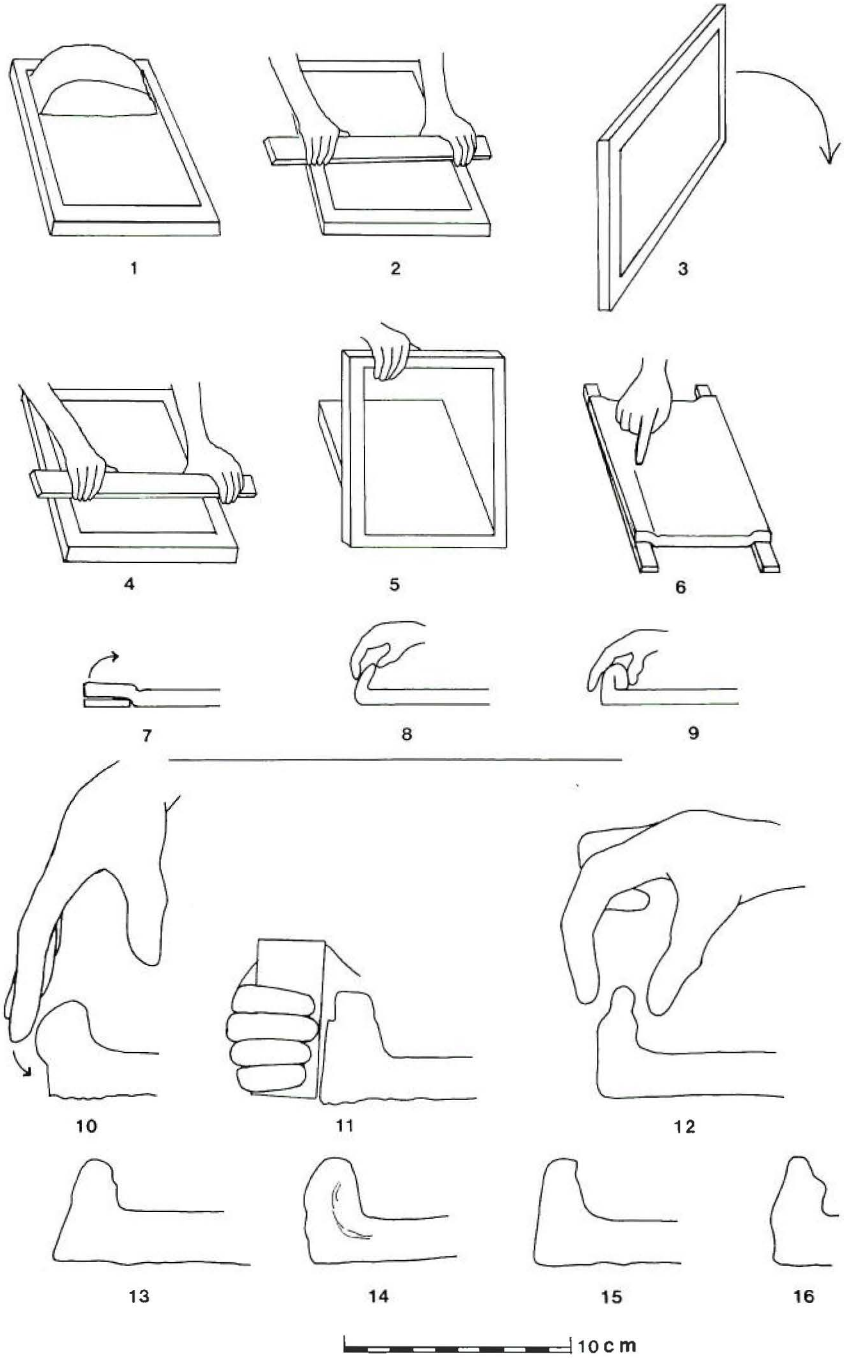


Fig. 6.
Tegula-manufacture: ware types III and V-2. Cf. fig. 4; here the lower surface is also smoothed (3-4). *Tegula*-fragments and the finishing of their flanges (10-16).

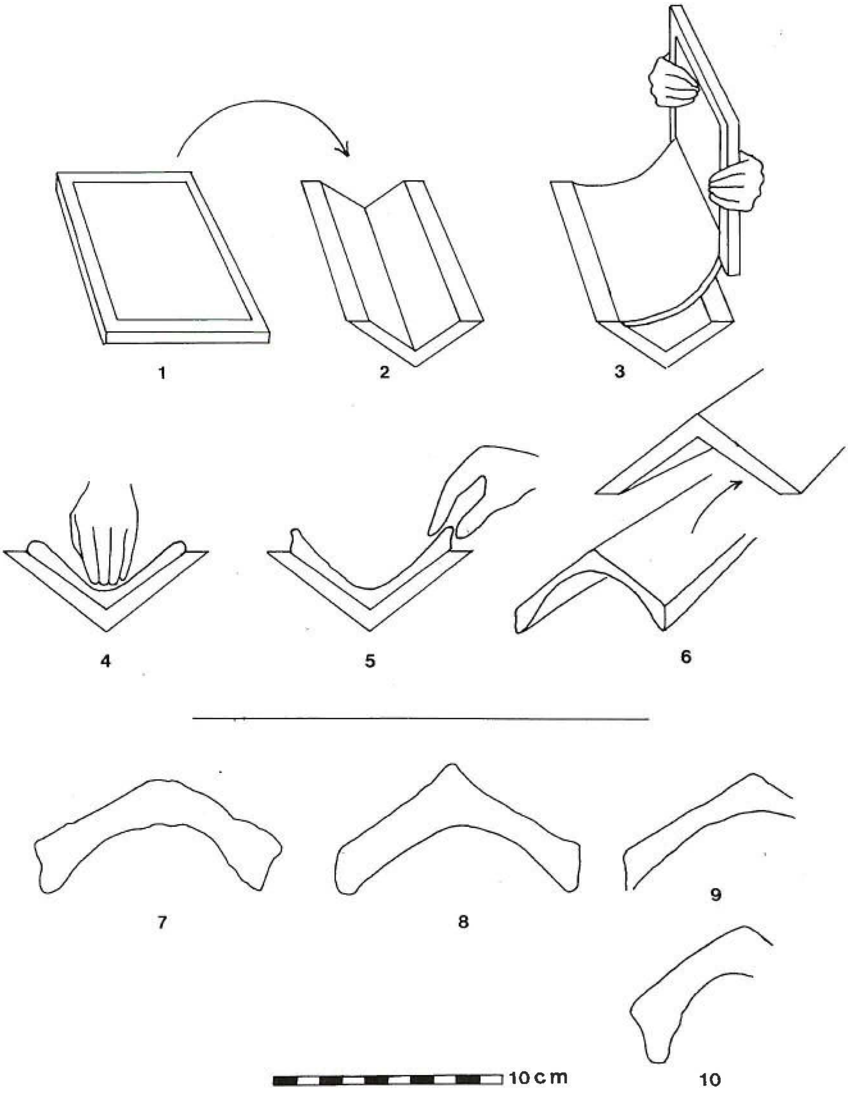


Fig. 7.
Imbrex-manufacture: ware type VI. Pressing the clay slab into a mould and removing the mould (1-6); *imbrex*-fragments (7-10).

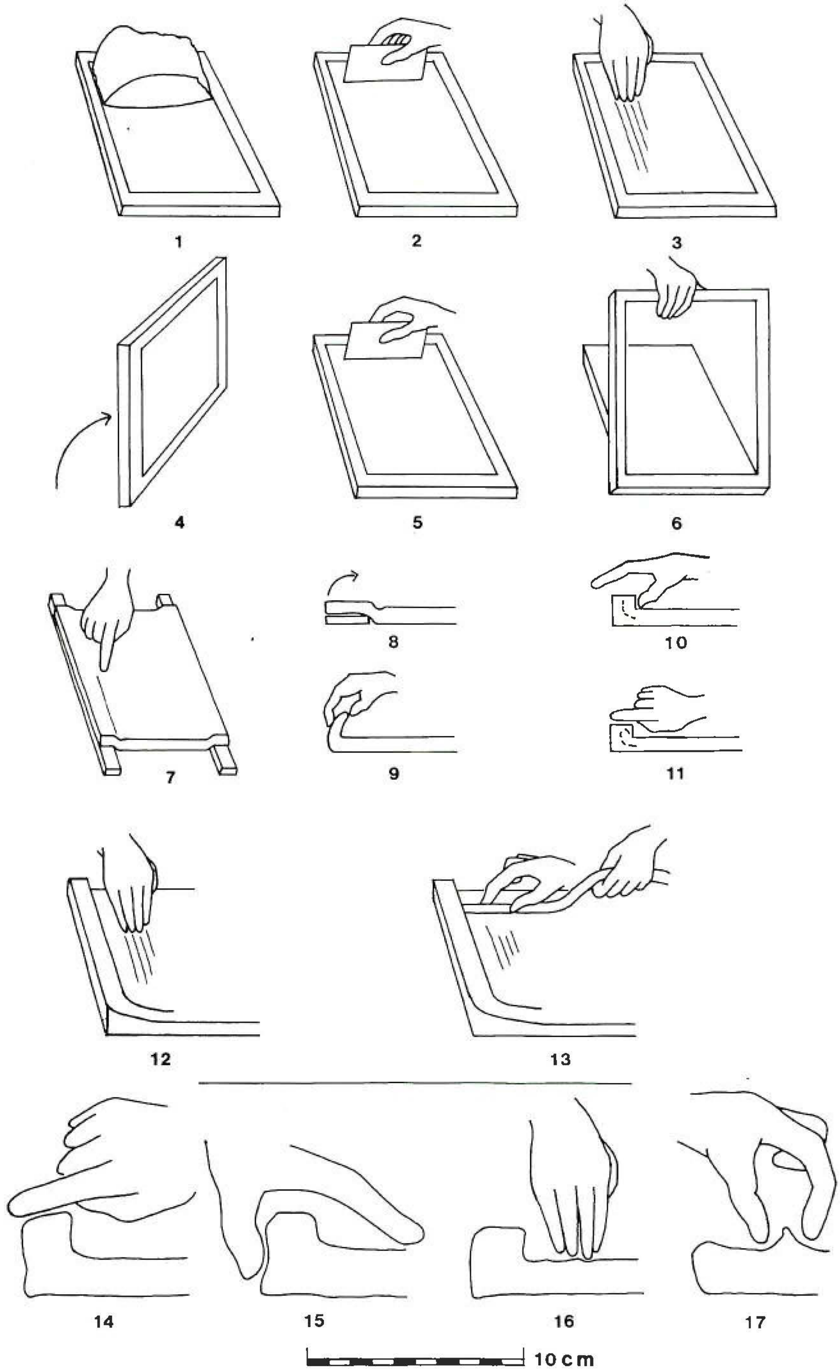


Fig. 8. *Tegula*-manufacture: ware type VI. Cf. fig. 5; a clay ridge is added (13,17).

repertoire in Umm Qeis Area I and are identical to one of the roof tile wares known from Jerusalem: roof tile ware 4 from the excavations underneath the Church of the Redeemer (Vriezen 1994: 259f.).

Tentative conclusions

In the study of the ware, different types were identified and some of these could be taken together in groups according to correspondences in main characteristics. Also, in the study of their manufacture, different processes were identified and each of these appeared to be related to one of the groups of ware types. Each of these groups is supposed to reflect a specific area of provenance (see Table 1). The architectural reasons for the presence of such a variety of roof tiles will be subject of further study[5].

ware type	temper	manufacture	provenance
I,II	mixed; no quartz	poor surface finish	local (?)
III	rounded basalt grains	surface carefully finished	basalt region
IV, V, V2	rounded quartz grains	surface carefully finished	quartz sand region
VI	little temper	angular forms; *imbrex* pressed into mould	Galilee; NW Transjordan

Table 1. Tentative conclusions regarding ware, manufacture, and provenance.

Appendix: the box tiles (*tubuli*)

A related type of tile is that of the box tiles (*tubuli*): rectangular ceramic pipes used for wall heating. The fragments found in Area I are all made of ware type I. They resemble the roof tiles, not only in ware type, but also in manufacture as they are built of rectangular flat tiles. However, as can be seen in the construction drawing (Fig. 9), their manufacture was more elaborate and a different type of "mould" was used. The air-holes and the deep finger made grooves inside the rectangular corners bear the traces of the assembling process. They form the distinguishing characteristics of these tiles together with the inward folded rims around the more or less round opening in the smaller sides.

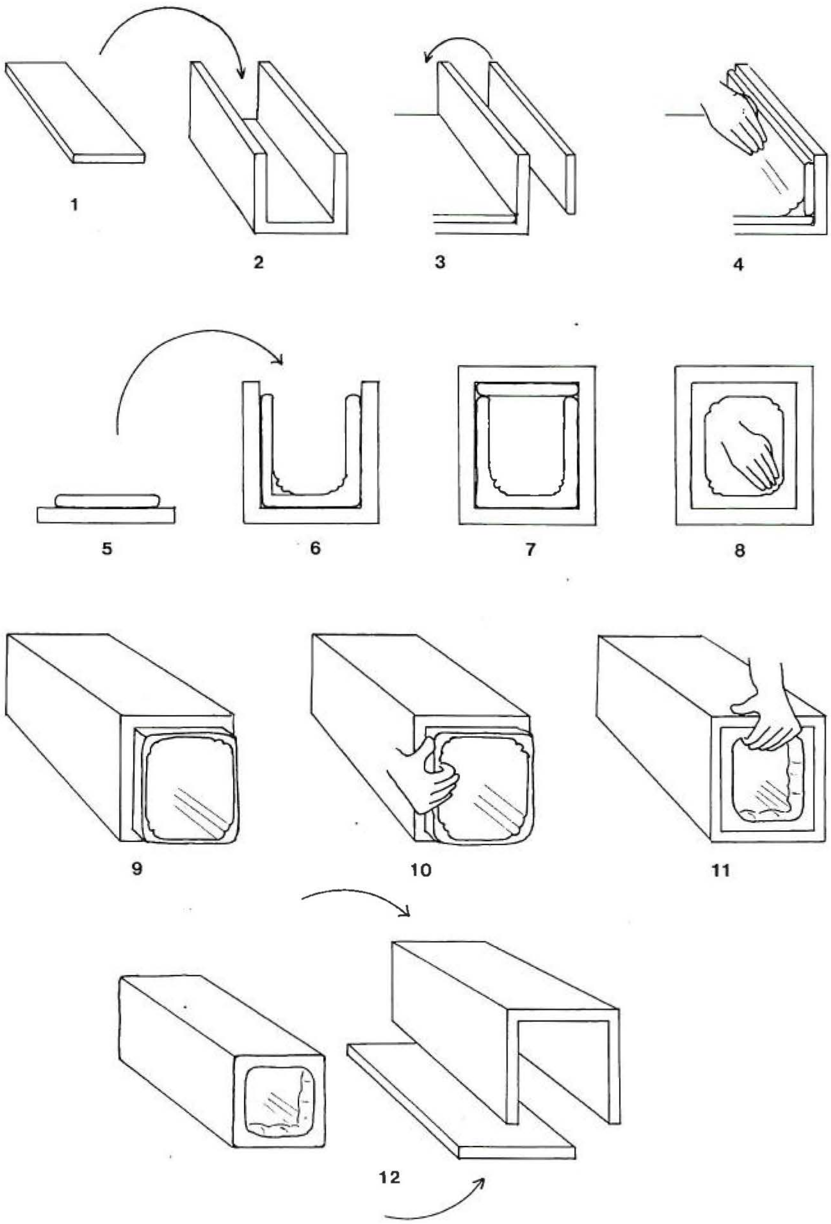


Fig. 9.
Tubulus-manufacture. Pressing a clay slab into a mould (1-2); placing a second clay slab into the mould and assembling the slabs (3-4); adding the fourth slab (5-8); folding the pinched-out clay back over the rim of the short side (9-11); removing the mould (12).

Notes

1. This study was financially supported by travelling grants from the Netherlands Organization for Scientific Research (NWO).

2. In this study 2750 fragments were examined (87% of the total tile repertoire excavated): 471.1 kg of *tegula* sherds and 60.0 kg of *imbrex* sherds.

3. We are thankful to Mrs. Susanne Kerner for presenting this sample to us.

4. The manufacturing process described only applies to the *tegula*-repertoire from Umm Qeis Areas I and III. In other parts of the ancient world *tegulae* may have been produced by different methods. See e.g. Rook 1979: 298-301.

5. For the interpretation of a *tegula*-repertoire consisting of various tile types excavated on one site, see Lammers 1994: 162-167.

References

Blümner, H. (1879), *Technologie und Terminologie der Gewerbe und Künste bei Griechen und Römern* II, Leipzig [reprint: Hildesheim 1969].

Hampe, R. and A. Winter (1965), *Bei Töpfern und Zieglern in Süditalien, Sizilien und Griechenland*, Mainz.

Holwerda, J.H. and W.C. Braat (1946), *De Holdeurn bij Berg en Dal. Centrum van pannenbakkerij en aardewerkindustrie in den Romeinschen tijd* (Oudheidkundige Mededelingen, Suppl.N.R. 26), Leiden.

Lammers, M. (1994), Dakpannen op De Horden. In: W.A. van Es and W.A.M. Hessing (eds.), *Romeinen, Friezen en Franken in het hart van Nederland*, Amersfoort: 160-167.

Landgraf, J. (1980), Keisan's Byzantine Pottery. In: J. Briend and J.-B. Humbert (eds.), *Tell Keisan (1971-1976), une cité phénicienne en Galilée*, Fribourg-Göttingen-Paris: 51-99.

Rook, T. (1979), Tiled roofs. In: A. McWhirr, *Roman brick and tile* (BAR, Int.Ser. 68), Oxford: 295-301.

Vriezen, K.J.H. (1994), *Die Ausgrabungen unter der Erlöserkirche im Muristan, Jerusalem (1970-1974)* (Abhandlungen des Deutschen Palästina-Vereins, Band 19), Wiesbaden.

Wagner-Lux, U. and K.J.H. Vriezen (1980a), Vorläufiger Bericht über die Ausgrabungen in Gadara (Umm Qes) in Jordanien in den Jahren 1976-1978. *Z.D.P.V.* 96: 48-58.

Wagner-Lux, U. and K.J.H. Vriezen (1980b), Vorläufiger Bericht über die Ausgrabungen in Gadara (Umm Qes) in Jordanien im Jahre 1979, *Z.D.P.V.* 96: 158-162.

Wagner-Lux, U. and K.J.H. Vriezen (1980c), A preliminary report on the excavations at Gadara (Umm Qeis) in Jordan from 1976 to 1979. *A.D.A.J.* 24: 157-161.

Wagner-Lux, U. and K.J.H. Vriezen, F. van den Bosch, N.F. Mulder and R. Guinée (1993a), Vorläufiger Bericht über die Ausgrabungs- und Vermessungsarbeiten in Gadara (Umm Qes) in Jordanien im Jahre 1992, *Z.D.P.V.* 109: 64-72.

Wagner-Lux, U. and K.J.H. Vriezen, F. van den Bosch, N.F. Mulder and R. Guinée (1993b), Preliminary report on the excavations and architectural survey in Gadara (Umm Qeis) in Jordan, Area I (1992). *A.D.A.J.* 37: 385-395.

