Spectrographic Analyses of Mycenaean Pottery from Ialysos on Rhodes: Results and Implications

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The changing relations between the important Mycenaean site of Ialysos on Rhodes and the Argolid (in the Greek Peloponnese) during the LH III period (the 15th-12th centuries B.C.) have been studied through the pottery found in the tombs of the cemetery from Ialysos. The results of spectrographic analyses of well characterised and dated pots from Ialysos have made possible a clear distinction between locally produced Rhodian pottery and imports that were primarily from the Argolid. During the LH IIIA2 period the large majority of the cemetery pottery at Ialysos was imported from the Argolid. The same situation pertains in the IIIB period, but there are examples of imported pottery from centres other than the Argolid, such as Crete. In the 12th century B.C. (IIIC), however, the position was completely reversed, and the fine Mycenaean pottery was almost exclusively made on Rhodes.

Introduction

One of the basic functions of composition and provenience studies of Late Bronze Age pottery from the Aegean (FIG. 1) has been the establishment of the composition characteristics of locally produced fine ware pottery from sites that may reasonably be presumed to have been production centres. At the major sites an attempt is made to select 20 examples of each of the main fine wares which are deemed in archaeological terms to be local products and are represented in the broad chronological period under study (for example the Late Bronze Age). Most frequently, a single composition type is encountered within such control material, as for example at Mycenae. The presence of more than one composition type at a site may indicate the existence of an imported group among the local pottery, the latter usually being in a majority.[1] Alternatively, it may be explained in terms of the variation in composition in the clay beds which were exploited in the vicinity of the site, or as the result of the addition of temper to the clay. The pottery at Chania in the Late Bronze Age provides a dramatic example of a probable combination of these two effects.[2]

It is against this background that the previous work on pottery from Ialysos and the rationale for the present study may be understood. Catling et al.[3] analysed 40 sherds from Ialysos and from their data isolated two similar composition types (called J and K) which they took to be local. But their significant and surprising discovery was the presence of a large number of Type A compositions (Peloponnese) among the samples. Papadopoulos and Jones[4] analysed an Ialysos control of 19 sherds and again the Peloponnese compositions formed a majority (this time 74%) over the proposed Rhodian compositions. Certainly Mycenaean imports from the mainland would be expected at Ialysos but since the control sherds chosen were not diagnostic, either in terms of date or likely provenience, the possibility that there existed on Rhodes a clay type other than Types J/K, which happened to be very similar to that of the Peloponnese, could not be excluded.

It was decided that in order to resolve this problem and to check the conclusions based on a stylistic analysis, such as those of Stubbings[5] or Mee,[6] a larger,

1. For example Amarynthos I (imported) and II (local) as described in H. W. Catling, E. E. Richards, and A. E. Blin-Stoyle, "Correlations between Composition and Provenance of Mycenaean and Minoan Pottery," *BSA* 58 (1963) 94-115.

2. H. W. Catling and R. E. Jones, "A Reinvestigation of the Provenance of the Inscribed Stirrup Jars Found at Thebes," *Archaeometry* 19:2 (1977) 137-46.

3. Catling et al., op. cit. (in note 1).

4. A. J. Papadopoulos and R. E. Jones, "Rhodiaca in Achaea," *Opuscula Atheniensia* 14 (1978) in press.

5. F. Stubbings, *Mycenaean Pottery from the Levant* (Cambridge 1951) 5-20.

6. C. B. Mee, "The Dodecanese in the Bronze Age" (London 1975), Ph.D. dissertation to be published as *Rhodes in the Bronze Age* (Warminster 1980) 49-152.

