ZEUXIPPUS WARE: AN ANALYTICAL APPROACH TO THE QUESTION OF PROVENANCE

A.H.S. MEGAW, P. ARMSTRONG, H. HATCHER

SUMMARY: In 1975 one of the present authors published information he had obtained from his excavations at the castle of Saranda Kolones at Paphos, Cyprus, concerning a high quality glazed table ware which has come to be universally known by the name he proposed; "Zeuxippus Ware".

The principal distinctive features of Zeuxippus Ware are its hard, red fabric, its fine walls and careful potting, the flaring profile of the inner face of its ring feet, and a shiny, hard glaze. The most numerous finds are of small bowls, with a variety of rim forms. A small number of closed shapes, flasks with distinctive quatrefoil mouths, have also been found. Decorative schemes vary but are usually based on incision. The interiors of the bowls are coated with a thick white slip, which may extend in tongues down the outer surfaces. Frequently the outer surfaces are painted with patterns of circles and semi-circles using the same white slip. The interiors of the bowls may be incised or rouletted, penetrating the slip and revealing the red body beneath. The bowls were fired upside down stacked on tripod stilts which have frequently scarred the delicately rendered decorations.

Zeuxippus Ware is divided into two classes, based on colouring: I is monochrome, II has green or yellow-brown highlights daubed on incised motifs. Although "prototype" Zeuxippus Ware appears to have been produced at a single location, type II ceases c. 1225, while versions of Class I ("Zeuxippus Derivatives") were produced in many places in the Eastern Mediterranean, the Black Sea and Italy, until the early 14th century. Misidentification of Prototype and Derivative Zeuxippus Ware has unneccessarily clouded the picture of production and trade patterns of this Crusader Ware.

The Oxford Byzantine Ceramics Project is a scientific program of chemical analyses of Medieval ceramics designed to set up a comprehensive control series of fabrics of Byzantine and other production sites in the Eastern Mediterranean. A further aim is to test unprovenanced wares against them, thereby establishing provenance. The scientific method employed is Inductively-Coupled Plasma Emission Spectroscopy, in which a possible nine major/miror elements and nineteen trace elements in the fabric of the vessel can be identified.

This paper presents the results of an analytical investigation into Zeuxippus Ware. The problems being tested were: 1. Are Zeuxippus I and II from a single source? 2. Can either or both be related to any of the production centres in the Oxford database? A selection of Zeuxippus Ware from the excavation of Saranda Kolones has been analysed, from both Classes I and II. The results are compared with a view to narrowing the options for the source of Zeuxippus Ware.

Introduction

Zeuxippus Ware was identified in the course of excavations of the castle of Saranda Kolones at Paphos, Cyprus, and recognised as being similar to a type of glazed ceramic found some decades before at Constantinople, in the baths of Zeuxippus (Megaw 1971; 1972a; 1972b; 1976; 1982; Rosser 1985). In a proposed classification of Zeuxippus Ware, based on the finds from Saranda Kolones, it was divided into four categories, a system subsequently maintained (Megaw 1968; 1989). Within the system were two sub-groups, I and II, I having a monochrome glaze, and II with added coloured highlights. I was further subdivided into a, b, and c, based on the glaze colours: a, creamy-white; b, orange brown, and c, green. As more examples of Zeuxippus Ware came to be published, the picture became more complicated, expressed through the use of expansive terms of reference such as Zeuxippus derivatives or family of Zeuxippus (Armstrong 1992). While the present authors continue to believe that the original four groups as defined in 1968 were products of a single manufacturing centre, by virtue of their common "glossy" glaze, distinctive exterior slip decoration, and apparently shared fabric, it has subsequently become clear that to call them all by an umbrella term (Zeuxippus) defining a unitary ware is perhaps misleading. If it is necessary to identify an overall aspect differentiating them from other classes of ceramics, then it must be their place of manufacture, based on their common fabric. The four groups (Ia, Ib, Ic, II) should be seen possibly as products of different workshops at one location, or of different potters in a workshop, or even of different styles from one workshop. The authors consider these four groups to be "prototypes" which came to be imitated in many ceramic manufacturing centres around the Mediterranean. It is not helpful anymore to think, or write, in term of Zeuxippus Ware, as reflected in the observations of Berti and Gelichi concerning Italy: It has become clear by now that Zeuxippus Ware is not a homogeneous group, "the product of a single centre" but rather a mixture of diversified

productions from several (not only Byzantine) Mediterranean locations (Berti, Gelichi 1997).

The general problem of distinguishing between local and imported wares, and hence building up patterns of distribution and trade, is being broached by several programs of materials analysis in various countries[1]. In England, the Oxford Byzantine Ceramics Project (OBCP) had already commenced on a program of analysis of Byzantine and related pottery from known production sites with the aim of establishing a chemical fingerprint, or "control group" for each (Armstrong, Hatcher 1997). Eventually it is hoped that it will be possible to match unprovenanced wares to control groups and so assign a source to them, or, at the very least, show that a particular centre was not their place of origin.

Aims

The present exercise falls into two distinct parts. In the first, samples from the two Zeuxippus categories Ia and II were tested and compared in order to clarify whether they correctly formed a coherent group. Of the classes of Zeuxippus as originally defined in 1968, Ia is closer to II than to Ib and Ic because of their shared distinctive cream-coloured glaze which not only distinguishes them from the wares of Ib and Ic, but from all other glazed wares of the Medieval period. The pearly hues and fine form of the famous Class II flasks have more in common with acclaimed Renaissance wares than contemporaneous popular ceramics of the Eastern Mediterranean. In the second section of this paper the same samples were then tested against three known production centres of glazed pottery in order, if not to elucidate the important place of manufacture of Zeuxippus prototypes, then to eliminate them from the list of possible sources. In an earlier study by the present authors, again attempting to locate its place of manufacture, samples of Zeuxippus-type wares from Saranda Kolones were tested against a Cypro-Levantine circulation, comparing the results with those from control groups of ceramics produced at Lemba, Lapithos and Dhiorios in Cyprus, and Acre and Al Mina (St Symeon) in the Levant (Megaw, Armstrong, Hatcher, in press). Unfortunately there were no matches, so this paper is looking further afield, to the Northern Aegean and Black Sea. In this part of the program, Zeuxippus Ware is compared with the products of Serres, Thessaloniki, and Kaffa, three glazed ceramic manufacturing centres whose products have been analysed by the OBCP.

