

# “Hyksos” Trade Connections between Tell el-Dabʿa (Avaris) and the Levant: A Neutron Activation Study of the Canaanite Jar

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## *Introduction*

On examination of the enigmatic “Hyksos” (Egyptian *hk w h swt*—“rulers of foreign lands”) of Egyptian history and legend, it is clear that Tell el-Dabʿa, as ancient Avaris, the capital of the Hyksos in the north-eastern Nile Delta (Bietak 1986, 1991a, and this volume), holds and will continue to hold a prime place in ongoing discussions and debates. Tell el-Dabʿa is pivotal also because it provides a stratified sequence of occupational and burial remains from the late Twelfth Dynasty of Egypt (late Middle Kingdom) through the Seventeenth Dynasty (the end of the Second Intermediate Period) that can be correlated with contemporaneous developments elsewhere in the Levant and Egypt. Bietak has shown that the major strata and sub-phases of Tell el-Dabʿa fit well with Middle Bronze (MB) sequences at other sites in the Eastern Mediterranean, even though the Dabʿa assemblages have a higher percentage of native Egyptian material and a distinctive Syro-Palestinian artifactual repertoire (see also Dever and Kempinski, this volume).

Contemporaneous inscriptions from Tell el-Dabʿa

are relatively few and shed limited light on historical and cultural developments during the Middle Bronze Age (see Bietak, this volume). Additional information about the role of the Hyksos at Tell el-Dabʿa, however, and especially their connections with the Levant, traditionally considered their origin (see Redford, this volume), can be gleaned by other methods.<sup>1</sup> In this chapter, Neutron Activation Analysis (NAA), a very precise physicochemical technique, is used to measure the chemical compositions of the pottery wares for one principal type at Tell el-Dabʿa: the so-called Canaanite Jar, or amphora (Fig. 5.1); (Grace 1956; Amiran 1970:102–105, 138–144; Wood 1987; Leonard 1995). Statistical evaluation of the data enables the vessels to be “fingerprinted,” that is, the source(s) of the clay(s) from which they are made and their place of manufacture, are, to a high degree of probability, established. The trade relations between Tell el-Dabʿa and other parts of the ancient world, which bear significantly on the economy—even the ethnic origins—of the “Hyksos,” can then be reconstructed and assessed.



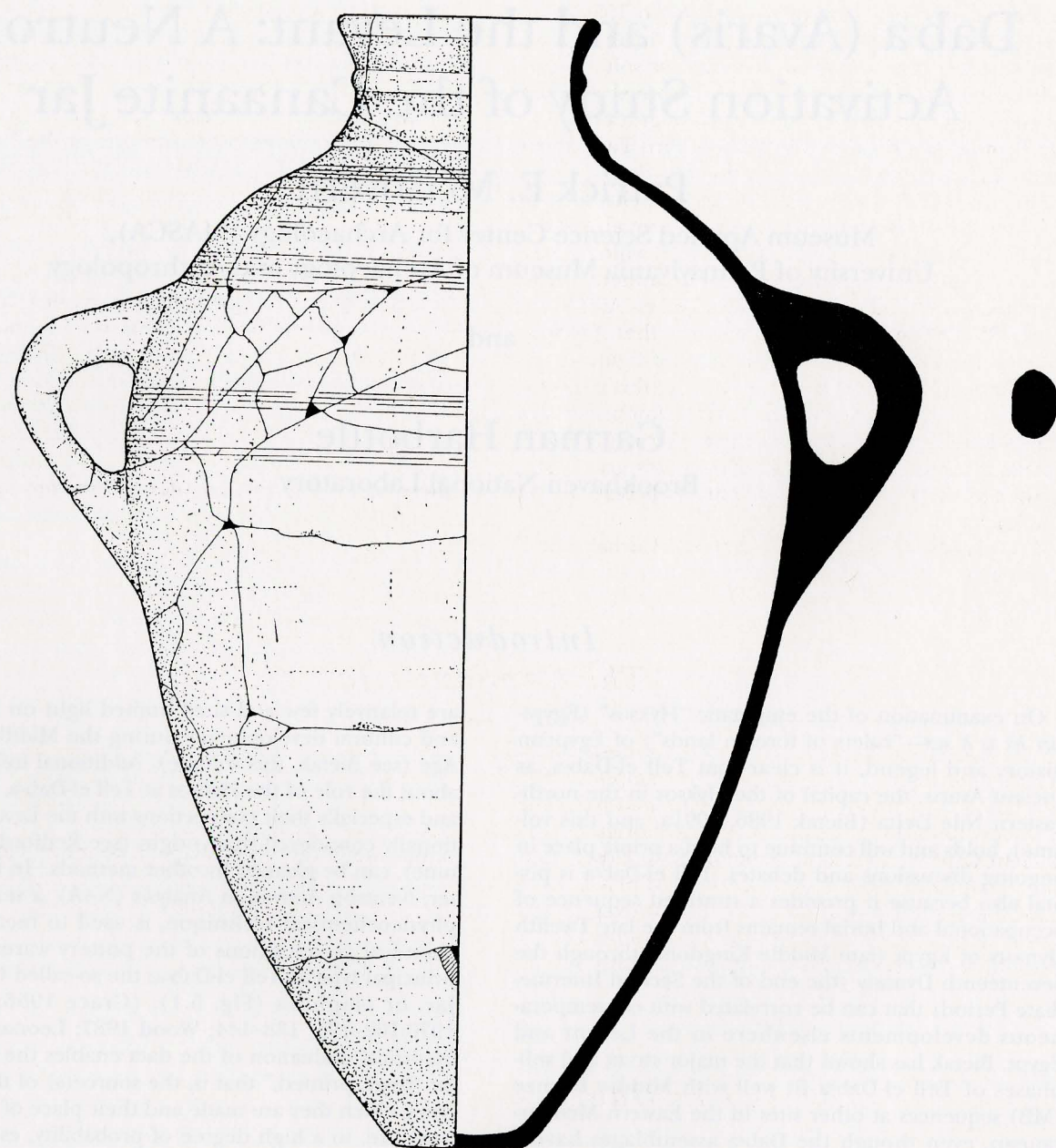


Figure 5.1. Representative Canaanite Jar of transitional Middle Bronze IIA-B type from Tell el-Dab'a (field no. 4538, Neutron Activation no. JH094, Field FI 1/20, grave 10, level b3); provenience according to the Neutron Activation Analysis results: "Gaza group of Middle Bronze Age sites" of southern Palestine.