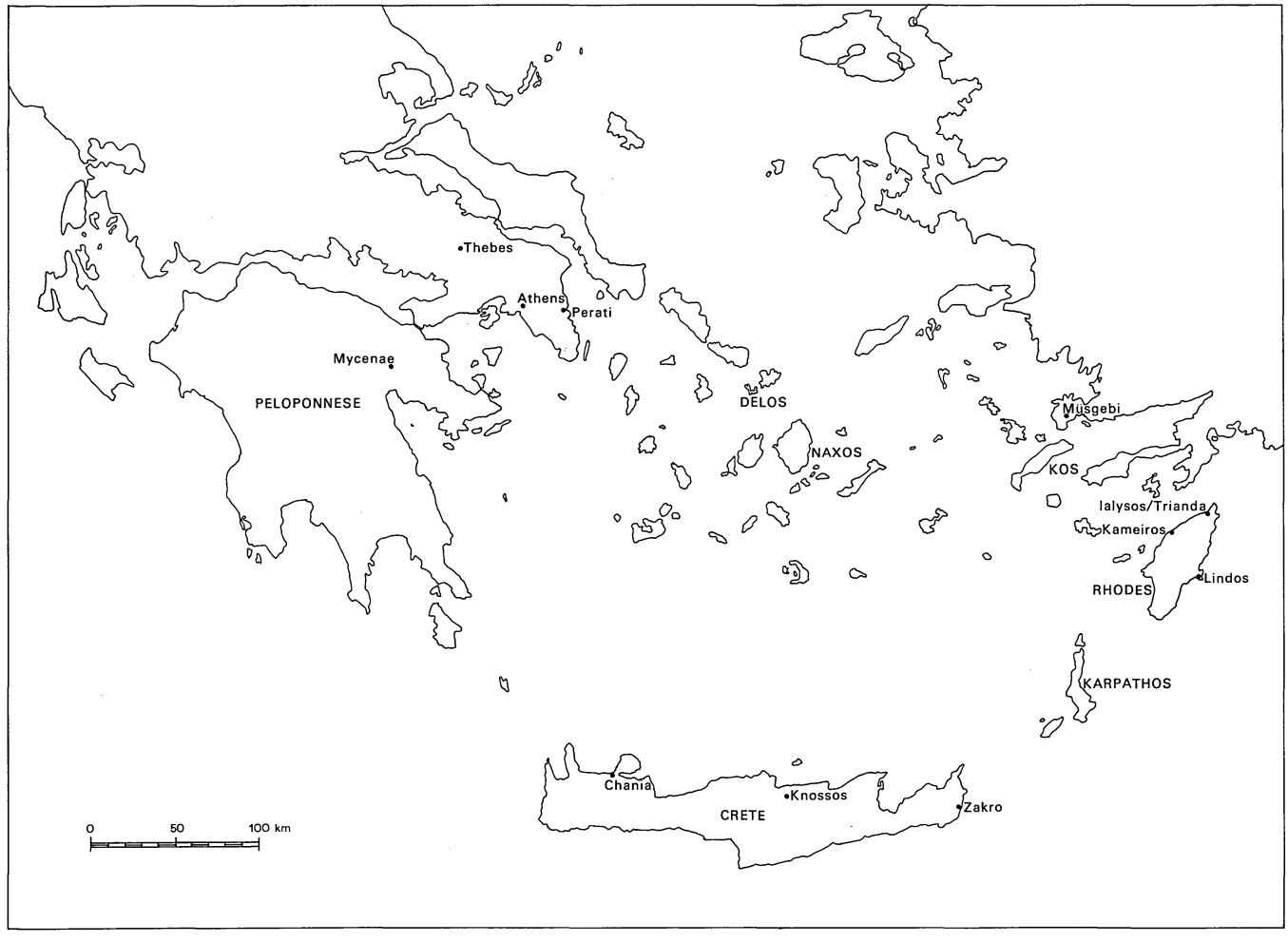

Figure 1. Map of the Aegean.

chronologically better defined sample should be analysed. This article presents the rather unexpected results based upon an analysis of 55 of the Mycenaean pots from Ialysos.

The Samples

Context

The chamber tomb cemeteries of Moschou and Macra Vunara, below the acropolis of Ialysos, were excavated by Biliotti in 1868-1871,[7] Maiuri in 1914-1923,[8] and Jacopi in 1927-1928.[9] Amongst the richest Mycenaean cemeteries, the Ialysos necropolis has marked Rhodes out as possibly the most important Mycenaean centre outside the Greek mainland. Hrozny and Page[10] even identified Rhodes as Ahhijawa, the Hittites' powerful western neighbour, although this now seems unlikely.[11] The cemeteries were in use from LHIIB-LHIIIC but the LHIIB-LHIIIA1 periods are not so well represented and it was therefore decided to concentrate on LHIIIA2-LHIIIC, that is, from the second quarter of the 14th century to the end of the 11th century B.C.

The number of samples from each of the three periods (IIIA2, IIIB, IIIC) is more or less the same:

7. E. J. Forsdyke, *Catalogue of the Greek and Etruscan Vases in the British Museum Vol. 1 Part 1: Prehistoric Aegean Pottery* (London 1925) 139-77; H. Walters and E. J. Forsdyke, *CVA Great Britain 7: British Museum 5* (London 1930) pls. 1-8.

8. A. Maiuri, "Jalisos—Scavi della Missione Italiana a Rodi (Parte I e II)," *ASAtene* 6-7 (1923-24) 83-341 (= Ialysos 1).

9. G. Jacopi, "Nuovi Scavi nella Necropoli Micenea di Jaliso," *ASAtene* 13-14 (1930-31) 253-345 (= Ialysos 2).

10. B. Hrozny, "Hethiter und Griechen" *ArchOr* 1 (1929) 323-43; D. Page, *History and the Homeric Iliad* (California 1959) 15.

11. G. Huxley, *Achaeans and Hittites* (Oxford 1960) 29; S. Iacovides, "Rhodes and Ahhijava," *Acts of the International Archaeological Symposium: The Mycenaeans in the Eastern Mediterranean* (Nicosia 1973) 189-92.

16:17:22. The ratio of local to imported pottery, on stylistic analysis, is roughly 2:1. A problem in selecting the likely local pottery is that the settlement connected with the tombs has not been excavated or even located. Obviously the proportion of imported, and therefore more prestigious, pottery will be higher in tombs. There are, however, a number of pot types characteristic of the Mycenaean period from Rhodes, the local origin of which has never been seriously doubted.

With three exceptions, the samples chosen are illustrated either in the *CVA* or in the excavation reports of Maiuri and Jacopi. In the following catalogue the samples are listed by period and pot type. The sample number is given first, followed by the British Museum inventory number or the tomb number, in the case of the pottery excavated by Maiuri and Jacopi, then the Furumark shape and motif, and finally the illustration reference.*

Catalogue

IIIA2

Piriform Jar

2 NT4:10	FS45/FM64	
12 NT10:2	FS35/FM27	*Ialysos 1* 115, fig. 35
42 NT48:2	FS34/FM22	*Ialysos 1* 203, fig. 126
43 NT50:1	FS35/FM18A+27	*Ialysos 1* 210, fig. 133
44 NT9:2	FS35/FM46	
46 BMA829	FS34/FM22	*CVA BM5* 3:13

Jug

10 NT4:5	FS133/FM67	*Ialysos 1* 96, fig. 11

Alabastron

17 NT29:3	FS85/FM32	*Ialysos 1* 159, fig. 84

Flask

31 NT62:8	FS188/L	*Ialysos 2* 267, fig. 13

Basket Vase

19 NT48:12	FS319/FM61A	*Ialysos 1* 205, fig. 128
30 NT63:2	FS319/FM46	*Ialysos 2* 269, fig. 14
45 BMA811	FS319/FM46	*CVA BM5* 1:3

Krater

28 NT60:2	FS54/Chariot	*Ialysos 1* 233, fig. 149

Kylix

14 NT28:17	FS269/M	cf. *CVA BM5* 5:5
20 NT48:11	FS264/M	*Ialysos 1* 204, fig. 127

*Abbreviations other than standard are as follow.