ARTICLES

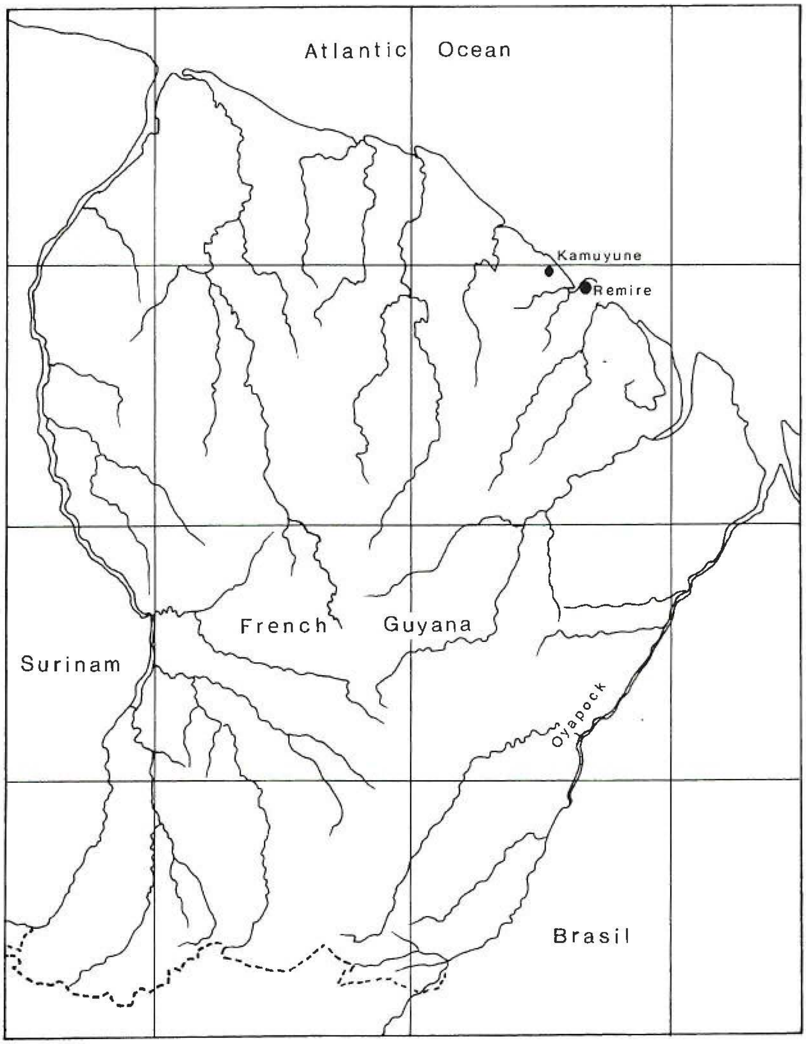


Fig. 1. Map showing the location of Kamuyune (French Guyana).

M. van den Bel [1]
G. Hamburg
L. Jacobs

THE USE OF *KWEP* AS A TEMPER FOR CLAY AMONG THE PALIKUR IN FRENCH GUYANA

Introduction (M.v.d.B.)

The Palikur (*paykwene*) are an Arawakan group which inhabit the left bank of the Oyapock Basin in French Guyana and the Curipi, Urucaua, and Uaca River in Brasil (Cf. Grenaud 1987). A few other Palikur villages are situated in French Guyana near Remire. In La commune Palikur de Macouria "Kamuyune", I executed a field research for an ethnoarchaeological masters thesis at Leiden University (Fig. 1; see opposite).

Among the Palikur only three or four women still fabricate ceramics. I noted that the natural clay the potter of Kamuyune used for the manufacture of pottery (according to the coiling technique) is very fat and is tempered with the ash of *kwep*, the bark of a tropical tree[1].

The question rises why the Palikur, like other indian groups living elsewhere in Amazonia (Boomert 1986; DeBoer and Lathrap 1979; Rostain 1994; Rye 1981), use burnt *kwep* as a temper and what are its specific properties. In order to answer these questions samples of the natural clay; *kwep* bark; *kwep* ash; and clay body (natural clay tempered with *kwep* ash), and two bowls made by the potter were analysed.

At the Energie Onderzoekscentrum in Petten elemental analysis was performed by using a Scanning Electron Microscope (SEM). At the Department of Pottery Technology (Leiden University) workability tests and porosity tests were carried out.

Some observations of a Palikur potter at work (M.v.d.B.)

The procurement of the raw materials is a time consuming activity. The Palikur potter uses a natural clay belonging to the alluvial clay deposits found in a broad zone along the coast of Surinam and French Guyana (Cf. IJzerman 1931: 36-76). The latest deposits comprise of fluvio-marine deposits, continental alluvia, and laterites in the Guyanas. The first are found in a broad zone along the coast. They are heavy or long clays and sands. These latest deposits in time lay on the continental alluvia, which further inland supersede the fluvio-marine ones on the surface. The laterites, although they may sometimes be alluvial, are kept apart from the

Newsletter of the Department of Pottery Technology (Leiden University) 13, 1995, 42-51.

continental alluvia. These cover the hills and mountains in the interior.

The fluvio-marine deposits consist of clays, sands and on a smaller scale also decayed vegetable matter. The clays and sands may be copiciously mixed with marine-shells. The clays are heavy and, in a dry state, have a bluish-gray or greenish colour, sometimes showing brown spots of iron-oxide. The quartz-sands vary considerably in grain-size (and to the extent to which the grains are water-worn). Fine-grained sands are extremely common. These deposits are formed by the rivers, especially in the rainy season, which carry colloidal matter down to the sea. Where the fresh and salt water mix, the material is deposited.

The clay which the potter used was a cream coloured fat clay with spots of red brown iron-oxide. This clay is called *hibug* by the Palikur. The potter prefers a white kaolin clay which was actually not found in the vicinity of the village and hence she used a second choice *hibug*. It is a very fat clay, which is collected in plastic condition at riverbeds in the surroundings of the village. Young men belonging to the family spend an afternoon to choose and gather good clay, which is not spoilt with too many roots or little granites, from the clayey banks. Whether the clay is suitable enough a small test is performed by the potter at home. A few fingerpots are put in an open (cooking) fire to seek if they crack. If they crack the clay is considered not suitable enough.

The clay presents several technical problems for the use of the coiling technique by the potter. The vessels can easily collapse by the weight of newly attached coils. Due to the excessive shrinkage of a very fat clay it is difficult to fasten the coils to each other. Furthermore, cracks easily develop during drying. By adding non-plastic material or temper to the clay these problems can be prevented. Various non-plastic materials can be used as temper. The Palikur potter uses *kwep* bark.

The potter and her family go together to the forest to collect *kwep* bark. The potter seeks a suitable tree to cut down and to peel off its bark. In order to test the quality of the bark, the potter chops off a piece of bark on which she chews. When the bark piece tastes like "cement", it is suitable and the tree is cut down. The collected bark is then dried, fired, pounded and sieved (mesh: 1 mm). By kneading about two volumes of dry ashes through one volume of clay, the substance becomes more solid and manageable.

The potter uses the coiling technique which is commonly used in all Amazonia (e.g. DeBoer and Lathrap 1979). Coils are made on a flat wooden board and attached to each other and built up. Coils vary in thickness according to the size of a vessel. Once attached to the vessel, the coil is scraped and homogenized with a piece of a gourd. As soon as the vessels had become leatherhard they were polished with a 'maripa'- nut (Fig. 2) and, before firing, slipped with *atamna* (a red clay mixed with water). The woman's husband fired the vessels in an open fire. The vessels are placed on pieces of wood and surrounded with wood along the upstanding vessel until its rim is reached. The wooden tower is lit in the afternoon to speed up the firing process because the northeastern wind sets in and burns till dawn. After firing, vessels are painted with extracts of nuts, barks and other vegetal material, mainly red and black. Palikur decoration motives find their origins mainly

Fig. 2. The leatherhard vessels were polished with a 'maripa'-nut.

in sacred stories and further in religious events and political/social structure. The motives can be considered as pictograms since they have their own specific name in Palikur language (van den Bel 1995). Thus, decoration motives act as a means of communication. The repertoire of the potter is guided by the demand of the inhabitants. She provides the village with jars, bowls, griddles (manioc plates), storage vessels, figurines and toys made of the same claybody.

The SEM analyses (G. H.)

The SEM analyses yielded the following results (Table 1):

The natural clay is a kaolin clay mainly existing of $Al_2O_32SiO_22H_2O$ (Fig. 3). Mineral pollutions make the raw material suitable for the production of pottery. The *kwep* ashes mainly exist of two elements: silica (Si) and oxygen (O) forming SiO_2 (Fig. 4). Therefore, the *kwep* ash (like quartz) is suitable as a tempering material.

Fig. 5 shows the fat structure of the natural clay. The *kwep* ash makes the clay body owning a porous structure (Fig. 6). For the elemental analysis of the clay body the reader is referred to Fig. 7.

	Weight percentage:		
Element	Natural clay	*kwep* ashes	Clay body
Na	1.12	0.19	2.35
Mg	0.93	0.29	1.31
Al	14.05	0.00	10.45
Si	23.69	44.06	24.18
S	1.24	0.70	2.83
K	1.98	0.93	2.32
Ti	0.55	0.48	0.46
Fe	2.19	0.00	3.26
O	54.25	53.34	52.84
Total	100	100	100

Table 1. The elemental analysis of the natural clay (see Fig. 3), the *kwep* ashes (see Fig. 4), and the clay body (natural clay tempered with *kwep* ashes)(see Fig. 7) at 15.0 Kv and 40 degrees in weight percentages.

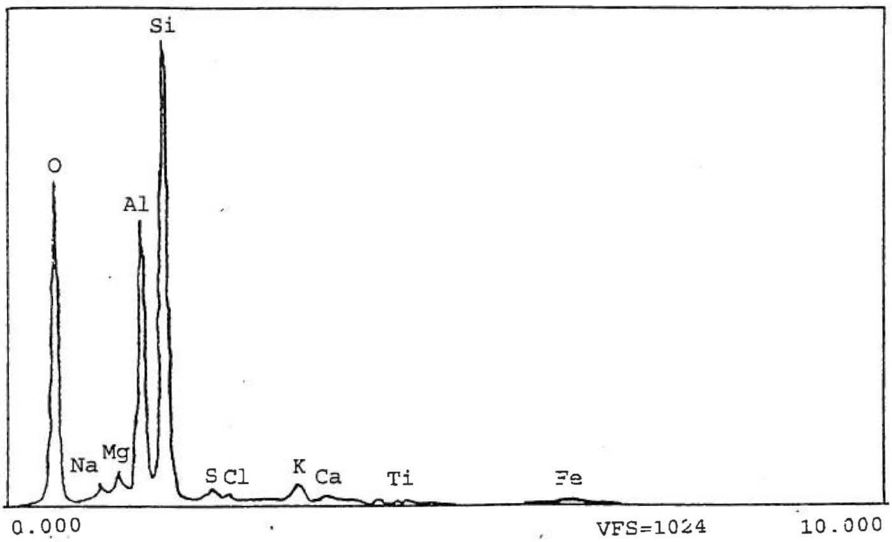


Fig. 3. Element spectra of the natural clay.

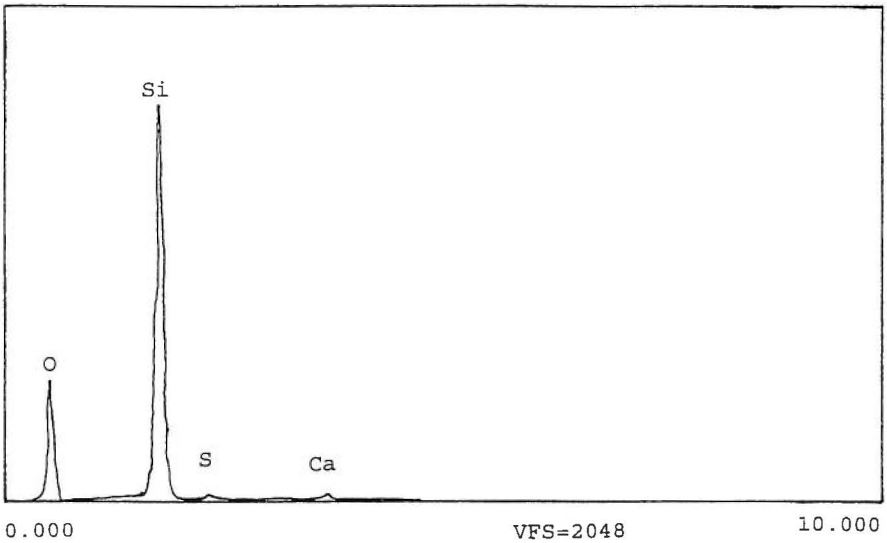


Fig. 4. Element spectra of the *kwep* ash.

Fig. 5. Electrical scan of the natural clay. Enlarged 1.000x at 15 Kv; scale 10.

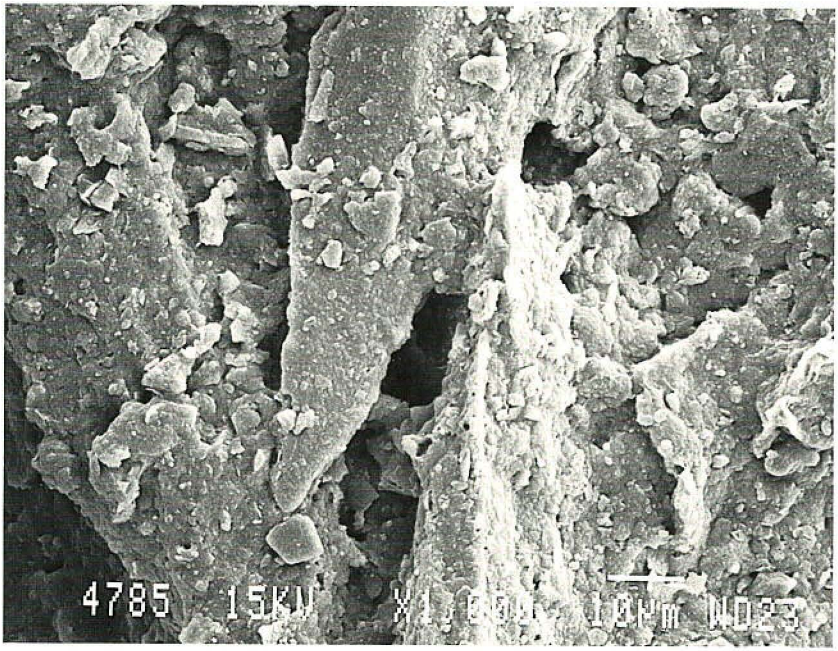


Fig. 6. Electrical scan of the clay body (natural clay tempered with *kwep* ash). Enlarged 1.000x at 15 Kv; scale 10μm.

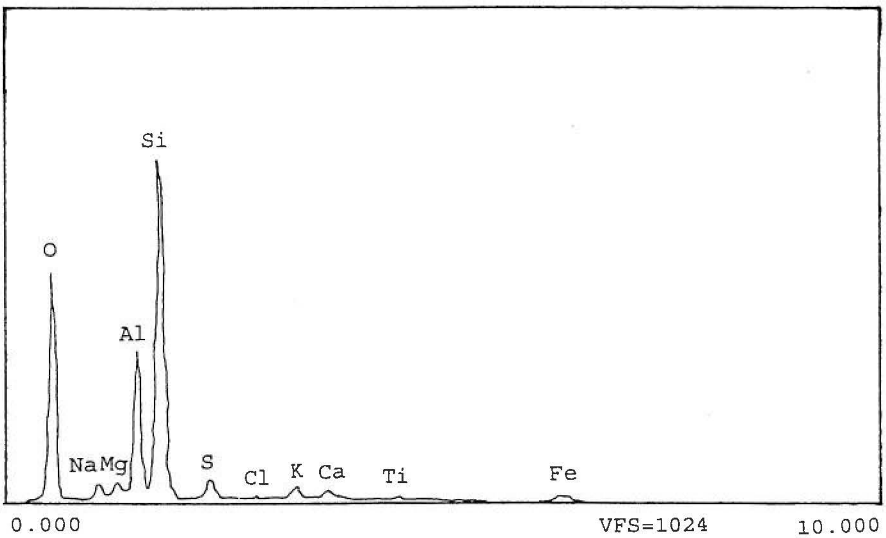


Fig. 7. Element spectra of the clay body (natural clay tempered with *kwep* ash).

Workability tests and porosity tests (L. J.)

Workability tests were carried out with test bars of equal size made of the natural clay, the clay body (natural clay tempered with *kwep* ash: the natural clay tempered with 30% (weight) fine quartz-sand (grain size < 0.3 mm), and the natural clay tempered with 30% (weight) pounded shell-sand (grain size < 1 mm).

The linear dried shrinkage of the natural clay and the snap-strength of the natural clay in bone-dry condition demonstrate that the natural clay used by the Palikur potter is very fat. The linear dried shrinkage of the natural clay is 8.5 - 9%. The test bars warp during drying in the air under normal conditions and tend to crack. The snap-strength is related to the fatness of the clay. The larger the snap-strength, the fatter the clay. The snap-strength of the natural clay is 22 kg per cm^2. The snap-strength of a normal wheel clay is about 19 kg per cm^2.

The dried shrinkage of the clay body is 3%, i.e. a 2/3 reduction of the shrinkage corresponding with the quantity of the added *kwep* ashes. The linear dried shrinkage of the natural clay tempered with the maximum amount of quartz-sand that can be added (30% weight) is 6.5%. The linear dried shrinkage of the natural clay mixed with 30% (weight) dry pounded shell is 5%. Since the mass density of shell-sand is smaller than that of quartz-sand, the volume of the added shell-sand was larger than the same weight of added quartz-sand. For this reason, the shrinkage was reduced more by adding shell-sand than by adding quartz-sand. After firing the test bars the linear shrinkage does not increase.

All test bars made of tempered clay yield a good product at 700 and 750°C. The test bar made of clay tempered with shell-sand does not disintegrate after firing at 700°C, but does at temperatures higher than 750° C.

In a test tube *kwep* ashes appear to absorb about 40% water (weight) before being saturated. This is certainly more than clays can normally contain (only bentonites can absorb more than 50 weight percentages of water). The porous structure of the ash functions like a sponge. By adding the dry ashes which immediately absorb much moisture, the unworkable soft and sticky clay substance becomes kneadable. It is necessary to add approximately two volume units of *kwep* ashes.

The high apparent porosity of the clay-*kwep* ash mixture after firing (34%) approximately corresponds with the high apparent porosity of the two bowls (32%). Normally the apparent porosity of ceramics measures 10 till 15%. For instance, the apparent porosity of the fired test bar made of the natural clay tempered with quartz-sand, is 15%. Since the bowls are polished, the permeability is rather low.

Conclusion (M.v.d.B.)

In principle the Palikur potter has an excellent clay at her disposal. However, the natural clay is too fat for using the coiling technique. The clay has to be tempered. For this purpose the potter uses burnt *kwep*. Since the structure of the ash particles

is open and brittle the water absorbing capacity of the ashes in the clay body is very high (Fig. 8). Technically, this seems to be the most attractive character of *kwep* and for this reason the natural clay becomes immediately more workable after adding the *kwep* ash. Unlike quartz-sand or shell-sand, the porous *kwep* ash enables the clay body to dry fast and evenly. The natural clay tempered with *kwep* ash shrinks less than a clay tempered with a maximum amount of quartz-sand or shell-sand. Although the use of *kwep* ash has certain technical advantages it does not seem the main reason why this kind of temper was used by the Palikur potter.
Since the technical advantages of *kwep* as a temper are little over other tested tempers it seems to be more likely to assume that the use of *kwep* is traditional among the Palikur. How long this tradition has been in use is unknown.

