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PROVENANCE DETERMINATION OF MYCENAEAN IIIC VESSELS FROM THE 1934–1939 EXCAVATIONS AT TARSUS-GÖZLÜKULE BY NEUTRON ACTIVATION ANALYSIS*

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Neutron Activation Analysis (NAA) has been carried out in order to determine the provenance of a selected set of 30 sherds of Mycenaean style excavated at Tarsus-Gözlükule. The provenance could be established or made feasible in 80% of the samples. The results confirm the current status of research, namely that in the LH IIIC phase trade patterns changed and Mycenaean wares, which used to be exported to the Near East, were now produced locally. At Tarsus, the LH IIIC imports came from Cyprus and the eastern Aegean.

KEYWORDS: TARSUS, CILICIA, TURKEY, NAA, MYCENAEAN POTTERY, LHIIIC, CYPRUS, MYCENAE/BERBATI, BIRD BOWL WORKSHOPS

INTRODUCTION

Neutron Activation Analysis of Mycenaean style pottery assemblages found in the Near East shows that as of LHIIIC, local or regional production dominates and imports diminish. This is generally taken as evidence for changing trade patterns and taste, as well as perhaps for a movement of dislocated people from the Aegean realm further east in the course of the 12th century BC. The excavations directed by Hetty Goldman in 1934–39 and 1947–48 at the Eastern Mediterranean settlement mound of Tarsus-Gözlükule in Cilicia (Province of Mersin, Turkey: see Fig. 1), revealed a corpus of Mycenaean-style vessel fragments, a selection of which (~120) was presented in the final excavation report (Goldman 1956). The site is located south of the main pass through the Taurus mountain range (the Cilician Gates); it lay close to the Mediterranean coast on the east bank of the Cydnos (Berdan/Tarsus Çay) river, which was later rerouted. The large mound contains stratified remains dating to the Late Bronze Age, including a monumental Hittite-type structure, a Hittite tablet and sealed clay bulla, which—taken together—indicate a Hittite political presence in the region (Goldman 1956). The Mycenaean sherds come from disturbed LBIIb levels and are unstratified (Goldman 1956; Slane 2003). French restudied this material, including all preserved fragments (~850), and published an analysis of vessel forms and decoration (French 1975).

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Figure 1 *A map of the Eastern Mediterranean, showing Tarsus-Gözlükule, Mycenae and Kouklia.*

In 2001, research at Tarsus-Gözlükule was resumed by a team lead by Boğaziçi University, in co-operation with Bryn Mawr College. The aim of the new project (2001–06) was to reassess the Goldman material data in view of current research and prepare for new excavations on the mound (Özyar 2005). These began in 2007 (Özyar *et al*. 2009). As part of the re-evaluation process, Mountjoy re-investigated and fully documented all extant Mycenaean vessel fragments; they are now housed in the Boğaziçi University Tarsus-Gözlükule Research Centre, next to the mound (Mountjoy 2005a).

The aim of the present work is to distinguish groups of locally produced Mycenaean vessels from imported specimens using Neutron Activation Analysis (NAA) and, if possible, to determine the places of origin of the imports. The large Bonn databank has more than 8000 pottery samples from the Eastern Mediterranean, many of these samples from the Late Bronze Age, and the large number of elemental concentration patterns of known origin will be used for comparisons in this context.

PROVENANCE DETERMINATION, NAA AT BONN, AND STATISTICAL GROUPING

Pottery vessels made with the same clay paste in a certain workshop can be recognized by measuring elemental concentrations, particularly those of the minor and trace elements. All vessels having a similar composition pattern have a very high probability of having the same origin, provided that many elements, the more the better, have been measured with low uncertainties. The provenance of such a group of similar composition can be established by comparison with patterns of reference material of known origin (Mommsen 2007).

The analytical method of NAA used at the Bonn archaeometry laboratory for the elemental analysis of pottery is well suited to this type of examination and has already been described at length (Mommsen *et al*. 1991). About 30 minor and trace elements can be measured with small uncertainties. The method has been in use for more than 25 years (Mommsen and Sjöberg 2007). It is a modified version of the NAA procedure developed at Berkeley (Perlman and Asaro 1969). A sample of about 80 mg of pottery powder is usually obtained by drilling with a corundum (sapphire) pointed drill with a diameter of 10 mm; it leaves a shallow depression about 1.5–2.0 mm deep. The standard used is the Bonn pottery standard calibrated with the well-known Berkeley Pottery standard (Perlman and Asaro 1969). Therefore, our measured concentration values can be directly compared to the values of the Berkeley laboratory and its Jerusalem offshoot (see below).

The formation of groups of samples having the same composition and, hence, the same provenance, is done using a statistical procedure that works like a 'filter' (Beier and Mommsen 1994a,b). Starting with a given composition and its standard deviation, all the samples with a statistically similar composition can be sorted out of a large databank; during this process, the statistical procedure considers not only the experimental uncertainties but also a possible constant shift of all values caused by a 'dilution' of the clay paste with, for example, varying amounts of pure sand (quartz) or calcite. This dilution effect was already recognized by Sayre and Dodson (1957), who pointed out its importance when comparing elemental patterns (for examples, see Mommsen and Sjöberg 2007; Sterba *et al*. 2009).

