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## A provenance study of Mycenaean pottery from Northern Israel

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## ABSTRACT

The occurrence of imported Mycenaean pottery in the Late Bronze Age southern Levant is one of the most conspicuous aspects of Eastern Mediterranean trade connections during this period. A group of 183 Mycenaean pottery vessels from 14 sites in northern Israel, from both coastal and inland settlement contexts were analyzed by Neutron Activation Analysis. The results indicate that the vast majority of these vessels have a similar profile and can be provenanced to the north-eastern Peloponnese or more specifically, to the Mycenae/Berbat workshop in the Argolid. Possible interpretations of these results are presented and discussed against the historical and cultural background of the Late Bronze Age Eastern Mediterranean.

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## 1. Introduction

Pottery vessels and sherds are often the most tangible evidence of trade relations and exchange systems of ancient societies, and the study of their distribution forms the basis of any analysis of these systems. This is especially relevant when dealing with “international periods” of intensive contacts between palatial polities, such as the Late Bronze Age (henceforth, LBA) in the eastern Mediterranean. The 14th–13th centuries BCE witnessed an unprecedented burst of economic activity, including trade in raw materials (such as copper, tin, ivory, glass, wood, semi-precious stones) and prestige goods (textiles, luxury vessels, works of arts and glyptics, among others). These interrelations are documented in written records from the period, and are further reflected in the rich and diverse archaeological finds known from this period in Egypt, the Levant, Anatolia, Cyprus and the Aegean area.

Pottery vessels of various forms and functions manufactured in the Mycenaean centers on the Greek Mainland during the 15th–13th centuries BCE were found in large quantities throughout the eastern Mediterranean and are an important component of the complex cultural relations of the period (Hankey, 1993; Wijngaarden, 2002). These ubiquitous vessels, technologically superior to other ceramic families and especially suited for the storage of precious liquids and unguents, were highly appreciated in Anatolia,

the Levant and Egypt (Leonard, 1994). The homogenous appearance of these vessels and their wide distribution make them ideal candidates for the study of trade, intercultural relations and the reconstruction of the complex economic system of the Late Bronze Age (Sherratt, 1999).

The important contribution of Mycenaean pottery for the reconstruction of trade and cultural relations was recognized already in the works of the pioneers of Aegean and Near Eastern Archaeology. During these early stages, the main emphasis was on stylistic and typological aspects of the vessels, as well as their chronological attribution and regional distribution (Hankey, 1967). In recent decades, a wider array of studies dedicated to the Mycenaean vessels addresses issues of production processes, intra- and inter-regional patterns of distribution, consumption and the social implications of the use of these vessels in their diverse find-contexts (Cadogan, 1993; Steel, 1998, 2002; Wijngaarden, 2002). Other studies suggest the existence of specialized ports of trade (*emporía*) along the Levantine coast, serving as preferred destinations for these items and as central gateway sites within the system (Yon et al., 2000; Balensi, 2004; Artzy, 2005; Bell, 2005).

Chemical analysis of pottery vessels, and especially the method of Neutron Activation Analysis (NAA), forms an important contribution to the study of Mycenaean exports. Several studies using Instrumental Neutron Activation Analysis (henceforth, INAA) on Mycenaean pottery from various contexts around the eastern Mediterranean were performed in the last decades (e.g., Asaro and Perlman, 1973; Gunneweg et al., 1992; Mommsen et al., 1992, 1995, 2002, 2005; Hoffmann and Robinson, 1993; Maran et al., 1997;

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Gunneweg and Michel, 1999; Hein et al., 1999; Mommsen and Maran, 2000–2001; French and Tomlinson, 2004; D'Agata et al., 2005; Badre et al., 2005; Mommsen and Sjöberg, 2007; Yellin, 2007). Despite the fact that some of these studies refer, directly or indirectly, to examples of Mycenaean pottery found in LBA southern Levant, no systematic large-scale provenance study has yet been carried on this group (a notable exception is the analysis of 86 Mycenaean sherds from Tell Abu Hawam, published in a cursory manner in Hoffmann and Robinson, 1993). These studies indicated that the majority of the Mycenaean pottery found in southern Levantine contexts was produced in the Argolid, the region of Mycenae probably at a workshop located in Berbati (e.g., Asaro and Perlman 1973; Mommsen et al., 2001; French and Tomlinson, 2004, Table 1; see Åkerström, 1968; Schallin, 1997). In the framework of the current project, 183 pottery vessels and sherds from fourteen sites in northern Israel were sampled and analyzed by INAA. This is the largest group analyzed so far and it forms a part of a unique inter-site study dedicated to a well-defined region in the Levant.

The main aims of the current project were: 1. Reconstruction of the exchange system of imported Mycenaean pottery in one important sub-region of the southern Levant, namely the area of modern-day northern Israel, on the basis of the provenance of the sherds and their respective attribution to Mycenaean production centers. 2. Identification of the Canaanite ports of trade (*emporía*), which regulated the distribution of the Mycenaean imports. The chemical composition of the sherds from Levantine coastal sites can form the basis for testing claims of directional trade connecting Canaanite coastal sites with different mainland Greek production centers, as suggested by previous studies (e.g., Gunneweg and Michel, 1999). 3. Reconstruction of the intra-regional distribution patterns of Mycenaean pottery in the Levant: from its arrival to the Canaanite coastal gateways, through its dissemination to the inland consumer-sites and its use in its final destination. 4. Contextual analysis of the Mycenaean vessels in Canaanite sites, as part of the analysis of their reception and patterns of their use, consumption and discard in Canaanite contexts. To this end, an attempt was made to collect as many examples from well-stratified LBA settlement contexts as possible (Table 1). The employment of INAA was a natural choice for such a project due to the extensive previous research and the rich databank focusing on the Aegean region available at the Bonn laboratory. Altogether 183 vessels were analyzed in this study (Table 1). Out of the fourteen sites sampled in northern Israel (Fig. 1) three major sites yielded the largest corpus of Mycenaean sherds; Hazor, Tell Abu Hawam and Dan (altogether 111 samples). Most of the samples originate from settlement