FS	= Furumark shape.
FM	= Furumark motif.
Ialysos 1	= Maiuri A., "Scavi della Missione Archeologica Italiana a Rodi (Parte I e II)," *ASAtene* 6-7 (1923-24) 83-341.
Ialysos 2	= Jacopi G., "Nuovi Scavi nella Necropoli Micenea di Jaliso," *ASAtene* 13-14 (1930-31) 253-345.

Catalog (cont.)

Rhyton

8 NT4:4	FS199/FM21	*Ialysos 1* pl. 1

IIIB

Piriform Jar

9 NT10:5	FS37/FM19	*Ialysos 1* 117, fig. 37
47 BMA838	FS37/FM70	*CVA BM5* 2:5

Stirrup Jar

39 NT38:3210	FS167/FM19	
51 BMA897	FS167/FM18	*CVA BM5* 6:29
52 BMA904	FS182/FM27	*CVA BM5* 6:33

Jug

22 NT59:5	FS120/FM6+18A+23	*Ialysos 1* 227, fig. 144
26 NT53:4	FS118/FM18A+23+25	*Ialysos 1* 217, fig. 139

Flask

50 BMA884	FS186/L	*CVA BM5* 3:9

Brazier

7 NT5:11	FS316/UP	*CVA Italy 10* 1:1

Krater

11 NT5:1	FS11/FM62	*Ialysos 1* 102, fig. 20
40 NT53:3	FS28/FM23	*Ialysos 1* 216, fig. 138

Kylix

23 NT53:6	FS258/FM23	*Ialysos 1* 218, fig. 140
24 NT59:6	FS258/FM21	*Ialysos 1* 228, fig. 145
49 BMA863	FS266/UP	*CVA BM5* 5:20

Bowl

25 NT53:15	FS284/FM62	*Ialysos 1* 218, fig. 140
54 BMA947	FS300/FM57	*CVA BM5* 8:12

Cup

48 BMA851	FS245/FM62	*CVA BM5* 5:15

IIIC

Stirrup Jar

29 NT15:2	FS176/FM21	*CVA Italy 10* 2:7
33 NT83:6A	FS176/FM43+58	*Ialysos 2* 316, fig. 63
34 NT85:1A	FS176/FM21	*Ialysos 2* 324, fig. 72
35 NT84:6	FS176/FM21	*Ialysos 2* 322, fig. 69
38 NT73:1	FS176/FM21	*Ialysos 2* 293, fig. 37
53 BMA932	FS176/FM21	*CVA BM5* 7:16

Amphoriskos

4 NT17:34	FS59/FM65	*Ialysos 1* 125, fig. 44
21 NT35:5	FS64/L	*Ialysos 1* 183, fig. 107
32 NT17:16	FS62/FM43+75	*Ialysos 1* 118, fig. 38
36 NT85:2	FS61/FM19	*Ialysos 2* 325, fig. 73

Jug

5 NT17:44	FS155/FM19	*Ialysos 1* 125, fig. 44
6 NT17:19	FS107/L	*Ialysos 1* 122, fig. 41
16 NT20:4	FS157/L+Snakes	*Ialysos 1* 136, fig. 58

Pyxis

3 NT17:51A	FS12/FM43+73	*Ialysos 1* 124, fig. 43
41 NT32:27	FS99/FM19	*Ialysos 1* 180, fig. 105

Catalog (cont.)

Brazier		
27 NT38:25	FS316/L	*Ialysos 1* 191, fig. 114
Multiple Jar		
37 NT87:13	FS330/FM43	*Ialysos 2* 334, fig. 83
55 BMA959	FS328/FM43	*CVA BM5* 7:10
Kylix		
18 NT32:35	FS275/L	*Ialysos 1* 179, fig. 104
Bowl		
1 NT17:55	FS284/FM50	*Ialysos 1* 124, fig. 43
13 NT21:14	FS289/L	*Ialysos 1* 140, fig. 63
15 NT21:31	FS291/L+Figurines	*Ialysos 1* 143, fig. 31

Method

All samples were analysed by optical emission spectroscopy using the method described by Catling et al.,[12] with certain modifications regarding technique and calibration given by Schweizer.[13] Samples 1-47, 49, 51, 53, and 54 were obtained by drilling approx. 50 mg. of powder with a tungsten carbide drill head. Ialysos 48, 50, 52, and 55 were obtained by scraping with a steel scalpel blade. The samples from Trianda (the Minoan settlement 1.4 km. from Ialysos), Kameiros, Lindos, and Seraglio on Kos were all obtained by breaking a chip, which was free of paint or slip, from the sherd and grinding it to powder. Nine elements in their oxide form were determined in all cases. The Ialysos samples, with the exception of 7 and 27, were classified as fine. Evaluation of the analytical precision of the technique based on the analysis of 20 samples of a Mycenae pottery standard indicated an average standard deviation of 10%. The precision of the Mg, Cr, and Ni determinations, the three important diagnostic elements in this study, were 6, 11 and 10% respectively. Multiple sampling experiments from single sherds were performed; they involved taking five samples by drilling and five by breaking off chips. It was noted that there was 20% greater variance within the compositions obtained by drilling than by the other method.

Assignment of provenience in the present study was made by comparing the composition of the material in question with the control composition data for approximately 50 Late Bronze Age sites in the Aegean which are on file in the Fitch and Oxford Laboratories. A breakdown of this number into regions reveals the following: Peloponnese 15, Crete 9, Cyclades 6, Dodecanese 3, Attica 4, Boeotia and Euboea 7, Thessaly and Macedonia 6 sites. It should be borne in mind, however, that the quality of the control material selected for each site, and hence the quality of the composition data is uneven, the larger sites generally being better characterised than the smaller ones. In general, the composition ranges associated with an 80% level of confidence are determined for each control. A good match between the composition under study and a control composition is one in which there is overlap between the concentration ranges for at least six elements.