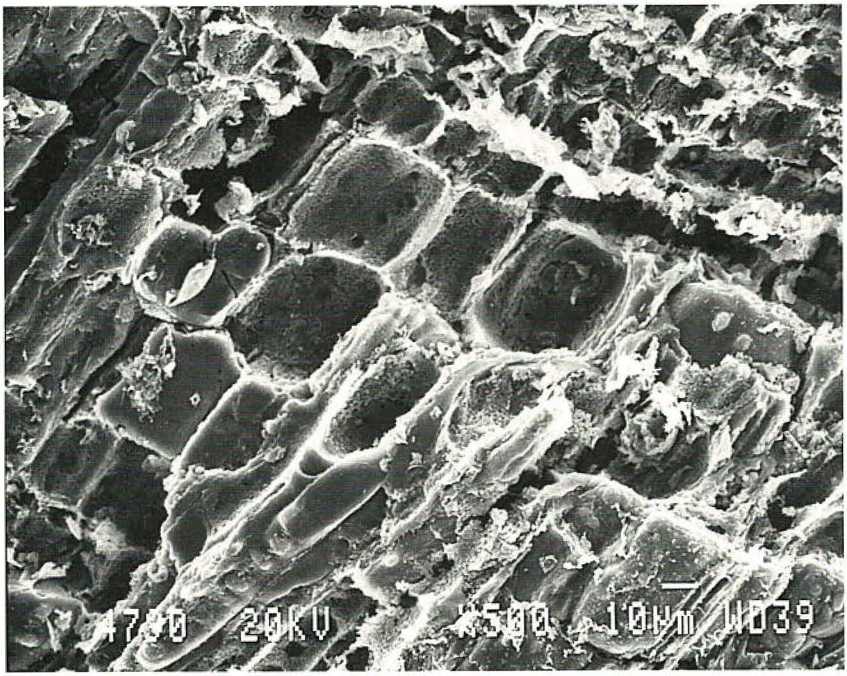


Fig. 8. Electrical scan of *kwep*-ashes. Enlarged 500x at 20 Kv; scale 10μm.

Notes

1. *Kwep* or *kwepi* was determined by Boomert (1986) as *Licania apetela*. This tree belongs to the *Chrysobalanaceae* family and the *Licania* species. It is commonly known as 'caraipé'(DeBoer and Lathrap 1979: 116).

References

Bel, M. van den (1995), *Kamuyune. The Palikur potters of French Guyana.* Masters thesis, Leiden.

Boomert, A. (1986), The Cayo complex of St. Vincent: ethnohistorical and archaeological aspects of the Island Carib problem. *Antropologica* 66: 3 - 68.

DeBoer, W.R. and D.W. Lathrap (1979), The making and breaking of Shipibo-Conibo ceramics. In: C. Kramer (ed.), *Ethnoarchaeology. Implications of ethnography for archaeology*, New York: 102-138.

Grenaud, P. (1987), La cote d'Amapa, de la bouche de l'Amazone à la baie d'Oyapock, à travers la tradition orale Palikur. Boletim do Museu Emilio Paraense Goeldi Série Anthropologia vol. 3 (1), Belém.

Polak, A.M. (1992), *Major timber trees of Guyana. A field guide* (Illustrations by H.R. Rijpkema), The Tropenbos Foundation, Wageningen.

Rostain, S. (1994), *L'occupation amerindienne ancienne du littoral de Guyane.* 2 vols. Thèse de Doctoral. Université de Paris I - Pantheon/Sorbonne, Paris.

Rye, O.S. (1981), *Pottery technology. Principles and reconstruction*, Washington D.C.

IJzerman, R. (1931), *Outline of the geology and petrology of Surinam (Dutch Guyana)*, Dissertation, Utrecht.

M. B. Annis
L. Jacobs
R. F. Docter

ARCHAIC COMMERCIAL AMPHORAE FROM CHARTAGE: A TECHNOLOGICAL ANALYSIS

Introduction (R.F.D.)

Between 1986 and 1993 archaeological excavations were carried out at Carthage by the University of Hamburg under the direction of H.G. Niemeyer (Niemeyer 1989, 1990). At the crossing of the Roman *Decumanus Maximus* and *Cardo X* an area of about 500 m^2 was investigated so as to be able to study the physical appearance of the early Phoenician colony. Here, at the centre of the Archaic city, remains of six houses were found. One of these, named House 1, could be excavated in its entirety. Its successive construction phases were found to date from shortly before the middle of the eighth century B.C. until the destruction of Carthage in 146 B.C. (Niemeyer, Docter *et al.* 1993; Niemeyer, Docter, Rindelaub 1995). The excavations at this site were a direct continuation of the investigations carried out by H.G. Niemeyer at the Phoenician settlement of Toscanos (Niemeyer 1982) on the southern coast of Spain (1961-1986).

As a spin-off of the two excavations a PhD project focussing on transport amphorae from the 8th until the 6th century B.C. was launched (Docter forthcoming). The project had two main aims. The first was to arrive at a classification of Phoenician amphorae from the western and central Mediterranean on the basis of stratified material from Carthage and Toscanos, with special reference to the local productions[1]. The second aim was to compare the two settlements in a functional way, particularly on the basis of their transport amphorae.

The majority of the amphorae was Phoenician, but Greek and Etruscan forms and fabrics were also represented. A preliminary, visual classification of the sherds was made by the excavators. In order to better define this first classification and to explain some morphological and physical characteristics of the sherds from a technological point of view, the different amphora classes were investigated at the Department of Pottery Technology at Leiden (DPTL). The assumed provenances of the different classes also had to be checked. This was done in a thin-section project[2]. The present article discusses only one of the classes of the amphora sherds excavated at Carthage, namely the class termed 'central Italian'.

The earliest layers of the Carthaginian settlement were found to contain many fragments of handmade transport amphorae, which were assumed to have been produced in central Italy (Niemeyer, Docter *et al.* 1993)[3]. This was suggested by

Newsletter of the Department of Pottery Technology (Leiden University) 13, 1995, 53-79.

morphological affinities with later Etruscan amphorae from the third quarter of the seventh century and later, but also by the results of a thin-section analysis performed by F. Durando (Bonazzi & Durando in press). The results of this analysis linked the class with an amphora of central Italian provenance found in T.418 at the necropolis of the Valle di San Montano on Ischia (Buchner & Ridgway 1993). The fact that most of the sherds were covered with a red to reddish brown wash or scum moreover suggested a link with the later *impasto rosso* ware from Cerveteri, which shows this same surface treatment[4]. However, since the dates of the bulk of the fragments from Carthage conflicted with the traditional date for the earliest production of Etruscan amphorae, some doubts arose whether the amphorae had indeed been produced in central Italy[5].

The class was labelled '*ZitA*', which is short for the German *zentral-italische Amphoren*. Five sub-classes were distinguished on the basis of the shape of the vessels, their surface treatment and colour, some visual characteristics of the fabric and its hardness[6]. The stratigraphical position of the sherds, i.e. their chronology, was also taken into consideration. Apart from the sub-class ZitA 1 and the closely related ZitA 2, three more sub-classes were defined, i.e. ZitA 3, ZitA 4 and ZitA 5, which each consisted of relatively few fragments. The ZitA class was represented at Carthage by 1322 catalogued fragments, which had belonged to some 200 vessels. The greatest numbers of sherds were found in the layers dating from the first three phases of the settlement, from about 760 B.C. onwards. A smaller number came to light in layer IVa, from the second quarter of the seventh century, and practically none were found in layer IVb (after 645). Only a very small sub-class, morphologically identical with the Etruscan amphorae produced from the last third of the seventh century B.C. onwards, was attested in later periods. Examples of ZitA amphorae have been found in Latium, Campania, Ischia, Sicily, Sardina and Spain (Docter forthcoming).

The ZitA class was studied by M. Beatrice Annis and Loe Jacobs from the perspective of the manufacturing process and by Geerten Blessing from a petrological point of view. Both investigations highlighted the relatively complex character of this class, compared with the other amphora classes from Carthage that were submitted to the same kind of investigations. The final ZitA classification has benefited greatly from discussions amongst the participants of this project. The present report focusses on the results of the technological analysis performed by the DPTL.

Manufacturing technique (M.B.A. & L.J.)

Forming technique

The vessels classified as 'zentral-italische Amphoren' (ZitA) were made by hand, with the exception of the rims, which were thrown. Traces of junctures showed that the amphora's body was built up in parts. From the fact that the rims were thrown we may infer that a kind of wheel was available for the potters. The vessels were hence manufactured according to a composite forming method, in this case involving moulding, hand building and throwing - a common phenomenon in pottery making.

Reconstruction of the working method

The (scarce) base fragments were both flat and rounded (Fig. 1: a-c). They showed marks indicating that the clay had been pressed into a supporting mould (Fig. 2) which may have been made of pottery or of some other material.

Slabs of clay were then attached one by one to the base, a technique known as slab building or, in the case of smaller pots, morsel building (Rice 1987: 125). The clay was pressed against a support - which was constantly shifted -, spread out and drawn. The support may have been the inside of a large sherd or some tool specially made for this purpose. The soft slabs of clay were spread out by hand and with the aid of a kind of rib. That way the vessel was built up vertically. Near the top of the vessel the wall was then pressed inwards to form the shoulder. The amphora may have stood on a rotating or stationary support while its body was being formed.

The uneven surface of the inside wall showed traces of pressing, smearing and wiping in various directions (Fig. 3: a, b, c). Some junctures were clearly visible and indicated that the clay slabs had been pressed obliquely over one another (Fig. 4). An oblique juncture is favourable for the adhesion of the slabs because in such a way more pressure can be applied to a larger surface. The aforementioned traces also indicated that the clay had been processed while it was still soft, which is again an indication that the wall had to be supported while the vessel was being formed.

Intermittent drying phases will certainly have been necessary, to enable the soft clay to stiffen sufficiently to be able to support more slabs without deforming. As far as the shrinkage during drying and firing is concerned, a clay blend containing a high percentage of non-plastic inclusions, like that which was used for these amphorae, was certainly an advantage. In the meanwhile the potter could work on other vessels of the same kind.

The inside of some sherds showed marks indicating that the potter had used a scraper to thin the wall after a drying phase. This scraper had a curved edge, enabling the potter to scrape the vessel's concave wall. In some cases the marks indicated the use of a scraper with a serrated edge, made of, for instance, flint or obsidian. Of course grooves are also formed in the clay's surface when, as in the case of these amphorae, the clay contains coarse sand grains (Fig. 5).

When the amphora was relatively stiff it was fastened to a wheel, or to a pivoted turntable that was kept in constant rotation. A coil of clay was attached to the shoulder and the rim was then folded outwards to a varying extent while the wheel rotated. As a result, only the rim had the smooth appearance characteristic of wheel-thrown pottery (Fig. 6). The transition from the wheel-thrown rim to the

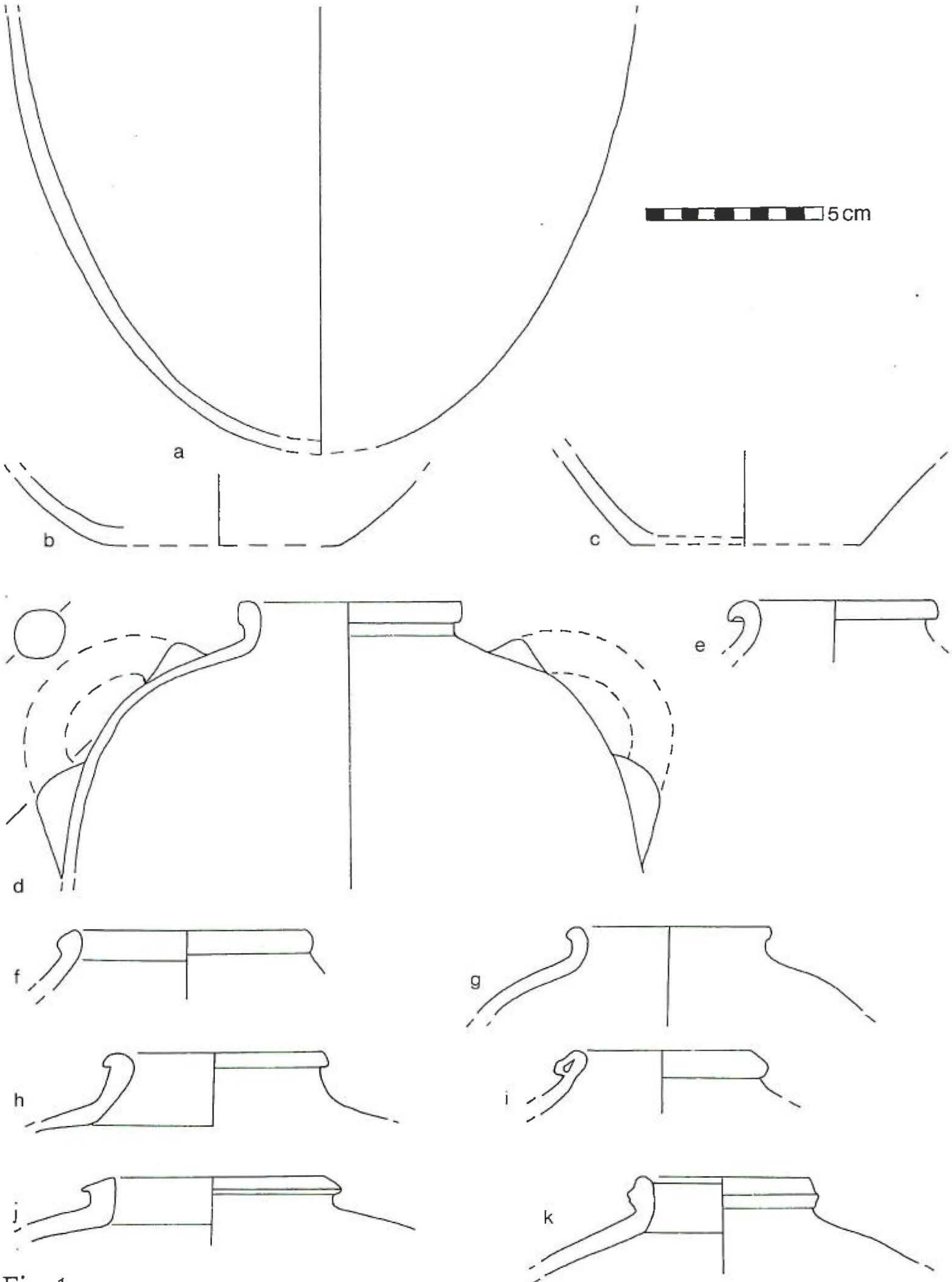


Fig. 1.
Some fragments of *Zit*A amphorae from Carthage: *a-c* base fragments; *d-k* variants in the shapes of the rims; *d* upper part of a amphora showing the attachment of the handles.

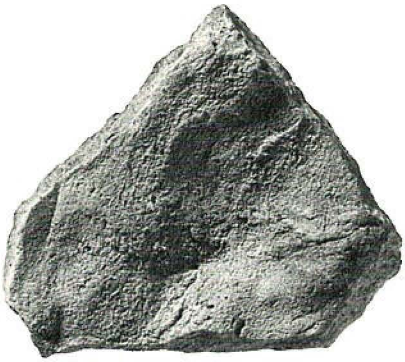


Fig. 2.
Base fragment showing marks caused by pressing the soft clay into a mould (scale 1:0.87).

hand-formed shoulder was often clearly visible on the inside of the vessels (Fig. 7). A number of variants in the shape of the rims are shown on Fig. 1: d-k.

The outer wall of the vessel was then smoothed (Fig. 8) and the handles were rolled and attached to the upper part of the body (Fig. 1: d). Some differences were also observed in the shape, curve and attachment of the handles which, owing to the fragmentary nature of the sample, could not be associated with specific differences in the shapes of the amphorae.

Finally, the potter coated the amphora's outer surface with a more or less liquid slip which he applied with wet hands, or with a cloth, sponge or something similar. On firing, this - ferruginous - slip resulted in a red coating showing traces of wiping in different directions (Fig. 9). Not all the vessels have such a coating. In several cases the red surface seems to be the result of the formation of a layer of scum, due to the presence of soluble iron salts in the clay (Peacock 1984: 263-4.). L. Jacobs (1991/92) established that the formation of scum is also related to the firing conditions. From a technological point of view, the difference between scum and slip is not without significance. A layer of scum has more or less the same effect as a slip: it reduces the pot's permeability. It can also be an element of recognition for the consumers. But unlike scum, a slip implies an extra phase in the manufacturing process (preparing, applying and drying). Moreover, there where the clay of the slip is different from that of the body, it requires compatibility between the two materials. Scum may be formed by chance (as a result of the presence of soluble salts in the clay) or it may be intentionally produced, e.g. by adding salt or brackish water to the clay (Combès and Louis 1967: Pl. IX, 1). David Peacock (1984: 264) regards this phenomenon as an indication of production in coastal regions.

To test the result of this analysis the ceramist L. Jacobs made a replica of the amphora at the laboratory of the DPTL. The blend processed had an amount of non-plastics comparable to that of the ZitA amphorae. The tools used to build up the body were of fired clay and were made by L. Jacobs for this purpose. The vessel was formed on a turntable except for the rim which was thrown on the wheel. The experiment confirmed the reconstruction of the forming technique described above. Some steps of the forming process are shown on Figs. 10-16.

Firing conditions

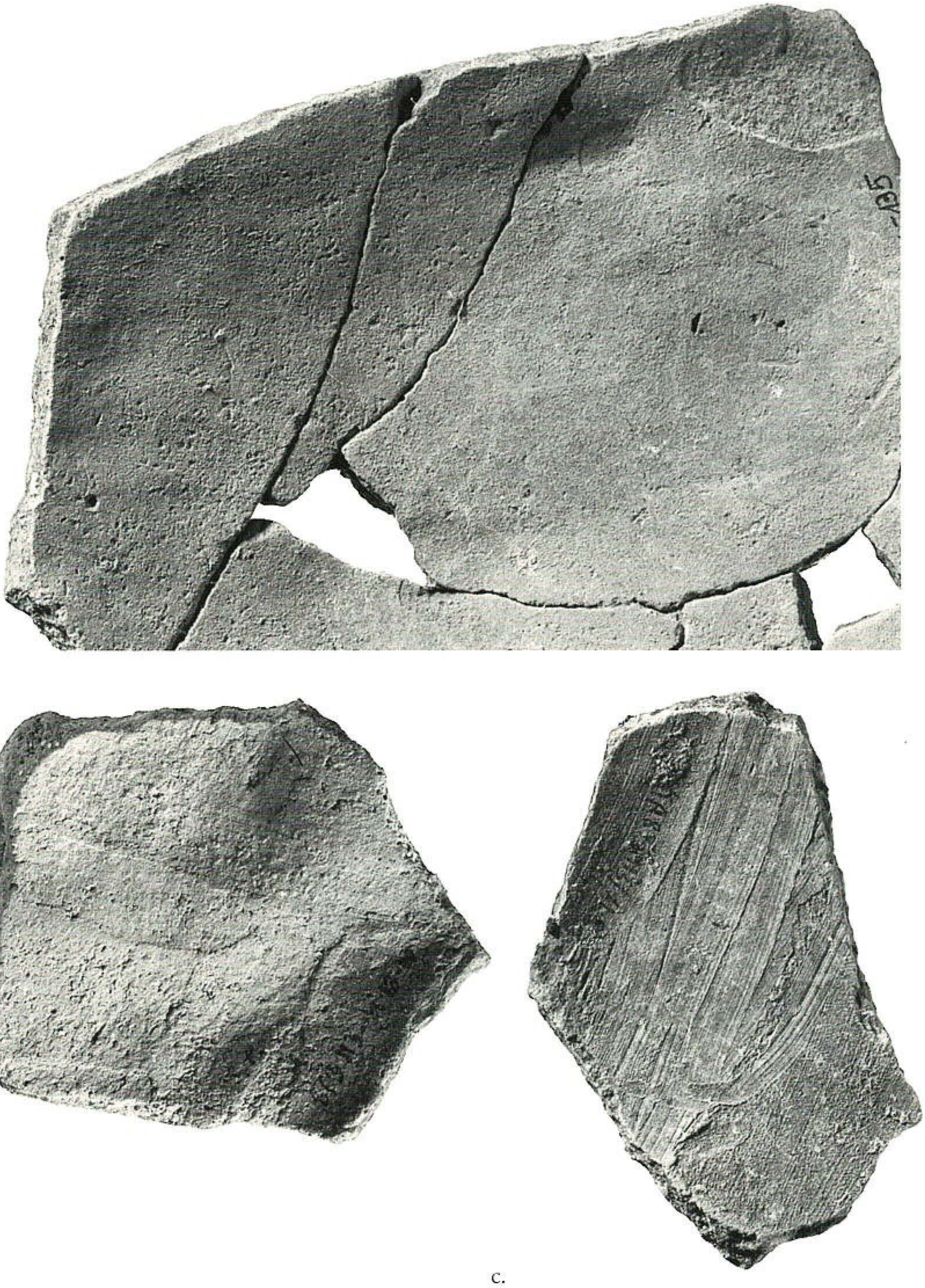
The great majority of the sherds had a grey-black core, while the colour of the surface varied: from reddish-brown to grey or even black. The fabric was well-fired, i.e. the blend had been fired for a sufficient length of time and at a sufficiently high temperature to obtain a fairly hard product[7]. The atmosphere had varied during the firing (oxidizing, neutral and reducing) - a phenomenon usually observed in cases of firing without full control (Rye 1981: 115 and Fig. 104: 3-4). This does not automatically imply firing in bonfires or with clamp method, in which the pottery and the fuel are not separated. The vessels may also have been fired using other kinds of firing structures. As recent ethnografic and experimental work in Africa has demonstrated, various techniques, from open firing to updraft kiln, may produce similar firing conditions (Gosselain and Livingstone Smith 1995: 153-155).