### *The Cultural and Archaeological Setting*

The Middle Bronze Age in the Eastern Mediterranean, dating from about 1900/1875 to 1550 B.C.,<sup>2</sup> was a period of dramatic development in the urban civilization of the Levant (see Dever, this volume). As will become evident below, special note should be taken of the developments in the "Gaza group of Middle Bronze Age sites" along the southern Palestinian coast (Fig. 5.2; see Oren, this volume). Here, a large number of Middle Bronze city-states were clustered in the vicinity of modern Gaza close to or along the coastal plain. Besides ancient Gaza itself, which is covered by a modern city and has been excavated only to a limited extent, the group includes Tell el-'Ajjul (very likely Sharuhēn, the Hyksos bastion that Ahmose fought and defeated after three years of fighting; see Kempinski 1974, and Redford and Oren, this volume), Tell Jemmeh, Tell el-Far'ah South (which has also been identified with Sharuhēn), Tel Haror (Tell Abu Hureira), and Ashkelon. Also part of this group, but farther to the north and inland, are Tell Beit Mirsim and Lachish.

Tell el-Dab'a/Avaris shared in the MB urban devel-

opment. This site went from being a relatively small village in the late Middle Kingdom (stratum H/d2, beginning ca. 1815 B.C., according to Bietak 1991a) to a huge urban complex of temples, palaces, cemeteries, and residences by the Hyksos period proper (stratum E1/2nd half of b1, beginning ca. 1620 B.C.). The expansion of Tell el-Dab'a into one of the largest settlements in the Eastern Mediterranean during the later Middle Bronze Age, encompassing an approximately 2 km<sup>2</sup> area with a high density of settlement, points to a concomitant growth in population. This demographic increase has been variously explained, as the result of native Egyptians and/or descendants of Semitic slaves who worked in Middle Kingdom Egypt (Van Seters 1966) settling at Tell el-Dab'a, or of the infusion of new peoples from Syria-Palestine, in accordance with the Manethoan tradition reported by Josephus. As this NAA study minimally shows, however, intensive trade connections with MB city-states elsewhere in the Eastern Mediterranean were crucial to the economic development of the site.

### *The Canaanite Jar*

The Canaanite Jar (Fig. 5.1) is an apt designation for this pottery type—an ovoid-shaped amphora with two handles, a rounded or slightly flattened base, and a narrow mouth—because it most likely originated in ancient Canaan, a regional name that was closely associated with the Syro-Palestinian coast (Speiser 1936; Landsberger 1967). Indeed, the earliest examples of the type occur there, and their antecedents can be traced back to the handleless jars of the Early Bronze

Age in the same region (Parr 1973). The Canaanite Jar, with a capacity of approximately 30 liters, became the liquid container and the export pottery vessel *par excellence* for Mediterranean sea trade. With relatively minor modifications of shape, it continued to perform these functions for thousands of years, through Greek and Roman times (Koehler 1995) and up until the Islamic period.

### *The Tell El-Dab'a Corpus of Canaanite Jars*

Based on the 273 Canaanite Jars that were included in the NAA study,<sup>3</sup> the MB amphoras of Tell el-Dab'a are remarkably standardized in their size, overall shape, rim and base profiles, ware, and other features, attesting to a high level of craftsmanship (see "Short Excursus on Canaanite Jar Fabrication and Fabrics," below).

The stylistic development of the Canaanite Jar at Tell el-Dab'a is nearly identical to that of other MB sites in Syria and Palestine. For example, the mid-MB

IIA through early MB IIB rims of the Canaanite Jars, in both the Delta and Palestine, are generally elongated and flaring, sometimes developed on the exterior, and have an exterior ridge (see Fig. 5.1). Less-flaring rims, which have highly developed interior and exterior profiles, begin to appear in MB IIB and are very common by MB IIC throughout the Eastern Mediterranean.

What is particularly significant for the pottery sequence at Tell el-Dab'a, however, is that the earliest stage of MB IIA in Syria-Palestine appears to be miss-