SAMPLE CHOICE

The fabric of the majority of sherds, as observed by visual inspection, is sand-coloured with two variants: a sandy yellow buff and a sandy tan (deep buff), caused by different firing conditions. Very fine silver mica can be seen in all these sherds in strong light and the paint is usually matt. This large group has a high probability of being locally made. A few other sherds have buff fabric, often with lustrous paint, and are considered to be imports. Owing to the limited number of 30 samples to be chosen for analysis, only a spot sampling of the many different groups of shapes and decorations (Mountjoy 2005a) could be done, with special emphasis on some conspicuous pieces; for example, those with lustrous paint. Table 1 gives a list of the samples taken in June 2008 at Tarsus. Besides the Mycenaean sherds nos. 1–30, six more sherds of different date were sampled to test whether potters of earlier or subsequent centuries used the same clay pastes as during the Mycenaean period; should this be the case, the assignation of a chemical pattern to a local workshop at Tarsus would be strengthened.

RESULTS OF THE NAA

The measured elemental concentration data of the 36 samples from Tarsus with labels Tars 1–36 can be found on the website of the Helmholtz-Institut für Strahlen- und Kernphysik: http://mommsen.hiskp.uni-bonn.de/top.html.

Using the filter procedure described above, seven different chemical patterns could be detected in the set of 30 Mycenaean samples, together with an additional pattern in the two Middle Bronze Age sherds. These compositional groups are depicted in the result of a discriminant analysis shown in Figures 2 and 3. Six Mycenaean samples are chemical loners (see Table 1). About 20% of a group of samples is usually assigned as such 'singles' in provenance studies of pottery.

Table 1 *A list of Mycenaean pottery samples taken from the 1934–1939 excavations of the Tarsus-Gözlükule mound, stored at the Boğaziçi Üniversitesi Tarsus-Gözlükule Excavation Depot Tarsus, Mersin, Turkey. The samples* ***Tars 1–30*** *are listed with the catalogue numbers of Mountjoy (2005). The figures cited are shown in (a) Goldman (1956) and (b) French (1975). Apart from the sample* ***Tars 1*** *(LHIIIA2–LHIIIB), all the other samples,* ***Tars 2–30****, date to the LHIIIC period. Samples* ***Tars 31–36*** *are presumably local samples of different periods taken for comparison. They are published in the catalogues of Ünlü (2005, Cat. 11, 14), Yalçın (2005, Cat. 30, 38), and Slane (2003, inv. nos. 12, 11). The NAA groups are described in the text*

Bonn label, Tars	*Catalogue (Mountjoy 2005a)*	*Figures: (a) Goldman (1956); (b) French (1975)*	*NAA group*
1	1	(a) 333, 1345	MYBE
2	12	(a) 333, 1308a	TarA
3	15	(a) 332, 1277	Single
4	20	(a) 337, 1346	TarA (Cr^+)
5	42	(a) 337, 1348	TarA (Cr^+)
6	43	(a) 335, 1329	B
7	47	(a) 333, 1280c	CypG
8	48	(a) 333, 1280a	CypG
9	49	(b) 4.2	CypG
10	50	(a) 333, 1282	CypG
11	51	(a) 333, 1283	CypG (Ta^-)
12	52	(a) 333, 1281	CypG
13	53	(b) 4.4, 5	CypG (U^+)
14	56	(a) 333, 1286	CypI
15	64	(a) 333, 1338	Single
16	69	(a) 333, top	TarB
17	74	(b) 14, second left	TarB
18	132	(a) 335, 1336b	Single
19	133	(a) 335, 1333	RHc1
20	134	(a) 335, 1326	TarA
21	137	(a) 335, 1297	TarA
22	141	(a) 335, 1334	Single
23	152	(a) 333, 1341	Single
24	156	(b) 7.1 E363	CypG
25	157	(a) 335, 1328	CypG
26	160	(a) 335, 1332	CypG
27	187	(a) 330, 1257	TarA
28	208	(a) 330, 1256	TarA
29	244	(a) 330, 1304	TarA
30	288	(a) 335, 1258	Single
31	Ünlü Cat. 11	Third fragment from left	Single
32	Ünlü Cat. 14	Large fragment	Single
33	Yalçın Cat. 30	Depot Box IA 090-04(1)	Single
34	Yalçın Cat. 38	Depot Box IA 089-01	Single
35	Slane Inv. No. 12	A 643-4	TarC
36	Slane Inv. No. 11	A 286	TarC

Nothing can be concluded about these samples. They may have been contaminated during production in antiquity or during our investigation; or they may represent the first member of a clay paste not encountered before.

The most abundant chemical pattern is found in the sherds of the typical sand-coloured fabric assumed to be locally made; it is named **TarA**. This group has eight members and its composition