In principle, in the case of the sherds with a light surface and a dark core - the large majority of the finds - the atmosphere during the final phase had been oxidizing and the temperature had been fairly high, but this phase had not lasted long enough to allow the complete oxidation of the organic material contained in the clay[8].

The different steps in the manufacturing process are schematically indicated here below (Table 1). The steps indicated between brackets were not always carried out. As Owen Rye (1981: 4-5) pointed out, these small differences in the sequence of the manufacturing process do not mean differences in tradition.

forming of the base in a supporting mould
building up of the body and shoulder from slabs
[thinning of the wall by scraping]
shaping of the rim on a wheel
smoothing of the outside surface
attachment of the handles
[application of slip]
drying
firing

Table 1. The different steps in the manufacturing process.



a.

b.

c.

Fig. 3.
Marks on the inside surface:
a) and b): pressing and smearing; c) wiping (scale 1:0.87).

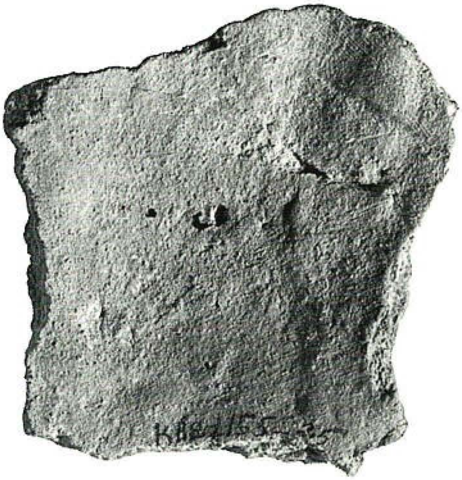


Fig. 4. Oblique junction of clay slabs (scale 1:0.87).

Fig. 5. Drag marks on the inside wall caused by scraping (scale 1:0.87).

Fig. 6. Thrown rim (scale 1:0.87).

Fig. 7. Marks on the inside wall showing the transition from the hand-formed shoulder to the thrown rim (scale 1:0.87).

Fig. 8.
Small grooves closely spaced showing smoothing of the outer surface (scale 1:0.87).

Fig. 9. Traces of red slip on the outer surface of a vessel (scale 1:0.87).

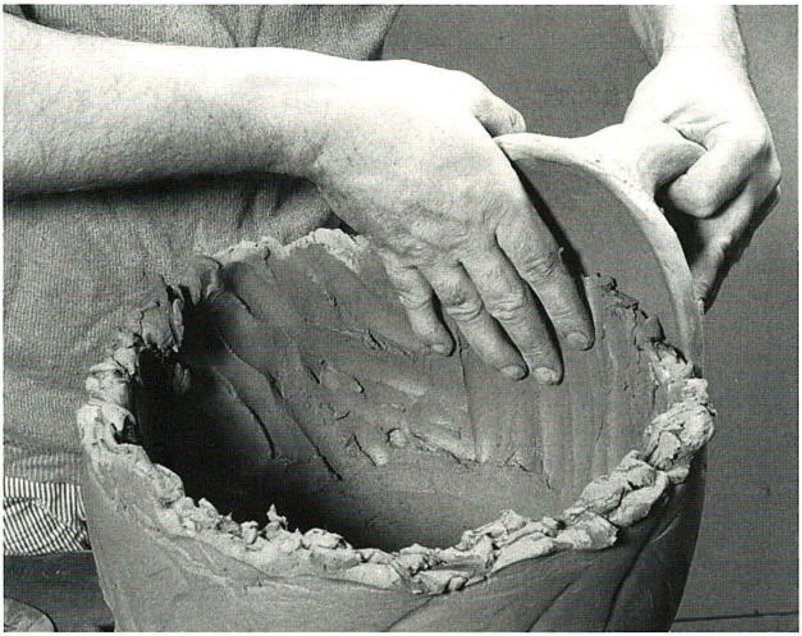
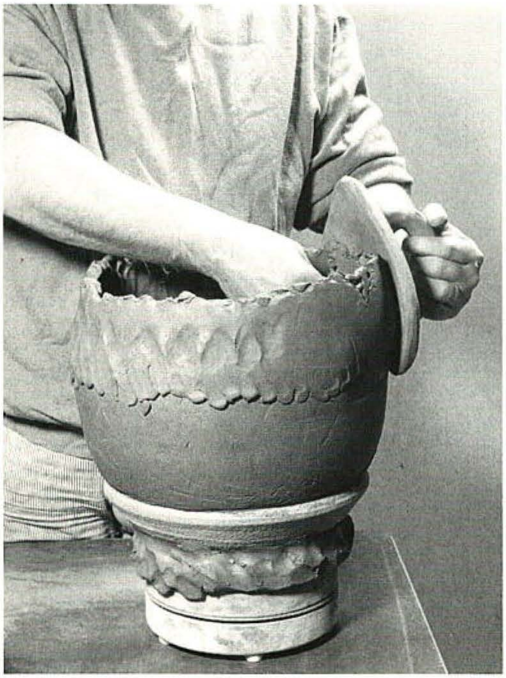


Fig. 10. Pressing and drawing the slabs of clay against an earthenware support.

Fig. 11. Thinning the wall with a rib.



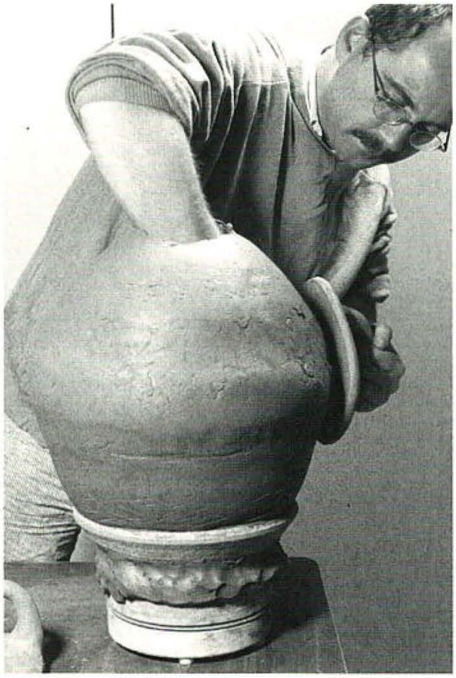


Fig 12. Building up the body.

Fig. 13.
Forming the shoulder by pressing the wall inwards and supporting it on the interior with an earthenware 'anvil'. The marks on the wall will be later erased by smoothing.

Fig. 14. Kneading some extra clay onto the shoulder after a drying phase.

Fig. 15. Throwing the rim.

Fig. 16. Coating the vessel with a slip.

Macroscopic analysis of the fabric

Method

For the analysis of the fabric a selective sample was first taken which consisted of a number of 'diagnostic' sherds (rim and wall fragments and handles). This was prepared for firing tests and thin-section analysis. A random sample of a larger number of sherds was also taken which was intended for purely binocular analysis. The samples analysed were 57 out of a total number of 1322 excavated sherds. The fresh break of the fired and oxidized samples was examined with a binocular microscope (25 to 50x magnification) and each sherd was individually described. A steel needle and a hydrochloric solution (30%) were used as aids in the identification or description of some inclusions: the former to test the grains' hardness and structure, the latter to determine the presence of carbonates (cf. Peacock 1977: 30-32; Stienstra 1986; Orton, Tyers and Vince 1993: 231-242). The grain size was determined with the aid of a scale incorporated in the eyepiece and a reference collection. The latter consisted of ceramic material manufactured at the DPTL, to which certain amounts of sand of a selected size had been added. The aforementioned reference collection was also used to determine the total amount of non-plastic inclusions. This amount was expressed in a percentage that refers to the (known) weight ratio of clay and non-plastics in a dry, unfired condition (Jacobs 1983).

Classification criteria

Different groups of sherds were distinguished in principle on the basis of similarities and differences in a number of properties which together provide a picture of the individual sherds, i.e. the type of inclusions and their size, shape and total quantity and the type of matrix and its colour. The individual groups distinguished consequently differ from one another in qualitative and quantitative terms. The final classification however had also to be justifiable from the potter's viewpoint. In fact the aforementioned properties are not only a means for characterising individual sherds, they also provide information on the tradition behind the production, in particular the selection of the raw materials, their preparation and the behaviour of the blends during processing. This analysis can also yield an indication of the geological character of the region in which the pottery was produced.

The groups

The ZitA amphorae were divided into four groups on the basis of the above criteria: Z1, Z2, Z3 and Z4. Group Z2 was split up into three subgroups. 'Borderline cases', i.e. samples which could be classed in a particular group as far as some properties were concerned, but to a lesser extent with respect to others, are indicated between brackets. Two examples of 'borderline cases' are shown on Fig. 17: c and 19: b.

Group Z1[9]

The sherds that were classified in this group contained a wide range of different types of inclusions, in considerable amounts and poorly sorted, from very coarse to very fine. Group Z1 was originally split up into subgroups Z1a and Z1b on account of quantitative differences: the size and number of non-plastics in Z1a were both larger than those in Z1b (Fig. 17: a,b). However, this difference was ultimately considered irrelevant with respect to the preparation of the raw material and the blend's processing properties in relation to the established manufacturing technique.

Various types of quartzes and feldspars prevailed; micas (muscovite, biotite and phlogopite) and iron oxide concretions and nodules occurred in varying amounts in all of the sherds. Kaolins (altered feldspars), 'dark' minerals - largely amphiboles and pyroxenes -, volcanic glass and tuff were also frequently encountered, together with fragments of different rocks. The latter inclusions - possibly considerably affected by erosion - were rather varied and difficult to identify with the employed analytical method. Fragments of composite rocks and of conglomerates were observed, usually with quartz-feldspar-mica (mainly biotite, but also muscovite and phlogopite), but also with quartz-feldspar-iron oxide and quartz-feldspar-dark minerals inclusions. The colour and hardness of the aforementioned rock fragments differed considerably. A few sherds were found to contain shale and undissolved lumps of clay.

The grain size (Wenthworth-Lane classification: Stienstra 1986) varied considerably. The majority of the non-plastic had sizes between 'very coarse sand' (2000μ) and silt ($< 64\mu$); all intermediate fractions were represented. The largest particles had diameters of no less than 6000μ. They were rather exceptional, but inclusions of up to 4000μ occurred fairly frequently.

Expressed in weight percentage, the total amount of non-plastic matter in this group was between 15/20 and 30%. From the potter's viewpoint, i.e. as far as the clay's manufacturing properties are concerned, this amount is considerable.

The matrix had an open, granular and poorly compact structure. The refired fabric's colours (Munsell 7.5YR 6/4 light brown; 5YR 6/4 light reddish brown) indicated a calcareous-ferruginous clay (Fig. 17).

Group Z2

Characteristic of this group was the conspicuous predominance of quartzes and feldspars over other types of inclusions. Subgroups Z2a and Z2b moreover showed a remarkably good grain size sorting. The types of inclusions were more or less the same as those of group Z1, but, on the whole, they occurred in higher weight percentages. No significant differences were observed in the matrix' colour or structure. The refired fabric's colours were Munsell 7.5YR 6/4 light brown and 5YR 5/4 reddish brown.

Subgroup Z2a[10]

Good grain size sorting: the 'medium-fine sand' fraction clearly prevailed. The fractions ranged from 600μ to silt fraction. Grains of 1000μ were sporadically observed.

The total percentage of non-plastics was between 30 and 35%. From the potter's viewpoint, i.e. as far as the clay's manufacturing properties are concerned, this amount is high (Fig. 18: a).

Subgroup Z2b[11]

The sorting of the grain size was good: the 'coarse-medium sand' fraction clearly prevailed. The fractions ranged from 1000μ to silt fraction. A noteworthy quantity of microfossils constituted another characteristic of this subgroup. The total amount of non-plastic inclusions was approximately 25% (Fig. 18: b).

Subgroup Z2c[12]

Poor grain size sorting. The fractions ranged from 2000μ, very coarse sand (sporadically observed), to silt fraction. A few exceptional inclusions had sizes of 6000μ. The total amount of non-plastics was between 25 and 35% (Fig. 18: c).

Group Z3[13]

This group differed from the others in its relatively low non-plastics content, the smaller grain size and the compactness of the matrix. The red slip was particularly well visible.

As in group Z1, the type of inclusions varied considerably: quartzes, feldspars, iron oxide concretions, micas, altered felspars, microfossils, dark minerals and fragments of different rocks.

The grain size was well sorted and on the whole below 600μ; larger grains were observed only sporadically. The total amount of inclusions was less than 15% which, in relation to the forming technique, is rather low.

The colours of the refired matrix were lighter than in the other groups: Munsell 7.5YR 7/6 reddish yellow; 2.5YR 6/6 light red (Fig. 19: a,b).

Group Z4[14]

This fabric was characterised by almost equal - large - amounts of dark and light inclusions poorly sorted.

As far as the dark non-plastic inclusions are concerned, the majority were pyroxenes. Biotite, manganese and iron oxide nodules and rock fragments were represented in smaller percentages. Among the light inclusions quartzes and feldspars prevailed, but muscovite, kaolin and rock fragments were also well represented. Carbonate grains were observed sporadically.

The majority of the grains were between 1000μ and 100μ, i.e. in the coarse, medium fine and very fine sand fractions. Generally speaking, the upper limit was

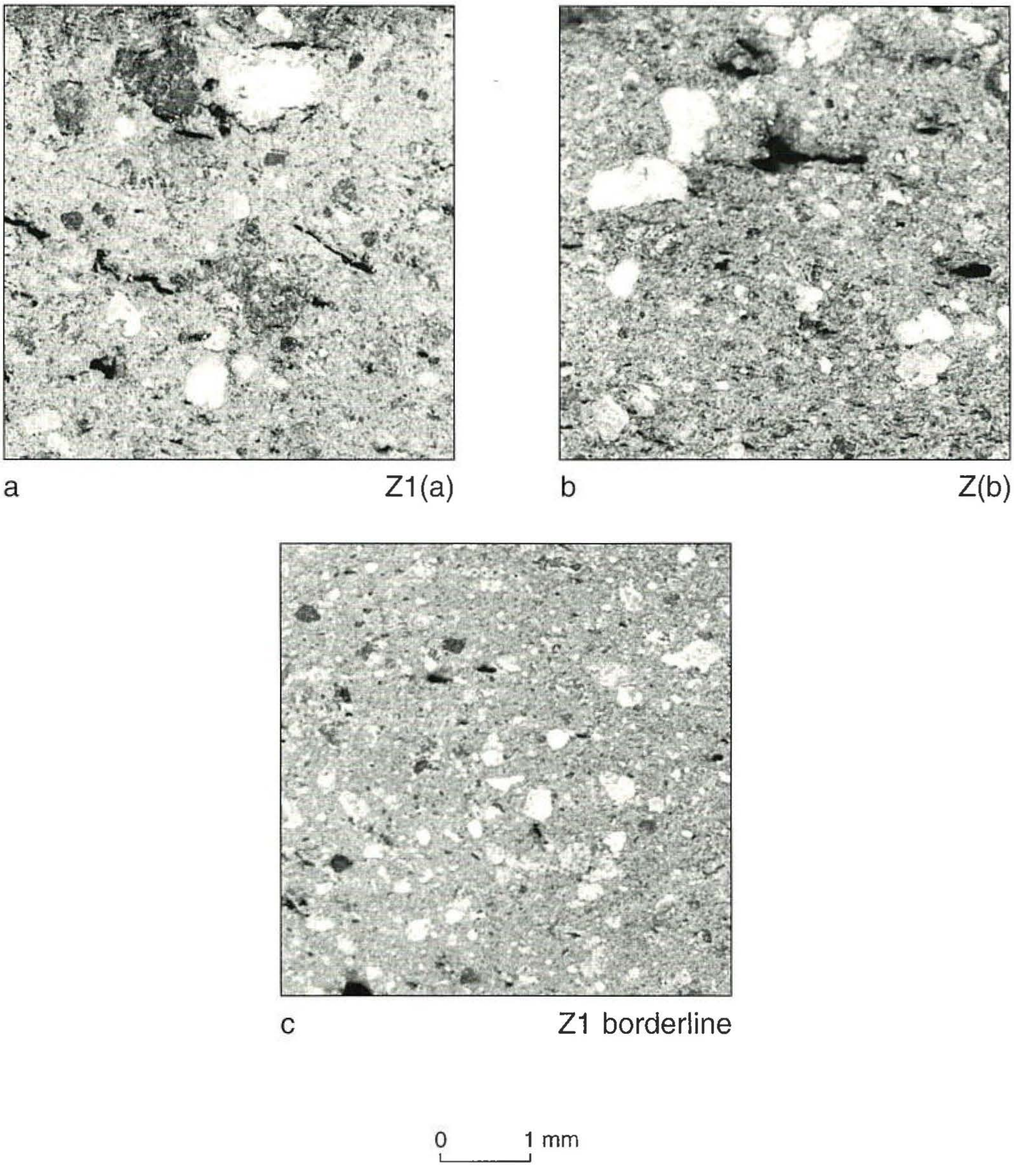


Fig. 17. Macrophotographs (12x) of the fabrics after refiring at 800°C: a) sample 47; b) sample 46; c) sample 38.