Method of analysis

Although classed as a "destructive method" because it is necessary to drill a small amount of powder (about 200mg) from the sherd or pot, and from a part which has not been subjected to weathering, inductively-coupled plasma emission spectroscopy (ICP-AES) has the advantage of routinely providing good information about a wide range of elements from a relatively small sample. Analyses include nine major elements – aluminium, calcium, magnesium, iron, sodium, potassium, titanium, manganese and phosphorus – and twenty minor and trace elements – barium, cobalt , chromium, copper, lithium, niobium, nickel, scandium, strontium, vanadium, yttrium, zinc, zirconium, lanthanum, cerium, neodymium, samarium, europium, dysprosium, ytterbium. The data can therefore be compared with earlier analytical work which was often limited to the major elements, and with work from laboratories which use more sophisticated techniques such as neutron activation to construct a chemical fingerprint based on minor and trace elements. This is important when data is to be compared with that from other laboratories, and results are to be used by colleagues. The OBCP is cooperating in an international exercise of intercomparison of results from different laboratories[2].

In common with other laboratories, statistical programs are used to examine the chemical data to identify patterns, and link samples with similar compositions together in clusters which should correspond to archaeologically valid groups. While a minimum number of 30 samples for each group is preferred, the OBCP has been working with groups of twenty sherds[3].

The production centres

Thessaloniki was one of the principal cities of the Byzantine empire and as such undoubtedly had potters' workshops to service the needs of its population. Unfortunately no kilns have yet been found, though areas of waste products from the manufacture of ceramics have been located during excavation. The samples from Thessaloniki tested here were selected by Demetra Papanikola-Ba-

1. Information about the different programs can be found in: *Materials Analysis* 1997.

2. Established by Dr Yona Waksman (Laboratoire de céramologie, CNRS UPR7524, Lyon, France). The intercalibration program aims at enabling a common use of data from the French and British chemical databases on Byzantine ceramics.

3. Statisticians would take thirty as the minimum number, but often this is not possible in archaeological work.

kirtzis, whose familiarity with the ceramics of that city enables her to identify its products macroscopically[4]. Previous analytical work on Thessaloniki pottery concluded that it was a major manufacturing centre quite distinct from the glazed ceramics found at, for instance, Corinth (Megaw, Jones 1983). The pottery analysed here from Thessaloniki is taken from 13th-century glazed wares, mostly incised under a coloured glaze. It is close in date to our control group and employs similar artistic crafts in its production.

Thessaloniki Catalogue

(A229.445) Bowl. Ring foot. Incised.
In and out: white slip and deep yellow glaze. In: incised line around tondo.

(A229.446) Bowl. Rim. Incised.
Almost vertical plain rim sharply offset from shallow body. In and upper out: white slip and deep yellow glaze. Two incised horizontal bands around rim.

(A229.447) Bowl. Rim. Incised.
Plain rim on hemispherical body. In and upper out: white slip and deep yellow glaze. Two incised horizontal bands around rim. Splash of brown over rim.

(A229.448) Bowl. Body sherd. Incised.
In and upper out: white slip and deep yellow glaze. Two incised horizontal bands around rim.

(A229.449) Bowl. Body sherd. Incised.
In and upper out: white slip and deep yellow glaze. Two incised horizontal bands around rim.

(A229.450) Bowl. Body sherd. Incised sgraffito.
In and upper out: white slip and deep yellow glaze. In: ?random incised pattern.

(A229.451) Bowl. Body sherd. Incised sgraffito.
In and upper out: white slip and pale yellow glaze. In: incised horizontal line bounding infill of oblique parallel incised lines.

(A229.452) Bowl. Body sherd. Incised.
In and upper out: white slip and pale yellow glaze. In: edge of incised horizontal line.

(A229.453) Bowl. Body sherd. Incised.
In and upper out: white slip and pale yellow glaze. In: edge of pair of incised concentric circles; edge of incised line.

(A229.454) Bowl. Rim. Incised.
Almost vertical plain rim sharply offset from shallow body. In and upper out: white slip and yellow glaze. In: incised horizontal bands on top and bottom of rim.

(A229.455) Bowl. Body sherd. ?Incised.
Broken just below rim. Almost vertical rim sharply offset from shallow body. In and upper out: white slip and deep yellow glaze.

(A229.456) Bowl. Rim. Incised.
Almost vertical thickened plain rim offset from deep body. In and upper out: white slip and deep yellow glaze. In: incised horizontal bands at top and bottom of rim.

(A229.457) Bowl. Body sherd. Incised.
In: white slip and green glaze; incised concentric circles.

(A229.458) Bowl. Body sherd. Incised.
In: white slip and cream glaze; edge of incised arcs.

(A229.459) Bowl. Body sherd. ?Incised.
In: white slip and deep yellow glaze.

(A229.460) Bowl. Body sherd. ?Incised.
In: white slip and cream glaze.

(A229.461) Bowl. Ring foot. Incised.
Tall ring foot. In: white slip and deep yellow glaze; edge of incised line.