Results

The compositions of Samples 1-55, which are grouped chronologically, are given in Table 1. The highly distinctive composition which was thought to be characteristic of Rhodes by Catling et al.[14] and by Papadopoulos and Jones[15] is immediately apparent in many of the Ialysos samples. That Ialysos is represented by this composition type alone is supported first by the correlation between the archaeological expectations for 11 'certain' Rhodian products (Samples 5, 6, 7, 13, 16, 19, 27, 34, 36, 53, and 55) and their Ialysos type compositions. The seven other predicted Rhodian products (Samples 12, 29, 30, 37, 38, 42 and 45), however, fall into three different composition types (see below). Such diversity of local clay types at a single site is highly unlikely in geological terms. Secondly, the compositions of six definitively local LM IA sherds from Trianda (TABLE 3(a)) match those of Ialysos very closely. Furthermore, preliminary analysis of some Archaic pottery (7th-6th centuries B.C.) from the cities of Lindos and Kameiros indicates that the Ialysos/Trianda composition type extends into the centre of the island. A more detailed analytical study of these sites and others in southern Rhodes is currently being planned. It is worth noting in passing that the compositions of the local Mycenaean pottery from Ialysos and from the Seraglio site on Kos can be distinguished with ease. The compositions of the two coarse samples, 7 and 27, however, are not consistent with those of the proposed locally produced fine ware samples, a result which emphasises the need for care in selecting the control material and which also highlights the unsuitability of coarse pottery for spectrographic analysis. Nevertheless, both samples are taken to be local since their compositions each contain a feature of the typical Ialysos composition: Sample 7 has a very high Cr content, whereas sample 27 has a high Ni content. Their

12. Catling et al., op. cit. (in note 1).

13. A. J. N. W. Prag, F. Schweizer, and J. Williams, "Hellenistic Glazed Wares from Athens and Southern Italy: Analytical Techniques and Implications," *Archaeometry* 16 (1974) 153-88. As a result of the recalibration, all composition data obtained at the Oxford Research Laboratory before 1970 have been corrected.

14. Catling et al., op. cit. (in note 1).

15. Papadopoulos and Jones op. cit. (in note 4).

Table 1. Composition of pottery samples from Ialysos, Rhodes.

Sample	%age Al	Mg	Fe	Ti	Mn	Cr	Ca	Na	Ni
LH IIIA2									
2	22.8	4.0	8.6	0.95	0.082	0.035	17.4	1.65	0.025
8	22.8	4.0	8.6	1.01	0.105	0.037	17.4	0.80	0.027
10	19.4	3.3	8.1	0.91	0.094	0.036	17.0	0.85	0.025
12	17.6	2.9	7.3	0.81	0.087	0.031	7.9	1.30	0.021
14	17.5	3.4	8.0	0.90	0.120	0.029	10.3	1.10	0.022
17	19.1	3.7	10.6	0.82	0.142	0.032	10.7	1.32	0.035
19	10.4	13.1	10.0	1.00	0.142	0.185	21.4	0.55	0.115
20	19.1	3.7	7.4	0.81	0.103	0.029	14.6	0.80	0.021
28	19.0	3.1	7.9	0.78	0.100	0.030	17.5	1.75	0.024
30	16.5	1.3	6.2	0.75	0.061	0.027	3.9	1.50	0.030
31	21.9	4.2	9.9	0.87	0.121	0.036	12.5	0.52	0.029
42	20.5	4.2	8.1	0.85	0.093	0.033	25.2	0.92	0.020
43	19.0	3.4	8.1	0.81	0.090	0.037	13.5	0.85	0.023
44	21.6	3.3	7.8	0.85	0.084	0.032	19.5	1.50	0.020
45	18.5	1.6	6.2	0.84	0.067	0.025	4.7	1.80	0.013
46	13.1	2.5	6.9	0.60	0.091	0.032	9.8	1.20	0.025
LH IIIB									
7	16.1	3.5	9.7	0.77	0.152	~0.500	7.5	0.60	0.072
9	18.2	5.5	9.0	0.85	0.103	0.055	8.4	1.45	0.044
11	13.7	3.5	10.5	0.95	0.078	0.085	16.7	1.75	0.064
22	15.9	2.7	7.8	0.74	0.091	0.031	11.5	0.83	0.023
23	11.5	10.0	10.7	0.82	0.200	0.113	15.2	0.65	0.107
24	16.8	3.0	8.4	0.69	0.111	0.030	14.5	1.17	0.028
25	23.2	4.0	8.4	0.94	0.130	0.035	19.5	0.94	0.024
26	19.0	3.4	8.3	0.79	0.103	0.028	13.7	0.90	0.021
39	19.0	3.4	8.4	0.82	0.098	0.034	14.8	1.30	0.024
40	18.0	3.5	8.1	0.97	0.086	0.074	15.0	0.78	0.044
47	17.0	4.3	9.5	0.91	0.118	0.055	9.5	1.70	0.034
48	20.7	3.2	7.8	0.85	0.084	0.030	16.5	0.83	0.024
49	15.1	9.3	11.2	0.99	0.095	0.092	7.0	2.20	0.082
50	13.1	1.1	6.5	0.82	0.077	0.025	7.9	2.00	0.013
51	19.9	4.7	8.5	0.85	0.086	0.040	14.2	0.99	0.027
52	24.0	3.4	8.2	0.90	0.077	0.036	11.1	0.88	0.021
54	12.0	8.1	10.8	0.89	0.087	0.088	5.0	1.90	0.066
LH IIIC									
1	12.0	13.2	10.6	1.06	0.138	0.150	13.2	0.76	0.185
3	21.0	2.7	6.8	0.86	0.077	0.035	13.4	1.34	0.022
4	12.4	11.5	12.1	1.00	0.150	0.185	9.2	0.98	0.150
5	11.6	13.2	12.1	1.10	0.184	0.220	21.5	0.88	0.135
6	11.8	10.1	9.9	0.95	0.194	0.160	~30.0	0.67	0.107
13	12.4	11.6	10.0	1.03	0.105	0.115	11.0	0.59	0.112
15	11.7	10.8	11.0	1.05	0.142	0.150	15.5	0.54	0.115
16	12.7	11.7	10.7	1.06	0.104	0.135	10.5	0.78	0.125
18	14.4	12.5	14.0	1.07	0.160	0.210	11.0	1.04	0.125
21	12.1	11.0	9.6	0.92	0.125	0.145	11.0	0.57	0.140
27	13.5	2.9	12.6	0.80	0.118	0.049	6.0	0.77	0.101
29	16.5	4.4	9.0	0.89	0.100	0.054	15.3	1.13	0.042
32	14.2	12.5	13.3	1.20	0.149	0.160	12.2	0.59	0.160
33	10.7	15.0	10.5	0.96	0.176	0.135	28.5	0.46	0.120
34	10.0	13.5	11.3	1.05	0.155	0.114	13.5	0.45	0.130
35	22.0	0.6	2.4	1.07	0.047	0.016	2.8	0.83	0.005