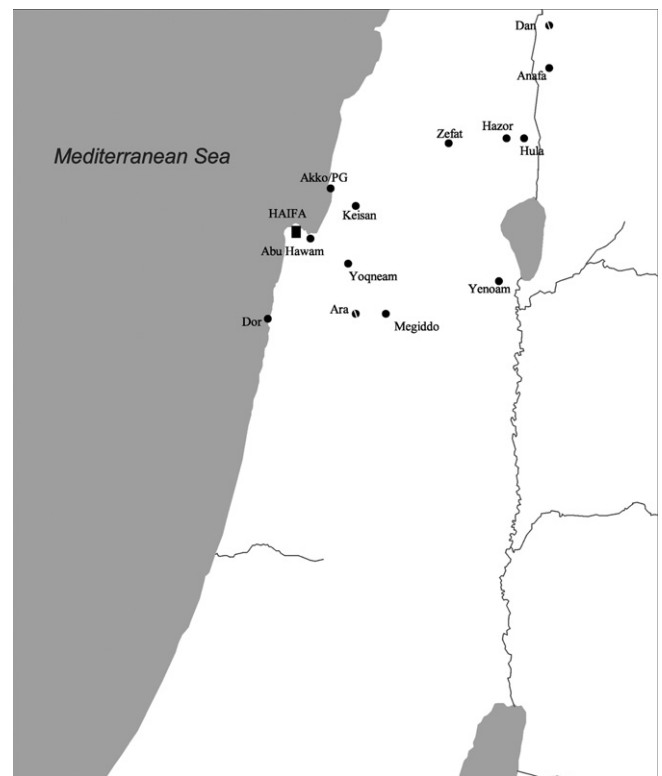


Fig. 1. Map of northern Israel with sites selected for the study.

contexts (170, 93%) and only 13 vessels are attributed to mortuary contexts. Various vessel-shapes are represented in the sample: both open forms such as bowls, cups, kylikes and kraters, and closed ones such as jugs, and piriform and stirrup-jars (see Table 2). It is noteworthy that open forms, deemed unsuitable as trade containers and as such are expected to be rare in southern Levantine contexts (Leonard, 1994), comprise one third of our corpus.

The period within the Late Helladic (henceforth, LH) stylistic sequence most commonly represented in our corpus is the LHIIIA2–LHIIIB (i.e., the 14th century BCE); five vessels are identified as early (LHII and LHIIIA1 covering the 15th–early 14th century BCE), and nine are later (LHIIIB2–LHIIIC attributed to the late 13th–early 12th century BCE) in the sequence (Table 2).

Table 1

Samples according to sites and their provenance according to INAA.

| Site      | No. of samples | Context type | Location in Israel | Provenance: Argolid (MYBE) | Other mainland | Cyprus | Other provenance/unlocalized |
|-----------|----------------|--------------|--------------------|----------------------------|----------------|--------|------------------------------|
| Abu Hawam | 33             | Settlement   | Coastal            | 28                         | 3              | 0      | 2                            |
| Akko      | 7              | Settlement   | Coastal            | 5                          | 0              | 2      | 0                            |
| Akko (PG) | 7              | Burial       | Coastal            | 0                          | 7              | 0      | 0                            |
| Anafa     | 7              | Settlement   | Non-coastal        | 6                          | 0              | 0      | 1                            |
| Ara       | 4              | Burial       | Non-coastal        | 3                          | 0              | 0      | 1                            |
| Dan       | 30             | Settlement   | Non-coastal        | 27                         | 0              | 0      | 3                            |
| Dor       | 16             | Settlement   | Coastal            | 5                          | 0              | 7      | 4                            |
| Hazor     | 48             | Settlement   | Non-coastal        | 43                         | 2              | 0      | 3                            |
| Hula      | 1              | Settlement   | Non-coastal        | 1                          | 0              | 0      | 0                            |
| Keisan    | 10             | Settlement   | Non-coastal        | 8                          | 0              | 1      | 1                            |
| Megiddo   | 7              | Settlement   | Non-coastal        | 2                          | 0              | 3      | 2                            |
| Yenoam    | 1              | Settlement   | Non-coastal        | 1                          | 0              | 0      | 0                            |
| Yoqneam   | 10             | Settlement   | Non-coastal        | 8                          | 0              | 1      | 1                            |
| Zefat     | 2              | Burial       | Non-coastal        | 1                          | 1              | 0      | 0                            |
| Coastal   | 63             | Non-coastal  | 120                |                            |                |        |                              |
| Total     | 183            |              |                    | 138                        | 13             | 14     | 18                           |

**Table 2**

Mycenaean vessels sampled according to vessel type and Late Helladic (LH) date.

| Type             | No. | Open/closed | Typological date | No. |
|------------------|-----|-------------|------------------|-----|
| Bowl             | 13  | Open        | LHII             | 3   |
| Cup              | 15  | Open        | LHIIIA1          | 4   |
| Deep krater      | 3   | Open        | LHIIIA2          | 64  |
| Krater           | 7   | Open        | LHIIIA2-B        | 44  |
| Kylix            | 8   | Open        | LHIIIB           | 45  |
| Rhyton           | 3   | Open        |                  |     |
| Goblet           | 3   | Closed      | LHIIIB2-C        | 9   |
| Amphoroid krater | 12  | Closed      | LHIIIC           | 3   |
|                  |     |             | General LH       | 2   |
|                  |     |             | Other            | 9   |
| Pyxis            | 13  | Closed      |                  |     |
| Alabastron       | 2   | Closed      |                  |     |
| Flask            | 8   | Closed      |                  |     |
| Piriform jar     | 17  | Closed      |                  |     |
| Jugs             | 5   | Closed      |                  |     |
| Stirrup jar      | 50  | Closed      |                  |     |
| Other/sherds     | 24  |             |                  |     |
| Total open       | 53  |             |                  |     |
| Total closed     | 125 |             |                  |     |

## 2. Analytical procedure

The INAA was performed in Bonn and is a modified version of the procedure given by [Perlman and Asaro \(1969\)](#), described in more detail in [Mommensen et al., 1991](#). The samples were drilled by a diamond point from the sherds and weighed to about 80 mg. The concentration of thirty elements, if present above detection limits, was obtained by comparison of the Bonn standard, calibrated against the well-known Berkeley Pottery Standard. The assignment of chemical groups to the individual samples was made according to the statistical filtering method developed in Bonn ([Beier and Mommensen, 1994](#); [Mommensen et al., 2002](#), pp. 615–617), which uses a modified Mahalanobis distance as a dissimilarity measure, and takes into account both individual elemental measuring errors and various dilution effects (which result in constant shifts in elemental values, determined using the 'best relative fit' method, e.g., [Mommensen and Sjöberg, 2007](#)). The high precision of the results as well as a databank of over 8000 samples from the eastern Mediterranean, mainly from Greece and the Aegean region, but including also some 500 from Palestine, 120 from Egypt and over 50 samples from Cyprus, enables to confidently assign most samples to relatively 'chemically-compact' groups, which are thence geographically provenanced according to reference materials. Further statistic treatment as Discriminant Analysis can further assist in examining the validity of the assignment to chemical groups.