(A229.462) Bowl. Body sherd. Slip-painted.
In: slip-painted circles enclosing dots under cream glaze.

(A229.463) Bowl. Body sherd. Incised sgraffito.
In: white slip and cream glaze; part of incised band and three infilled incised circles.

(A229.464) Bowl. Body sherd. Painted Incised.
In: white slip and cream glaze; two incised concentric circles bounding tondo; centre highlighted with green; edge of incised line on body.

4. Relying on an individual's expertise has necessarily been substituted for collecting samples from a known kiln, since no actual kilns have been located, though debris from pottery manufacture has been discovered at a number of places in the city: Bakirtzis, Papanikola Bakirtzis 1981: fig. 17; Papanikola-Bakirtzis 1987; a particular class of ceramics, identified by a distinctive bird decoration, has also been demonstrated to have been produced in Thessaloniki: Papanikola-Bakirtzis 1983.

Serres, a Macedonian city on the banks of the river Strymon, prospered in the Late Byzantine period (Xyngopoulos 1965). Excavations in the district of the old Metropolitan church of Agioi Theodoroi provided evidence of a substantial potters' quarter in the Late Byzantine period[5]. The characteristics of its products are carefully-incised bowls highlighted with colour and slip-painted decoration on the exterior. Ceramic bowls manufactured at Serres travelled far: they have been found at Philippi and Maroneia in Thrace; Torone in the Chalkidiki; at Skopje and Prilep; and in the Peloponnese at Corinth and Argos[6]. The sherds from Serres analysed here are all coloured incised wares of the second half of the 13th century. Though slightly later in date, they share aspects of Zeuxippus Class II, especially the exterior slip-painted decoration.

Serres Catalogue

(A229.425) Bowl. Body sherd. Painted Incised.
In: white slip; incised glaze.

(A229.426) Bowl. Body sherd. Painted Incised.
In: white slip; incised lines radiating from centre highlighted with green and yellow-brown; yellow glaze.

(A229.427) Bowl. Body sherd. Incised.
In: white slip; incised ?fish scales; yellow glaze.

(A229.428) Bowl. Body sherd. ?Incised.
In: white slip; pale yellow glaze.

(A229.429) Bowl. Body sherd. Painted Incised.
In: white slip; incised concentric circles highlighted with green and yellow-brown; yellow glaze.

(A229.430) Bowl. Body sherd. Painted Incised.
In: white slip; incised lines forming two sides of triangle highlighted with green and yellow-brown; yellow glaze.

(A229.431) Bowl. Body sherd. Painted Incised.
In: white slip; incised pairs of lines forming point of triangle highlighted with green; pale green glaze.

(A229.432) Bowl. Body sherd. Painted Incised.
In: white slip; edge of incised line highlighted with green; yellow glaze.

(A229.433) Bowl. Body sherd. Painted Incised.
In: white slip; incised pair of concentric circles highlighted with green; pale yellow glaze.

(A229.434) Bowl. Body sherd. Painted Incised.
In: white slip; edge of incised line highlighted with green; pale yellow glaze.

(A229.435) Bowl. Body sherd. Painted Incised.
In: white slip; incised lines radiating from centre highlighted with green and yellow-brown; yellow glaze.

(A229.436) Bowl. Body sherd. ?Painted Incised.
In: white slip; fragment of complex incised decoration; yellow glaze.

(A229.437) Bowl. Body sherd. Painted Incised.
In: white slip; fragment of complex incised decoration highlighted with green; yellow glaze.

(A229.438) Bowl. Body sherd. Painted Incised.
In: white slip; part of incised circle highlighted with green; pale yellow glaze.

(A229.439) Bowl. Body sherd. Painted Incised.
In: white slip; part of incised circle highlighted with yellow; pale yellow glaze.

(A229.440) Bowl. Body sherd. Painted Incised.
In: white slip; fragment of complex incised decoration highlighted with green; pale yellow glaze.

(A229.441) Bowl. Body sherd. Painted Incised.
In: white slip; fragment of complex incised decoration highlighted with green and yellow-brown; yellow glaze.

(A229.442) Bowl. Body sherd. Painted Incised.
In: white slip; fragment of complex incised decoration highlighted with green and yellow-brown; yellow glaze.

(A229.443) Bowl. Body sherd. Incised.
In: white slip; fragment of complex incised decoration highlighted with green; pale yellow glaze.

(A229.444) Bowl. Body sherd. Painted Incised.
In: white slip; random patches of green and yellow-brown; pale yellow glaze.

5. D. Papanikola-Bakirtzis in Papanikola-Bakirtzis, Dauterman Maguire, Maguire 1992: 27-31, describes the location and ware.

6. For references to the Serres ware finds from Thessaloniki, Philippi, Maroneia, Corinth, Skopje and Prilep see Papanikola-Bakirtzis, Dauterman Maguire, Maguire 1992: 35 n. 18; Torone: from the joint Archaeological Society and Australian Institute excavations on the Lekythos promontory; Argos, from recent excavations in the centre of the modern city.

Kaffa (ancient Theodosia) was an exciting cosmopolitan Medieval city and centre of trade, organised by the Genoese. Its international character is illustrated by the number of Byzantine churches and monasteries there, side-by-side those of other religions and nationalities. Some of the most spectacular finds of Zeuxippus Class II have been made in the Crimea (Yakobson 1950: pl. 26). For this reason, although the pottery analysed here is perhaps two centuries later than the Zeuxippus test group from Saranda Kolones, similarities in style of manufacture, and the unique opportunity to test production material from the part of the world where some of the finest examples of Zeuxippus Class II have been found made Kaffa an obvious choice to be included in the present exercise[7].

Kaffa Catalogue

(A229.382) Beaker. Complete profile.
Monochrome. White slip and green glaze in and half out.