Table 1 (cont.)

Table 1 (cont.)

Sample	%age Al	Mg	Fe	Ti	Mn	Cr	Ca	Na	Ni
36	11.2	10.6	12.1	0.91	0.162	0.120	11.3	0.56	0.130
37	14.5	5.1	8.9	0.73	0.095	0.095	23.5	0.92	0.055
38	22.2	1.2	6.9	1.06	0.066	0.023	6.9	2.50	0.009
41	10.5	11.0	10.7	0.91	0.175	0.122	21.0	2.45	0.130
53	14.7	14.0	13.9	1.07	0.167	0.170	23.9	0.44	0.160
55	11.8	13.5	13.0	1.16	0.104	0.170	14.0	0.84	0.130

Table 2. Mean characteristics of compositions of pottery samples from Ialysos.

	No. of Samples	*Sample No.*	*Percentage:*	*Al*	*Mg*
LH IIIA2					
Local	1	19		10.4	13.1
Argolid imports	13	2,8,10,12,14,17,20, 28,31,42,43,44,46	Mean	19.5	3.5
			Std. dev.	2.6	0.5
Mycenae IIIA	19		80% range	16.4-22.0	3.1-4.7
LH IIIB					
Local	1	23		11.5	10.0
Argolid imports	8	22,24,25,26,39,48, 51,52	Mean	19.8	3.5
			Std. dev.	2.8	0.6
Mycenae IIIB	19		80% range	16.9-22.3	2.0-5.0
LH IIIC					
Local	16	1,4,5,6,13,15,16,18, 21,32,33,34,36,41,53,55	Mean	12.1	12.2
			Std. dev.	1.4	1.4
Argolid import	1	3		21.0	2.8
Mycenae IIIC	7		80% range	14.6-19.6	2.5-3.9

Percentage: (cont.)	*Fe*	*Ti*	*Mn*	*Cr*	*Ca*	*Na*	*Ni*
	10.0	1.00	0.142	0.185	21.4	0.55	0.115
Mean	8.3	0.84	0.101	0.033	14.1	1.12	0.024
Std. dev.	1.0	0.10	0.017	0.003	5.1	0.37	0.004
80% range	7.8-10.8	0.66-0.96	0.087-0.130	0.030-0.046	12.0-19.0	0.27-2.03	0.025-0.037
	10.7	0.82	0.200	0.113	15.2	0.65	0.107
Mean	8.2	0.82	0.098	0.033	14.5	0.98	0.024
Std. dev.	0.3	0.08	0.017	0.004	2.7	0.17	0.003
80% range	7.4-10.4	0.74-0.98	0.075-0.119	0.025-0.043	12.0-18.2	0.80-1.80	0.019-0.035
Mean	11.6	1.03	0.149	0.154	16.1	0.81	0.135
Std. dev.	1.4	0.09	0.028	0.032	6.7	0.49	0.021
	6.8	0.86	0.077	0.036	13.4	1.34	0.023
80% range	7.1-9.1	0.75-0.93	0.079-0.095	0.026-0.044	7.2-17.0	0.41-1.33	0.016-0.032

compositions have *not* been included in the calculations leading to the data given in Table 2.

The mean characteristics of the Ialysos type compositions for each period have been determined and are presented in Table 2. A large number of Ialysos samples, detailed in Table 2, may confidently be assigned to the Argolid because of the close match between their mean compositions and those of control pottery from Mycenae of the LH IIIA, B, and C periods (TABLE 2). The discrepancies are small and are not considered significant: the mean Ni content of the LH IIIA2 Argolid samples found at Ialysos lies just outside the contemporary Mycenae Ni ranges and the Al, Fe, and Mn contents of Sample 3, the only proposed Argolid import of the LH IIIC period, lie outside the corresponding concentration ranges of the Mycenae LH IIIC control.

Samples 30, 38, 45, and 50 have similar compositions, and they form a compact group which matches the control (Middle and Late Cycladic) data for one of the

Table 3. Comparisons of compositions of pottery samples from Ialysos and other contexts