## 3. Results

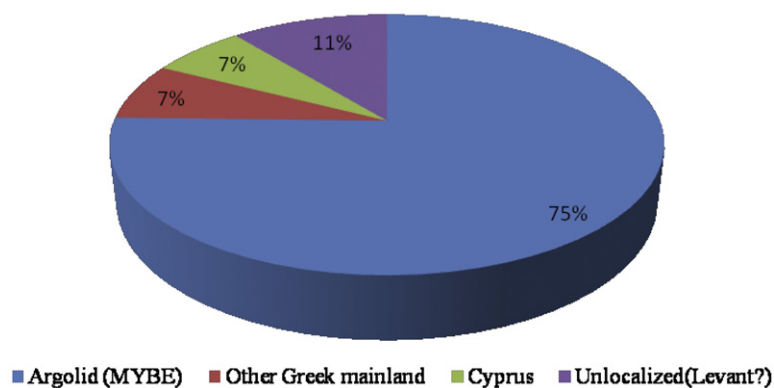
The results according to the Bonn grouping method indicate that the large majority of the analyzed Mycenaean vessels share a similar clay profile (MYBE compositional group; [Table 1](#), [Figs. 3 and 4](#)). This profile is provenanced to the Argolid/north-eastern Peloponnese, the Mycenaean/Berbat (MYBE) group ([Table 3](#); [Figs. 5 and 6](#)), and represents pottery produced in the Berbati workshop ([Fig. 2](#); [Åkerström, 1968](#); [Schallin, 1997](#)) and probably elsewhere in the north-eastern Peloponnese (see below). At least 138 samples in our corpus are related to this profile (75% of the entire sample). Of these, 87 samples belong to the main 'core group', which represents the most compositionally homogenous part of this large group. Most of the samples from the major sites analyzed, Hazor, Abu Hawam and Dan belong to this group. An additional 51 samples belong to various subgroups, which have been formed, since they have the same general composition but vary somewhat in single

**Fig. 2.** Map of the Peloponnese with sites mentioned in the text.

elements (e.g. MBKR: lower in K and Rb) or may have generally reduced concentrations as consequence of a dilution. The various subgroups are separated from the core group in order to achieve a more efficient initial grouping of new samples and reduce the spread values of single elements in the group MYBE. In this way a better group separability from other non-MYBE groups (see, [Mommensen, 2001](#)) is attained. Generally, the sub-grouping of this large chemical group MYBE has no archaeological meaning (i.e. the subgroups cannot as yet be assigned to any different workshops or production lines).

In the Bonn databank the large chemical group MYBE and its subgroups include to-date over 1000 samples, mainly of Late Bronze Age Mycenaean pottery from the Aegean and elsewhere. These include wasters from the Berbati pottery workshop, and also pottery from later Geometric and even Archaic periods. This may be somewhat problematic as the Mycenaean workshop at Berbati was supposed to have ceased to function during the LHIIIB. Moreover, MYBE appears in other sites in Greece also for pottery which is typologically not Argive ([Mommensen et al., 2001](#), p. 348). Thus, this profile may represent a general profile of the north-eastern Peloponnese in various periods, or may even include profiles of workshops in other regions of the Peloponnese, which have not yet been archaeologically recognized (see below), rather than a specific Mycenaean palatial Argive workshop.

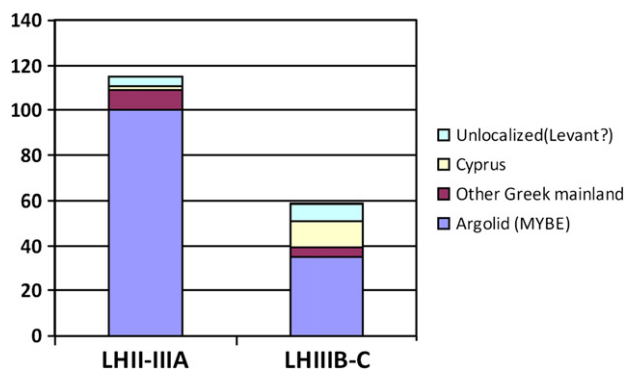
In the sample from northern Israel an additional eight samples were related to the ACb2 compositional group ([Table 3](#)) known from samples from the western Peloponnese (Achaia [9 samples], Elia [4], Arcadia [7], Messenia [12], unpublished); seven of these come from Akko-Persian Garden and one comes from a tomb at Zefat. This profile, multiplied with a 0.86 dilution factor, is generally not very different of the MYBE profile, but the Cs and Rb values are lower. While alkali elements can be affected by post-depositional alteration (see, e.g., [Schwedt et al., 2004](#)), this cannot be responsible for the very large differences in the concentrations of these elements, which are about three to five times higher in the MYBE group in comparison with the ACb2 group. The good statistical separability of group ACb2 from MYBE is obvious in the discriminant calculations [Figs. 5 and 6](#) (In [Hein et al., 2002](#) another group ACa from the western Peloponnese is compared to the MYBE group and found to be chemically nearly not distinguishable.). [Gunnweg and Michel \(1999\)](#), using data measured at Berkeley, have also

**Provenance of Mycenaean pottery from Northern Israel according to INAA (n=183)****Fig. 3.** General provenance of the samples according to INAA grouping (N = 183).