(A229.383) Beaker. Almost complete profile.
Plain.

(A229.384) Bowl. Body sherd. Painted Incised.
In: white slip; groups of three parallel incised lines radiating from centre to rim highlighted with green and brown daubs; yellow glaze.

(A229.385) Bowl. Ring foot. Slip-painted.
In: slip-painted wavy lines radiating from centre under yellow glaze.

(A229.386) Bowl. Rim. Incised.
In: white slip; band on incised triangles around exterior of rim.? waster.

(A229.387) Bowl. Rim. Incised.
In: white slip; incised lines around horizontal everted rim.? waster.

(A229.388) Bowl. Ring foot. Incised.
In: white slip; incised decoration. ?waster.

(A229.389) Tripod firing stilt.

(A229.390) Tripod firing stilt.
Plain.

(A229.391) Tripod firing stilt.
Plain.

(A229.392) Tripod firing stilt.
Traces of green glaze.

(A229.393) Tripod firing stilt.
Plain.

(A229.394) Unidentified form.
Traces of green glaze. Waster.

(A229.395) Unidentified form.
Traces of green glaze. Waster.

(A229.396) Unidentified form.
Plain. Waster.

(A229.397) Unidentified form.
Traces of green glaze. Waster.

(A229.398) Unidentified form.
Plain. Waster.

(A229.399) Unidentified form.
Traces of green glaze. Waster.

(A229.400) Unidentified form.
Traces of green glaze. Waster.

(A229.401) Unidentified form.
Traces of green glaze. Waster.

(A229.402) Unidentified form.
Traces of green glaze. Waster.

(A229.403) Bowl. Body sherd.
No decoration. Waster.

Test group

Since identification and full classification of Zeuxippus Ware was based on finds from excavations at Saranda Kolones, it is appropriate that sherds from this site should form the principal test group of ten samples each from Ia and II.

7. We are most grateful to Dr Helen A. Aibabine and Dr Serguei G. Botcharov for generously providing the samples tested here. The kilns from which the samples came are dated by coins to the second decade of the 15th century.

Test Catalogue

Zeuxippus Class I

(A229.121) Bowl. Ring foot. 3 joining frr.
In: white slip; gouged circle at tondo; cream glaze.

(A229.122) Bowl. Body sherd.
In: white slip; incised sgraffito within and radiating from tondo; cream glaze. Out: edge of slip-painted decoration; cream glaze.

(A229.123) Bowl. Rim.
In and out: white slip under cream glaze.

(A229.124) Bowl. Ring foot.
In: white slip; four incised concentric circles at tondo; cream glaze.

(A229.125) Bowl. Ring foot.
In: white slip; three incised concentric circles at tondo; cream glaze.

(A229.126) Bowl. Ring foot.
In: white slip; three incised concentric circles at tondo; cream glaze. Out: white slip; two incised lines around body just above base.

(A229.127) Bowl. Rim.
In: white slip; three incised concentric circles at tondo; cream glaze.

(A229.128) Bowl. Body sherd.
In: white slip; broad incised line on upper edge of rim; cream glaze. Out: slip-painted circles; cream glaze.

(A229.129) Bowl. Ring foot.
In: white slip; cream glaze. Out: white slip on upper body; incised line around lower edge of slip.

Zeuxippus Class II

(A229.131) Bowl. Rim.
In: white slip; broad incised lines marking edges of rim; incised sgraffito motif highlighted in yellow-brown; cream glaze.

(A229.132) Bowl. Rim.
In: white slip; broad incised lines marking edges of rim; incised sgraffito motif highlighted in yellow-brown; cream glaze.

(A229.133) Bowl. Rim.
In: white slip; broad incised lines marking upper edge of rim; incised sgraffito motif highlighted in yellow-brown; cream glaze.

(A229.134) Bowl. Ring foot.
In: white slip; incised sgraffito motifs in tondo highlighted in black-brown; cream glaze.

(A229.135) Bowl. Rim.
In: white slip; broad incised lines marking edges of rim; incised sgraffito motif highlighted in yellow-brown; cream glaze.

(A229.136) Bowl. Ring foot.
In: white slip; incised sgraffito motif in tondo highlighted in yellow-brown; cream glaze. Glaze on foot ring.

(A229.137) Bowl. Ring foot.
In: white slip; incised sgraffito motifs in tondo highlighted in yellow-brown; cream glaze.

(A229.138) Bowl. Rim.
In: white slip; broad incised band around rim highlighted in part with black-brown; cream glaze.

(A229.139) Bowl. Ring foot.
In: white slip; incised sgraffito motifs in tondo highlighted in yellow-brown; cream glaze.

(A229.140) Bowl. Body sherd.
In: white slip; cream glaze.

Standards

The standards used to check the calibrations in this project were NBS 102, NBS 679 and ECRM 776, which are all certified reference materials, and the "Knossos sherd" (Kn sherd) which has been used by both the Oxford and Fitch (Athens) laboratories for over 20 years. The accuracy on all elements was satisfactory, that is, the concentrations obtained lay close to the expected values, within the experimental errors for the method (ICP-AES).