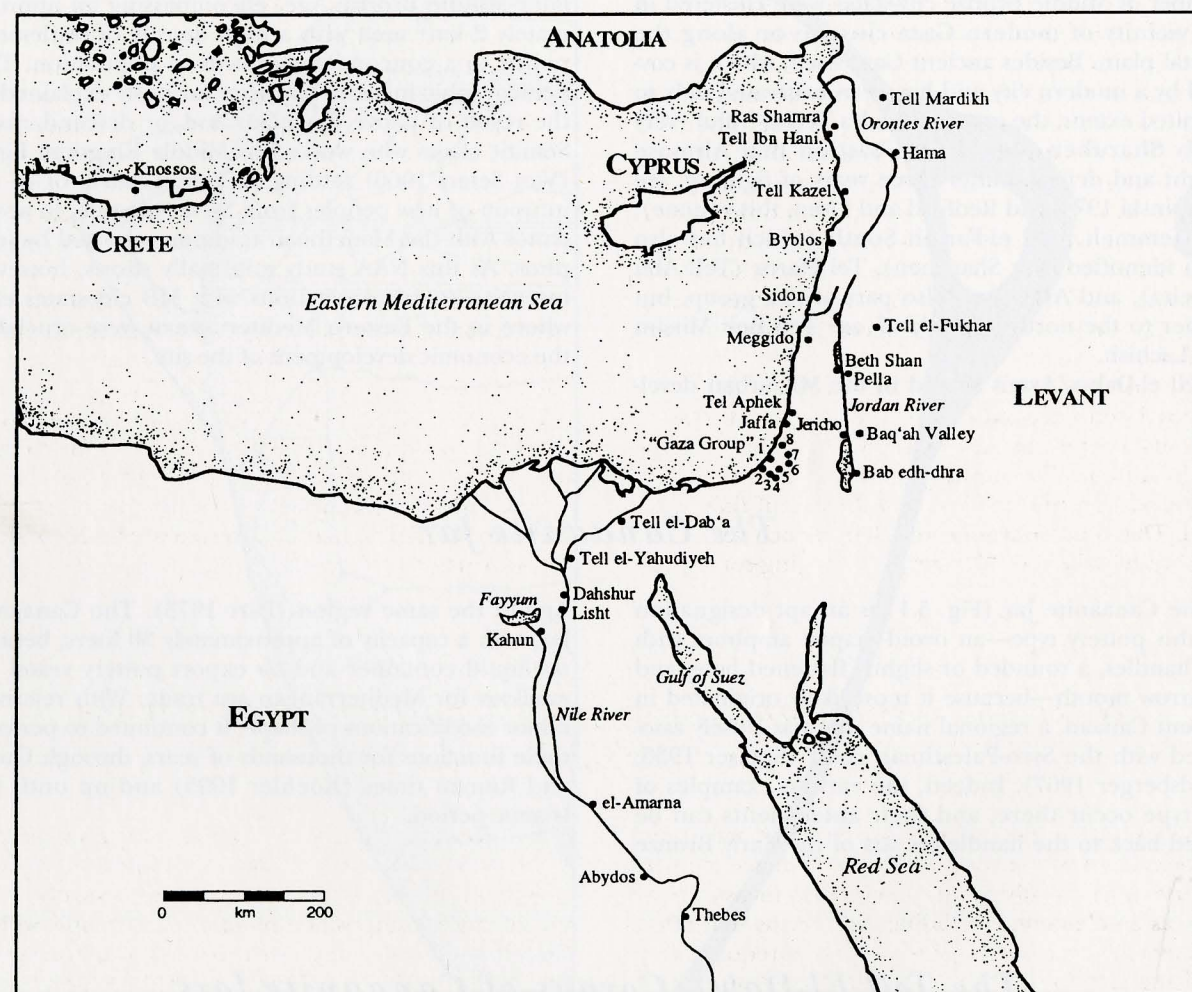


Figure 5.2. Eastern Mediterranean, showing Middle Bronze Age sites and regions referred to in the text. The "Gaza group of Middle Bronze Age sites" includes: (1) Gaza, (2) Tell el-Ajjul, (3) Tell Jemmeh, (4) Tell el-Far'ah South, (5) Tel Haror, (6) Tell Beit Mirsim, (7) Lachish, and (8) Ashkelon.

ing here (see Bietak, this volume). The Canaanite Jars from the earliest MB levels at Tel Aphek/Antipatris (Beck 1975: fig. 1:16; 1985:186-187, fig. 2:12-15), for example, do not have pronounced exterior ridges below the rims; the ridged variety of the Canaanite Jar, together with other pottery types (such as slipped and highly polished jugs and juglets), appears later in the Eastern Mediterranean MB IIA sequence. The earliest Canaanite Jars at Tell el-Dab'a are almost exclusively of the ridged variety, the several exceptions including a rim that is flattened on top and tapered, and another tapered rim form that is turned back on itself toward the sidewall of the vessel. And the amphoras are found together with highly burnished and slipped jugs and juglets, as well as other types, that become more prevalent in later MB IIA. It might be argued that these stylistic differences are the result of regional rather than chronological factors. But, as will be seen from the NAA results (below), the most parsimonious, and therefore most probable, explanation of the differences is that Tell el-Dab'a was occupied at a somewhat later date in MB IIA than Tel Aphek and other coastal sites (e.g., Tel el Ifshar, personal communication from S. Paley).

Based on the number of Canaanite Jars that have already been excavated at Tell el-Dab'a, M. Bietak (personal communication) has estimated that as many as two million Canaanite Jars might eventually be recovered from the MB levels of the site, if fully excavated. This is an enormous number of such vessels for a period of only about 250 years, averaging some 8000

jars per year, or about 20 jars per day.

Is it conceivable that so many amphoras could have been imported? To be sure, the overland route through the Sinai, with a well-defined chain of way-stations, does not appear to have been in operation during the Middle Bronze Age (see Oren, this volume). Sea transport, especially for heavy loads, would have been an excellent alternative. The harbor at Tell el-Dab'a, although long since silted up, was reached via the Pelusiac branch of the Nile. Based on a systematic program of subterranean drilling by J. Dorner (unpublished; see Bietak 1991a:28, figs. 1, 2), an intricate system of waterways has been defined around the site, and a harbor area has been located where ships could have been moored. Corroborating this finding, the contemporaneous Kamose stela mention ships docked together in the harbor of Avaris (see Redford, this volume).

The importation of two million Canaanite Jars by sea over several hundred years is certainly possible, even if shipping had to be confined to those times of the year when the weather and prevailing winds and currents were favorable. Cargoes might vary, but shipment by Canaanite Jars had the added advantage that they could be used as ballast in the holds of ships.<sup>4</sup>

Local production of Canaanite Jars, using native Egyptian clays, might also help to explain the numerous amphoras at Tell el-Dab'a. Although all of the latter are stylistically and technologically similar to their Eastern Mediterranean counterparts, the NAA study readily resolved this issue.