reported a very similar profile in six other samples from the cemetery at Akko (Gunneweg and Michel, 1999, Table 2, Column 3; if multiplied by 0.93, yet, some difference in Hf, Lu, both higher in ACb2, is found in our data). Another group of eight samples (Gunneweg and Michel, 1999, Table 2, Column 1) multiplied with a factor 1.09, runs also somewhat, but less similar to Group ACb2 with Cs differing the most (lower in ACb2). In the Perlman Mycenaean databank, evaluated with the Bonn statistical procedure (Mommensen et al., 2002), a group Ni3P is also quite similar to ACb2 (Ni3P multiplied by 0.97 resembles ACb2, but Hf and Lu are higher in ACb2). This is a group of samples found at Nichoria and other sites nearby (Fig. 2). An evaluation of the same Berkeley data at Manchester (Hoffmann et al., 1992) also reports this profile as Cluster 5. Since the number of members in the Bonn group ACb2 as well as in the Berkeley group NI3P, although small in both cases, is highest for Messenia, a provenance of these groups from the western Peloponnese is probable.

In addition, two vessels from Abu Hawam and two examples from Hazor were shown to come from the Tiryns/Asine workshop (group TIR, Table 4, Figs. 5 and 6), the only Argive composition that clearly represents an identified workshop other than Mycenaean/Berbat. Another vessel from Abu Hawam was grouped as member of UL19 (un-located group 19) (Table 4). This is a still non-localized small group that is shared by another five samples from Euboea and several other pieces from different Greek Mainland sites.

Nine samples, of which at least several are typologically attributed to LHIIIB2-C, belong to group CypH which is with high probability provenanced to Cyprus on account of reference material from Sinda (Mommensen and Sjöberg, 2007, pp. 366–367, Tables 3 and 4).

**Fig. 4.** General provenance of the samples separated according to stylistic dating (N = 183).

Note that Sinda is located in the eastern part of Cyprus, yet, the specific provenance determination of this chemical group within Cyprus is still not secure. Two samples from Dor belong to group CypG (see Table 5); this group includes pottery which is associated with Cyprus on the basis of stylistic considerations. Two additional samples from Akko were grouped as matching the CypG compositional group (Table 5), which may also be provenanced to Cyprus, since it is very close in composition to group CypG, if multiplied by a best relative fit factor 0.87 (see D'Agata et al., 2005). Another sample from Dor belongs to the small group EnkA (Table 5), also including Cypriote style vessels.

**Table 3**

Comparison of average grouping values of the groups MYBE lev (this study) and MYBE ref (Argive reference) and similarly ACb2 lev, ACb2 ref. Concentrations of elements M in µg/g (ppm), if not indicated otherwise, and spreads σ in percent of M, individual samples corrected for dilution.

|      | MYBE lev           |       | MYBE ref           |       | ACb2 lev           |       | ACb2 rev           |       |
|------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|
|      | 138 samples        |       | 297 samples        |       | 6 samples          |       | 32 samples         |       |
|      | $M \pm \sigma$ (%) |       | $M \pm \sigma$ (%) |       | $M \pm \sigma$ (%) |       | $M \pm \sigma$ (%) |       |
| As   | 5.71               | (51.) | 5.93               | (54.) | 5.77               | (21.) | 6.79               | (56.) |
| Ba   | 432.               | (22.) | 400.               | (23.) | 504.               | (23.) | 357.               | (36.) |
| Ca % | 9.52               | (15.) | 9.29               | (23.) | 8.07               | (26.) | 5.85               | (44.) |
| Ce   | 62.4               | (2.1) | 62.5               | (2.7) | 82.7               | (2.0) | 72.4               | (3.5) |
| Co   | 26.7               | (6.0) | 29.3               | (9.5) | 32.3               | (4.6) | 31.3               | (15.) |
| Cr   | 227.               | (16.) | 228.               | (13.) | 274.               | (3.8) | 281.               | (11.) |
| Cs   | 8.30               | (7.0) | 8.81               | (12.) | 1.54               | (44.) | 1.78               | (21.) |
| Eu   | 1.11               | (3.1) | 1.13               | (4.4) | 1.54               | (1.8) | 1.39               | (4.9) |
| Fe % | 4.92               | (4.2) | 5.14               | (4.2) | 6.78               | (3.3) | 5.69               | (10.) |
| Ga   | 21.0               | (14.) | 20.8               | (19.) | 20.3               | (13.) | 19.0               | (18.) |
| Hf   | 3.71               | (8.7) | 3.55               | (9.1) | 4.52               | (7.5) | 4.95               | (13.) |
| K %  | 2.59               | (8.4) | 2.59               | (13.) | 1.11               | (13.) | 1.49               | (22.) |
| La   | 30.4               | (2.5) | 31.1               | (3.2) | 39.4               | (3.8) | 35.2               | (5.3) |
| Lu   | 0.42               | (4.1) | 0.42               | (5.3) | 0.58               | (3.2) | 0.49               | (5.7) |
| Na % | 0.60               | (24.) | 0.54               | (40.) | 0.24               | (15.) | 0.57               | (49.) |
| Nd   | 25.5               | (3.8) | 26.1               | (6.7) | 35.4               | (2.5) | 30.7               | (12.) |
| Ni   | 250.               | (24.) | 230.               | (18.) | 286.               | (13.) | 255.               | (13.) |
| Rb   | 144.               | (7.8) | 148.               | (8.7) | 37.3               | (31.) | 53.0               | (22.) |
| Sb   | 0.58               | (15.) | 0.61               | (20.) | 0.73               | (10.) | 0.62               | (21.) |
| Sc   | 20.1               | (3.8) | 21.3               | (4.4) | 26.4               | (3.0) | 21.8               | (10.) |
| Sm   | 4.71               | (4.3) | 4.76               | (5.6) | 6.73               | (1.2) | 5.89               | (8.1) |
| Ta   | 0.77               | (4.4) | 0.80               | (6.5) | 0.98               | (6.5) | 0.99               | (6.7) |
| Tb   | 0.65               | (6.8) | 0.67               | (7.1) | 0.89               | (5.9) | 0.87               | (7.2) |
| Th   | 10.6               | (2.7) | 10.8               | (3.4) | 14.2               | (3.2) | 12.8               | (4.9) |
| U    | 2.25               | (8.8) | 2.26               | (6.7) | 2.13               | (5.3) | 2.31               | (12.) |
| W    | 2.16               | (14.) | 2.13               | (15.) | 2.13               | (12.) | 2.23               | (18.) |
| Yb   | 2.66               | (2.8) | 2.73               | (3.2) | 3.80               | (2.8) | 3.31               | (2.6) |
| Zn   | 105.               | (8.9) | 110.               | (9.3) | 117.               | (12.) | 111.               | (14.) |
| Zr   | 69.7               | (41.) | 148.               | (26.) | 106.               | (47.) | 223.               | (16.) |