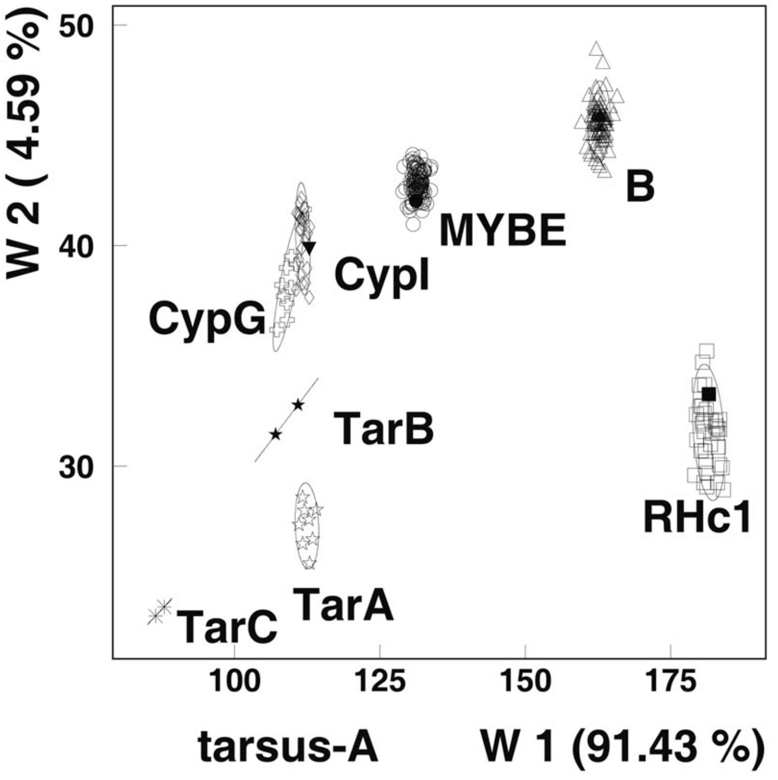

Figure 2 *The result of a discriminant analysis of 270 samples, corrected for dilution, assuming eight clusters, using all elements given in Tables 2–4 except As, Ba and Na. Plotted are the discriminant functions W1 and W2, which cover 91.4% and 4.6% of the between-group variance. The ellipses drawn are the 2σ boundaries of the groups. The group TarA and the sample pairs TarB and TarC are considered to be local products; the other samples shown (group CypG and the samples with full symbols) are imports to Tarsus and are depicted together with their reference groups (see Tables 3 and 4). The different groups are well separated. The two overlapping groups from Cyprus CypI and CypG are resolved in a different projection (see Fig. 3).*

is new to us. It is different from all other patterns in our databank and up to now it occurs only at Tarsus. The pattern is shown in Table 2, column 1. It can be taken with high probability to represent the locally produced wares at Tarsus during the LH (Late Helladic) IIIC period. It is not found in the non-Mycenaean sherds Tars 31–36, but these sherds date to earlier and later than the Mycenaean sherds. They are chemical singles except for the two Middle Bronze (MB) red gritty bowls Tars 35 and 36, which form a chemical pair with the pattern **TarC**. The two Early Iron Age (EIA) vessels, Tars 33 and 34, are chemically different and belong to different clay pastes of the EIA, also unknown to us, but they are both generally close to the composition TarC. The pattern **TarB** of the pair of Mycenaean sherds Tars 16 and Tars 17 is also not very different from the pattern TarC. If all the values of TarB are multiplied by the best relative fit factor of 0.79 with respect to pattern TarC, many elemental concentrations are statistically similar, with the exception of Cr (TarB, 222 ppm; TarC, 278 ppm; uncertainty in both cases below 3.2%). Determining the provenance of patterns with only a few members is difficult, but since the group comprising these two pairs and the EIA-singles are all very well separated from other compositional groups,

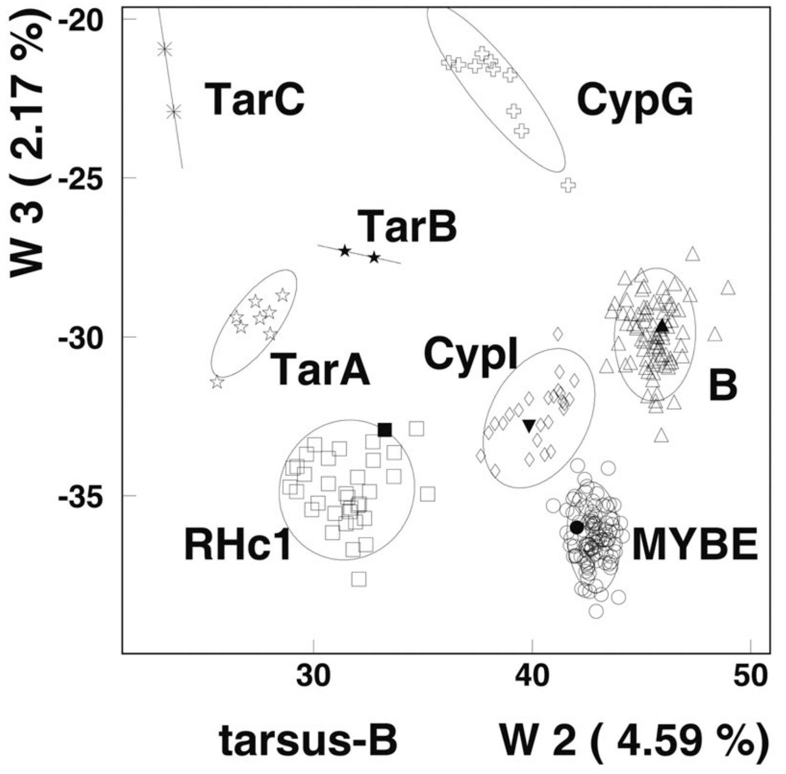

Figure 3 *The result of the same discriminant analysis as in Figure 2, now plotting the discriminant functions W2 and W3, which cover 4.6% and 2.2% of the between-group variance. The Cypriot groups CypG and CypI are separated here.*

it is highly probable that its general composition represents different local clay pastes processed at or near Tarsus. The patterns of TarB, TarC and of the two EIA samples are given in Table 2, columns 2–5.