### Neutron Activation Analysis and Pottery Provenience in the Old World

The physicochemical method of NAA has been extensively employed in pottery provenience studies, because of its sensitivity and precision in measuring as many as 35 elements, including rare earths that often characterize a clay source, and because it requires very small samples (50-200 mg) that are non-destructively analyzed.<sup>5</sup>

Relating the chemical composition of a particular ancient pottery sample to a given clay source, thereby "fingerprinting" the pottery and its presumed place of manufacture, is based on what has become known as the Provenience Postulate (Weigand, Harbottle, and Sayre 1977:15-34). Briefly, the assumption is made that the chemical variation within a given clay source is less than that between different sources. A native clay, however, was often modified by the ancient potter. Inorganic aplastics (temper) or organic materials might be added to the clay body, to improve its work-

bility, drying and firing properties, and functionality (Rye 1981). If these inclusions are relatively "pure" (e.g., quartz, calcite, or straw), the diluent effect on the chemical composition of an ancient sample will be spread across the range of elements and correction factors (e.g., least-means fitting) can be readily applied. The addition of complex heavy minerals, which are unpredictably able to enhance or diminish certain elemental concentrations, are less easily corrected for statistically.

A range of univariate and multivariate algorithms—means and standard deviations, and correlational, clustering, and principal components analyses of at least 15 elements—are used to define local chemical groups of ancient pottery, with widely divergent samples (outliers) being excluded. Archaeological and geological criteria are important in refining and testing these groups, whether they are well-dated pottery types, clays



from specific geochemical regimes, clay beds within a single deposit, or others. For example, cooking pots, as well as walls and kilns of mudbrick (sunbaked clay), are usually made of local clay and are not transported to another site. The NAA analyses of such samples should then serve to confirm a hypothesized local group based on other pottery types. This approach is essential when an ancient clay source has been totally exploited or systematic clay sampling has not yet been carried out in a region.

The Middle Bronze Age NAA pottery study includes 578 pottery and clay samples from well-defined archaeological contexts at the key site of Tell el-Dab'a, the ancient "Hyksos" capital of Avaris (below), in the northeastern Nile Delta (Bietak 1986, 1991a). To date, an additional 760 pottery and clay samples from 55 coastal and inland sites of Syria, Lebanon, Jordan, and Israel—including Ras Shamra/ancient Ugarit, Tell Kazel, Tell Mardikh/ancient Ebla, Hama, Byblos, Sidon, Kamid el-Loz, Megiddo, Tel Aphek, Jaffa, Ashkelon, Tell el-'Ajjul, Tell Beit Mirsim, Beth Shan, Pella, Jericho, Tell el-Fukhar, Khirbet Umm ad-Dananir, and Rujm al-Henu (West) in the Baq'ah Valley of Transjordan, and Bab edh-Dhra', etc. (Fig. 5.2)—have been analyzed. Another 119 pottery and clay samples have been tested from sites along the Middle and Upper Nile—Kahun and Dahshur near Lisht, el-Amarna, Abydos, etc.—that range in date from the Old to the New Kingdom (ca. 2700–1070 B.C.). Previous Brookhaven projects (e.g., Kaplan 1980; Brooks et al. 1974:48-80), accounting for 1208 pottery and clay samples from 79 more Levantine and Egyptian sites, complete the data bank for this region.

The clays that have thus far been analyzed date from the Lower Cretaceous period to recent times and derive from deposits throughout the Levant and Egypt. The red loess clays of the southern Palestinian coastal region, the yellow limestone-derived clays of the Palestinian hill country, Transjordanian smectites and kaolin clays, Egyptian alluvial and marl clays, and so on are well represented in the data bank.

In general, our Old World data bank has excellent temporal and spatial coverage of other regions of the Near East and Mediterranean, including the Sudan, Greece, Iraq, Iran, and parts of Turkey. This wide areal coverage, coupled with large numbers of samples

for locally defined groups, enables us to apply powerful multivariate statistics to determine the archaeological origin of the Canaanite Jars at Tell el-Dab'a.

It is quite common for the elements in clays and minerals to co-vary with one another. For example, in nature the high correlation ( $r > 0.99$ ) of iron (Fe) and scandium (Sc), both trivalent ions of about equal size, is well known. Univariate statistics can be very misleading if this relationship goes unrecognized. Two Palestinian clay sources of importance in this study—the red loess clay of the southern coast and the yellow hill country clay—have similar univariate distributions, but have clearly distinguishable Sc/Fe ratios (Brooks et al. 1974:48-80).

If the variance-covariance matrix for many elements of a presumed local group is calculated, a new set of standardized orthogonal coordinates (eigenvectors) can be defined in multidimensional Mahalanobis space that takes advantage of elemental correlations (Harbottle 1991:413424). For the statistical calculations, the oxide data (Table 5.1) were converted to logarithms, since many chemical elements appear to be lognormally distributed in nature, and are also standardized by this procedure (Harbottle 1976). The Mahalanobis distance of a given sample from the origin or centroid of the group is directly related to the probability of the group membership of that sample, assuming a multivariate normal distribution (Sayre 1975). Using the oxides of 15 elements in the calculation, it has been estimated by comparisons of the large Brookhaven New World pottery data bank (about 10,000 samples) against the Old World data bank (about 5000 samples) that the accidental assignment of a sample at a Mahalanobis distance probability (MDP) of 1% is nil for these two archaeologically and geochemically distinct regions (Harbottle 1991). Within a more circumscribed region, such as the Eastern Mediterranean, where the same or related geological processes have been at work, this unique chemical "fingerprinting" is not ensured. But with high correlations between many elements, such as is characteristic of Levantine clays and pottery, it is possible to achieve extremely good results. An MDP above 5% for a sample tested against a group with a high sample number to variate ratio is a strong guarantee that it belongs to that group.