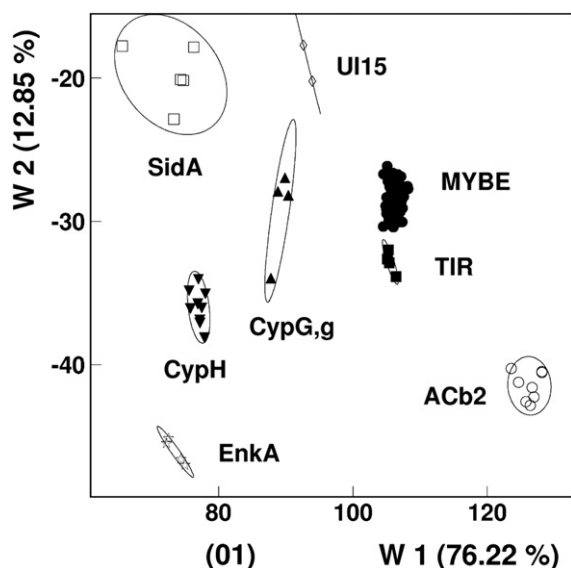


**Fig. 5.** Result of a Discriminant Analysis of the 170 grouped samples from northern Israel assuming 8 clusters. All elements given in the data tables have been used except, because of zero data in some of the smaller groups, As, Ba, Na, Ni, and Zr. The individual samples have been corrected for dilution with respect to the grouping values. Plotted are the discriminant functions W1 and W2, respectively, describing 76% and 13% of the between-group variance. The ellipses are the  $2\sigma$  boundaries (95% confidence limit) of the groups.

Five samples (from Dan, Hazor, Yoqneam, Abu Hawam and Keisan) are grouped as SidA (Table 4, Fig. 5). This compositional group includes also LHIII C members from Sidon (unpublished). The chemical profile is different from Aegean compositions and thus, this group possibly has a Levantine provenance whose exact location is still unknown. It is noteworthy that most of the vessels with non-Argive chemical provenance were identified by naked eye as probably or possibly not produced in Mycenaean workshop in the Aegean. In addition, two samples grouped as UI15 are unlocalized as were nine single and two samples that were each paired with

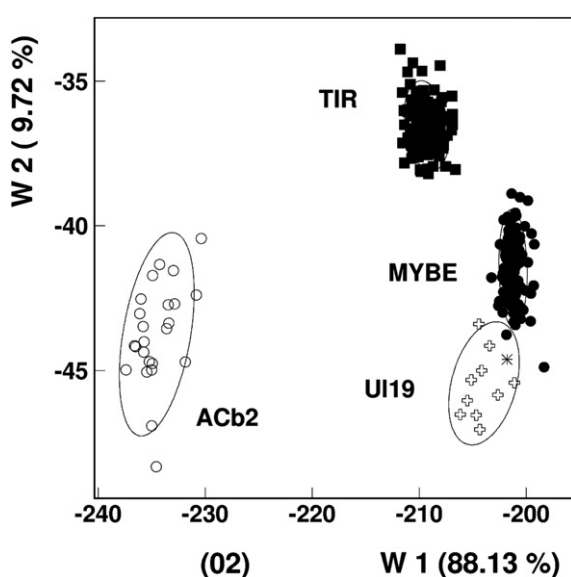


**Fig. 6.** Result of a Discriminant Analysis similar to Fig. 5, but showing only the Greek groups represented in northern Israel. Groups TIR, ACb2, and UI19 include here also Argive and other reference pieces. The single sample of this study assigned to group UI19 is highlighted.

**Table 4**

Comparison of average grouping values of the groups TIR lev (this study) and TIR ref (Argive reference) and full groups UI19 (general Greek) and SidA (Levant). Concentrations of elements  $M$  in  $\mu\text{g/g}$  (ppm), if not indicated otherwise, and spreads  $\sigma$  in percent of  $M$ , individual samples corrected for dilution.