Since the samples were run in two different batches, the amount of variation obtained when one sample is repeated needs to be estimated, especially when the samples are to be used in a statistical program, or compared with data from other laboratories. The certified materials and the "Kn sherd" were analysed at frequent intervals throughout both rounds of analysis, and the coefficients of variation calculated by dividing the standard deviations by the means for each element (and multiplied by 100) lay between 2% and 5% except for potassium and titanium in NBS 102, and titanium in NBS 679 and ERCM 776, where they are higher but still less than 10%. Similarly, the coefficients of variations for the trace and rare earth elements in all the standards except NBS 102 are under 5% for many of the elements, Zr, Nd

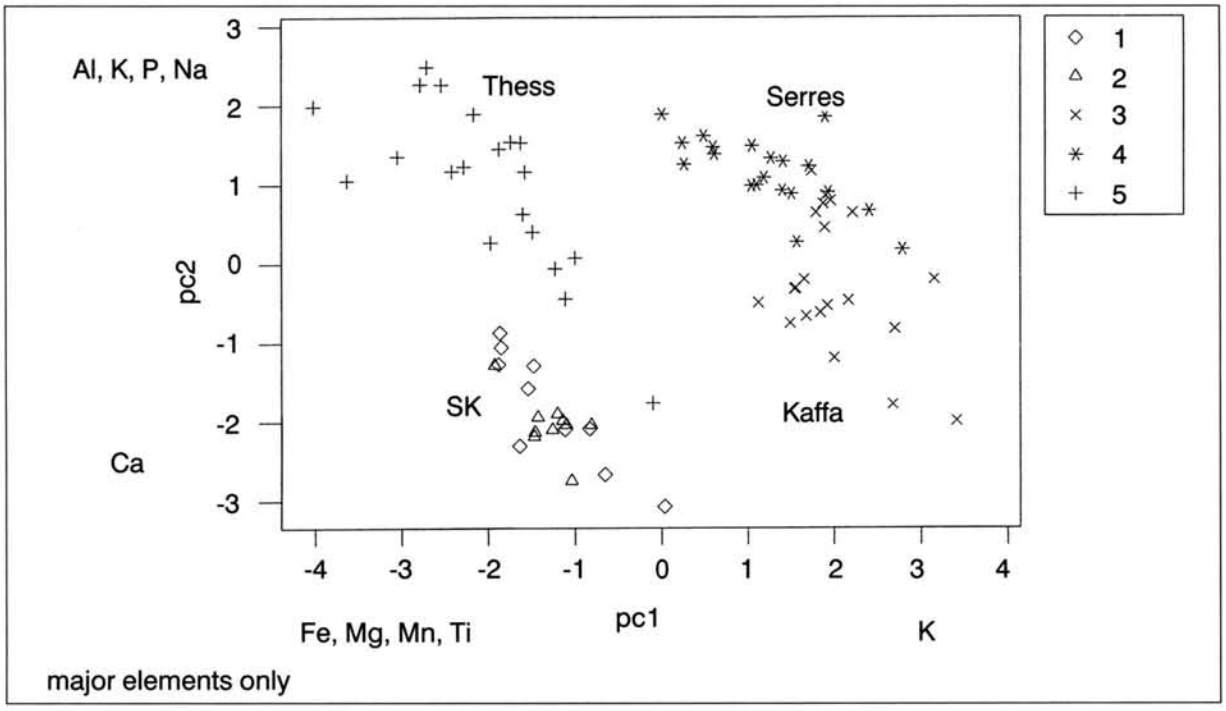

Fig. 1. PCA plot for Saranda Kolones (Zeuxippus), Kaffa, Serres, and Thessaloniki.

and Sm being the exceptions (but not above 10%). The results for the standards are shown in Table 1 (major elements) and Table 2 (trace and rare earth elements).

Results

The analytical results, as group means and standard deviations, are given in Table 3 (major elements) and Table 4 (minor and trace elements). From Table 3, it can be seen that most of the major elements show some differences between groups in their concentrations. The difference between the averages for the Zeuxippus groups 1 and 2 from Saranda Kolones is so small that they have been combined and treated as one group. The Kaffa group has a larger standard deviation than the other groups in its calcium concentrations, probably because some coarser ware and clay had been included in the group. The pottery from Thessaloniki also has a spread of values in its major element concentrations; here it seems that a number of workshops are employing a similar clay. More samples from each suspected workshop would probably clarify the situation by splitting the samples according to clay sources. The multivariate clustering program provided by MINITAB, using the correlation matrix for the major elements only, was employed to examine the ICP-AES data for grouping. The outcome of the clustering is illustrated in the Principal Components plot (Fig. 1). Although it displays only 60% of all the variation present in the data, this plot of the first two principal components demonstrates the relationship of the samples to each other, and suggests that groups can be distinguished.

Principal Components Analysis (PCA) was applied to the chemical results to cluster together pottery of similar composition (see Fig. 1) and produced a plot using the first two principal components, calculated from the correlation matrix for the major elements. Although it displays only 60% of all the variation in the data, the main structure of the groups is clear. On the bottom (x) axis, the samples are plotted according to their potassium, iron, magnesium, manganese and titanium concentrations. The other (y) axis uses calcium, aluminium, potassium, phosphorus and sodium to separate out the samples. Each point represents an individual sherd, and each group has a different symbol.

The groups are fairly closely related, but they do not overlap significantly, except in the case of the two classes of Zeuxippus Wares[8]. A few of the Kaffa samples spread

8. To test the proposition that there are two distinct groups, corresponding to the different classes of Zeuxippus Wares, would require a further analysis program, based on twenty samples of each.