	Group		*%age Al*	*Mg*	*Fe*	*Ti*	*Mn*	*Cr*	*Ca*	*Na*	*Ni*
(a)	Trianda	Mean	11.7	11.6	11.0	0.94	0.147	0.29	20.5	0.45	0.150
	(6 samples)	Std. dev.	0.6	1.8	1.0	0.03	0.012	0.03	6.1	0.12	0.013
(b)	30,38,45,50	Mean	17.6	1.3	6.5	0.87	0.068	0.025	5.9	1.95	0.016
		Std. dev.	3.8	0.2	0.3	0.13	0.007	0.002	1.9	0.42	0.009
	Rizocastelia I	Mean	16.0	1.7	5.8	0.66	0.080	0.022	8.1	1.30	0.014
	(7 samples)	80% range	13.2-18.8	1.3-2.1	5.5-6.1	0.57-0.75	0.040-0.120	0.008-0.036	4.0-12.1	0.74-1.86	0.011-0.017
	Zakro I	Mean	17.9	3.0	7.4	0.98	0.047	0.018	7.0	0.94	0.004
	(10 samples)	80% range	12.0-23.8	2.9-3.1	4.8-10.1	0.66-1.30	0.021-0.073	0.010-0.026	5.3-8.7	0.18-1.70	0.002-0.007
(c)	35		22.0	0.6	2.4	1.07	0.047	0.016	2.8	0.83	0.006
	Zakro III	Mean	20.6	2.0	8.8	1.03	0.038	0.019	2.4	0.74	0.006
	(11 samples)	80% range	18.3-22.8	1.2-2.8	5.6-11.9	0.75-1.31	0.013-0.063	0.012-0.026	1.2-3.6	0.34-1.14	0.003-0.009
	Chania I	Mean	16.0	0.6	1.7	1.05	0.026	0.014	0.5	0.83	0.008
	(9 samples)	80% range	13.3-18.7	0.4-0.9	1.1-2.4	0.91-1.19	0.018-0.034	0.008-0.020	0.3-0.8	0.51-1.15	0.004-0.011
(d)	49 and 54	Mean	14.5	8.7	11.0	0.94	0.091	0.090	6.0	2.05	0.074
	Perati	Mean	17.4	5.1	11.4	0.92	0.143	0.085	21.6	1.10	0.052
	(11 samples)	80% range	13.1-21.7	2.2-8.0	7.6-15.2	0.69-1.15	0.045-0.240	0.066-0.104	11.7-31.5	0.61-1.60	0.035-0.069
	Porto Rafti	Mean	18.5	6.6	9.7	1.03	0.179	0.103	16.8	1.98	0.040
	(18 samples)	80% range	12.2-24.8	4.9-8.3	6.1-13.3	0.62-1.44	0.109-0.250	0.059-0.150	13.2-20.4	1.40-2.60	0.025-0.055
(e)	9,11,29,37,	Mean	16.3	4.4	9.2	0.88	0.097	0.070	14.7	1.12	0.047
	40 & 47	Std. dev.	1.8	0.8	0.8	0.09	0.014	0.018	5.5	0.38	0.011
	Thebes	Mean	18.7	5.4	9.0	0.88	0.101	0.062	14.3	1.30	0.053
	(20 samples)	80% range	15.2-22.2	3.1-7.7	7.0-11.0	0.73-1.03	0.070-0.132	0.020-0.104	9.3-19.3	0.72-1.88	0.020-0.086
	Knossos	Mean	20.3	5.1	9.5	0.95	0.077	0.065	15.1	1.34	0.043
	(16 samples)	80% range	17.3-23.4	2.2-8.0	7.8-11.2	0.82-1.08	0.058-0.096	0.051-0.079	9.2-21.0	0.96-1.72	0.023-0.063

Rizocastelia groups on Naxos[16] for all elements except Fe, Ti, and Na, and that for one of the composition groups at Zakro[17] in eastern Crete for all elements except Mg, Na, and Ni (TABLE 3(b)). The data for this group, therefore, are consistent, albeit imperfectly, with a Naxian or E. Cretan origin. No alternative can be suggested, except to note the similarity in composition between this group and that of six 'Rhodian' pots of the Archaic period found on Delos[18] which could represent a clay source on Rhodes as yet undiscovered. More confidently Cretan in origin, however, is sample 35 whose unusual composition resembles one of the composition groups at both Zakro[19] and Chania.[20] Examination of the control data for these sites (TABLE 3(c)) indicates that this sample matches the former site marginally better than Chania, although it is clear that certain elements (two and three elements respectively) fall outside the control concentration ranges, a result which may partly be a result of the complex and varied clay morphology at the two ends of the island of Crete.

Samples 49 and 54 form a pair having Mg, Cr, and Ni contents that are too low for inclusion in the local Ialysos group. They are difficult to place, but there is some measure of similarity between their compositions and those encountered in eastern Attica, as exemplified by the control data for Perati and Porto Rafti island, and that at Thebes in Boeotia. Five elements in the mean composition of Samples 49 and 54 lie within the concentration ranges for these three sites (TABLE 3(d)); wide discrepancies are noted in the Mn and Ca contents. The inability of researchers to distinguish between Knossian and Theban pottery compositions has been recognized since the initial studies of Catling et al.[21] and those of Catling and Millett[22] on the inscribed stirrup jars from Thebes. Recent work in this laboratory has confirmed this situation[23] and has also demonstrated the existence of considerable heterogeneity resulting in wide concentration ranges which overlap for all elements at two sites. The evidence is, therefore, equivocal when considering the provenience

16. Rizocastelia I group as defined in R. E. Jones, "Composition and Provenance Studies of Cycladic Pottery with Particular Reference to Thera," *Thera and the Aegean World—Second International Scientific Congress* (Athens 1978) 471-82.

17. Zakro I group as defined in H. W. Catling and A. Millett, "A Study of the Inscribed Stirrup Jars from Thebes," *Archaeometry* 8 (1965) 3-85.

18. These unpublished analyses have recently been obtained as part of an analytical project with Professor J. Boardman on some Orientalising and Archaic pottery from the Rheneia pit on Delos.

19. Zakro III group as defined in Catling and Millett op. cit. (in note 17).

20. Chania I group as defined in Catling and Jones op. cit. (in note 2).

21. Catling et al., op. cit. (in note 1).

22. Catling and Millett op. cit. (in note 17).

23. P-A. Mountjoy, R. E. Jones and J. F. Cherry, "Provenance Studies of the LMIB/LHIIA Marine Style," *BSA* 73 (1978) in press.