|      | TIR lev            |  | TIR ref            |  | UI19                     |  | SidA                     |
|------|--------------------|--|--------------------|--|--------------------------|--|--------------------------|
|      | 4 samples          |  | 138 samples        |  | 11 samples (incl. 1 lev) |  | 12 samples (incl. 5 lev) |
|      | $M \pm \sigma$ (%) |  | $M \pm \sigma$ (%) |  | $M \pm \sigma$ (%)       |  | $M \pm \sigma$ (%)       |
| As   | 7.28 (4.4)         |  | 6.82 (45.)         |  | 5.23 (24.)               |  | –                        |
| Ba   | 494. (13.)         |  | 491. (20.)         |  | 315. (14.)               |  | 549. (69.)               |
| Ca % | 7.03 (10.)         |  | 8.91 (20.)         |  | 11.1 (14.)               |  | 19.6 (24.)               |
| Ce   | 69.3 (1.5)         |  | 67.0 (2.1)         |  | 59.6 (4.3)               |  | 40.0 (7.9)               |
| Co   | 23.2 (4.2)         |  | 23.4 (5.5)         |  | 30.4 (2.8)               |  | 8.36 (11.)               |
| Cr   | 183. (2.9)         |  | 176. (4.9)         |  | 239. (6.0)               |  | 142. (35.)               |
| Cs   | 4.61 (3.3)         |  | 4.80 (6.8)         |  | 9.04 (6.9)               |  | 2.59 (10.)               |
| Eu   | 1.29 (2.9)         |  | 1.30 (3.6)         |  | 1.10 (4.1)               |  | 0.83 (5.5)               |
| Fe % | 4.96 (3.9)         |  | 5.06 (2.8)         |  | 5.47 (3.1)               |  | 2.42 (4.7)               |
| Ga   | 14.9 (23.)         |  | 19.5 (25.)         |  | 23.4 (11.)               |  | 10.2 (11.)               |
| Hf   | 4.45 (8.5)         |  | 4.33 (6.4)         |  | 3.41 (7.3)               |  | 2.95 (7.3)               |
| K %  | 2.16 (2.2)         |  | 2.26 (13.)         |  | 1.07 (25.)               |  | 1.35 (13.)               |
| La   | 31.2 (0.9)         |  | 30.8 (1.9)         |  | 30.0 (2.7)               |  | 20.2 (7.8)               |
| Lu   | 0.45 (4.1)         |  | 0.43 (4.4)         |  | 0.46 (11.)               |  | 0.28 (7.6)               |
| Na % | 1.33 (12.)         |  | 1.29 (19.)         |  | 1.28 (9.3)               |  | 0.31 (28.)               |
| Nd   | 26.7 (7.2)         |  | 28.2 (8.3)         |  | 25.8 (7.3)               |  | 16.1 (13.)               |
| Ni   | 193. (20.)         |  | 172. (9.7)         |  | 253. (9.2)               |  | 188. (91.)               |
| Rb   | 107. (3.5)         |  | 110. (8.3)         |  | 71.4 (24.)               |  | 50.3 (14.)               |
| Sb   | 0.61 (10.)         |  | 0.64 (17.)         |  | 0.63 (12.)               |  | 0.71 (18.)               |
| Sc   | 19.6 (4.2)         |  | 20.0 (2.7)         |  | 22.8 (2.6)               |  | 9.66 (6.0)               |
| Sm   | 5.34 (6.4)         |  | 5.41 (5.4)         |  | 4.62 (4.6)               |  | 2.95 (11.)               |
| Ta   | 0.83 (4.4)         |  | 0.87 (6.0)         |  | 0.79 (6.1)               |  | 0.60 (8.3)               |
| Tb   | 0.77 (6.2)         |  | 0.76 (6.5)         |  | 0.64 (7.2)               |  | 0.48 (7.1)               |
| Th   | 10.7 (2.2)         |  | 11.0 (2.3)         |  | 11.0 (3.6)               |  | 5.74 (10.)               |
| U    | 1.88 (13.)         |  | 2.05 (6.8)         |  | 2.13 (13.)               |  | 2.30 (21.)               |
| W    | 1.70 (9.3)         |  | 2.13 (20.)         |  | 2.17 (29.)               |  | 0.86 (10.)               |
| Yb   | 2.75 (4.3)         |  | 2.86 (3.9)         |  | 2.69 (2.7)               |  | 1.86 (5.2)               |
| Zn   | 90.0 (7.0)         |  | 92.1 (9.5)         |  | 117. (9.3)               |  | 120. (39.)               |
| Zr   | 98.0 (28.)         |  | 170. (24.)         |  | 130. (35.)               |  | 67.7 (44.)               |

another sample in the databank ('pairs' No. 40 and 120; note that the sherds of both these pairs are stylistically dated to the LHIIIB2–C). Some of these may belong to unlocalized Mycenaean workshops (maybe six according to typological grounds), but they may represent also Levantine or other eastern Mediterranean workshops. A similar variability of sources of the 13th century BCE Mycenaean style pottery from the Levant was reported from sites in southern Israel and northern Sinai (Mommensen et al., 2005). In our project, at least 75% of the samples share a common profile, the MYBE group (see Fig. 3); and if only vessels of clear Aegean origin are considered this percentage rises to 91%. It is also noteworthy that vessels identified as LHIIIA2–B and earlier, imported to the southern Levant in the 14th century BC, were more commonly attributed to the MYBE group (87% of the earlier samples, Fig. 4). Chronologically later sherds show more diversity in their chemical profile and assumed provenance (only 59% belong to MYBE group; see below).

#### 4. Discussion

The occurrence of imported Mycenaean pottery in the Late Bronze Age southern Levant is one of the most conspicuous residues of the Eastern Mediterranean trade connections during this period. The relative quantities of Mycenaean pottery, especially in comparison to those of the imported Cypriot pottery, in sites of the southern Levant are relatively small (Äström, 1993; Artzy, 2005). The distribution pattern of the Mycenaean pottery may indicate a presence of a 'down the line' trade pattern with the domination of few suppliers in the Argolid, where Tell Abu Hawam serves as

**Table 5**

Comparison of average grouping values of the groups CypH lev (this study) and CypH ref (reference) and CypG,g lev, CypG,g ref and full group EnkA. Concentrations of elements *M* in  $\mu\text{g/g}$  (ppm), if not indicated otherwise, and spreads  $\sigma$  in percent of *M*, individual samples corrected for dilution.