Besides these three new patterns, TarA, TarB and TarC, four other patterns in the Mycenaean sample set could be separated out; these are already known to us from the Bonn databank of patterns. As expected, the LHIIIB sample **Tars 1** has the pattern MYBE and is an import from the Argolid or the northeastern Peloponnese. Prior to the LHIIIC phase, in LHIIIA2–IIIB, many vessels with this pattern were exported to the Eastern Mediterranean (e.g., Badre *et al*. 2005). The assignment of this pattern not only to the workshop at Berbati near Mycenae, where wasters with pattern MYBE have been found (Mommsen *et al*. 2002, 621), but also to the larger area of the northeastern Peloponnese, has been discussed in Zuckerman *et al*. (2010). **Tars 6** belongs to Group B, which suggests that it is an import from somewhere in northern Ionia (Teos?) in the eastern Aegean. Group B is assigned to the Archaic 'bird bowl workshops', which produced, besides bird bowls, a wide variety of different shapes and styles, from Wild Goat to black-figure (Akurgal *et al*. 2002, group B/C; Mommsen *et al*. 2006b, table 2, group B; Schlotzhauer and Villing 2006). The vessel **Tars 19** is a member of the group RHc1, which now has 35 samples and is assigned archaeologically to the island Kos (Mommsen *et al*. in press). Most of the members of this group have been found as imports in Rhodes (Marketou *et al*. 2006), but there are also examples at Enkomi, Naukratis and other places. These samples and the three reference groups

Table 2 *Group patterns TarA, TarB and TarC and sample patterns of Early Iron Age vessels Tars 33 and 34 measured by NAA and considered to be locally produced at Tarsus. Given are concentrations C or averages M of elements in μg g^{-1} (ppm), if not indicated otherwise, and experimental errors δ or spreads σ (root mean square deviations) as percentages of C or M, respectively. Individual values are corrected for dilution. The group TarA includes the two samples Tars 4 and 5 with higher Cr values, which explains the large spread of 14% (without them, the average Cr value is 468 ppm [±5.7%])*

	TarA (eight samples)		*TarB (two samples)*		*TarC (two samples)*		*Tars 33 (one sample)*		*Tars 34 (one sample)*	
	M	σ (%)	*M*	σ (%)	*M*	σ (%)	*C*	δ (%)	*C*	δ (%)
As	11.1	(25.)	14.4	(12.)	15.2	(44.)	12.2	(0.6)	50.8	(0.3)
Ba	383.	(37.)	239.	(5.2)	285.	(28.)	234.	(4.5)	604.	(2.1)
Ca (%)	9.05	(17.)	14.2	(1.1)	13.9	(1.2)	13.1	(1.2)	11.5	(1.4)
Ce	52.9	(3.1)	55.1	(7.0)	45.1	(3.7)	37.7	(2.0)	35.8	(3.1)
Co	21.6	(5.2)	22.9	(2.9)	17.3	(6.5)	16.7	(0.6)	14.9	(0.6)
Cr	497.	(14.)	281.	(3.2)	278.	(1.8)	240.	(0.4)	305.	(0.4)
Cs	5.95	(9.0)	4.99	(10.)	3.24	(4.5)	4.82	(1.5)	3.62	(1.8)
Eu	0.93	(2.8)	0.95	(4.3)	0.78	(2.5)	0.72	(2.3)	0.61	(2.6)
Fe (%)	3.65	(4.4)	3.84	(3.6)	2.94	(6.7)	3.34	(0.4)	3.06	(0.4)
Ga	10.4	(33.)	12.9	(20.)	8.49	(54.)	11.4	(11.)	11.1	(12.)
Hf	4.62	(4.2)	3.51	(1.6)	2.98	(1.7)	2.27	(2.0)	3.18	(1.4)
K (%)	2.22	(12.)	2.15	(13.)	2.16	(7.6)	1.92	(0.8)	2.66	(0.7)
La	24.7	(2.3)	26.2	(8.6)	19.9	(0.7)	18.4	(0.6)	16.9	(1.2)
Lu	0.32	(4.0)	0.31	(5.5)	0.26	(4.1)	0.24	(4.5)	0.23	(4.8)
Na (%)	1.00	(9.1)	0.46	(18.)	0.64	(12.)	0.48	(0.5)	0.59	(0.5)
Nd	19.3	(3.4)	20.4	(3.2)	14.8	(3.6)	13.6	(3.9)	12.7	(4.4)
Ni	202.	(17.)	246.	(13.)	186.	(57.)	261.	(11.)	173.	(15.)
Rb	89.9	(11.)	78.2	(2.5)	54.7	(2.9)	63.4	(2.6)	67.6	(2.4)
Sb	1.15	(8.6)	0.91	(13.)	0.74	(6.9)	1.38	(4.6)	0.83	(6.4)
Sc	14.1	(4.6)	14.3	(4.3)	10.5	(4.5)	12.9	(0.1)	11.0	(0.1)
Sm	3.67	(3.3)	3.89	(6.3)	2.85	(0.8)	2.55	(0.3)	2.30	(0.3)
Ta	0.73	(4.3)	0.76	(3.5)	0.58	(3.9)	0.57	(4.1)	0.60	(3.8)
Tb	0.50	(10.)	0.55	(7.0)	0.44	(7.7)	0.37	(9.2)	0.39	(8.3)
Th	9.91	(5.3)	9.00	(6.9)	7.37	(5.4)	6.68	(0.7)	6.92	(0.7)
U	1.81	(5.8)	2.46	(7.2)	1.72	(23.)	1.86	(4.3)	3.91	(2.3)
W	1.73	(16.)	1.46	(19.)	1.26	(8.1)	1.14	(8.3)	1.19	(8.3)
Yb	2.11	(4.1)	2.06	(3.4)	1.69	(2.5)	1.61	(2.5)	1.46	(2.9)
Zn	73.1	(8.4)	122.	(1.7)	79.6	(3.6)	93.9	(2.0)	83.2	(2.1)

are listed in Table 3. Finally, the stirrup jar **Tars 14** has the pattern CypI, which was first measured in sherds from Qantir (Mommsen *et al*. 1996; Mountjoy and Mommsen 2001: called there I-Cyp) and which is assigned with high probability to a Cypriot production site (Mommsen *et al*. 2006a). Owing to a lack of reference material from Cyprus, the exact location of this workshop on the island cannot yet be specified more precisely.