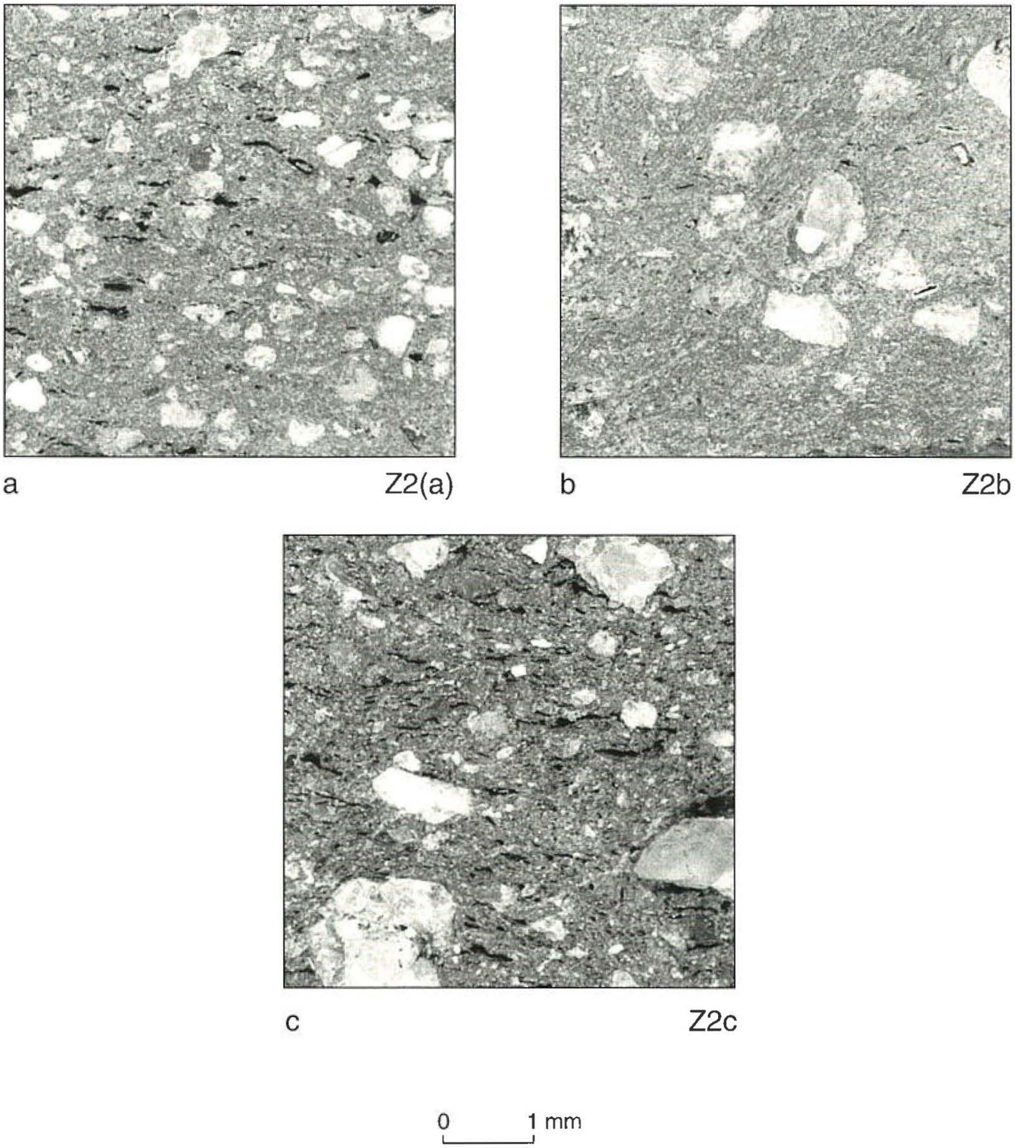


Fig. 18. Macrophotographs (12x) of the fabrics after refiring at 800°C: a) sample 19; b) sample 22; c) sample 14.

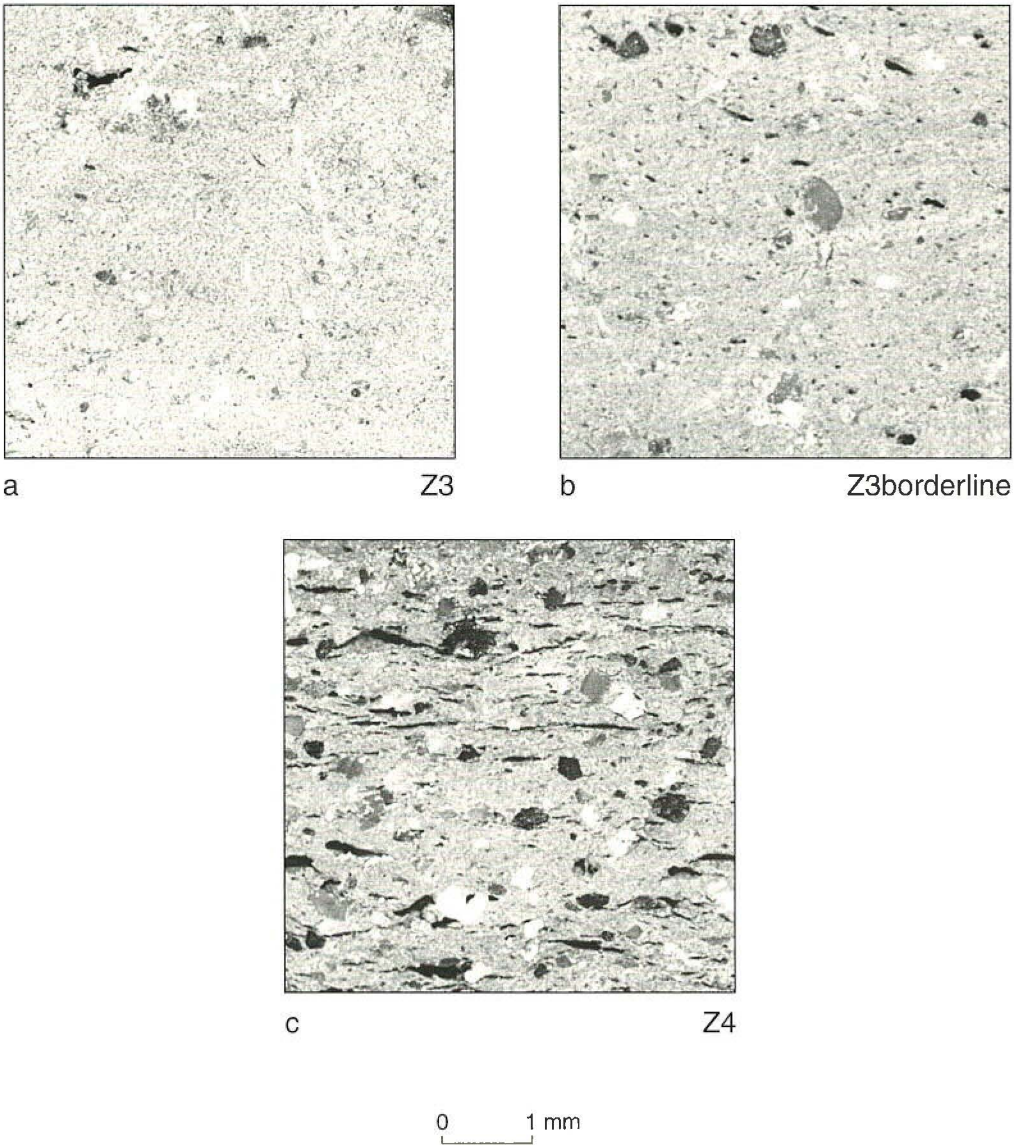


Fig. 19. Macrophotographs (12x) of the fabrics after refiring at 800°C: a) sample 36; b) sample 29; c) sample 6.

2000μ, but a few larger grains (5000μ) were sporadically observed. The silt fraction represented the lower limit. All intermediate fractions were present. The total amount of non-plastic inclusions varied between 25 and 30/35%.

The refired sherd had a poorly compact yellowish red (Munsell 5YR 5/6) or light brown (Munsell 7.5YR 6/4) matrix (Fig. 19: c).

Some additional comments

As already mentioned above, the method used to manufacture the ZitA amphorae can be defined as a combination of moulding, hand building and throwing. The rims do not necessarily have to have been thrown on a potter's wheel. As the experiment has proven, rims like those of the ZitA amphorae - made from a clay with a fairly high temper content which offered little resistance - can also be thrown with the aid of a pivoted turntable which the potter or his assistant keeps in constant rotation. The ethnographic literature contains many examples of well-rotating pivoted turntables with which rims like those of the Zita amphorae could be produced[15]. Manual manufacture with a turntable as an accessory tool would indeed be more in accordance with the central Italic indigenous context, which does not seem to have included the production of true wheel-thrown pottery (Docter *et al.* forthcoming). In theory, however, we cannot exclude the possibility that the potters made use of an instrument with the properties of a fast wheel (Cf. e.g. Hankey 1968; Nicholson 1994; Vossen 1990: 223-228).

As regards the fabric, characteristic of all of the ZitA sherds was the considerable range of different types of inclusions. The sorts of these inclusions are not in contrast with the geological character of the supposed region of provenance. The distribution of the various sorts however varied: in group Z1 the light inclusions prevailed over the dark ones; in Z2 the - mainly remarkably well-sorted - quartzes and feldspars clearly dominated over the other types of non-plastics; group Z4 was found to contain almost equal amounts of light and dark grains (Figs. 17-19).

The total amounts of inclusions and their sizes were also found to differ. The sherds of group Z3 contained the same types of inclusions as those of the other groups - particularly group Z1 - but in much smaller amounts; the non-plastics were much smaller in size too. This was also the only group whose sherds had a clearly different matrix, in terms of both fineness and compactness. The properties of this blend must consequently differ from those of the clays used for the vessels of the other groups. The sherds of group Z3 were moreover coated with a fairly thick red slip. That may be a characteristic of this group, but the sample was too small to be able to verify this.

The shape of the inclusions could not be used as a basis for distinction: all of the hard grains in the sherds of the ZitA amphorae were angular/subangular while all the soft ones were subrounded/rounded. From this it could however be inferred that the non-plastics had not been transported over great distances. The raw material was probably of local provenance, as was indeed also suggested by the variation in grain size, which can be a sign of poor natural selection. The sorting of groups Z1 and Z4 was particularly poor. Only a small number of sherds - those of subgroups Z2a and Z2b - showed a good selection of the non-plastics, but the shape of the grains was again predominantly angular/subangular. Whether this good sorting was the result of natural selection or of the deliberate addition to the clay of a sand fraction - obtained with a sieve - is difficult to establish (Cf. Rice 1987: 406-413). As a fairly tolerant method had been used to form these amphorae, great accuracy in the quantity and size of the non-plastic inclusions in the blend was not of essential importance. The experiments have shown that the clay must preferably contain a certain amount of temper not only to avoid the formation of cracks during drying and firing, but also to prevent that amphorae made of a too fat blend would collapse under their own weight during the forming process. As far as this aspect is concerned, group Z3 differed from the other groups in that it had a fairly low non-plastics content. The sherds of this group were probably made from a clay that shrunk only little without further additions. These qualitative and quantitative differences in fabric are archaeologically relevant as they are related to the interpretation of a ceramic industry (Cf. e.g. Arnold 1971; Arnold 1993: 72-80; Annis 1992; Annis forthcoming).

The groups distinguished by the different researchers match only partially. The discrepancies can clearly be traced back to differences in the employed analytical methods and the associated classification criteria: visual and typo-chronological; technological; petrological. A good example illustrating the benefit that can be derived by simultaneously carrying out different types of analyses is provided by the classifications of samples nr. 1 and 2. Roald Docter regarded these sherds, from a total sample of 12 (belly) sherds, as an independent group (ZitA 4) on the basis of various visual characteristics - in particular their light surface -, the sherds' stratigraphic positions and the results of comparisons with pottery from other excavations. The petrologist Geerten Blessing classified the two sherds as a separate group (Group I) because of the characteristic rock fragments they contained (in particular andesine plagioclase), which could moreover be regarded as indications that the raw material might come from Ischia. On the basis of the technological analysis carried out by the DPTL however, these sherds were included in the group Z1. They could not be classed as a separate group because macroscopically the type of inclusions and their amounts and sizes and the type of matrix and its colour did not differ significantly from those of the sherds of group Z1. The sherds moreover showed no indications of any differences in the manufacturing method; the only difference was the light colour of the surface, but that was insufficient evidence for regarding this (very small) number of sherds as a separate group. The fragments of group Z3 on the contrary, which did not differ from those of subclass ZitA 1 and Group IV in an archaeological and petrological respect, proved to differ considerably from the other samples as far as indications of the manufacturing method were concerned.

All of the ZitA samples we investigated belonged to the same pottery-making tradition. The observed differences in the shapes of the vessels, the raw materials used and the various steps in the production process may be personal (individual potters), topographic (different workshops and clay beds), chronological (changes in manufacturing techniques during the approximately hundred years of the production). Our efforts to discover consistent correlations between the different phenomena so as to be able to accurately establish the various steps in the manufacturing technique used for the different groups[16] were not successful. This was undoubtedly partly due to the small size of our sample. As far as the size of the sample is concerned, a further analysis of a larger number of sherds, particularly of group ZitA 4 (Pithecoussan?) seems to be archaeologically important.

It would also be interesting to investigate the distinction between scum and slip from a chronological and topographic viewpoint, that is, if one wishes to accept the assumption that the presence of scum may be regarded as an indication that the vessel in question was produced in a coastal region.

Some final considerations concern the organization of the industry within which the ZitA amphorae were produced. The products' relatively high degree of standardization in shape and manufacturing technique and the considerable numbers in which they were attested in Carthage, may imply an activity aimed at the distribution of commodities, while the products' substantial area of diffusion implies the intervention of middlemen traders.

According to the model developed by David Peacock, the industry may have been organized on the level of a 'household industry' or a 'workshop' (Peacock 1982: 8-9 and 17-28). However, the possibility of itinerant potters should also be considered. Of course these different modes of production may well have existed alongside one another. For the problems regarding the discrepancy between economic theories and archaeological evidence, David Peacock himself (1982: 26) warned: "the dividing line between workshop and household industry can be hard to discern", while Prudence Rice (1987: 171-172) indicated the weaknesses of the criteria for identifying modes of ceramic production in an archeological record. More recently, in an ethno-archaeological study of contemporary industries in Mexico, Ph. J. Arnold III (1991) has once again stressed the limitations of and ambiguities in the identification of the kind of production organization in an archaeological context and reaffirmed the need for new strategies, in particular strategies focusing on the chronological and spatial organization of the activities.

Conclusions

The technological and petrological investigations proved to be useful complements to the archaeological research. The petrographical analyses led to the conclusion that the class may well have originated in central Italy, as already assumed on the basis of other evidence. Most of the inclusions point to the north of Tuscany, in particular the Colline Metallifere, while some other components match volcanic rocks occurring on the island of Ischia and in the La Tolfa region (southern Etruria). On the other hand, a group of less characteristic sherds might have come from Tuscany, but also from Latium or Campania. Although some regions could be identified as the origins of some of the groups with a greater degree of probability than others, generally speaking prudence is called for in drawing conclusions in this respect (Docter *et al.* forthcoming; Bonazzi and Durando in press)[17].

The reconstruction of the forming technique in turn supports the conclusion that the ZitA amphorae were produced in a non-Phoenician pottery-making tradition. The Phoenicians usually employed the fast wheel to manufacture vessels of this size and function, while true wheel-thrown pottery does not seem to have been produced in the Italic indigenous context at this time (Docter *et al.* in press).

To sum up, several new questions have arisen from this pilot investigation. To find answers to these questions further comparative research should be carried out. The same kind of analyses will have to be applied to larger numbers of ZitA amphorae from different excavations in order to arrive at a better definition of the groups and their spatial distribution through time.

Notes

1. The long-awaited publication of J. Ramón Torres, which deals with the Phoenician and later Punic amphoras of the central and western Mediterranean (Ramón Torres 1995), has recently appeared. Although its geographical scope is comparable, its chronological scope reaches well into the first century B.C. His approach is more general and starts mainly from complete vessels stemming from chronologically less well defined contexts.

2. Dr. A. Ennabli, conservateur en chef du site et du Musée de Carthage, is to be thanked for his generous permission to have a selection of the material temporarily on loan for study purposes. The thin sections were prepared at the DPTL by E. Mulder and were analysed by G.H.J.M. Blessing at the *Rijksdienst voor Oudheidkundig Bodemonderzoek* in Amersfoort. This project was made possible by the generous support of the Netherlands Organization for Scientific Research (NWO).

3. The class was first discussed in a preliminary excavation report (Niemeyer, Docter et al. 1993: 231-234; fig. 12a-b, d-f). The limits of the conventional term 'Central Italian' are expanded here to enclose Etruria, Latium and Campania included the island of Ischia.

4. The similarity was noticed already in 1990 by D. Ridgway (Edinburgh) after autopsy of some fragments. In 1993 *impasto rosso* ware from Cerveteri could be studied in the Archaeological Museum of Milano.

5. A. o. by F.-W. von Hase (Mainz)(personal communication).

6. The observations on the fabric were made using a magnifier (8 x).

7. It is well-known that the oxidation of the iron compounds contained in the clay takes place in an oxidizing atmosphere after all the organic matter also present in the clay has been burned. As carbon shows a greater affinity to oxygen than iron, the iron can only oxidize after any carbon has burned. Under favourable conditions, i.e. if the clay-body has an open structure and it is heated slowly, the carbon may burn at a temperature around 600° C already (Shepard 1965: 21, 216; Rice 1987, 335; Grimshaw 1980: 258, 714). Experiments carried out at the DPTL have shown that when

the clay contains few organic compounds, or when no carbon is formed during firing, any iron compounds present, such as mono- or bivalent iron oxides, may oxidize at very low temperatures if the clay still contains moisture at temperatures around 200-300° C already.

8. This was verified by subjecting the selected sherds to firing tests in an electric kiln: the sherds were fired at temperatures to a maximum of 800° C, increasing by 50°C per hour, the raised temperature being maintained for 30 min. At 600°C the great majority of the samples were entirely or almost entirely oxidized. At 800°C complete oxidation had taken place. The Munsell readings were done by E. Mulder.

9. Sample numbers: 1, 2, 9, 11, 13, 15, 16, 27, 30+41, 31, 33, 34, 35, (38), (42), (43), 44, 46, 47, 49, 50, 51.

10. Sample numbers: 12, 19, 37, 52.

11. Sample numbers: 22+24, 28.

12. Sample numbers: (3), 14, 18, (20), (21), 23, 25, 26.

13. Sample numbers: (29), 32, 36, 39, 40, 45, 48, 53.

14. Sample numbers: 4, 5, 6, 7, (8), (10), 17 and E53. Sample E53, a handle classed as 'Etruscan' which was also included in the analysis, was found to bear a remarkable resemblance to the sherds of group Z4 and for that reason it was classified in that same group. Two other 'Etruscan' sherds included in the analysis showed the same fabric characteristics.

15. Peacock (1982: 26-28) discusses the use of instruments of this type in 'workshop industries'. It is common knowledge that what is important in this respect is not only the type of instrument that was used, but also the way in which it was used: Foster 1959; Balfet 1973; 1984. For experiments relating to this matter see Edwards and Jacobs 1986; Roux and Corbetta 1989; Courty and Roux 1995.

16. In more concrete terms, for example: the selection of the non-plastic inclusions + the use of a scraper + the application of a slip + the firing in an oxidizing atmosphere.

17. It may be possible to identify the region of origin with a greater degree of accuracy by comparing the results with the databank of the *Sezione di mineralogia applicata all'archeologia of the Istituto di Storiz della Cultura Materiale* of the University of Genova and of the *Società Laboratorio analisi e Ricerche Archeometriche (LARA)*, which has been systematically analysing clays and pottery from different Italian regions under the supervision of Tiziano Mannoni since 1969 and now possesses an extensive databank: Mannoni 1982; D'Ambrosio, Mannoni and Sfrecola 1986.