|      | CypH lev                    |       | CypH ref                    |       | CypG,g lev                  |       | CypG,g ref                  |       | EnkA                        |       |
|------|-----------------------------|-------|-----------------------------|-------|-----------------------------|-------|-----------------------------|-------|-----------------------------|-------|
|      | 9 samples                   |       | 54 samples                  |       | 4 samples                   |       | 11 samples                  |       | 4 samples                   |       |
|      | <i>M</i> $\pm$ $\sigma$ (%) |       | <i>M</i> $\pm$ $\sigma$ (%) |       | <i>M</i> $\pm$ $\sigma$ (%) |       | <i>M</i> $\pm$ $\sigma$ (%) |       | <i>M</i> $\pm$ $\sigma$ (%) |       |
| As   | 16.0                        | (51.) | 11.3                        | (86.) | 8.64                        | (56.) | 8.51                        | (60.) | 27.0                        | (79.) |
| Ba   | 565.                        | (53.) | 534.                        | (38.) | 662.                        | (46.) | 498.                        | (36.) | 701.                        | (90.) |
| Ca % | 12.8                        | (20.) | 12.1                        | (40.) | 8.76                        | (25.) | 7.36                        | (20.) | 10.5                        | (3.1) |
| Ce   | 38.5                        | (6.5) | 39.1                        | (4.6) | 64.4                        | (4.2) | 62.2                        | (4.7) | 31.2                        | (4.3) |
| Co   | 17.9                        | (8.2) | 20.4                        | (12.) | 22.1                        | (3.6) | 21.5                        | (6.8) | 25.1                        | (10.) |
| Cr   | 275.                        | (7.0) | 290.                        | (12.) | 101.                        | (11.) | 93.3                        | (16.) | 291.                        | (2.1) |
| Cs   | 3.00                        | (11.) | 3.36                        | (17.) | 3.74                        | (7.8) | 3.59                        | (11.) | 2.57                        | (12.) |
| Eu   | 0.99                        | (2.7) | 0.97                        | (5.1) | 1.17                        | (2.2) | 1.11                        | (5.0) | 0.87                        | (4.1) |
| Fe % | 3.82                        | (2.8) | 4.16                        | (5.4) | 4.07                        | (5.2) | 4.04                        | (4.6) | 5.03                        | (1.9) |
| Ga   | 10.7                        | (26.) | 13.0                        | (31.) | 16.4                        | (7.2) | 15.3                        | (17.) | 12.8                        | (31.) |
| Hf   | 2.98                        | (4.9) | 2.98                        | (6.8) | 3.44                        | (2.4) | 3.37                        | (3.0) | 2.50                        | (7.9) |
| K %  | 1.99                        | (14.) | 1.69                        | (11.) | 1.66                        | (8.2) | 1.64                        | (11.) | 1.77                        | (4.5) |
| La   | 19.7                        | (4.2) | 19.8                        | (3.7) | 28.8                        | (6.1) | 27.8                        | (4.8) | 14.6                        | (3.7) |
| Lu   | 0.34                        | (4.4) | 0.34                        | (6.5) | 0.37                        | (7.3) | 0.36                        | (4.9) | 0.36                        | (4.2) |
| Na % | 1.10                        | (10.) | 1.11                        | (24.) | 0.46                        | (32.) | 0.46                        | (30.) | 1.27                        | (8.1) |
| Nd   | 17.6                        | (6.8) | 17.5                        | (9.4) | 23.6                        | (3.1) | 22.2                        | (7.2) | 13.9                        | (5.0) |
| Ni   | 186.                        | (18.) | 186.                        | (17.) | 158.                        | (18.) | 141.                        | (68.) | 175.                        | (19.) |
| Rb   | 63.1                        | (6.4) | 60.0                        | (13.) | 70.7                        | (6.9) | 66.0                        | (7.7) | 54.6                        | (19.) |
| Sb   | 0.59                        | (14.) | 0.75                        | (26.) | 0.52                        | (11.) | 0.51                        | (14.) | 0.72                        | (27.) |
| Sc   | 17.8                        | (4.9) | 18.0                        | (5.6) | 15.4                        | (9.1) | 14.5                        | (7.5) | 21.8                        | (4.1) |
| Sm   | 3.56                        | (4.5) | 3.48                        | (8.9) | 4.60                        | (5.3) | 4.21                        | (5.5) | 2.96                        | (3.9) |
| Ta   | 0.56                        | (5.7) | 0.58                        | (6.3) | 0.99                        | (8.2) | 1.00                        | (5.6) | 0.44                        | (7.1) |
| Tb   | 0.54                        | (7.6) | 0.56                        | (7.6) | 0.68                        | (6.0) | 0.66                        | (6.3) | 0.49                        | (9.4) |
| Th   | 5.62                        | (3.8) | 6.05                        | (6.9) | 7.66                        | (7.1) | 7.39                        | (5.2) | 4.55                        | (4.4) |
| U    | 2.06                        | (13.) | 2.52                        | (24.) | 1.80                        | (9.0) | 1.41                        | (9.5) | 1.57                        | (9.9) |
| W    | 1.57                        | (16.) | 1.39                        | (16.) | 1.57                        | (33.) | 1.47                        | (16.) | 1.57                        | (29.) |
| Yb   | 2.18                        | (3.2) | 2.14                        | (5.7) | 2.43                        | (3.0) | 2.27                        | (2.3) | 1.99                        | (2.9) |
| Zn   | 119.                        | (25.) | 101.                        | (29.) | 89.9                        | (22.) | 93.8                        | (34.) | 221.                        | (77.) |
| Zr   | 43.3                        | (64.) | 102.                        | (43.) | 91.7                        | (25.) | 90.5                        | (32.) | 43.8                        | (60.) |

a Mycenaean 'port of trade' and an 'emporium' (Balensi, 2004; Artzy, 2005). The results of all previous provenance studies of Mycenaean pottery from 14th to early 13th centuries southern Levantine contexts (Asaro and Perlman, 1973; Hoffmann and Robinson, 1993; Gunneweg and Michel, 1999; Mommsen and Maran 2000–2001, p. 102; Mommsen et al., 2005; also for Tel Kazel, in the northern Levant, see Badre et al., 2005, p. 17), as well as those of the current study, indicate that a single chemical profile dominates most of these imports. Initially, this profile was assigned to a workshop near Mycenae (Berbati, the MYBE group), yet, as noted above, this profile may represent a general profile of the north-eastern Peloponnese and may also represent other workshops in other regions of the Peloponnese, which have not yet been archaeologically recognized. Vessels provenanced to other workshops in the Argolid (most notably four sherds attributed to a Tiryns/Asine workshop), as well as in other regions in Greece are rare, and their appearance mainly at Tell Abu Hawam and Hazor is noteworthy.

One interesting exception may be a small group of vessels found in the Late Bronze Age tombs at the cemetery near Akko (the Persian Garden) and at Safed (Upper Galilee). This group, already recognized by Gunneweg and Michel (1999), presents a different profile, as yet archaeometrically unlocalized but probably from the western Peloponnese region (or Nichoria? See above). The suggestion that these vessels were brought to the site by a distinctive group of foreigners, which were later buried in these tombs with their original belongings (Gunneweg and Michel, 1999) should be treated with caution as an over-simplistic argument equating "pots to people" (see also Artzy, 2005, p. 358, note 25). It might be tentatively suggested that this phenomenon reflects a different trade and distribution pattern, making Akko an independent Levantine emporium importing Mycenaean vessels from a distinct

Argive workshop and distributing it on a northern route to certain locations in the Upper Galilee area (Artzy, 2005, pp. 359–360, Pl. LXXVIIc).