Tars 7–10 belong to a Near Eastern Group of stirrup jars discussed by Mountjoy (Mountjoy 2005a, 95; Mountjoy 2005b). They all have the same composition and so originate from the same source. Other imports to Tarsus from this same source are the stirrup jars **Tars 11–13** and the patterned deep bowls **Tars 24–26**. We called this eighth pattern CypG, because a comparison with Cypriot patterns measured at Berkeley showed a close agreement in composition with a pattern published for Palaepaphos (Kouklia) (Karageorghis *et al*. 1972, table 1, col. 3; Gunneweg and Perlman 1994, table 1, col. 2, there with additional values for Ce, Eu, Sm and Yb).[1] The pattern of group CypG is compared in Table 4 to the Kouklia pattern. The assignment of group CypG to the region of Kouklia assumes that the Kouklia pattern of 19 LHIIIC samples measured in Berkeley has been obtained from locally made sherds and that all these vessels have not been imported to Kouklia from somewhere else.

ARCHAEOLOGICAL DISCUSSION

The chemically defined groups described above are now considered from a stylistic point of view. It should be noted that the stylistic groups do not belong exclusively to one chemical group. All the sherds analysed are fully published, with illustrations, in Mountjoy (2005a).

Group MYBE

There is one sample. Sample 1 Cat. 1 comprises the lower body of a closed vessel, probably a piriform jar FS 45, 48 or a stirrup jar FS 166, 167. It dates to LHIIIA2–IIIB. The buff fabric and lustrous orange paint indicated that this was an import. NAA assigns it to the north-east Peloponnesian Mycenae–Berbati group.

Group TarA

Eight samples belong to this group, which is the dominant local group.

Sample 2 Cat. 12 is a collar-necked jar, decorated with large antithetic spirals with open centres and abbreviated loops; the spirals are the variant without a central triglyph. The decorative syntax of Sample 4 Cat. 20 is an exact replica of a vase from Hala Sultan Tekke (Åström 1983, fig. 218). It had, therefore, been assumed that Sample 4 was an import from Cyprus, but this has turned out not to be the case. Sample 5 Cat. 42, which is probably from a strainer jug, and Sample 20 Cat. 134, a krater fragment, are both decorated with very similar birds; they may well have come from the same local workshop. Sample 21 Cat. 137 is one of a large group of vases decorated with long lozenges in the curves of antithetic spirals. They are found in the east Aegean at Troy (Mountjoy 1999b, 341, fig. 20.70), Bademgediği Tepe (Meriç and Mountjoy 2002, 85, fig. 3.2) and on Chios (Mountjoy 1999a, Chios nos. 1 and 2) and Kos (Mountjoy 1999a, Kos no. 100). The Bademgediği example has been shown by NAA to be a Koan import (Mommsen *et al*., in prep.); this seemed a likely source for Sample 21, but NAA has shown that it is local. There is another

[1]The stirrup jar from Tell Keisan, called Keisan 34, is described in Balensi (1981).

Table 3 *NAA data of Mycenaean sherds considered to be imported to Tarsus and their reference patterns (MYBE, northeastern Peloponnese; B, bird bowl workshops, un-located in northern Ionia (Teos?); RHc1, Kos, see text). Concentrations of elements C or averages M in μg g^{-1} (ppm), if not indicated otherwise, and experimental errors δ or spreads σ in % of C or M, respectively. The individual samples from Tarsus have been corrected with the best relative fit factor with respect to the reference group*