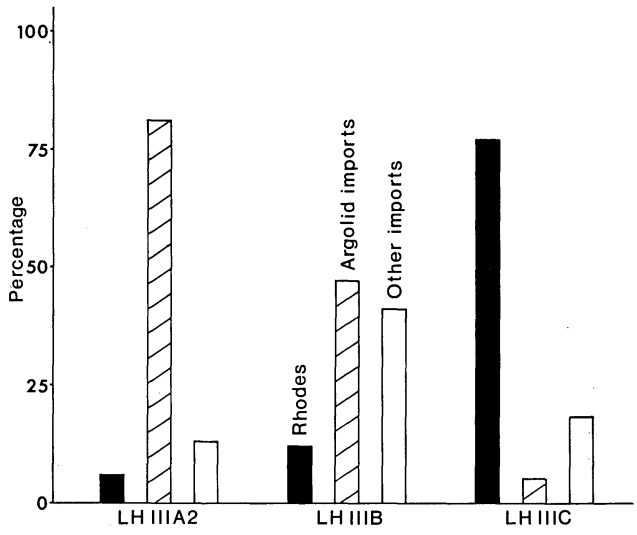

Figure 2. Diagram showing the relative proportions of Rhodian products, and imports from the Argolid and elsewhere for each of the three periods considered.

of Samples 9, 11, 29, 37, 40, and 47 whose mean composition fits the control characteristics for Thebes and Knossos for nine and seven elements respectively (TABLE 3(e)). The better match with Thebes rather than Knossos may simply be the result of the wider ranges at the former site.

Discussion

IIIA2

Of the 16 IIIA2 samples, no less than 15 are imported (see FIG. 2). The six piriform jars analysed prove to be from the Argolid yet only Sample 2 was selected as a likely import since it is FS45, a type exported widely to the Eastern Mediterranean but not especially common at Ialysos. On the other hand the majority of FS34 and FS35 piriform jars are from Rhodes.[24] Taylour,[25] who comments that "the large three-handled jar (F34-5) is found predominantly in Rhodes and is generally characteristic of that island," suggests that 12 FS35 piriform jars in Petsas' House Apotheke A at Mycenae might have been imported. Stubbings[26] likewise states that FS34 and FS35 piriform jars "have long been recognised as characteristic of Rhodes."

Especially surprising is the discovery that Samples 12 and 43 were imported from the Argolid. These are decorated with plastic knobs, listed by Furumark as FM27:36. Five similarly decorated FS34 and FS35 piriform jars from Scoglio del Tonno are considered by Taylour[27] to have been imported from Rhodes, while Papadopoulos[28] comments that a FS34 piriform jar from Aigion in Achaea "should certainly be regarded as an import from (Rhodes)." This vessel has recently been analysed and its composition is consistent with an origin in the Peloponnese, if not Aigion itself.[29] A piriform jar from Asine[30] suggests a possible centre of production.

Characteristic of Rhodo-Mycenean pottery is the FS319 basket vase for which basketwork[31] and metal[32] prototypes have been argued. Fifty-four basket vases are known from Rhodes,[33] two from neighbouring Karpathos,[34] and one from Müsgebi.[35] It is therefore almost incredible that of the three basket vases analysed only Sample 19 has a Rhodian composition, Samples 30 and 45 matching East Crete/Naxos. The composition of 30 and 45, however, is like that of Archaic pottery ascribed a Rhodian provenience by Boardman[36] so that a clay source on Rhodes, matching East Crete/Naxos, cannot be discounted.

FS264 and FS269 kylikes have a wide distribution[37] but are most numerous on Rhodes and, being monochrome or unpainted, should be local; yet, Samples 14 and 20 are from the Argolid. It is interesting to note that in the Argolid FS265 supersedes FS264 within the IIIA2 period but there are only two FS265 kylikes from Ialysos while FS264 kylikes are present in later IIIA2 and even IIIB tombs.

24. A. Furumark, *Mycenaean Pottery I: Analysis and Classification* (Stockholm 1972) 589-90.

25. W. D. Taylour, *Mycenaean Pottery in Italy and Adjacent Areas* (Cambridge 1958) 128.

26. Stubbings, op. cit. (in note 5) 14.

27. Taylour, op. cit. (in note 25) 129.

28. A. J. Papadopoulos, *Excavations at Aigion 1970* (Göteborg 1976) 40.

29. Papadopoulos and Jones, op. cit. (in note 4).

30. O. Frödin and A. Persson, *Asine—Results of the Swedish Excavations 1922-1930* (Stockholm 1938) 379, fig. 248:2.

31. Furumark, op. cit. (in note 24) 73-74.

32. H. W. Catling, *Cypriot Bronzework in the Mycenaean World* (Oxford 1964) 219.

33. Mee, op. cit. (in note 6) 77.

34. S. Charitonides, Θαλαμοειδή Τάφο Καρπάθου, *Arch Delt* 17A (1961-62) pl. 25.

35. Y. Boysal, *Katalog der Vasen im Museum in Bodrum I—Mykenisch-Protogeometrisch* (Ankara 1969) pl. 32:5.

36. See note 18.

37. Furumark, op. cit. (in note 24) 630-31.

As expected the jug, the alabastron, the flask, the krater, and the rhyton were imported from the Argolid.

IIIB

Only two of the 17 IIIB pots analysed are local but the imports are no longer exclusively from the Argolid.

FS37 piriform jars are more or less unknown outside the Dodecanese[38] but both Samples 9 and 47 are imported. Their composition matches Thebes/Knossos but neither looks remotely Minoan so that Boeotia seems the more likely centre of production. The two kraters, Samples 11 and 40, also have Thebes/Knossos compositions and should likewise be imported from Boeotia. It must be stressed that there are no FS37 piriform jars or FS11 kraters from Boeotia, although FS281 kraters do occur. A much better perspective on the Mycenean of Boeotia, however, should soon be possible as the mass of pottery from recent excavations is published.

The three stirrup jars were chosen as being likely imports and are indeed from the Argolid. The jugs are both rather idiosyncratic and might have been local but are also from the Argolid. The flask, Sample 50, has an East Crete/Naxos composition and might well be Minoan since lentoid flasks are not unknown from Crete.[39] The FS316 brazier is especially characteristic of Rhodo-Mycenean pottery and it is consequently no surprise that Sample 7 should be local.