GROUP	Na <sub>2</sub> O PCT	K <sub>2</sub> O PCT	Rb <sub>2</sub> O PPM	Cs <sub>2</sub> O PPM	BaO PPM	Sc <sub>2</sub> O <sub>3</sub> PPM	La <sub>2</sub> O <sub>3</sub> PPM	CeO <sub>2</sub> PPM	Eu <sub>2</sub> O <sub>3</sub> PPM	Lu <sub>2</sub> O <sub>3</sub> PPM	HfO <sub>2</sub> PPM
GAZAGRP	0.855	1.63	43.9	1.43	550	18.9	33.7	73.8	1.71	0.596	11.30
DABAPAL	0.673	1.46	35.8	1.36	604	18.5	33.7	73.6	1.63	0.547	7.13
HILLCTR	0.137	3.44	80.5	4.21	169	23.8	24.2	59.2	1.40	0.471	4.25
MEGIDDO	0.469	1.20	35.7	1.02	2679	17.1	36.5	59.8	1.53	0.557	4.81
SIDON	0.267	0.60	49.5	1.43	3483	17.2	32.2	63.5	1.66	0.617	5.64
BYBLOS	0.317	0.69	52.2	2.92	278	19.4	36.1	78.3	1.56	0.515	7.64
IBN HANI	1.469	2.52	107.9	5.31	627	32.6	35.1	75.3	1.56	0.528	4.70
ORONTES	0.532	3.91	139.0	5.38	1211	27.0	61.7	140.9	2.64	0.793	8.05
BAQ'AH	0.279	2.08	72.4	3.98	421	29.6	29.7	64.0	1.47	0.597	5.82
DABAEG	1.671	1.77	45.5	1.20	659	34.1	34.4	72.8	2.22	0.579	7.64
FAYMARL	1.581	1.20	49.1	2.56	294	29.0	45.0	92.0	2.09	0.568	9.66

GROUP	ThO <sub>2</sub> PPM	Ta <sub>2</sub> O <sub>5</sub> PPM	Cr <sub>2</sub> O <sub>3</sub> PPM	MnO PPM	Fe <sub>2</sub> O <sub>3</sub> PCT	CoO PPM	CaO PCT	Sm <sub>2</sub> O <sub>3</sub> PPM	Yb <sub>2</sub> O <sub>3</sub> PPM
GAZAGRP	8.41	1.68	134	951	5.12	23.5	12.1	6.78	3.67
DABAPAL	7.66	1.62	149	847	4.82	21.1	15.9	6.52	3.39
HILLCTR	7.41	0.99	123	435	4.75	15.9	9.4	5.62	2.54
MEGIDDO	5.41	1.27	192	822	4.23	20.1	20.1	5.92	2.43
SIDON	6.52	1.62	149	622	4.32	24.6	20.4	6.82	3.17
BYBLOS	9.55	1.36	163	757	5.27	28.6	12.5	7.38	2.79
IBN HANI	11.09	1.38	493	1570	7.52	40.1	12.6	6.32	2.76
ORONTES	20.61	2.52	174	311	6.97	26.9	8.8	12.50	3.98
BAQ'AH	8.85	1.78	136	441	6.22	23.6	8.4	6.52	3.05
DABAEG	6.67	2.06	189	1409	8.93	42.3	15.9	7.41	3.25
FAYMARL	10.30	2.34	155	388	6.81	24.8	15.9	8.09	3.36

Table 5.1. Neutron Activation Analysis data for selected local Egyptian and Eastern Mediterranean groups: the imported southern Palestinian group of Syro-Palestinian pottery types at Tell el-Dab'a (labeled DABAPAL), the Egyptian Nile alluvial clay and pottery group for Tell el-Dab'a (DABAEG), the "Gaza group of Middle Bronze Age sites" (GAZAGRP), an Egyptian marl clay that outcrops north of the Fayyum at Qasr el-Sagha (FAYMARL), a Palestinian hill country limestone-derived clay and pottery group (HILLCTR; including clays collected in the vicinity of Yatta, Hebron, Tell el-Jib/Gibeon, and Arub), and local pottery groups farther to the north along the Eastern Mediterranean coast (Sidon, Byblos, and Tell Ibn Hani), as well as inland (Megiddo, several Orontes Valley sites [Tell Mishrife/Qatna, Selimiyeh, and Tell 'As], and the Baq'ah Valley of Transjordan). For other sites and regions, see the text and Figure 2. Data are expressed as mean percentage by weight (PCT) or parts per million (PPM). The statistical spread (1 standard deviation) is 10–20% of the tabulated value for all elements except the more mobile alkalis and alkaline earths, which range as high as 30%.