	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
Batch 1 Kn sherd	n=15								
x	13.94	7.66	5.57	11.28	1.00	2.48	0.67	0.24	0.10
s	*0.33*	*0.15*	*0.13*	*0.20*	*0.03*	*0.07*	*0.02*	*0.01*	*0.00*
cv	*2.37*	*1.95*	*2.41*	*1.78*	*3.08*	*2.91*	*2.75*	*4.02*	*4.22*
Batch 3 Kn sherd	n=10								
x	13.95	7.73	5.59	10.68	0.97	2.47	0.65	0.29	0.09
s	*0.32*	*0.16*	*0.14*	*0.22*	*0.03*	*0.06*	*0.02*	*0.01*	*0.01*
cv	*2.26*	*2.04*	*2.51*	*2.08*	*2.60*	*2.22*	*2.99*	*3.15*	*5.49*
*expected value	14.20	7.65	5.57	11.20	0.86	2.56	0.73		0.10
Batch 1 NBS 102	n=7								
x	2.03	0.76	0.21	2.40	0.02	0.32	0.16	0.06	0.00
s	*0.07*	*0.02*	*0.01*	*0.06*	*0.00*	*0.02*	*0.01*	*0.00*	*0.00*
cv	*3.57*	*3.18*	*4.59*	*2.53*	*0.00*	*6.07*	*6.62*		
Batch 3 NBS 102	n=3								
x	2.20	0.77	0.21	2.37	0.02	0.33	0.17	0.07	0.00
s	*0.04*	*0.01*	*0.00*	*0.05*	*0.00*	*0.03*	*0.01*	*0.00*	*0.00*
cv	*1.72*	*1.49*	*0.00*	*1.90*	*0.00*	*9.35*	*3.46*		
*expected value	1.96	0.66	0.21	2.29	0.015	0.32	0.16	0.03	
Batch 1 NBS 679	n=3								
x	20.43	14.25	1.31	0.26	0.18	2.79	0.90	0.17	0.24
s	*0.40*	*0.28*	*0.03*	*0.01*	*0.00*	*0.07*	*0.08*	*0.01*	*0.01*
cv	*1.97*	*1.96*	*1.93*	*3.85*	*0.00*	*2.58*	*9.22*	*5.88*	*2.37*
*expected value	20.80	12.94	1.25	0.23	0.18	2.93	0.96		0.22
Batch 3 ECRM 776	n=6								
x	28.52	1.64	0.52	0.38	0.49	2.86	1.55	0.09	0.01
s	*0.74*	*0.03*	*0.01*	*0.01*	*0.02*	*0.08*	*0.07*	*0.00*	*0.00*
cv	*2.58*	*1.76*	*1.90*	*1.97*	*3.50*	*2.88*	*4.34*		
*expected value	29.28	1.43	0.48	0.31	0.49	2.92	1.62	0.06	

Table 1. Standards used for Byzantine ICP-AES analysis, major elements (wt %)

	Ba	Co	Cr	Cu	Li	Nb	Ni	Sc	Sr	V	Y	Zn	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb
Batch 1 Kn sherd	n=15																			
x	350	33	332	73	52	12	328	20	321	145	23	123	36	30	50	28	5.6	1.0	3.2	1.6
s	*13.56*	*0.96*	*25.55*	*1.91*	*1.45*	*0.56*	*4.14*	*0.62*	*11.70*	*3.20*	*0.64*	*3.22*	*2.26*	*2.02*	*1.96*	*2.01*	*0.55*	*0.05*	*0.16*	*0.12*
cv	*3.87*	*2.91*	*7.68*	*2.64*	*2.80*	*4.60*	*1.26*	*3.14*	*3.65*	*2.20*	*2.80*	*2.61*	*6.21*	*6.78*	*3.93*	*7.22*	*9.89*	*5.35*	*5.15*	*7.50*
Batch 3 Kn sherd	n=10																			
x	343	33	334	73	48	10	330	20	319	146	22	117	36	27	48	22	4.6	1.0	3.0	1.4
s	*15.16*	*0.84*	*16.32*	*2.11*	*1.40*	*0.48*	*6.83*	*0.52*	*11.02*	*3.40*	*0.42*	*2.98*	*2.59*	*0.82*	*0.84*	*1.78*	*0.31*	*0.05*	*0.07*	*0.13*
cv	*4.42*	*2.52*	*4.89*	*2.90*	*2.90*	*4.69*	*2.07*	*2.63*	*3.46*	*2.32*	*1.90*	*2.54*	*7.28*	*3.02*	*1.77*	*8.22*	*6.74*	*5.38*	*2.36*	*9.54*
Batch 1 NBS 102	n=7																			
x	28	3	21	17	16	3	13	2	36	14	12	9	140	19	37	16	2.8	0.4	1.8	0.9
s	*1.07*	*0.49*	*2.98*	*0.58*	*3.18*	*0.76*	*1.21*	*0.00*	*1.27*	*0.76*	*0.53*	*2.30*	*12.28*	*0.95*	*1.21*	*1.25*	*0.46*	*0.05*	*0.15*	*0.05*
cv	*3.80*	*17.98*	*14.02*	*3.40*	*19.73*	*23.01*	*9.24*	*0.00*	*3.49*	*5.29*	*4.62*	*26.82*	*8.76*	*4.93*	*3.27*	*7.98*	*16.86*	*11.39*	*8.60*	*5.67*
Batch 3 NBS 102	n=3																			
x	33	3	21	16	12	3	12	2	38	15	11	8	134	19	35	13	2.0	0.4	1.5	0.8
s	*2.00*	*0.00*	*0.58*	*0.58*	*0.58*	*1.00*	*0.58*	*0.00*	*0.58*	*1.15*	*0.58*	*0.00*	*8.50*	*1.15*	*1.73*	*1.53*	*0.44*	*0.00*	*0.17*	*0.06*
cv	*6.06*		*2.79*	*3.53*	*4.68*	*33.33*	*4.95*	*0.00*	*1.53*	*7.87*	*5.09*	*0.00*	*6.36*	*6.19*	*4.95*	*11.46*	*21.79*	*0.00*	*11.55*	*6.93*
Batch 1 NBS 679	n=3																			
x	469	24	117	34	75	17	62	24	78	164	38	120	100	50	99	41	9.4	1.5	5.3	3.0
s	*9.07*	*0.58*	*1.73*	*1.53*	*1.00*	*0.58*	*0.58*	*1.00*	*2.52*	*3.06*	*3.21*	*1.00*	*9.07*	*2.89*	*2.65*	*1.73*	*0.30*	*0.06*	*0.35*	*0.15*
cv	*1.93*	*2.37*	*1.48*	*4.45*	*1.33*	*3.46*	*0.93*	*4.17*	*3.24*	*1.86*	*8.53*	*0.83*	*9.04*	*5.74*	*2.67*	*4.22*	*3.19*	*3.94*	*6.54*	*5.15*
Batch 3 ECRM 776	n=6																			
x	1143	3	141	28	84	25	37	24	167	194	27	63	148	67	128	57	8.9	1.4	2.9	2.3
s	*41.34*	*3.54*	*5.02*	*2.42*	*3.44*	*1.21*	*2.35*	*1.05*	*5.39*	*4.13*	*2.25*	*2.00*	*18.61*	*1.75*	*3.43*	*2.34*	*0.48*	*0.05*	*0.34*	*0.25*
cv	*3.62*		*3.56*	*8.55*	*4.12*	*4.78*	*6.43*	*4.46*	*3.24*	*2.13*	*8.44*	*3.17*	*12.56*	*2.63*	*2.68*	*4.08*	*5.38*	*3.60*	*11.90*	*10.72*