The kylikes are a mixture. Whorl shell is the motif on 70% of the IIIB1 kylikes from the Prehistoric Cemetery Central at Mycenae[40] but Sample 23 is local. Octopus, although quite common on the IIIB1 kylikes from Ialysos, almost completely drops out at Mycenae after IIIA2, yet Sample 24 is from the Argolid. That Sample 49 should have an eastern Attic composition is not entirely unexpected since analysis has shown that BMA863 had been tinned, a practice well attested at Athens.[41] The Athens composition is different from that of eastern Attica, however, so it seems unlikely that Sample 49 was imported from Athens.

Also from eastern Attica is the kalathos, Sample 54. There are FS300 kalathoi from Vourvatsi in eastern Attica,[42] although neither is decorated with net. The deep bowl, Sample 25, and the cup, Sample 48, were chosen as, and are indeed, Argolid imports.

IIIC

The IIIC pottery style of Ialysos had long been regarded as idiosyncratic[43] but the recent excavations at Perati and on Naxos have demonstrated the existence of an Aegean *koine*.[44] Nevertheless, although Ialysos, Perati, and Naxos share a common style, a single centre of production has never been considered likely, a supposition confirmed by the analysis of IIIC pottery from Perati and from Ialysos.

Of the 22 IIIC samples from Ialysos, no less than 17 are local. The kylix, Sample 18, was chosen as a possible import but the lack of kylikes in the IIIC tombs at Ialysos may now be seen to reflect their rejection as grave goods. This is also true of the deep bowl, Sample 1.

Of the imports, the pyxis, Sample 3, seemed more likely to be from Perati[45] than the Argolid. It is rather odd that the multiple jar, Sample 37, has a Thebes/Knossos composition. There are no less than 22 multiple jars from Ialysos but none of FS330 from either Thebes or Knossos. Sample 55, however, is local.

The octopus stirrup jars, Samples 29, 34, 35, 38, and 53, are extremely interesting. Inspired by LMIIIB stirrup jars[46] it comes as no surprise to find that Sample 35, which looks the earliest of the Ialysos octopus stirrup jars, has an East/West Crete composition.[47] Similarly Sample 29, which has a Thebes/Knossos composition, is exactly like a stirrup jar from Isopata.[48] The tentacles of the octopus on Sample 38 are interspersed with fish, birds, and fill motifs. This treatment is characteristic of the octopus stirrup jars from Naxos[49] and thereby explains the East Crete/Naxos composition. The typical Ialysos octopus has heavily fringed tentacles like Samples 34 and 53 which, not surprisingly, are local.

38. Ibid. 590.

39. S. Xanthoudides, Εκ Κρήτης, *ArchEph* (1904) 27, fig. 6.

40. E. French, "A Group of Late Helladic IIIB1 Pottery from Mycenae," *BSA* 61 (1966) 235.

41. S. Immerwahr, "The Use of Tin on Mycenean Vases," *Hesperia* 35 (1966) 394-95.

42. M. Benzi, *Ceramica Micenea in Attica* (Milan 1975) 67.

43. A. Furumark, "The Mycenaean IIIC Pottery and Its Relation to Cypriote Fabrics," *OpusArch* 3 (1944) 200.

44. V. Desborough, *The Last Mycenaeans and their Successors* (Oxford 1964) 228.

45. S. Iacovides, Ιερατή: Τό Νεκροταφεῖον B (Athens 1970) 258-61.

46. Furumark, op. cit. (in note 43) 201.

47. Compare M. Mackeprang, "Late Mycenaean Vases," *AJA* 42 (1938) pl. 28:5 from Chania.

48. A. Evans, "The Prehistoric Tombs of Knossos," *Archaeologia* 59 (1905) 531, fig. 122.

49. N. Zapheiropoulos, 'Ανασχαφαί Νάξου, *Praktika* (1960) pls. 276-77. C. Kardara, 'Απλώματα Νάξου — Κινήτα Ευρήματα Ταφῶν A καὶ B (Athens 1977) pls. 8-12 and 16-20.

Conclusions

Analysis of Mycenaean chariot kraters from Cyprus[50] proved that despite the then lack of mainland examples the centre of production was the Argolid. The results from Ialysos, suggesting that most of the IIIA2 and IIIB pottery was imported, further emphasises the need for caution when comparing cemetery and settlement deposits, especially where the pot type in question is present in the cemetery but absent in the settlement.

It would be wrong to assume that there was no local pottery production in IIIA2 and IIIB. Only the best, if possible imported, pottery will have been interred: this is obvious from a comparison of the ratio of unpainted:painted pottery from cemetery and settlement contexts. The high proportion of imports at Ialysos reflects the evident prosperity of the Mycenaeans of Rhodes rather than a dearth of local potters.

It might be suggested that there was no good clay source on Rhodes so that clay had to be imported from the Argolid or that there was a clay source that happens to match that of the Argolid in composition. This is not only inherently unlikely but is disproved by the excellent Minoan pottery from Trianda and Mycenaean IIIC pottery from Ialysos for which the same local clay was used.

That most of the IIIC pottery should have been locally produced is easily explained. The destructions on the mainland at the end of LHIIIB disrupted Mycenaean trade and at the same time caused an easterly population movement. The arrival of Mycenaeans in Cyprus in early LHIIIC is now widely accepted.[51] There seems little doubt that some of the refugees settled on Rhodes.[52] The present of potters amongst the refugees is only to be expected.

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50. H. W. Catling and A. Millett, "Mycenaean Pictorial Pottery from Cyprus," *BSA* 60 (1965) 212-24; H. W. Catling, R. E. Jones and A. Millett, "Composition and Provenance Problems in some Late Bronze Age Pottery Found in Cyprus," *Report of the Department of Antiquities of Cyprus*, in press.

51. H. W. Catling, "The Achaean Settlement of Cyprus," *Acts of the International Archaeological Symposium: The Mycenaeans in the Eastern Mediterranean* (Nicosia 1973) 34-39.

52. Mee, op. cit. (in note 6) 220, 395.

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