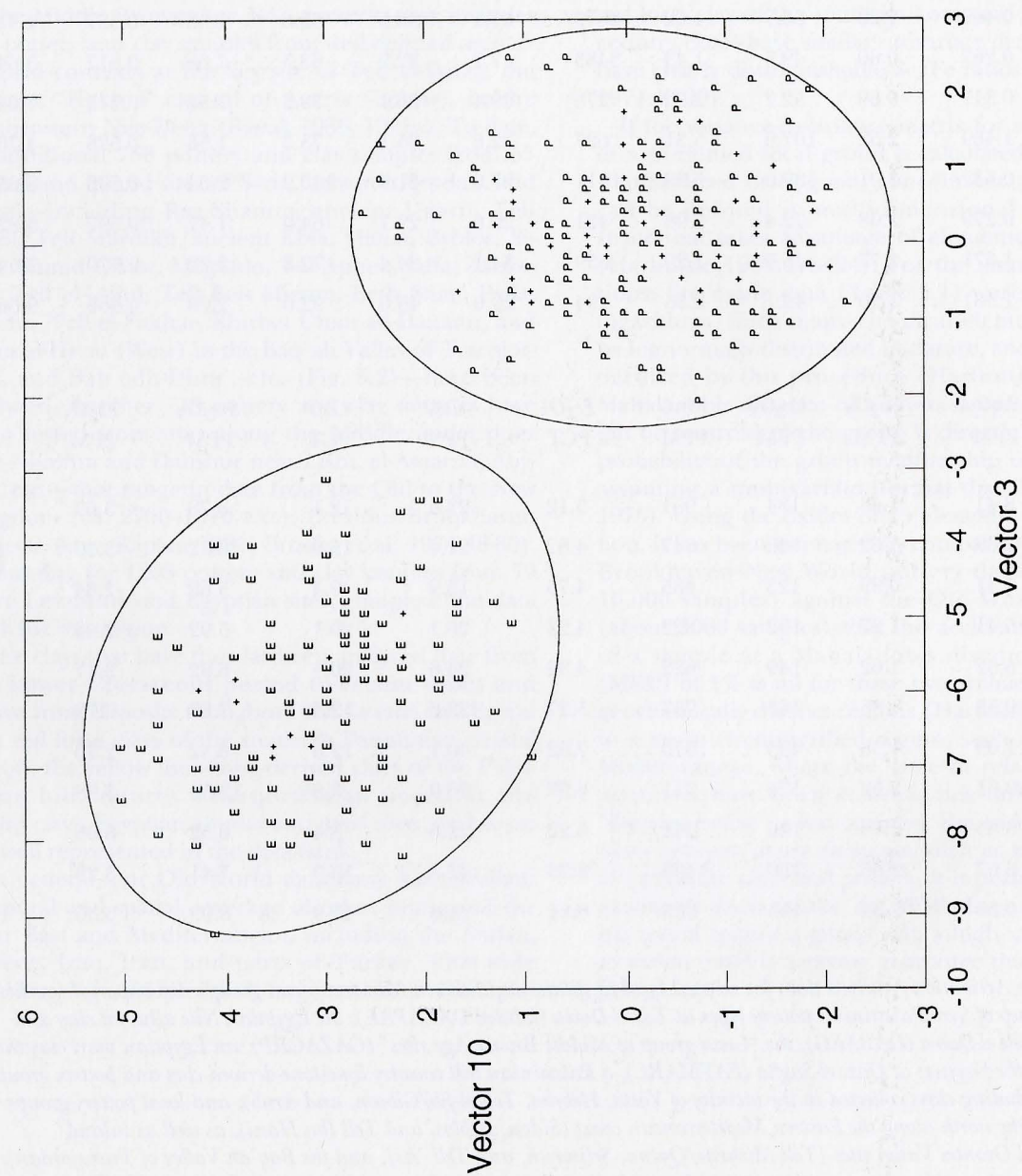


Figure 5.3. Plot of eigenvector 3 and 10 scores, with variance-covariance matrices "highly loaded" for Eu/Th and Hf/Mn, respectively. The Mahalanobis distance probability calculations, here indicated by a 95% confidence ellipse for samples belonging to a group, were carried out on the Neutron Activation Analysis data of a large group of Middle Bronze Age pottery imports (labeled P; multiple examples at the same coordinates denoted by +) from the "Gaza group of Middle Bronze Age sites" in southern Palestine, which were found at the Hyksos capital of Avaris (modern Tell el-Daba) in the northeastern Nile delta. This group is clearly distinguished from another large group of locally produced Middle Bronze Age pottery made of Egyptian Nile alluvial clay (labeled E) from the same site.

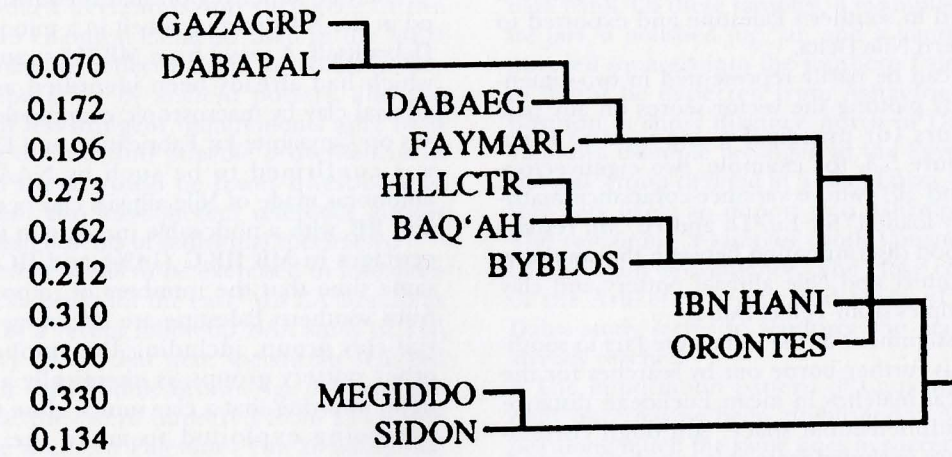


Figure 5.4. Dendrogram, based on a hierarchical aggregative clustering algorithm and the Neutron Activation Analysis means of the oxides of 15 elements for each group (Table 5.1). The mean Euclidean distance (MED) to each node in the dendrogram is listed along the ordinate. It has been empirically established that an MED less than 0.08 is usually indicative of group membership (here, only GAZAGRP and DABAPAL). Note that the imported southern Palestinian group of Syro-Palestinian pottery types at Tell el-Daba (labeled DABAPAL), almost three-quarters of which is comprised of Canaanite Jars, forms a cluster with the red loess clay groups of pottery from the "Gaza group of Middle Bronze Age sites" (GAZAGRP). More distant groups include the Egyptian Nile alluvial clay and pottery from Tell el-Daba (DABAEG), an Egyptian marl clay that outcrops north of the Fayyum (FAYMARL), a Palestinian hill country limestone-derived clay and pottery group (HILLCTR), and local pottery groups farther to the north along the Eastern Mediterranean coast (Sidon, Byblos, and Tell Ibn Hani), as well as inland (Megiddo, several Orontes Valley sites, and the Baq'ah Valley of Transjordan). For other Egyptian and Eastern Mediterranean groups, see the text, Table 5.1 caption, and Figure 5.2.