Table 2. Standards used for Byzantine ICP-AES analysis, trace and rare earth elements (ppm).

	wt %								
	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
Zeux 1									
x	15.06	7.18	3.60	7.97	1.26	2.50	0.77	0.22	0.15
s	*0.88*	*0.43*	*0.23*	*1.06*	*0.08*	*0.18*	*0.04*	*0.05*	*0.01*
Zeux 2									
x	14.99	7.16	3.60	7.78	1.25	2.44	0.75	0.19	0.15
s	*0.45*	*0.21*	*0.12*	*0.54*	*0.07*	*0.09*	*0.02*	*0.01*	*0.01*
GROUPS									
Zeux 1+2									
x	15.02	7.17	3.60	7.87	1.26	2.47	0.76	0.20	0.15
s	*0.68*	*0.33*	*0.18*	*0.83*	*0.07*	*0.14*	*0.03*	*0.04*	*0.01*
Kaffa									
x	17.55	6.63	2.38	9.10	1.22	3.63	0.69	0.22	0.09
s	*1.70*	*0.64*	*0.27*	*3.56*	*0.20*	*0.32*	*0.09*	*0.06*	*0.01*
Serres									
x	18.16	6.57	2.88	6.12	2.10	3.53	0.68	0.30	0.12
s	*0.75*	*0.49*	*0.24*	*1.00*	*0.15*	*0.28*	*0.03*	*0.04*	*0.01*
Thessaloniki									
x	18.01	7.95	3.43	5.02	1.51	2.79	0.79	0.36	0.15
s	*1.64*	*0.80*	*0.73*	*1.80*	*0.34*	*0.39*	*0.07*	*0.11*	*0.01*

Table 3. Results of ICP-AES analyses, major element means and standard deviations for each group (wt %).

		Ba	Co	Cr	Cu	Li	Nb	Ni	Sc	Sr	V	Y	Zn	Zr	La	Ce	Nd	Sm	Eu	Dy	Yb
Zeux 1																					
	x	488	26	204	45	73	12	158	19	289	127	21	95	33	37	62	33	6.5	1.1	3.3	1.6
	s	*129.02*	*1.65*	*17.29*	*3.11*	*6.18*	*0.52*	*11.02*	*1.26*	*23.38*	*13.57*	*1.16*	*7.01*	*1.20*	*1.69*	*2.25*	*1.51*	*0.26*	*0.06*	*0.12*	*0.08*
Zeux 2																					
	x	387	26	192	45	72	12	158	19	288	122	21	96	33	37	62	32	6.5	1.1	3.2	1.5
	s	*20.59*	*1.42*	*9.78*	*2.66*	*2.92*	*0.32*	*5.20*	*0.57*	*22.48*	*10.54*	*1.16*	*2.73*	*0.82*	*1.07*	*1.48*	*1.15*	*0.18*	*0.05*	*0.05*	*0.05*
Zeux 1+2																					
	x	437	26	198	45	73	12	158	19	289	125	21	95	33	37	62	32	6.5	1.1	3.3	1.5
	s	*103.76*	*1.50*	*14.81*	*2.82*	*4.76*	*0.44*	*8.39*	*0.97*	*22.33*	*12.12*	*1.17*	*5.23*	*1.02*	*1.38*	*1.85*	*1.34*	*0.23*	*0.06*	*0.11*	*0.07*
Kaffa																					
	x	477	36	109		84	12	73	17	296	132	21	100	57	36	64	28	5.5	0.9	2.5	1.4
	s	*44.73*	*40.90*	*10.48*		*23.44*	*3.45*	*11.44*	*1.74*	*106.84*	*13.20*	*4.52*	*23.04*	*21.50*	*5.86*	*7.89*	*3.32*	*1.08*	*0.10*	*0.53*	*0.42*
Serres																					
	x	611	23	71	45	51	13	41	15	271	104	25	119	11	39	66	28	5.6	1.0	3.1	1.6
	s	*30.53*	*2.87*	*7.47*	*15.98*	*4.13*	*0.80*	*3.15*	*1.02*	*28.98*	*8.35*	*1.03*	*10.95*	*1.93*	*1.91*	*3.63*	*1.92*	*0.32*	*0.05*	*0.16*	*0.10*
Thessaloniki																					
	x	451	37	199	70	43	12	117	22	164	142	24	100	37	37	64	26	5.7	1.1	3.2	1.5
	s	*61.04*	*9.03*	*47.62*	*16.35*	*7.64*	*1.94*	*43.79*	*1.93*	*38.09*	*15.80*	*4.56*	*14.99*	*14.13*	*4.16*	*8.60*	*4.34*	*0.92*	*0.12*	*0.60*	*0.32*

Table 4. Results of ICP-AES analyses, minor and trace element means and standard deviations for each group (ppm).

into the Serres group. In theory, this could mean that they come from Serres, but since it is known that all the Kaffa samples were excavated there, it is more likely that they have, by chance, a similar composition. A larger sample of glazed bowls from Kaffa would probably allow a clearer distinction to be made. The Thessaloniki group is also very spread out. This might be explained by a number of workshops using similar clays, a theory supported by the sampling technique, whereby sherds were selected from a range of locations. Again, larger sample numbers for each suspected workshop might clarify the situation.