References

Annis, M.B. (1992), Analisi tecnologica di ceramica a vetrina pesante e sparsa da San Sisto Vecchio in Roma. *Archeologia Medievale* 19: 123-178.

Annis, M.B. (forthcoming), Ceramic ethnoarchaeology in Sardinia (Italy): thin section analysis and the potter's craft. *Journal of Field Archaeology* forthcoming.

Arnold, D.E. (1971), Ethnomineralogy of Ticul, Yucatan potters. *American Antiquity* 36: 20-40.

Arnold, D.E. (1993), *Ecology and ceramic production in an Andean community*, Cambridge.

Arnold, Ph.J. III (1991), *Domestic ceramic production and spatial organization. A Mexican case study in ethnoarchaeology*, Cambridge.

Balfet, H. (1973), A propos du tour de potier, l'outil et le geste technique. In: *L'homme hier et aujourd'hui. Recueil d'etudes en homage à André Leroi-Gouran*, Paris: 109- 122.

Balfet, H. (1984) Methods of formation and the shape of pottery. In: S.E. van der Leeuw and A.C. Pritchard (eds.), *The many dimensions of pottery. Ceramics in archaeology and anthropology*, Amsterdam: 172-201.

Bonazzi, A. and F. Durando (forthcoming), Analisi archeometriche su tipi anforici fenici occidentali arcaici da Pithekoussai, Cartagine e Ibiza. *Acta Cádiz* forthcoming.

Buchner, G. and D. Ridgway (1993), *Pithekoussai I. La necropoli: tombe 1-723 scavate dal 1952 al 1961*, Monumenti Antichi Serie Monografica 4, Roma.

Combès, J.L. and A. Louis (1967), *Les potiers de Djerba*, Tunis.

Courty, M.A., and V. Roux (1995), Identification of wheel throwing on the basis of ceramic surface features and microfabrics. *Journal of Archaeological Science* 22: 17-50.

D'Ambrosio, B., T. Mannoni, and S. Sfrecola (1986), Stato delle ricerche mineralogiche sulle ceramiche mediterranee. In: *La ceramica medievale nel Mediterraneo occidentale. (Atti del III Congresso Internazionale Siena, Faenza 8-13 ottobre 1984)*, Firenze: 601-609.

Docter, R.F. (forthcoming), *Archaische Amphoren aus Karthago und Toscanos. Materialvorlage, Formentwicklung und Beitrag zur kolonialen Wirtschaft*. PhD dissertation.

Docter *et al.* (forthcoming): Docter, R.F., M.B. Annis, L. Jacobs and G.H.J.M. Blessing, Early Central Italian transport amphorae from Carthage: preliminary results. *Rivista di Studi Fenici* forthcoming.

Edwards, I. and L. Jacobs (1986), Experiments with stone 'pottery wheel' bearings. Notes on the use of rotation in the production of ancient pottery. *Newsletter, Department of Pottery Technology (Leiden University)* 4: 49-55.

Foster, G. M. (1959), The potter's wheel: an analysis of idea and artifact in invention. *Southwestern Journal of Anthropology* 15: 99-119.

Gosselain, O.P. and A. Livingstone Smith (1995), The Ceramics and Society Project: an ethnografic and experimental approach to technological choices. In: A. Lindahl and O. Stilborg (eds.) *The aim of laboratory analyses of ceramics in archaeology*, KVHAA Konferenser 34, Stockholm: 147-160.

Grimshaw, R.W. (1980), *The chemistry and physics of clays and allied ceramic materials* (4th edition revised), New York, John Wiley and Sons.

Hankey , V. (1968), Pottery making at Beit Shebab, Lebanon. *Palestine Exploration Quarterly* 5: 27-32, plates VII-XVII.

Jacobs, L. (1983), Notes about the relation between filler and clay and filler and shrinkage respectively. *Newsletter, Department of Pottery Technology (Leiden University)* 1: 6-12.

Jacobs, L. (1991/92), Causes for the pale colour of iron-containing, second millennium B.C. pottery from three archaeological sites in Mesopotamia. *Newsletter, Department of Pottery Technology (Leiden University)* 9/10: 7-21.

Mannoni, T. (1982), Present-day knowledge of Mediterranean pottery after ten years of thin-sectioning at the University of Genoa. In: I.C. Freestone, C. Johns and T. Potter (eds.), *Current research in ceramics: thin-section studies*. British Museum Occasional Papers 32, London: 89-91.

Nicholson, P.T. (1994), *The potters of Deir Mawas, a village in Middle Egypt,* Videofilm University of Wales, Cardiff, Great Britain.

Niemeyer, H.G. (1982), Die phönizische Niederlassung Toscanos: eine Zwischenbilanz, In: H.G. Niemeyer (ed.); *Phönizier im Westen. Die Beiträge des Internationalen Symposiums über »Die phönizische Expansion im Westlichen Mittelmeerraum« in Köln vom 24. bis 27. April 1979.* MB 8, 1982, 185-206.

Niemeyer, H.G. (1989), *Das frühe Karthago und die phönizische Expansion im Mittelmeerraum*, Hamburg.

Niemeyer, H.G. (1990), Karthago, Stadt der Phönizier am Mittelmeer. *Antike Welt* 21: 89-105.

Niemeyer, H.G., R.F. Docter *et al.* (1993), Die Grabung unter dem Decumanus Maximus von Karthago. Vorbericht über die Kampagnen 1986-91. *Römische Mitteilungen* 100: 201-244.

Niemeyer, H,.G., R.F. Docter and A. Rindelaub, (1995), Zweiter Vorbericht über die Grabung unter dem Decumanus Maximus von Karthago. *Römische Mitteilungen* 102:475-502.

Orton, C., P. Tyers and A. Vince (1993), *Pottery in archaeology*, Cambridge.

Peacock, D.P.S. (1977), Ceramics in Roman and Medieval Archaeology. In: D.P.S. (ed.) Peacock, *Pottery and early commerce. Characterization and trade in Roman and later ceramics*, London: 21-33.

Peacock, D.P.S. (1982), *Pottery in the Roman world: an ethno-archaeological approach.* London, New York.

Peacock, D.P.S. (1984), Seawater, salt and ceramics. In: M.G. Fulford, and D.P.S. Peacock (eds.), *The Avenue du President Habib Bourguiba, Salammbo: the pottery and other ceramic objects from the site.* Excavations at Carthage: the British Mission I, 2: 263-264.

Ramón Torres, J.R. (1995), *Las ánforas fenicio-púnicas del Mediterráneo central y occidental*, Barcelona.

Rice, P.M. (1987), *Pottery analysis. A sourcebook*, Chicago.

Roux, V. and D. Corbetta (1989), *The potter's wheel. Craft specialization and technical competence*, New Delhi.

Rye, O.S. (1981), *Pottery technology, principles and reconstruction,* Washington.

Shepard, A.O. (1965, reprint 1980), *Ceramics for the archaeologist*, Ann Arbor.
Stienstra, P. (1986), Systematic macroscopic description of the texture and composition of ancient pottery, some basic methods. *Newsletter, Department of Pottery Technology (Leiden University)* 4: 29-48.
Vossen R. (1990), *Reisen zu Marokkos Töpfern*, Hamburg.

H.J. Franken

THEORY AND PRACTICE OF CERAMIC STUDIES IN ARCHAEOLOGY

The following article is a critical examination of the value of pottery typologies as used in the dating of archaeological finds. It has been motivated by discussions and criticisms arising from my pottery reports published in *Excavations in Jerusalem 1961 - 1967, Vol. II. The Iron Age Extramural Quarter on the South-east Hill* (Franken and Steiner 1990).

Bourke has stated that there is no reason to prefer my approach over traditional methodology on "theoretical grounds" (Bourke 1992: 61). Proof for this statement is lacking in his 'review article', and what he means by 'theoretical grounds' is unclear. If these 'theoretical grounds' refer to the methods of making ceramic typologies the way this is generally done by Near Eastern archaeologists then there are only empirical reasons, not explicit theoretical ones. And empirical reasons are "based on practical experience without reference to scientific principles" (Webster Dictionary).

But I will take the words 'theoretical grounds' seriously as they ought to be understood and I shall deal with these grounds in a somewhat philosophical manner.

The idea of explanation

The idea that the archaeologist or the typologist who describes excavated pottery should try to explain his or her observations in order to raise typological studies to a scientific level is not common in Near Eastern archaeology. To describe the shape of a pot or a pot fragment is taken to be sufficient for the purpose of establishing dates for the archaeological levels from which these pots or fragments stem. Whether it is explicitly claimed that typological studies in archaeology are a scientific procedure or whether this is implied in the status which is claimed for those studies, the question arises as to why observation of shape alone, followed by a conclusion about the time of production cannot be said to be based on any known scientific procedure. This question also touches on a more rhetorical one: 'Why is common agreement amongst archaeologists about this procedure not sufficient to justify the activity', or 'Do not the results justify the methods?'

Normally one thinks of science as a scholarly activity which seeks to explain processes that have attracted people's curiosity. In that sense the history of science starts long before rationalistic or logical explanations were possible. For millennia mankind has tried to explain the world and has found sufficient explanation in myth and religion. There have always been two elements of human knowledge of the 'universe' and people's natural surroundings which under the circumstances explained

Newsletter of the Department of Pottery Technology (Leiden University) 13, 1995, 81-102.

the world fairly adequately. One is the practical knowledge of nature and the other element consists of knowledge of the causes in metaphysical terms. The extent of existing knowledge on soils, plants and animals in primitive society has often baffled western naturalists, (Lévi-Strauss 1962), and the wisdom comprised in myth is still the subject of scholarly investigation. Their motivation for concentrating on the environment in such detail, including the processes of nature and the properties of raw materials remains an enigma, but the extent of their knowledge was sufficient to enable these societies to survive. This knowledge, however, was always explained in terms of the numinous and nothing went without such an explanation. Modern science shares with primitive thought this need to explain its observations of natural processes. Whereas in daily life explanation is part of our thinking, this is not of the scientific variety because science tries to develop theories and methods of explanation which in turn may lead to techniques and other practicalities (Weaver 1967).

In science there is no simple answer to the question of what an explanation is. Here we are not concerned with this problem or its history but with the fact that attempts to explain events are a necessary element of all scientific work. If our observations do not generate meaningful questions our work is reduced to a mere playing around with objects. Questions are often determined by the schools where researchers have been educated. Since Petrie we have the question how to date archaeological levels or strata using pottery. This question has dominated pottery studies and has created a purposeful system which, in the wake of the great pioneering archaeologists, has been developed in such a way that it leads to the desired goal, making further questioning of the procedures superfluous. Up to now it has satisfied typologists of pottery to the extent that curiosity has been focused entirely on the end product: the date of the stratum.

In this way two important aspects of scientific research have been neglected. (1) There has been no room for the methodologist who guards the process of typological studies by analysing the logic of the procedures step by step. (2) Methodology and logic, which are in turn the subject of philosophical reflection for which I refer the reader to the relevant literature such as Harvey's *Explanation in Geography* (1969 and later editions).

Typologists of ceramics in Near Eastern archaeology are not aware of the relevance of modern systematic reflection on scientific research. This is regrettable in view of the immense amount of time and labour invested in pottery studies. Whereas research design is an important topic in some of these typological studies, it is not concerned with the problem of understanding ceramics as products of a craft or of the potter and his world but on the contrary almost exclusively focused on an analysis of pottery shapes and on establishing dates. What seems to be a shortcut by following the established track can be shown to be a very misleading method originating from sheer habit, following the trodden paths, or ill-conceived so-called systematics derived exclusively from the existing practices themselves.

In the following I will first sketch what seem to me to be some essential philosophical considerations because such considerations may make us aware of the fact that the observation of pottery is a subjective activity, which can only be questioned by the observer. The existing pottery shape typologies are entirely based on such individual judgements, and there is no uniform or generally accepted system of classifying shapes, let alone the admission that there is a possibility of any kind of abstraction. Then I will further analyse the existing practice of pottery studies in the Near East. Finally I will deal with the question of what particular mode of analysis is appropriate for explaining the essence of pottery. This will inevitably lead to the question of how reliable are comparative pottery studies and what else can one learn from ancient ceramics.

"Hume's Problem"

One of the main issues in the philosophy of science is the question that conclusions drawn from observations of facts cannot be proved to be true on theoretical grounds. In practice this refers to inductive procedures where classifications are based directly on observed features. This question is called "Hume's Problem". Hume argued that the validity of inductive procedures cannot be estabished by logical argument, but only by association. In the introduction to the first book of *A Treatise of Human Nature*, which was first published in 1739 Hume firmly declares his philosophical position:

> "And tho' we must endeavour to render all our principles as universal as possible, by tracing up our experiments to the utmost, and explaining all effects from the simplest and fewest causes, 'tis still certain we cannot go beyond experience; and any hypothesis, that pretends to discover the ultimate original qualities of human nature, ought at first to be rejected as presumtuous and chimerical. (...) But if this impossibility of explaining ultimate principles should be esteemed a defect in the science of man, I will venture to affirm, that 'tis a defect common to it with all the sciences, and all the arts, in which we can employ ourselves, whether they be such as are cultivated in the schools of the philosophers, or practised in the shops of the meanest artizans. None of them can go beyond experience, or establish any principles which are not founded on that authority." (Hume 1984: 44-45).

Magee describes induction as follows:

> "The method of basing general statements on accumulated observation of specific instances is known as induction, and is seen as the hallmark of science. In other words the use of the inductive method is seen as the criterion of demarcation between science and non-science. Scientific statements - based in short, on the facts - are contrasted with statements of all other kinds, whether based on authority, or emotion, or tradition, or speculation, or prejudice, or habit, or any other foundation, as alone providing sure and certain knowledge." (Magee 1977: 19).

Thus for instance the concept of fossil-type sherds or pots is typically based on induction; 'it has been demonstrated that fossil-type sherds can date an archaeological level', is such an inductive statement. Hume maintains that there is no theory that can demonstrate the truth of the statement and nobody since Hume has been able to demonstrate that Hume was wrong. It is not the accumulated empirical knowledge itself that is primarily questioned but it is the fact that there is no way to verify empirical generalisations which has worried both philosophers and scientists, because it takes the force out of any defence of their position. For instance when Bourke claims that the excavations at tell Nebi Mend begin "to answer the pressing need for reliably stratified local typologies from the inland region of the northern Levant" (Bourke 1993: 192) this is true to the extent that when successful it allows archaeologists to arrive at chronologically refined conclusions within the framework of their system, but says nothing about the validity of the results or the reliability of the procedures. Such typological systems build on empirical knowledge, and trust the results of accumulated evidence to such an extent that the need for explicit theoretical or scientific expression is not even felt.

However, a theory or 'theoretical grounds' is required when scientific status is claimed for applied methods. As an illustration one may point to the difference between the activities of collecting stamps as a hobby and collecting pot sherds from archaeological excavations. In the case of our stamp collector it would be improper to criticize the fact that he or she is only collecting stamps commemorating the great feats of aviation, or only those depicting butterflies. There is no theory to evoke any criticism. But collecting pot sherds in archaeology pretends to be a more serious business and one is allowed to criticize the way the archaeologist goes about his job of collecting and comparing sherds; see for instance Bourke (1993: 166-167), who sets off the value of coarse ware typologies against the type fossil concept. His six points mentioned under the heading "Methods and Aims" describe only technique and aim, but not method or theory in the systematic sense of these terms. They are in fact canons derived from a system but they cannot justify that system. They do not explain pottery nor indicate what can be done with ceramics. Such principles or ideas should be stated on theoretical grounds. Our observations of 'facts' are always influenced by ideas or theories or previous experiences which are normally not made explicit. Well-formulated theories counteract these unwanted 'deformations' of our observations.

Feyerabend quotes Nagel in his chapter on *The Structure of Science.*

> "Structure, says Professor Nagel, takes its ultimate point of departure from problems suggested by observing things and events encountered in actual experience. ...It aims to understand these observable things by discovering some systematic order in them i.e. by explaining them. It is this desire for explanations which are at once systematic and controlled by factual evidence that generates science. ...Understanding the structure of science, therefore, means understanding the structure of scientific explanations." (Feyerabend 1981: 62).
>
> "A science that is interested in analysis uses theories for describing the 'hidden' processes which constitute the observable traits. Such theories must be rich enough to express the specific features of the individual processes, and they must also be capable of giving an account of the manner in which all these processes collaborate and bring about the overt traits and observational facts to be analysed. In other words, they must provide statements and laws suitable for expressing those facts. Of course, the statements need not repeat what was said about the facts at an earlier time. ...The earlier formulations will usually

> contain the gross reactions of the observer and the crude beliefs emerging from them and it is just such beliefs one wants to exclude. All that is needed is that the order introduced into the observable material by the theory be comparable, both in complexity and in effectiveness, with the order established by the concepts and laws already in use."(o.c., 55).

What is meant here by theory and how does a theory obtain scientific status? One could say that a theory is a general statement, and there are two kinds. (1) General statements can be based on accumulated observations of specific instances: in the past A was always followed by B and therefore this will also be the case in the future. 'In the past the sun has always risen in the morning and of course it will rise tomorrow morning'. The conclusion seems logical and the process is known as induction. This is the kind of general statement that constituted Hume's problem. (2) The other kind of general statement refuses to have anything to do with induction. Such statements originate from an awareness that observed facts do not all fit in an existing general statement, there is conflicting evidence which demands revision of the prevailing one. Attempts at revision "involve the propounding of theories which, if they are to provide possible solutions at all, must go beyond our existing knowledge, and which therefore require a leap of the immagination" (Magee 1975: 26). The first kind of statement is static because it is not liable to be the subject of revolutionary changes, it builds on observations and finds regularities which it considers to be patterns governed by inner logic and its explanation is often based on myth. The second one is more dynamic, risking permanent uprooting and restating because it is looking for logical explanations. Popper came to define the scientific status through his study of the early Greek philosophers.

> "I thus felt that if a theory is found to be non-scientific, or "metaphysical" as we might say, it is not thereby found to be unimportant, or insignificant, or "meaningless", or "nonsensical". But it cannot claim to be backed by empirical evidence in the scientific sense - although it may easily be, in some genetic sense, the "result of observation".(Popper 1975: 37-38).

Thus there are naive theories, they may tell the truth or may not and there seems to be no way to decide the issue. This is not the case with scientific theories, which although they also cannot be verified, can be falsified. A general statement obtains scientific status not because the issue can be decided by it, but because it can be critically examined or falsified and replaced by a more reliable statement. How does this apply in the case of traditional pottery studies?

The typological system in Near Eastern archaeology

The typological system still in use in Near Eastern archaeology has not been described explicitly by its users. It is however clear that Near Eastern archaeologists work in isolation from the developments in typological studies in other parts of the world. It is in view of these developments that it is necessary to define explicitly in a theory what the Near Eastern archaeological system comprises and aims at. But any attempt at such a definition proves to be unsatisfactory. Archaeologists disagree on many areas of typological studies. Bourke discusses the problem of typologies based on complete pottery shapes versus tell-derived sherd typologies, and the weak stratigraphic basis for the latter in many reports (Bourke 1993: 164). It is clear that many typological studies are based on selections of pottery that are not necessarily represenative for an assemblage found in a stratum. However it can be said that the overall purpose is to arrive at a date for the pottery and the level or stratum in which it is found. The system consists roughly in sorting out which diagnostic features are thought to be important for that purpose. Thus the typologist defines types, describes his observations on the morphological features and other elements, orders the types into sequences and compares these with similar sets from other sites in order to arrive at chronological dates, the axiom being: these sherds with such features always indicate such a date, or in short: B always follows from A. However, that this is 'always' the case can only be demonstrated by means of a statistical argument and not by simply quoting cases where the conclusion seems to be true.