### The Neutron Activation Analysis Corpus of Tell El-Daba Canaanite Jars

To date, 273 Canaanite Jars from Middle Bronze Age levels at Tell el-Daba have been analyzed by NAA. This constitutes 48% of the Daba corpus of NAA analyses. The corpus also includes a range of other Syro-Palestinian pottery types—e.g., highly polished jugs and juglets, Tell el-Yahudiyeh juglets (Kaplan 1980; McGovern et al. 1994), and Levantine Painted Ware (Tubb 1983; Bagh 1988)—that were traded throughout the Eastern Mediterranean, as well as within Egypt, during the Middle Bronze Age. The NAA findings for these types are in close agreement with the NAA study of the Canaanite Jars (see note 3).

Fifteen chemical elements for which consistently reliable data had been collected for each sample at Brookhaven National Laboratory—sodium (Na), potassium (K), cesium (Cs), rubidium (Rb), barium (Ba), Sc, europium (Eu), thorium (Th), hafnium (Hf), manganese (Mn), cobalt (Co), chromium (Cr),

Fe, samarium (Sm), and ytterbium (Yb)—were used in the MDP calculations. Not correcting for dilution or concentration effects, 201 Canaanite Jars were determined to have MDPs ranging between 6.8% and 99.8% (average of 56.8%) of belonging to a tight chemical group of 268 Daba pottery vessels, also including the other important Syro-Palestinian types (noted above) that were recovered from Middle Bronze Age levels at Tell el-Daba (see Table 5.1).

Thirty-six Middle Bronze Age pottery samples from the "Gaza group of Middle Bronze Age sites" (Fig. 5.2) form a tight chemical group with 14 red loess clays of the region (Table 5.1). Using the mean concentrations of the oxides of 15 elements, the MDP that the Gaza group of pottery and clays belongs to the large, well-defined Daba group is 98.8%. Remarkably, all other well-defined local groups in the Old World data bank had a 0% probability of belonging to the Daba



group. It is virtually certain, therefore, that a large number of the Canaanite Jars found at Tell el-Dab'a were produced in southern Palestine and exported to the northeastern Nile Delta.

The MDPs can be partly represented in two-dimensional space by plotting the vector scores on any pair of eigenvectors (or principal components) for a group. In Figure 5.3, for example, two eigenvectors (denoted 3 and 10), whose variance-covariance matrices are "highly loaded" for Eu/Th and Hf/Mn respectively, show good discrimination between the southern Palestinian pottery and Nile alluvial pottery and clay groups for samples from Tell el-Dab'a.

The MDP assignment of the Canaanite Jars to southern Palestine is further borne out by searches for the closest chemical matches in mean Euclidean distance (MED)<sup>6</sup> multidimensional space. Although correlational effects are excluded from this calculation, excellent results can be obtained with 15 elements, because the variance in the MED approaches 0 as the inverse of the number of variables (Harbottle 1991). An MED of less than 0.08 has been empirically established to be indicative of group membership, especially in conjunction with a MDP greater than 5%.

The MED calculations in multidimensional space can also be partly represented by two-dimensional graphical representations, such as the dendrogram in Figure 5.3, which was generated by use of a hierarchical aggregative clustering algorithm based on the same 15 elements. The dendrogram shows the tight grouping of the Tell el-Dab'a Canaanite Jars, which are included in the larger Dab'a southern Palestinian group, and the Gaza group. The Nile alluvial group of pottery from Tell el-Dab'a, a marly clay deposit that outcrops north of the Fayum (Fig. 5.2) as the Qasr el-Sagha formation of Pleistocene date (Tobia and Sayre 1974; see also Said 1962), a Palestinian hill country limestone-derived clay and pottery group (including clays collected in the vicinity of Yatta, Hebron, Tell el-Jib/Gibeon, and Arub); and local pottery groups farther to the north along the Eastern Mediterranean coast (Sidon, Byblos, and Tell Ibn Hani) as well as inland (Megiddo in the Jezreel Valley, several Orontes Valley sites [Tell Mishrife/ancient Qatna, Selimiyeh, and Tell 'As]; and the Baq'ah Valley of Transjordan) are all very far removed in MED multi-dimensional space.

The relative percentage of amphoras coming from southern Palestine remains very constant in each Middle Bronze Age phase, ranging between 70% and 81%, up until MB IIC, when it drops to 54%. Because of the homogeneity of the red loess clay in this region, it is extremely difficult to isolate specific sites or workshops that produced the amphoras that eventually made their way to Tell el-Dab'a. In MED space, it may be noted that the locally defined groups at Tell el-'Ajjul and Ashkelon (see below) are especially close to many

of the Dab'a specimens.