CONCLUSIONS

The two classes of Zeuxippus Wares from Saranda Kolones appear to come from the same workshop or production centre. This place of manufacture remains unidentified, but was not at Thessaloniki, Serres or Kaffa. While Zeuxippus-type wares are found across a wide area of the Mediterranean, the origins of their prototypes remain elusive.

BIBLIOGRAPHY

Armstrong 1992 : ARMSTRONG (P.). – Zeuxippus Derivatives Bowls from Sparta, *in: Φιλολάκων. Lakonian Studies in Honour of Hector Catling* (ed. J.M. Sanders), London 1992, 1-9.

Armstrong, Hatcher 1997 : ARMSTRONG (P.), HATCHER (H.). – Byzantine and Allied Pottery, Phase 2: Past Work on Materials Analysis and Future Prospects, *in: Materials Analysis* 1997, 1-8.

Bakirtzis, Papanikola-Bakirtzis 1981 : BAKIRTZIS (CH.), PAPANIKOLA-BAKIRTZIS (D.). – De la céramique byzantine en glaçure à Thessalonique, *Byzantinobulgarica* 7 (1981), 421-436.

Berti, Gelichi 1997 : BERTI (G.), GELICHI (S.). – Zeuxippus Ware in Italy, *in: Materials Analysis* 1997, 85-104.

***Materials Analysis* 1997 :** *Materials Analysis of Byzantine Pottery* (ed. H. Maguire), Washington, D.C. 1997.

Megaw 1968 : MEGAW (A.H.S.). – Zeuxippus Ware, *BSA* 63 (1968), 67-88.

Megaw 1971 : MEGAW (A.H.S.). – Excavations at "Saranda Kolones", Paphos, *RDAC* 1971, 117-146.

Megaw 1972a : MEGAW (A.H.S.). – Saranda Kolones: A Medieval Castle Excavated at Paphos, *in: Πρακτικά του Πρώτου Κυπρολογικού Συνεδρίου*, 2, 1972, 177-182.

Megaw 1972b : MEGAW (A.H.S.). – Supplementary Excavations on a Castle Site at Paphos, Cyprus, 1970-1971, *DOP* 26 (1972), 322-343.

Megaw 1976 : MEGAW (A.H.S.). – Excavations at Saranda Kolones, Paphos, Preliminary Report on the 1966-67 and 1970-71 Seasons, *RDAC* 1976, 117-146.

Megaw 1982 : MEGAW (A.H.S.). – Saranda Kolones, 1981, *RDAC* 1982, 210-216.

Megaw 1989 : MEGAW (A.H.S.). – Zeuxippus Ware Again, *in: Recherches sur la céramique byzantine* (éd. V. Déroche, J.-M. Spieser), *BCH* Suppl. XVIII, 1989, 259-266.

Megaw, Armstrong, Hatcher, in press : MEGAW (A.H.S.), ARMSTRONG (P.), HATCHER (H.). – The Cypro-Levantine Circulation of Zeuxippus "Ware", *DOP* (in press).

Megaw, Jones 1983 : MEGAW (A.H.S.), JONES (R.E.). – Byzantine and Allied Pottery: A Contribution by Chemical Analyses to Problems of Origin and Distribution, *BSA* 78 (1983), 235-265.

Papanikola-Bakirtzis 1983 : PAPANIKOLA-BAKIRTZIS (D.). – Εργαστήριο εφυαλωμένης κεραμικής στη Θεσσαλονίκη. Πρώτες παρατηρήσεις, *in: Αφιέρωμα στη μνήμη Στυλιανού Πελεκανίδη, Μακεδονικά*, Παράρτημα 5, Thessaloniki 1983, 377-388.

Papanikola-Bakirtzis 1987 : PAPANIKOLA-BAKIRTZIS (D.). – The Palaeologan Glazed Pottery of Thessaloniki, *in: Recueil des Rapports du IVe Colloque serbo-grec sur l'art de Thessalonique et les pays balkaniques et les courants spirituels au XIVe siècle*, Belgrade 1987, 193-304.

Papanikola-Bakirtzis, Dauterman Maguire, Maguire 1992 : PAPANIKOLA-BAKIRTZIS (D.), DAUTERMAN MAGUIRE (E.), MAGUIRE (H.). – *Ceramic Art from Serres*, Urbana, Chicago 1992.

Rosser 1985 : ROSSER (J.). – Excavations at Saranda Kolones, Paphos, Cyprus, 1981-1983, *DOP* 39 (1985), 81-97.

Xyngopoulos 1965 : XYNGOPOULOS (A.). – *Έρευναι εις τα βυζαντινά μνημεία των Σερρών*, Thessaloniki 1965.

Yakobson 1950 : YAKOBSON (A.L.). – *The Medieval Chersonese, 12th-14th Centuries*, Moscow - Leningrad 1950 (Materials and Researches for the Archaeology of the USSR 17) (in Russian).