This is a description of how typologists go about their work and what they aim to achieve, but not a definition of the system on theoretical grounds. The process does not justify itself as is sometimes thought. Regardless of the flaws in the work of the individual typologist, these studies are based on induction as are the improvements which are gradually applied. What is lacking in these activities is: 'the aim to understand those observable things by discovering some systematic order in them'.

It would be trivial to quote Hume's contention that in cases of the observation that B always follows A in all known cases there is no possibility of demonstrating a causal relationship between A and B. Or when the archaeologist observes that a class of pottery is always found in the 12th century B.C. it cannot be demonstrated that there is a causal relation between class A and the 12th century. This would be a triviality in so far as that it does not seem to affect existing practices. Is it not true that in all known cases of excavations where this class is found it has been demonstrated one way or another that the stratum dates from the 12th century, and so one has an archaeological tool that does what it has been designed for: the finding of this pottery class shows that we have reached 12th century levels in the excavation. (This is an idealization of current opinion; in practise not even the possibilities of the statistical probability argument are used in support of this view.)

Hume's point has, however, far reaching consequences. It interferes at crucial points with the existing 'theory', quite apart from the question of how the connection between class A and the 12th century date has been constructed. "Hume's Problem" has been found to be unsolvable. Russell begins his chapter on Hume's philosophy by saying: "I cannot but hope that something less sceptical than Hume's system may be discoverable." (Russell 1979: 634). "Hume's Problem" is not a purely philosophical problem because once aware of its sting it stimulates a serious search for more certainty about the results of one's work. At this stage one can hardly talk about 'theoretical grounds'. And also no matter how advanced the inductive reasons are there is no escape from the verdict. It is philosophy that has shown how to proceed from this point and this involves in our case undermining the archaeological practice.

Popper has argued that the inductive method is not an answer to "Hume's Problem". In his *Objective Knowledge* Popper formalizes Hume's language and while discussing Hume's position and Russell's attempts to escape from its consequences he suggests a way out of this problem of induction (Popper 1975: 5). To attempt to prove the truth of a theory or justify our belief in a theory is to attempt the impossible. But what we can do is to justify our preference for one theory over another, in other words we can question a theory on the basis of which facts are interpreted when other facts are discovered which contradict the theory.

Thus the assumption that fixed connections exist between certain types of pot sherds and time is based on our observations and we say that the 'theory' holds until observations are made that contradict it. The theory can be tested by widening of the observations, by further testing of stratigraphic evidence, or when it can be demonstrated that observation of the pottery production system invalidates some of the accepted canons of the theory. Such testing can not be done, and it is important to see this, by using theories or suppositions within the existing method. These can only confirm the observations. To refute or criticize other people's observations need not affect the theory.

Lakatos and Kuhn have argued that the theory which is at the heart of the matter should be preserved as long as possible. These philosophers base their arguments on examples taken from physics and astronomy. Feyerabend has shown in his article 'Consolation for the specialist', published in 1981, that restricting this to these sciences was not Popper's intention. While discussing the positions of Kuhn and Lakatos, Feyerabend extracts three important points of view which seem to bring the philosophy of science into a humanistic context by the synthesis of two important "discoveries". These are Popper's discovery that science is advanced by a critical discussion of alternative views. Kuhn's discovery of the function of tenacity which prevents us from dismissing existing methodologies, theories or principles on naive falsification procedures. And thirdly, a more general principle, is the proven psychological or habitual resistance of well-entrenched positions to change. Feyerabend summarized the method of falsifying the 'standards and canons' and their underlying theories as follows: "Science proceeds by identifying problems and solving them with the help of hypotheses which are (a) relevant, (b) falsifiable and (c) richer in content than the descriptions from which the problem arose," (Feyerabend 1981: 22). This procedure he calls "a rule of thumb".

History of the present typological system

I have already stated that there is no comprehensive definition of the traditional typological system based on theoretical grounds. This is an old complaint. London refers to Badè, who in 1934 noted that archaeologists generally failed to discuss their methods and aims, thereby preventing others from assessing their conclusions (London 198: 34). Instead one has to turn to the explicitly stated, or more often implicitly assumed, to draw up a list of reasons for the typologist to go about his work the way he or she does. First I give a short survey of what is at the root of the method. London has devoted a chapter called 'A history of ceramic analysis in Israel' to it in her Ph.D. thesis, (London 1985: 8-80), which seems to be the best documented survey of the subject yet. She describes the period between 1955 and 1970 as "an incubation period for the developments that appeared in print in the following decade" (o.c., 53). Such developments were initiated by Anna O. Shepard and Frederick Matson and

> "Mineralogical and compositional studies were undertaken with greater frequency, but in most instances pottery was used to refine the chronological sequence and the understanding of regional differences as in the previous decades" (o.c., 54). "The archaeologist's ceramic expertise in identifying diagnostic sherds to provide an appropriate date remained the criterium for proper dating and the primary emphasis of ceramic analysis centering on chronological issues did not alter substantially". (o.c., 57).

Even though new research techniques were introduced they served the purpose of refining typologies, although demonstrating that the subjective element in comparative pottery studies could be reduced. There were also the technological studies aimed at reconstructing the craft, initiated by Kelso and Thorley, and Matson, as well as the first attempts to use pottery studies to solve problems related to social organization and human behaviour.

Definition of the assumptions

The following assumptions can be said to underly the current practise of the typological system including the search for parallels or 'parallel quoting'.

1. A pottery 'type' is defined by a description of morphological features. A pot that answers such a description belongs to that type. A pottery type is basically and sufficiently defined by its shape description.
2. A pottery type can be divided into subtypes by the observation of slight deviations from the standard form.
3. From an assemblage one can select pottery that occurs during a short period only, called 'type-fossil' sherds, to be used in comparative studies.
4. It suffices to use 'type-fossil' sherds in these comparative studies of pottery found in a culturally or ceramologically well-defined area and period.
5. Comparative studies are reliable for dating purposes when 'type-fossil' sherds of two or more sites are compared.
6. Refining the accuracy of the typology of the 'type-fossils' leads to refined chronological conclusions.

From these assumptions one could construct a theory that can be formulated as follows:

Properly selected 'type-fossil' ceramic vessels or fragments of such vessels (=diagnostic sherds) belonging to the assemblage of pottery of one archaeological stratum or substratum which is firmly dated by internal or external evidence, when compared with, and found to be identical to a similar selection of pottery from a (sub-)stratum excavated on any other site, provides a firm date for that stratum or substratum.

The description of the theory given above can be shortened to a more general statement: 'There exist pottery types which possess time-sensitive attributes'. When taken literally the expression is blatantly nonsensical, (as long as archaeometry has not developed generally applicable methods for the close dating of ceramics), but I may be forgiven for using it metaphorically and as shorthand.

Discussion.

One important issue concerning comparative studies is lacking in the description of the procedure. Comparing situations requires that not only what is present in one or more groups is compared, but also that what is present in one group but missing in one or more other groups from the sites that are compared, is mentioned. Comparative studies often omit this and this makes their results rather uncertain. Groups of pottery that are to be identified on the basis of the identity of other groups, as defined by the 'fossil types', require a good deal of similarity to be called 'identical'. How similar they are can only be established if what is absent in certain groups is also known.

I will now discuss some practical aspects to argue that this theory cannot be refuted using any or all of the assumptions on which the theory is based. Within the framework of the assumptions there are no means to escape from its inner logic, since there is no contradiction between the assumptions. It is a closed system.

The notion that some pottery has 'time sensitive attributes' cannot be asserted by simply analysing the shape of pots. These attributes can only be discovered by a complex process of scrutinizing shapes of pottery from assemblages, comparing them with those of other assemblages and deciding what the firmly established dates are, which must be found independently from that study and which constitute the point of departure.

A good illustration of this are the attempts to date Iron Age levels at Samaria. Here Kenyon was allowed by the expedition leader J.W.Crowfoot to introduce the stratigraphic method of excavating a site and to publish her stratified pottery groups (Crowfoot 1957). She established dates for the strata that were provided by the history of Samaria as described in the Old Testament. Her stratified and dated pottery groups served as fixed points in time that were used for the dating of finds from other sites. Tappy published a reconstruction of the stratigraphy and provenance of the pottery which was largely based on Kenyon's notes and drawings made in the field (Tappy 1992:15). Tappy showed that some of the dates attributed to the pottery had to be revised. Kenyon had already been attacked on several occasions after the publication of *Samaria Vol. III*. However Tappy created a more serious case. He rejected in fact Kenyon's "fundamental dating/depositional principle and her terminology in the final report" (o.c., 99). In his paragraph about 'Methodology' Tappy wrote:

> "We offer our stratigraphic correlations and comparative ceramic parallels in the following chapters under the overarching assumption that no site to date has been flawlessly excavated, recorded and reported. Errors of methodology,

judgement and, at times, even authorial bias have inevitably entered the literature at points." (o.c., 11).

Tappy has performed his 're-excavation' of Iron Age Samaria with skill, but does his "overarching assumption" help us in any way to overcome the problems he indicates? How serious are these problems and to what extent do they influence the results, that is the dates one arrives at using this study method? Will there ever be a site that is flawlessly excavated, recorded and reported? Will there ever be a time when "errors of methodology" belong to the past? Moreover does Tappy not make the same methodological mistake as Kenyon by applying circular reasoning?

Kenyon established dates for the Samaria pottery on the basis of literary evidence. Omri the king bought a hill called Samaria from Shemer for two talents of silver after which Omri built on the hill and called the name of the city which he built, after the name of Shemer, owner of the hill, Samaria, (1 Kings 16,24). Shemer would not have sold a hill on which there stood a village, and therefore Kenyon was satisfied that it was an unoccupied hill and the first pottery to appear on that hill must date from the foundation of the new city. Or, if B, the date of the stratum, is known, then A, the date of the fossil-type sherds can be deduced from it, and when A is firmly established in this way, it becomes a reliable tool for dating levels at other sites. But why should an uninhabited hill not have been inhabited at an earlier time? Or why could the hill not have been inhabited at the time it was sold to Omri? Simple questions indeed which do not really impinge upon the trustworthiness of the historical note. A fundamental and penetrating critique on the misleading nature of literary sources as an aid to the interpretation of archaeological finds can be found in Eggers (1959, Kap.V). Such use leads almost inevitably to circular reasoning which was stimulated rather than eliminated when Albright suggested the 'dovetailing' of historical and archaeological finds as a means to illuminate both the Biblical texts and the archeological finds.

As Tappy managed to sort out the dates of the Samaria pottery, Ussishkin managed to sort out the dates of the Lachish levels III and II. But we are still left with the problem: how could it be that pottery experts like Albright and Kenyon noticed so few differences between the pottery from Lachish levels III and II that they concluded that these could not be a century or more separated from each other, whereas Aharoni *cum suis* found such important differences that they concluded that there had to be a century or more between the two. Would Bourke's plea for statistical evaluation of the samples of pottery remedy such misjudgement by experts (Bourke 1993: 167)? Can expertise or statistics eliminate these hidden elements of circular reasoning? Petrie dated his finds at tell Hesi by the Egyptian imports that could be dated according to the Egyptian chronology as it was known in his day. At least this evidence was of a chronological nature. (cf. Eggers 1959, Kap. II und III). But since the dovetailing method has become normal practice in archaeological research the circularity of the argumentation has prevailed. Because the value of much of the historical information cannot be established beyond doubt, much of this information may not say what typologists thought it does. Some seem to have read the text as if it describes a well-known landscape in which they feel at home, attributing dates to sceneries which are by no means certain. Some forgot that the biblical map is not a geographical map and that identifications of sites may be totally mistaken. Is it still possible to eliminate all these uncertainties and circular arguments from the system of dating? (Cf. Eggers, o.c. Kap. IV). Lapp remarked:

> "The heart of these (excavation reports) provided sufficient plans, sections and commentary to make an independent assesment of the evidence. Even this involves an element of circular argument. The selected groups are used to clarify our understanding of normal ceramic typological development after they were selected as typical representative groups in the judgement of the author". (Lapp 1970: 244-246. Cf. Martin 1976: 86; Finkelstein 1988: 271).

Quite apart from these doubts, is this dating system not one that is completely closed in itself since it confirms itself at any step taken by the typologist, no matter whether the step is a good one or a bad one? There are no discoveries contradicting the assumptions. A sherd known as indicating the twelfth century found in a tenth century context does not upset the system, the sherd is said to be intrusive, or attribution to the level is uncertain, or the level may be a mixed layer, and so on. It seems that this system can be refined endlessly because there are an unlimited number of possibilities both in new excavations and in reworking existing typologies from published excavations, without ever becoming more reliable.

From inside the method one cannot question the general statement: 'there exist pottery types which possess time- sensitive attributes', because that is the theory or axiom on which the existence of the system depends. Like all closed systems, whether in archaeology, theology, philosophy or any other discipline it lives its own life. Such systems often exist side by side with other systems, and they cannot be reconciled because they are founded in ideas, convictions or dogma's which cannot be shaken by criticism from outside, which is considered to represent disbelief. And sceptics are inferior to believers, because they do not know their pottery.

Practical reasons for doubt

While performing one's research using, and also thinking about the established and generally accepted canons one may become increasingly aware of inconsistencies in the theory or of the limited scope of the suppositions. This creates the need to rethink the theory. And with luck one may realise what the problem with the theory is. One may then find oneself in the awkward position of having to approach the material one is studying from a different angle and to create a new basis to justify what one is doing.

Why one becomes dissatisfied is often difficult to explain: 'something is wrong', and this is <u>not</u> the way to find out about the system. How many people appear not to be dissatisfied with the same system? But if one works in a scientific manner one develops an awareness of the necessity to always be critical about the prevailing theory, be it one's own or someone else's. According to Popper empirical generalisations cannot be verified but they are falsifiable and therefore they can be tested by systematic attempts to refute them. This does not mean that observations made using the existing theory are to be refuted. In the first place, falsification concerns the theory in its existing form. In our case this means that one has to provide a theory which reveals the flaws of the existing theory and overcomes them. And the main flaw of the system is that it lacks the power to explain observed traits evident in pottery such as shapes.

What causes this feeling that something is wrong? I think that one can create it. As an example I mention the test I carried out with the Iron Age pottery from Jericho, using bowls which are similar to those called class 4 in *Jerusalem Vol. II* (Franken and Steiner 1990). There were only rim fragments of these bowls extant. They were clearly made by one method: the rim was folded to the outside and the fold was pressed back against the wall of the pot (Franken 1974: 99). All available sherds, 66 in total, were laid out in a straight line. I first tried to find identical shapes: there were none. Then I tried to rearrange the sherds in a row in such a way that subdivisions could be made which could be distinguished by traits characteristic for each group. Such traits could be that the shape of the rim in section was more or less oval, or round, or triangular or square. This failed because "more or less" allowed for many sherds to be attributed to two or more groups So I decided that all these rims were 'triangular' in section. Next I sorted the sherds according to rim diameters. This only showed that the larger diameters go with somewhat heavier rims, as one would expect, but this is not always the case. Then I arranged them according to direction: slanting to the outside, standing vertical or bending to the inside (Franken and Steiner 1990: 64 and fig. 6-18) which produced groups not based on rim shapes and again different from the previous ones. Arranging them according to temper groups produced a different sequence once again. Finally I arranged them according to the stratigraphic phases and found that I had 21 small and statistically meaningless groups from which no development of shape could be deduced. Logically one must admit that this test demonstrated that all 66 sherds were individuals, and that any attempt to subdivide them depended entirely on subjective judgement. The only trait common to all sherds was the technique of construction. Similar tests on the pottery classes from the Iron Age at Jerusalem gave similar results. For instance see *Jerusalem Vol. II*, class 11, pp. 117-119. When applied to the Jerusalem bowls class 4, where fig. 6-18 suggests a possible but highly schematic subdivision into 20 'subclasses', based on the way the potters finished the shape of the rims, one finds that there are: 20x8 (= diameters measured at 2 cms intervals) x4 (= main temper groups found in the class 4 bowls) is 640 possible combinations of attributes for the rims alone! Bourke's remark that Ch.3 in Vol.II restates the "interminable argument between typological 'lumpers' and 'splitters'", completely missed my reasons for writing that chapter and he ignores the argumentation. (Bourke 1992: 60). I use different criteria than he does to decide which forms of pottery belong to one and the same 'type'. The crux is that his and my concepts about pottery studies and pottery typology are incommensurable. And it is also clear that he does not realise the need to define the range of relevant attributes to be used in pottery studies Talking about lumpers and splitters one quite often finds 'types' composed of pots made in more than one method lumped together because these methods are not understood, and one also finds the opposite: pots belonging to one construction method, forming a subclass, being attributed to several types.

Scientific pottery studies

Claiming that one's research activities have scientific status presupposes the construction of theoretical explanations for the observed phenomena. A theoretical explanation for the observed existence of pottery shapes distinguishes ceramics from things that grow naturally in nature and defines them as artifacts, denoting that people used materials found in nature to produce them. This means that pottery has to be explained like any other artifact by analysing the production methods. The general statement can be phrased as follows:

Conclusions drawn from observation of ceramics from antiquity are reliable to the extent that they are based on analysis of the craft and/or analysis of the raw materials. The knowledge thus obtained becomes richer to the degree that a larger period of the tradition can be viewed. In other words, the history of the potter's craft, in any particular case, provides the information for the study of this aspect of ancient cultures and evidence for dating. Knowledge of the raw materials is based on two lines of research which only partly overlap: one is the analysis of the properties of raw materials in terms of pot making, being part of the analysis of the craft, the other requires proper chemical analysis to identify sources. And here begins the trouble with the claim that someone knows the pottery.

As it has long since been demonstrated that nearly identical shapes of pottery can be produced using different techniques and different materials found in the same or in different cultures it is clear that observation of identity of shape is not sufficient to conclude identity of 'types'. Thus the prevailing system is refuted because of its lack of explanatory power, caused by lack of knowledge of the craft.

The idea of identity of forms and their synchronous development

Identity of shape is based on a conclusion from a morphological analysis and is not a fact in itself. It is an observation that can be criticized. The idea of identity of shape of pots in Near Eastern archaeology lacks definition; it is taken for granted. When can one say that two pots have identical shapes? When using a kick wheel or electric wheel the modern potter can make so-called repeat items which must have very nearly identical shapes. Otherwise pieces made in moulds or machine-pressed pottery have identical shapes if they come from the same production line. When the eye is trained to search for traces of the production methods of pre-industrial pottery it sees dissimilarities in shapes not observed before by typologists. It is undeniable that typologists usually look at certain traits, selected for the purpose, and miss others.

Shapes come about as the result of certain methods of making pots. Evidence of a particular method of making pots is preserved in every shape that is produced in that method. And traditional potters employ one or two of such pot constructing methods. There are no traditional potters who do not stand in a living stream of a tradition, meaning that a potter does precisely what his or her father or mother did. Although this statement is amply confirmed by present day ethnological observations, it can only be assumed to be also true for the past. There are strong indications in the nature of the craft itself that such was indeed the case in all pottery producing societies. Then it follows that one has to study such traditions of pot making in order to understand pottery.

One may ask whether the study of the craft as a means to explain pottery shapes will alter the results of comparative pottery studies. That depends on the case. I will first show how a study of the craft may affirm results from parallel quoting. This would be the case when it can be shown that a pottery market existed supplied by all the workshops in the area, from which the inhabitants of the quoted sites obtained their pottery. Alternatively it could be shown that there was one large pottery production centre like a village of potters from which the pottery was transported to these sites. This would guarantee that all shapes that were produced at a certain time can be found in that region. Development of pottery shapes would be manifest everywhere and new products would find their way to the customers within the region and occasionally beyond that area (Franken in van As 1987: 43-48). Obviously such an explanation cannot be tested by an analysis of shape alone and parallel quoting cannot do anything to confirm or refute this explanation. For a correct approach to such questions see for instance the case of Kefar Hananya in Roman Galilee (Adan-Bayewitz 1993: 47 et passim, Adan-Bayewitz and Wieder 1992: 189-205).