	Tars 1 (one sample; factor 0.97)		*MYBE (102 samples; factor 1.00)*		*Tars 6 (one sample; factor 0.97)*		*B (81 samples; factor 1.00)*		*Tars 19 (one sample; factor 1.02)*		*RHc1 (34 samples; factor 1.00)*	
	C	δ (%)	*M*	σ (%)	*C*	δ (%)	*M*	σ (%)	*C*	δ (%)	*M*	σ (%)
As	5.78	(1.2)	5.69	(51.)	11.1	(0.8)	18.9	(54.)	116.	(0.2)	14.6	(55.)
Ba	306.	(4.4)	391.	(21.)	487.	(3.2)	569.	(16.)	701.	(2.5)	741.	(22.)
Ca (%)	8.78	(2.1)	9.55	(19.)	2.58	(7.0)	5.62	(38.)	1.45	(14.)	3.88	(34.)
Ce	63.3	(1.4)	62.5	(2.2)	78.0	(1.8)	85.0	(5.7)	109.	(2.1)	104.	(5.7)
Co	25.8	(0.5)	27.7	(4.5)	15.1	(0.6)	20.3	(16.)	20.5	(0.6)	19.2	(13.)
Cr	203.	(0.5)	214.	(8.2)	159.	(0.5)	149.	(11.)	123.	(0.6)	274.	(15.)
Cs	8.90	(1.1)	8.44	(6.9)	20.5	(0.7)	19.1	(16.)	12.0	(0.9)	12.4	(8.4)
Eu	1.14	(1.9)	1.15	(4.5)	1.31	(1.7)	1.34	(5.0)	1.46	(1.6)	1.47	(4.7)
Fe (%)	5.04	(0.3)	5.10	(3.4)	4.12	(0.4)	4.56	(6.0)	4.26	(0.4)	4.23	(6.1)
Ga	18.3	(5.3)	20.0	(20.)	18.5	(6.6)	21.4	(26.)	15.6	(14.)	22.2	(20.)
Hf	3.55	(1.5)	3.65	(6.7)	6.36	(1.0)	6.42	(5.0)	7.29	(0.9)	7.31	(9.4)
K (%)	2.49	(0.5)	2.62	(6.6)	2.87	(0.6)	2.70	(7.0)	3.46	(0.9)	3.04	(6.7)
La	31.6	(0.4)	31.2	(2.4)	38.4	(0.6)	40.3	(4.1)	53.6	(0.9)	52.9	(7.1)
Lu	0.43	(3.3)	0.42	(6.1)	0.49	(3.0)	0.48	(4.8)	0.44	(3.5)	0.41	(8.0)
Na (%)	0.64	(0.4)	0.53	(20.)	0.80	(0.4)	0.73	(23.)	1.49	(0.4)	1.24	(20.)
Nd	27.5	(2.6)	26.4	(5.6)	31.7	(2.4)	31.7	(9.0)	37.4	(2.4)	38.9	(9.9)
Ni	277.	(13.)	210.	(12.)	74.5	(46.)	101.	(22.)	171.	(19.)	237.	(24.)
Rb	142.	(1.8)	148.	(4.4)	160.	(1.6)	148.	(8.3)	160.	(1.6)	167.	(4.4)
Sb	0.58	(11.)	0.56	(13.)	0.84	(7.8)	1.14	(30.)	1.68	(4.5)	1.93	(17.)
Sc	20.4	(0.1)	20.9	(2.6)	20.2	(0.1)	20.0	(5.4)	15.0	(0.1)	14.0	(6.4)
Sm	5.11	(0.2)	4.81	(5.2)	5.79	(0.2)	6.10	(12.)	6.38	(0.2)	6.69	(8.4)
Ta	0.77	(3.7)	0.80	(6.8)	1.30	(2.4)	1.26	(6.2)	1.33	(2.4)	1.48	(4.9)
Tb	0.68	(6.5)	0.67	(7.0)	0.73	(6.0)	0.81	(6.6)	0.72	(5.9)	0.83	(8.0)
Th	11.1	(0.5)	10.9	(2.5)	16.4	(0.4)	17.1	(5.2)	27.4	(0.3)	27.2	(7.5)
U	2.27	(4.5)	2.24	(6.1)	4.13	(2.8)	3.38	(14.)	7.00	(2.2)	5.11	(13.)
W	1.66	(6.1)	2.17	(14.)	2.55	(4.7)	2.81	(13.)	3.29	(5.3)	3.45	(14.)
Yb	2.68	(2.1)	2.75	(3.2)	3.24	(1.8)	3.30	(3.7)	2.97	(2.3)	3.05	(6.8)
Zn	108.	(1.9)	109.	(9.2)	100.	(1.9)	108.	(11.)	96.9	(2.0)	86.9	(15.)

Table 4 *NAA data of Mycenaean sherds considered to be imported from Cyprus to Tarsus and their reference patterns. Concentrations of elements C or averages M in μg g^{-1} (ppm), if not indicated otherwise, and experimental errors δ or spreads σ in % of C or M, respectively. The sample Tars 14 has been corrected with the best relative fit factor 1.08 with respect to the reference group CypI. The group Kouklia is from Gunneweg and Perlman (1994)*

	Tars 14 (one sample; factor 1.08)		*CypI (27 samples; factor 1.00)*		*CypG (10 samples; factor 1.00)*		*Kouklia (19 samples; factor 1.00)*	
	C	*δ (%)*	*M*	*σ (%)*	*M*	*σ (%)*	*M*	*σ (%)*
As	12.2	(0.9)	12.4	(63.)	11.8	(88.)	–	
Ba	354.	(4.1)	511.	(53.)	418.	(25.)	–	
Ca (%)	10.6	(1.9)	9.64	(30.)	7.29	(22.)	7.30	(22.)
Ce	42.8	(1.8)	43.5	(4.7)	62.5	(4.9)	53.6	(18.)
Co	30.1	(0.5)	31.6	(6.7)	21.5	(6.0)	20.2	(8.2)
Cr	401.	(0.4)	332.	(21.)	89.9	(13.)	97.0	(11.)
Cs	3.99	(2.2)	4.54	(9.9)	3.55	(11.)	3.79	(11.)
Eu	1.04	(2.1)	1.02	(4.0)	1.11	(5.4)	1.29	(8.5)
Fe (%)	5.24	(0.3)	5.45	(4.8)	4.16	(6.5)	3.92	(6.4)
Ga	13.8	(13.)	16.1	(26.)	14.7	(16.)	–	
Hf	3.39	(1.7)	3.24	(7.5)	3.37	(2.1)	3.13	(7.0)
K (%)	2.33	(0.9)	2.06	(16.)	1.63	(12.)	–	
La	20.7	(0.6)	20.8	(3.2)	27.8	(4.3)	27.6	(8.3)
Lu	0.39	(4.0)	0.39	(6.0)	0.37	(8.0)	0.30	(6.6)
Na (%)	1.24	(0.4)	1.01	(32.)	0.50	(31.)	0.35	(24.)
Nd	18.5	(3.9)	17.7	(12.)	22.2	(7.0)	–	
Ni	263.	(15.)	307.	(17.)	98.5	(31.)	92.0	(18.)
Rb	69.5	(3.0)	74.2	(12.)	64.9	(6.9)	74.0	(14.)
Sb	1.04	(7.1)	1.02	(20.)	0.55	(19.)	–	
Sc	22.0	(0.1)	22.2	(4.7)	15.2	(12.)	14.2	(7.1)
Sm	3.70	(0.3)	3.45	(11.)	4.27	(6.6)	4.40	(14.)
Ta	0.63	(4.7)	0.65	(6.7)	0.98	(6.9)	1.07	(7.5)
Tb	0.62	(7.6)	0.59	(8.1)	0.65	(6.6)	–	
Th	6.63	(0.9)	6.91	(4.5)	7.32	(4.3)	7.35	(7.2)
U	2.00	(5.8)	1.95	(18.)	1.51	(20.)	1.52	(14.)
W	1.37	(11.)	1.66	(19.)	1.40	(22.)	–	
Yb	2.35	(2.5)	2.27	(3.3)	2.32	(4.3)	2.25	(9.8)
Zn	102.	(2.1)	100.	(9.1)	86.5	(11.)	–	