The phenomenon of a single chemical source for most of the Mycenaean pottery in the southern Levant can be interpreted in several ways:

1. All these Mycenaean vessels were produced in one workshop and exported from one major Argive center, probably Mycenae, to the southern Levant. Such a monopoly of a specific workshop dominating a system of directional trade was previously suggested by Podzuweit and embraced by Badre et al. for the imported Mycenaean pottery found at Tel Kazel on the Syrian coast (Badre et al., 2005, p. 15, 36). This assumption might lend support to Balensi's suggestion of a system of Mycenaean 'proto-marketing' to the southern Levant during the 14th and early 13th centuries BC, where Tel Abu Hawam served as 'port of trade' with particular relations to its suppliers in the Argolid (Balensi, 2004).
2. All these Mycenaean vessels were produced in one workshop, but then exported under the supervision of several Mycenaean centers in the Argolid, all acquiring pottery for this purpose from the same industrial workshop.
3. Alternatively, there is an option of several workshops providing for the needs of several Mycenaean centers in the Argolid (or even a larger region). The similarity of the geology of the Argolid sub-areas (Whitbread, 1995, pp. 355–359; Higgins and Higgins, 1996, pp. 40–42, Fig. 5.1), as well as the limitations of the chemical grouping mostly due to the lack of sufficient reference material, prevents the distinction of these assumed workshops in the north-eastern Peloponnese (with the exception of the paste with pattern TIR).

Several problems regarding the very large MYBE group and its subdivision into several 'core groups' were noted in previous studies (Hein et al., 1999, 2002; Mommsen, 2001, p. 661), and may indicate that the third interpretation presented above is viable. The rather homogenous geological setting of the Argive plain covered mostly with alluvial and wind-blown silt (Whitbread, 1995, pp. 355–359; Higgins and Higgins, 1996, pp. 40–42, Fig. 5.1) may create a relative homogeneity of clay sources upon large areas. In general, the variability in most of the elements measured by INAA within chemical groups provenanced to various regions in Greece is not significant. It is only slightly higher than the typical variability within a single defined clay source (Mommsen et al., 2001). As noted the MYBE group also appears in other sites in Greece and also for pottery which is typologically not Argive (Mommsen et al., 2001, p. 348). Moreover, as this chemical group contains so many samples the identification of less distinct profiles with roughly similar composition is difficult. For this purpose a compositional 'core group' was defined, but one cannot rule out the possibility that with further reference material certain 'subgroups' of this profile could be provenance to other workshops in the same region.

Analysis of Mycenaean pottery from Greece indicates that an important Argive site such as Midea yielded pottery of both MYBE (provenance to the Mycenae region) and TIR (provenanced to the region of Tiryns or Asine) (Mommsen and Maran, 2000–2001, Table 1). Such an occurrence of these two profiles would fit well with a reconstruction of the major status of the two Mycenaean palatial centers of Mycenae and Tiryns, or alternatively as suggested by Jung, with Tiryns as the harbour site serving the palatial center of Mycenae (Badre et al., 2005, note 69).

One can offer a tentative scenario according to which during the Mycenaean palatial period a certain workshop or workshops located in some region of the Argolid supplied the large majority of Mycenaean pottery exported to the southern Levant and in particular to the region of northern Israel. Their main gateway in this region was Tell Abu Hawam, and there are hints of other, probably smaller, distribution centers such as Akko and Tel Nami (Artzy, 2005). The chemical analysis of the Mycenaean pottery does not provide evidence for direct trade relations between major Canaanite inland centers as Megiddo, Hazor and Dan and Mycenaean centers. It does, however, hint to the existence of the terrestrial trading routes between the coastal entry points and their inland clients, such as that between Tell Abu Hawam and the Jezreel Valley sites, and a possible branch leading from the northern port of Akko to the Upper Galilee. Further work is still necessary in order to draw these routes more accurately (Artzy, 2005, pp. 359–360, Fig. 5).

Another observation of the current study is chronological in nature. The dominant MYBE provenance is typical for the earlier phase of the Mycenaean-Levantine contacts, namely the 14th–early 13th centuries (LHIIA–IIIB). In the later part of the 13th and the early 12th centuries BC a much more diverse array of origins can be traced for the Mycenaean pottery (Fig. 4), represented by groups such as TIR, UI15 and Cyp. This change should be attributed to the changing historical and cultural circumstances during this crucial period in the Eastern Mediterranean.

## 5. Conclusions

The chemical analysis of 183 samples of Mycenaean pottery from fourteen sites in northern Israel indicated that the large majority (75%) share a common chemical profile. This profile can be provenanced to the north-eastern Peloponnese. Possible place of origin are the workshops of Mycenae/Berati, but other locations within this region cannot be ruled out. Other profiles occur mostly in the site of Tell Abu Hawam, a site which yielded the highest

number of Mycenaean pottery in the southern Levant, and is presumed to be the main gateway in this region. During the LHIIIB–C there is a rise in variability of sources of Mycenaean pottery, and a higher proportion of the sampled may be provenanced to Cyprus and possibly to locations in the Levant.

The results presented in this paper include the analysis of a large portion of the well-stratified LBA Mycenaean pottery from sites in northern Israel. This is the largest assemblage of Mycenaean pottery analyzed thus far from the Levant, and is one of the few to be published in any detail. The next step in the study of trade patterns of Mycenaean pottery to the Levant would be to examine and provenance other groups of pottery from Late Bronze Age sites in central and southern Israel (as Ashdod, Lachish, Ashkelon, etc.), as well as contemporary centers to the north of this region (i.e., Lebanon and Syrian coasts, sites as Sidon, Sarepta, Beirut, Kamid el-Loz, Tel Kazel and Ugarit). This analysis will indicate whether this trend of a nearly single source of Mycenaean pottery occurs in other regions of the Levant.

Contextual information regarding the Mycenaean imports in their Levantine findspots was also analyzed in detail in the framework of the present study, in an attempt to reconstruct the patterns of their reception and consumption within the Canaanite sphere. The results of this analysis are beyond the scope of this paper, and will be discussed in length elsewhere.

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