However if every site in the set of compared sites had its own potteries the picture may change drastically. There is no guarantee at all that those potteries developed their techniques and forms simultaneously. On the contrary, under such circumstances the potter's ideosyncrasies may have been cultivated and if potters of various places were at all in contact with each other they would rather have stuck to their individual approaches than make an attempt to assimilate their products to certain standards. What incentive would there have been to do so? The Iron Age pottery from Jerusalem shows that potters working side by side or close to each other stuck to their own family traditions of preparing clays. Why should some potters not be slower than others in picking up new trends? Potters continue to produce shapes like those made by their fathers as long as their customers would take them. Crafts develop for all kinds of reasons. Just like today, demand is one of them. For instance if one potter takes the complaints about a bad design of the rim of a bowl seriously and makes a stronger one which solves the problem, how would one find out how long it would take in the Iron Age before most bowls were fitted with the new rim? We have the example of the replacement of the rim of class 2 (Franken and Steiner 1990: 103) by that of class 4 in Iron Age II at Jerusalem. It certainly was a slow process and a matter of several generations. One of the aspects of parallel quoting is that minor deviations of a 'standard' form give rise to a search for exact parallels in the literature. Typologists do not take into consideration that individual potters may have their own individual way of making a 'type'. Hamer has pointed this out. Technique is

> "The individual way in which each potter carries out a process. Technique is allied to skill. It is developed by establishing a personal relationship with the work and is often the result of repeated progressive actions. Technique cannot be taught or learnt, it can only be acquired. What is taught is a method or a

process" (Hamer 1975, sub voce).

My book on the history of the pottery and potters from Jerusalem (forthcoming) presents two important cases of potters working in isolation from the developments taking place in the country. One is the case of the potters working for the Jebusite settlement in the 12th and 11th cent. B.C., (Ch. 4). The other example is the continuation of the production of Iron Age II pottery together with a totally different type after the exile, (Ch. 7).

These are just some examples showing that the reality could very well have been far more complicated than the theory about synchronous developments in the craft which has been taken for granted. But quite apart from such theories or convictions there are concrete indications that changes took place as the graphs in *Jerusalem Vol. II* show (Franken and Steiner 1990: 74), and as soon as some of the reasons for developments of the craft are tracked down one can also see whether these reasons were compelling for all potters in the region or not. Even if they are it does not follow that all potters reacted simultaneously. Otherwise one would have to assume that potters met annually to discuss their affairs. It is clear that the matter of the slow developments observed in the history of the local craft needs to be investigated before anything can be said about contemporaneity of shapes at different sites.

Knowledge of the processes of pottery making

This investigation requires knowledge of the processes of pottery making, just as understanding flint tools requires knowledge of the techniques of flint knapping and other ways of making stone tools, and just as knowledge of metal objects in archaeology requires knowledge of ancient metal working industries.

The problem with the study of clay vessels is that clay products pose incomparably more problems to the student of techniques than for instance stone objects. Fired pottery has gone through chemical processes by the action of heat, which drastically limits the possibility of explaining certain traits, unless one can test the raw materials that were used in the production. There is far too little appreciation in Near Eastern archaeology of the fact that clays have their own individuality, meaning that there are uncountable differences and that each potter's clay makes special demands on the potter's skill. It is possible to make some general statements about properties of clays and in our case, potter's clays. There are many clays that cannot be used for pot making in their natural state, and most potter's clays must be prepared before they can be used. Chemical analyses of pot sherds are usually not 'translated' into properties that are good or bad for making pots. Hence their use is mostly restricted to provenance studies. To understand the relation between clay and potter requires knowledge of those properties of the clays which turn them into potter's clays. The distinction between clay definitions has to be clear. Rice states the case as follows:

> "For anthropologists and archaeologists studying pottery, these issues of depositional context, particle size, chemical structure, and mineralogical composition are essential in a way, but in another sense they are of little

importance. The significance of these different viewpoints depends on the questions being asked. Chemical or mineralogical data on clays are not informative unless research questions are framed so that chemistry and mineralogy can provide answers". (Rice 1987: 51).

Archaeometry

Archaeometry is a powerful technique in provenance studies. Adan-Bayewitz' study of *Common Pottery in Roman Galilee* (1993) is an excellent example of a successful application showing how centres of production can be traced. Adan-Bayewitz also gives a good deal of information about the firing processes of clays and some about the preparation of the same, but not the forming techniques and their history. Some archaeologists use xeroradiography to find out how pots were made (Glanzman 1983). This may be useful but it does not explain why the potter used the technique and thus it does not create understanding about the craft. So it can only confirm the analysis made by the ceramist.

Examples of explanation in pottery studies

To demand exacting precision of the analysis of the raw materials used in the craft would defeat its purpose. Observations from the fired body can be summarized in general statements. As an example one can point to a highly calcareous clay containing iron. If it is observed that some pots made from such a clay have a dark red colour but others a pale creamish colour one may suggest the following explanation: pots with the dark red colour were fired well below a temperature of 900 °C. and the pots with a pale surface colour well over that temperature, because at the critical temperature of 900 °C. the iron content of the clay reacts with the lime and becomes volatile so that it can no longer determine the surface colour. However in order to demonstrate that the same clay has been used in both cases one must be lucky and find a pot showing both traits like one that was rather unevenly fired in the kiln, which can easily happen. (Jacobs in van As 1992: 7-22). Another example is the dark core of sherds. The dark colour is caused by carbon dioxides which become volatile at 700 °C., thus allowing the iron to oxidize and colour the sherd reddish. It requires some time before the temperature has thoroughly penetrated into the sherd. Thus to note that a sherd has a dark core, as is so often done in pottery studies, is the same as stating that the sherd was not fired over 700 °C. for any length of time. If dark cores are a common feature in an assemblage it would be sufficient to say that the pottery was normally fired below 700 °C. or somewhat higher for a short time only. But one should also take into consideration the fact that in an updraft kiln there may be a difference of 200 °C. of the heat close to the fire box and that close to the vent in the top. Pots lower down in the pottery chamber may have been fired to a reddish colour right through whereas those nearer the top did not get sufficient heat for the carbon dioxides to be burnt out.

These are examples of explanations of observed traits which are based on knowledge of the craft but to what extent they apply in a specific case can only be demonstrated if there exists enough specific information.

Keeping these restrictions in mind one can say that general statements about pottery and the potter's craft apply if they are based on observations derived from the craft itself. In this respect it should be noted that the language developed by the craftsmen is not generally applicable or common language. Potter's language is a practical one and the meaning of potter's terminology is determined by the potter's particular methods. One potter may say that a clay is too lean to be used, that is: for his method of producing pottery whereas another potter may find the same clay to be too plastic for his purposes. The few potter's terms used by Near Eastern archaeologists do not contribute to our knowledge. Thus one finds statements like 'well made pottery', 'well levigated clays', 'wheel made' or 'hand made' and 'coarse grit'. These are inadequate or simply misleading, as perusal of Rice (1987) or Hamer's *Dictionary* (Hamer 1975) shows.

There is not the slightest hint of the maker of pots in most comparative pottery studies. Sometimes one finds a note saying that it would be useful to find a kiln site and wasters because this could tell us something about the production. Sure enough there could be surprises but the pottery itself contains many traits that tell us about what was going on in the workshop and on the kiln site. Information from ethnographical studies on the lives and the work of potters is useful but here one seldom finds homologous information. Analogous information may point to homologous features but this can only be demonstrated by applying the physical laws that play a role when clays are prepared for pot making and firing. Analogous observations like the description of the wheel does not by itself clarify the issue of 'hand-made' or 'wheel-made' pottery unless it is accompanied by observations on the relationship between the workability of the prepared clay paste and the applied technique of constructing pots. A general statement should be used to demonstrate that the case is homologous: 'Given these properties of the potter's clay and these techniques that are applied to make the pots from these clays, it is necessary that the wheel should have such and such properties'. And also: 'Given such properties of the clays and such techniques, there will always be such and such a product'. Stress is not on the design of the wheel used but on its performance, if and when a wheel is a necessary tool in the production. Pots can be produced that look perfectly wheel made with no wheel being involved in the production. Thus there is no warrant for statements such as: 'This pot is hand made but its rim is finished on the wheel', as is often said in the case of M.B.I assemblages.

Potters thoroughly prepare their clays prior to use. They manipulate the raw clays to change the properties and to adapt them to their needs. Hence the extraction or addition of non-plastics or the mixing of several clays to form one paste. An example of the latter is found in *Jerusalem Vol. II*, 79. Some clays cannot be used to make pots for containing foodstuffs, since in the fired state they have an adverse influence on the food stored in them, some clays cannot be used on a kick wheel, some cannot even be used on a wheel at all. Some pots have been made in the Near East from marley clays and some even from clayey marls. Some clays are suitable for making pots with painted decorations and others are not. If one is able to recognize such features one also finds explanations for facts that have often hardly been noticed and yet are culturally important. And when the archaeologist is aware of the need to explain pottery then expert advice is required, just as one needs the association with a paleobotanist to study excavated plant remains.

One cannot learn to understand pottery from observation of shape alone. The study and description of the morphology of pots is of course an essential part of pottery studies in archaeology. But only applied knowledge of the craft of potting leads to understanding and produces explanations for observed traits. These explanations primarily aim at making pottery studies in archaeology more reliable and more productive.

The study of pottery traditions

In my argumentation the study of a 'tradition' of pot making has become the basis for virtually all aspects of archaeological ceramic studies. How is tradition to be defined and why does it occupy a central position or what are the consequences?

Modern potters no less than traditional ones go about their jobs with extreme care. Modern ones have the advantage of having at their disposal scientific literature in which the chemistry is explained and they can use factory-made basic ingredients. Most traditional potters depend entirely on orally transmitted knowledge of their craft by the potting families and on learning in the workshops. The knowledge consists of the rules stating what the potter must do and what he must not do. This creates the impression that such potters are notoriously conservative. Foster has given the reasons for the conservatism of potters:

> "Assuming for the sake of argument, that potters in peasant societies are conservative as a class not only in their work, but, ...in basic personality structure as well, can we adduce a possible reason? I believe so. This reason lies in the nature of the productive process itself, which places a premium on strict adherence to tried and proven ways as a means of avoiding economic catastrophe. Pottery making is a tricky business at best, and there are literally hundreds of points at which a slight variation in materials or process will adversely affect the results. A slight difference in raw materials, in glazes, in paints, in firing temperatures - any of these may mean that a week's or a month's labor is in vain" (Foster in Matson 1966: 49).

These "tried and proven" ways may not be so obvious to the occasional observer of a potter at work, but closer contact with the workshop will reveal that there is not only a strong relation between the potter's preference for a specific clay and other materials and the techniques of the potter (Balfet in Matson 1966: 161) but that the entire process is carefully watched.

All pottery traditions in the Near East ultimately go back to the Neolithic. That was the time when all basic knowledge of the craft was not so much invented as discovered by much trial and error. This process is described in Franken (1974: 175ff). A summary in Bienkowski (1991: 62-68) and in Homes-Fredericq and Franken (1986: 51-52). Neolithic potters experimented with non-plastic tempers and found out what they do in clays and what the possibilities are. Orton writes:

> "Since the 1960s a more systematic approach to fabric analysis has come to take one of the central positions in pottery studies. It was seen as one of the means of breaking out of the strait-jacket of primarily chronological concerns and expanding the scope of the study into areas of technology, trade and exchange." (Orton c.s. 1994: 132).

The mere fact that one can make typologies from Iron Age pots can only be explained by reference to the existence of a tradition. The overall uniformity of types of pottery stems from 'dictates', derived from empirical knowledge, stating which raw materials must be used and what techniques must be applied and how to apply them, and how to fire the pots. If this was not so, there would be no recognizable styles of pottery from all ages and places in the world. And the truth is that traditional potters have no choices or alternatives in their work. They may or may not know why certain things have to be done or are strictly forbidden to do, but they usually know the genius of the kiln that causes clay to turn into stone, which is a mystery for humans, and they fear the demoniac powers that will try to destroy their work. The religious metaphor can sometimes be discovered.

A definition of pottery traditions

A tradition can be defined by the study of recurring traits in pottery production or *the constants*. These constants are the methods employed by the potters, to be reconstructed from the study of a chronological sequence of assemblages excavated at one site. This includes the processes involved in the making of the various pottery classes as far as these can be explained from one single method. It also includes the type of clay that agree with the production method, as well as the methods of drying, firing and marketing the pottery. An assemblage often consists of more than one tradition; the cooking pots may come from a different tradition than the rest of the repertoire and may come from another workshop. The output of the workshop has to be worked out statistically. Which pottery classes were produced and in what quantities is an important aspect of a tradition. (And to define the classes one has to refer to the construction methods and not to the techniques of the individual potters).

Traditions develop within their own technical constraints. When a new method turns up in an assemblage this points to influence from outside, (Franken 1982: 142). It is very unlikely that it will be an invention by the established potters and therefore one has to investigate the possibility of a new workshop having been established or of local trade. In both cases there is the question of the origin of the new method.

A tradition may be confined to a few workshops producing either art pottery or pots for specific purposes. On the other hand, a tradition may be found spread over large areas and be applied in many workshops each with their own ideosyncrasies. Different traditions may live side by side for longer or shorter periods.

Parallel quoting is invalidated by its use of the wrong premisses. The 'new' theory which insists on an explanation of observed traits does not dismiss the possibility of finding dates for strata by comparing pottery. It indicates, however, that the situation in the world of ceramic production is far more complicated than is often thought. It also indicates that pottery can only date strata to broad periods. The real parallels are the assemblages in their totality, but the possibilities for close dating are grossly overrated in Near Eastern archaeology.

Conclusion

Summing up this apologia, I have given my 'theoretical grounds' for refuting that aspect of routine procedures of pottery studies in the Near East, consisting of 'parallel quoting'. I have argued that this empirical and largely intuitive and rather naive system has to be replaced since it can in no way be considered as a logical system and because it does not provide valid explanations for observed features. Too much is taken for granted in that system and no matter how many attempts are made to improve it, they do not concern the distinctly logical gap between observations and conclusions. The publication of the Deir ᶜAlla study of the pottery, performed in close coöperation with the ceramist Kalsbeek (Franken 1969) was a first attempt, of which Lapp recognized the value (Lapp 1970). It can now be established that I was not the only pioneering archaeologist at that time. Many were seeking solutions to problems they sensed in the traditional archaeological pottery studies, often quite independently from each other but mostly inspired by the work of Anne Shepard. That they have now joined forces in world archaeology should no longer be ignored. There is at present a large body of practical pottery studies that show new and more rewarding directions, and if archaeologists were not as conservative as traditional potters and pottery were allowed to tell its own tale, archaeology would have a better tool for reconstructing the past. Amongst others Orton c.s. (1993) shows how to construct that tool.

References

Adan-Bayewitz, D, and M. Wieder (1992), Ceramics from Roman Galilee: a comparison of several techniques for fabric characterization. *Journal of Field Archaeology* 19:189-205.

Adan-Bayewitz, D. (1993), *Common pottery in Roman Galilee. A study of local trade*, Bar-Ilan University Press, Jerusalem.

As, A. van (1992), *Newsletter, Department of Pottery Technology (Leiden University)* 9/10: 7-22.

Balfet, H. (1966), Ethnographical observations in North Africa and archeological interpretation: The pottery of the Maghreb. In: F.R. Matson (ed.), *Ceramics and man*, Chicago: 161-177.

Bienkowski, P. (1991), *The art of Jordan*, National Museums & Galleries on Merseyside, Stroud-Gloucestershire.

Bourke, S. (1992), Excavations in the Iron Age extra-mural quarter on the South-East Hill of Jerusalem. Review article. *Palestine Exploration Quarterly - january-june 1992*: 59-62.

Bourke, S. (1993), The transition from the Middle to the Late Bronze Age in Syria: the evidence from Tell Nebi Ment. *Levant* XXV: 155-196 (p.164f.).

Crowfoot, J.W., A.M. Crowfoot, and K.M. Kenyon (1957), *Samaria Sebaste III. The objects from Samaria*, London, Palestine Exploration Fund.

Eggers, H.J. (1959), *Einfürung in die Vorgeschichte*, München.

Feyerabend, P.K. (1981), *Philosophical Papers*, Vol. 2, Cambridge.

Finkelstein, I. (1988), *The archaeology of the Israelite settlement*, Jerusalem.

Franken, H.J.(1969), *Excavations at tell Deir ʿAlla. A stratigraphical and analytical study of the Early Iron Age pottery*, Leiden.

Franken, H.J. (1974), *In search of the Jericho potters*, Amsterdam.

Franken, H.J. (1987) Potmaking in antiquity and the "ceramic horizon" in archaeology; in: A. van As *et al.*, *Contributions to the study of pottery technology*; Publicatie van het Gallo-Romeins Museum no.34, Tongeren: 43-48.

Franken, H.J., and Steiner, M.L. (1990), *Excavations in Jerusalem 1961 - 1967, Vol. II; The Iron Age extramural quarter on the South-east hill.* British Academy Monographs in Archaeology No 2.

Glanzman, W. (1983), Xeroradiographic examination of pottery manufacturing techniques: a test case from the Beqʿah Valley, Jordan. *Masca Journal* 2(b): 163-169.

Hamer, F. (1977[2)]. *The potter's dictionary of materials and techniques*, London-New York.

Harvey, D. (1971), *Explanation in geography*, Bristol, 3rd ed.

Homès-Fredericq, D. and Franken, H.J. (1986), *Pottery and potters. Past and present: 7000 years of ceramic art in Jordan*, Tübingen.

Hume, D. (1984), *A treatise of human nature. Book 1 - Of the understanding*; Ed. by E.C. Mossner, Penquin Classics.

Lapp, P.W. (1970), The Tell Deirʿ Alla challenge to Palestinian archaeology. *Vetus Testamentum* 20: 243-256.

Lévi-Strauss, C. (1962), *La pensé sauvage*, Librairie Plon. Paris.

London, G. (1985), *Decoding designs: The late third millennium B.C. pottery from Jebel Qaʿaqir*, University Microfilms International.

Magee, B. (1977), *Popper*, Glasgow.

Martin, M.E. (1976), *The appraisal of argument in biblical archaeology*, Leiden, unpublished Ph.D. study.

Matson, F.R. (1966), *Ceramics and man*, London.

Nagel, E. (1961), *The structure of science*, London.

Orton, C., P. Tyers and A. Vince (1993), *Pottery in archaeology*, Cambridge Manuals in Archaeology, Cambridge.

Popper, K.R. (1975), *Objective knowledge*, Oxford.

Rice, P.M. (1987), *Pottery analysis. A source book*, Chicago-London.

Russell, B. (1979), *History of western philosophy*, London.

Rye, O.S. (1981), *Pottery technology. Principles and reconstruction*, Washington.
Shephard, A.O. (1976), *Ceramics for the archaeologist*, Washington D.C.
Tappy, R.E., 1992. *The Archaeology of Israelite Samaria*, Harvard Semitic Studies 44, Atlanta, Georgia.
Weaver, W., 1967. *Science and imagination. Selected papers of Warren Weaver*, New York.

* This article is a shortened version of Chapter 1 of my forthcoming book on the history of pottery and potters of Jerusalem.