example from Cilicia from Kazanlı (Sherratt and Crouwel 1987, 329, fig. 4.3); the NAA result for Tarsus Sample 21 raises the question as to whether the Kazanlı sherd is local or an east Aegean import. Samples 27, 28 and 29 Cat. 187, 208 and 244 are deep bowls. Sample 27 has a standard decoration of an antithetic spiral flanking a panelled pattern, but Sample 28 has an antithetic spiral flanking a vertical tight wavy line. This is a very popular Philistine decorative syntax in the Philistine Bichrome phase, equivalent to LHIIIC Middle in Greek mainland terms (e.g., Dothan and Ben-Shlomo 2005, 138, fig. 3.46). The Tarsus material is unstratified; it might be that this syntax appears earlier here than in Philistia. Sample 29 is decorated with stemmed spirals with multiple loops to the stem, to which there are good parallels from Enkomi (Dikaios 1969–71, pls. 109.6, 110.12), but it has turned out to be a local product. The imitations of Cypriot motifs on Samples 4 and 29 and of an east Aegean motif on Sample 21 demonstrate that Tarsus took part in the trade route from the east Aegean to the Levant.

Group TarB

Only two samples belong to this group Samples 16, 17 Cat. 69, 74. Sample 16 is a flask and 17 a one-handled conical bowl FS 242. This is the second commonest shape at Tarsus (Mountjoy 2005a, nos. 74–127). Only one example was sampled, as sampling was limited and the large numbers of this shape suggested local production. It is, therefore, a surprise that it is TarB and not TarA. If TarB is a local group, which it seems to be, then the flask should also be local. The two pieces both have the decorative motif of a spiral with an open centre. Usually, FS 242 at Tarsus has an eye spiral (Mountjoy 2005a, Cat. 106–7, 110–17) or concentric circles on the interior base (Mountjoy 2005a, Cat. 118–22); examples with spiral with an open centre are rare (Mountjoy 2005a, Cat. 108–9). It may be that these pieces belong to a particular Tarsus workshop. It is hoped to do more analysis to resolve this question.

Group CypG

Ten samples belong to this group. This high number is not as surprising as it might appear, as the samples were chosen with a Cypriot provenance in mind. NAA on material from Kouklia, which forms a control group, allows CypG to be assigned to this site (see above). Samples 7, 10 Cat. 47, 50 belong to a Near Eastern Group of vessels comprising stirrup jars from Bethshan, Tel Keisan, Tarsus, Hala Sultan Tekke, Alassa and Kouklia (Mountjoy 2005b, 329–33). The defining factor of this group is the groups of narrow bands all down the body of the vase; in addition to this, most of the vases have a lozenge chain on the belly, the lozenges having either concave or straight sides. These vessels seem to have been made in different workshops on Cyprus. Tarsus Samples 7, 10 and the Tel Keisan stirrup jar belong to the Kouklia CypG workshop together with Tarsus Samples 8–9 Cat. 48–49; not enough of the lower body of the latter is extant to know whether or not they belong to the Near Eastern Group. In addition to these, the stirrup jars Samples 11–13 Cat. 51–53 belong to CypG. Sample 11 does not match the other stirrup jars in decoration. It has a lozenge on the shoulder instead of in the belly zone, but the lozenges are straight-sided and are comparable to Cypriot examples (e.g., Karageorghis 1974, pl. CLIX.174). Sample 12 has a triangular patch with dot fill on the shoulder and a lozenge chain in the belly zone. The triangular patch is very close to that on a collar-necked jar from Enkomi (Dikaios 1969–71, pl. 82.13). A similar decorative syntax of a triangular patch and a lozenge appears on a stirrup jar from Byblos, which should also be a Cypriot export (Salles 1980, pl. 12.6). Sample 13 may be part of a large stirrup jar that is now missing (Goldman 1956, fig. 333.1278). The remaining three samples,

Samples 24–26 Cat. 156–57, 160, are from deep bowls. Sample 24 may depict a bull. Its fabric suggested a local provenance (Mountjoy 2005a, 108), but NAA has shown otherwise. Sample 25 depicts the so-called spotted humped duck (Vermeule and Karageorghis 1982, 167). Other sherds from Tarsus have a more complete representation of this bird protome (Goldman 1956, fig. 335.1323, 1324); 1323 is now in the Bryn Mawr College collection, but 1324, the most complete example, is unfortunately missing. The Kouklia provenance for CypG is supported by Sample 25, since there is a very good example of this idiosyncratic duck from Kouklia itself (Maier *et al*. 1969, 401 fig. 22), which matches the Tarsus examples. Sample 26 depicts a fish with spot-filled body. The spots are set in vertical lines, similarly to those of the ducks. There is a good parallel from Enkomi (Vermeule and Karageorghis 1982, V.140).

Group CypI

Sample 14 belongs to this group, which has also been found at Qantir (Mountjoy and Mommsen 2001, 125, 130, called ICYP). It is a stirrup jar with very late decoration (see discussion in Mountjoy 2005a, 96). The assignment of Sample 14 to Cyprus means it can only date to LC IIIB, the period equated to Submycenaean on the Greek mainland, when the so-called Proto-White Painted ware was in vogue (Iakovou 2006, 195 n. 35). There are no close parallels to the decoration, but a vase from Alaas has similar triangle with diagonal fill (Karageorghis 1975, T.17.24 pl. 60); however, the triangles on the Alaas vase, as on all others, have a double frame on both sides, not on one side only as Tarsus Sample 14.

Group RHcl

Sample 19 Cat. 133, a krater sherd depicting a bird with dot-fringed body and a fish, belongs to this group. The group comes from Kos (Mommsen *et al*. in press). Such a provenance for Sample 19 is highly likely, especially as it has the gold mica, which is present in pottery from this island. NAA has already isolated a bird with dot-fringed body from Bademgediği Tepe as coming from Kos (Meriç and Mountjoy 2002, 85, fig. 3.14; Mommsen *et al*., in prep.), but from a different NAA group.

Group B

Sample 6 Cat. 43 with lustrous paint may belong to a jug depicting a bull with a spotted body, although a spotted humped duck cannot be ruled out; the clay differs from the local clay (Mountjoy 2005a, 92, 94). The chemical assignation to northern Ionia for this piece is archaeologically unlikely.

Singles

There are six singles. They comprise Samples 3 Cat. 15, 15 Cat. 64, 18 Cat. 132, 22 Cat. 141, 23 Cat. 152 and 30 Cat. 288. Sample 3 is an amphoriskos with tight wavy lines, which may be Cypriot Proto-White Painted; Sample 15 is an octopus stirrup jar, which may be Minoan, as it has a Minoan filling motif between the tentacles (Mountjoy 2005a, 104), Sample 18, which is probably from an amphoroid krater, is unusual in having bichrome decoration; Sample 22 has the loop of antithetic spiral with heavy fill, a motif similar to that on Koan examples (Mountjoy 1999a, Kos no. 113), but it does not conform to the Koan chemical pattern; Sample 23 is a krater with the pleonastic decoration, which is usual on Cyprus (for parallels at Enkomi, see Mountjoy 2005a, 105); it may come from a Cypriot site not yet known to NAA. Finally, Sample 30 is from a deep bowl found in a pit with a bulla of the Hittite queen Puduhepa (Mountjoy 2005a, 110). The bulla suggests a LHIIIB date, but stylistically the sherd could be LHIIIB or LHIIIC Early.

Group TarC

Samples 35 and 36 are rim fragments of MBA carinated bowls in Red Gritty Ware. They come from a crate of pottery labelled MB Red Gritty Ware by the Goldman team in the 1940s. The crate was reboxed, inventorized and associated with her own stratigraphic level AIII (Slane 2003) by Slane in 2000. Both fragments come from MB strata in Section A (lot designation marked as A286 on no. 35 and A643–4 on no. 36). Number 35 corresponds to Slane's box inventory no. 12 and no. 36 to inventory no. 11. Red Gritty Ware is one of the characteristic local wares of the EBA Tarsus (Goldman 1956), but seems to have continued into the MBA.

Non-Mycenaean singles

Samples 33 and 34 belong to Early Iron Age plain ware storage vessels. Number 33 is the rim fragment of a large pithos (dia. 0.36 m) with a simple, thick everted rim and slipped exterior, found in Section B Room T and dated stratigraphically to EIA II or III; these are the architectural phases that follow EIA I, the last phase containing local LB material and LHIIIC fragments (Yalçın 2005, Cat. 30). Number 34 is the rim fragment of a small to medium-sized jar (dia. 0.22 m) with a thick, short ledge rim and slipped exterior, found in Section B (lot designation B126). Both samples were selected because they represent typical local storage vessels that continue the LBA Hittite monochrome ware tradition in the EIA.

Samples 31 and 32 are from painted vessel fragments of the LBA to IA Transitional Period, assumed to be produced locally. Number 31 belongs to a krater with four handles (dia. 0.32 m) made of reddish clay with copious limestone and fine black grit. Red band below rim and below handles, red wavy, almost zigzag line around neck (Goldman 1956, Cat. 1353; Ünlü 2005, Cat. 11). Number 32 is the fragment of a large vessel of unknown shape (preserved dia. ~0.42 m), made of light buff clay with reddish buff slip. Hatched decoration in reddish brown paint covers the entire preserved fragment and a band emphasizes where the wall curves towards the base (Ünlü 2005, Cat. 14).These two samples were selected because each represents a type of painted decoration (31 wavy lines and 32 hatched decoration) typical for the painted transitional pottery tradition that is assumed to be local.

DISCUSSION

In spite of the limited number of sherds analysed, the results of NAA on the Tarsus pottery provide information on the exchange networks in the Eastern Mediterranean in the late LH III period. The only LH IIIB sherd analysed belongs to the Mycenae/Berbati group; this is a predictable assignation, since large amounts of pottery from this area were exported to the Near East in LH IIIA2–IIIB. Two local groups, TarA and TarB, could be isolated. More work needs to be done on TarB, since only two sherds could be assigned to it. The same applies to another group, TarC, consisting of two Middle Bronze Age sherds that form a chemical pair. However, the large local group TarA is of particular interest, as it includes pottery with imitations of Cypriot and East Aegean motifs, demonstrating that contact with these areas must have been intensive rather than sporadic. Moreover, actual imports have been isolated from these areas; NAA has shown that pottery belonging to the Kouklia CypG group and to the Kos RHc1 group is present. There is also a member of the CypI group. Although this group has not yet been located at a particular Cypriot site, the presence at Tarsus of a sherd belonging to it demonstrates yet another connection between Tarsus and Cyprus. Since only 30 sherds could be analysed, the numbers assignable to each chemical group are small; it is thus all the more interesting that several groups are represented and that a geographical range is covered. These encouraging results suggest there is great potential for further NAA analyses to be carried out in Cilicia.

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