The only other region that is consistently represented in the NAA corpus, albeit in a minor way, is Tell el-Dab'a itself. A vessel from MB IIA stratum c of area FI, which had already been identified as made of Nile alluvial clay by macroscopic examination (see "Excursus on Canaanite Jar Fabrication and Fabrics," below), was confirmed to be such by NAA. A few more amphoras made of Nile alluvial clay occur in MB IIA-B and IIB, with a noticeable increase in the relative percentages in MB IIB-C (14%) and IIC (23%), at the same time that the numbers of imported amphoras from southern Palestine are declining. The Nile alluvial clay group, including the amphoras as well as other pottery groups, is chemically and statistically tight, implying that a clay source close to Tell el-Dab'a was being exploited to make the amphoras. If amphoras were coming from other parts of Egypt, one would expect a much less well-defined group, since Nile alluvial clays are notoriously inhomogeneous (Allen and Hamroush 1984).

Two other amphoras (0.7% of the amphora corpus) definitely derive from areas outside southern Palestine or the Nile Delta: (1) an example from MB IIA stratum d1 of area FI, which is from the region of Tell 'Arqa, a site in northern Lebanon, and (2) an example from a questionable context at Tell el-Dab'a, possibly MB IIA stratum d of area FI, which is made of marl clay from the Qasr el-Sagha formation.

It should be noted that relatively more Canaanite Jars of questionable provenience occur in MB IIA levels at Tell el-Dab'a than in subsequent Middle Bronze Age phases, all of which are of approximately the same duration: 28% (MB IIA), 17% (MB IIA-B), 19% (MB IIB), 15% (MB IIB-C), and 23% (MB IIC). More than two-thirds of the MB IIA amphoras—a total of 16 examples—were recovered from early MB IIA strata d1 and d2 of area FI. Five of the latter are possibly from southern Palestine,<sup>7</sup> including one which is most similar chemically to an Ebla specimen (MED of 0.083) that itself is of questionable origin (i.e., it is not close in MED space to the locally defined Ebla group). Another questionable amphora is possibly from the region of Kamid el-Loz in the inland Biqa'a Valley of Lebanon (MED of 0.095). Ten examples lack any clues to their origins. By contrast, only 12% of the amphoras from late MB IIA strata c and G in areas FI and AII, respectively, have uncertain proveniences—three possibly being from southern Palestine, one possibly from Ruweisé along the southern Lebanese coast (MED of 0.081), and four lacking any chemical match.

A case might be made that relatively more amphoras from early MB IIA levels at Tell el-Dab'a are of uncertain provenience, because they derive from sites or regions of Lebanon and Syria that are not well represented in the NAA data bank. It must be appreciated, however, that statistically some samples with question-

able proveniences are always to be expected. Moreover, the standard deviations and variances in the oxides of the 15 chemical elements used in the MED and MDP calculations reflect natural variability in clay beds, clay preparation by ancient potters, and the analysis itself. If less-stringent requirements were used in establishing definite and possible proveniences of samples, then there would be fewer questionable proveniences but also less-coherent reference groups and more misassignments of individual specimens.

The caution that needs to be exercised in interpreting the statistical results for the early MB IIA amphoras is highlighted by a recent follow-up NAA study of Tell el-Dab'a pottery vessels that were specifically selected because of their early Middle Bronze Age date and the probability that they were imported from Levantine regions outside southern Palestine. The 20 additional MB IIA Canaanite Jars of this follow-up group are comparable in type, ware, and other features to the larger amphora corpus. Thirteen of these specimens were excavated from strata d1 and d2 in area FI at Tell el-Dab'a, and 8 of them could be assigned to the southern Palestinian group, in addition to 1 example possibly deriving from southern Palestine, 1 example being made of Qasr el-Sagha marl clay, and 2 examples lacking any provenience. Clearly, the relative percentage of amphoras with questionable origins in the follow-up study (20%) is much less than that for the early MB IIA amphoras in the larger corpus (70%), and accords with the percentages of amphoras with uncertain proveniences belonging to other phases of the Middle Bronze Age. As a final note on this follow-up NAA study, of 4 additional amphoras from late MB IIA strata d1-c in area FI, 2 were definitely from southern Palestine and 2 possibly from this region.

Seven MB IIA samples from Ashkelon were also recently analyzed, because this important southern

Palestinian coastal site was poorly represented in the data bank. Of these samples, 4 examples (two Canaanite Jars, a polished jug/jar, and a handmade cooking pot) fell squarely into the southern Palestinian group, as might be expected from Ashkelon's geographic position, a short distance north of Gaza. A Tell el-Yahudiya example belonged to the Egyptian Nile alluvial clay group defined at Tell el-Dab'a, and was therefore very likely an import into Ashkelon from Dab'a. The remaining 2 samples (both Canaanite Jars) were of uncertain provenience. The close correspondence of the Ashkelon results and those of the follow-up Dab'a study serves to reinforce the main conclusions already reached.

The importation pattern of Canaanite Jars, apparently once having been established in MB IIA, continues along much the same lines in succeeding MB phases. The vast majority of the specimens come from southern Palestine, with the occasional possible import from Lebanon or Syria and the number of amphoras made of Nile alluvial clay increasing somewhat toward the end of the period. Inland and coastal Syria is represented by two Canaanite Jars in MB IIA-B possibly originating from the Tell Mardikh/Ebla region, and by a single example possibly from Tell Ibn Hani in MB IIB.

A comparison of the results from the macroscopic ware observations (see "Short Excursus on Canaanite Jar Fabrication and Fabrics," below) and the NAA analyses is also instructive. There is excellent agreement for the imported (type IV) and Nile alluvial pastes (type I). Queried examples of subtypes I-b and I-c are definitely from southern Palestine. Very occasionally, Egyptian marl fabrics (type II) are confused with imported wares: two MB IIA amphoras, which were classified as subtypes II-a and II-b, derive from southern Palestine, according to the NAA results.

## Conclusions

This NAA study of Canaanite Jars found at Tell el-Dab'a/Avaris is important for the perspective it provides on economic and social developments at what has been identified as the capital of the "Hyksos" in the northeastern Nile Delta during the period from the later Middle Kingdom through the Second Intermediate Period. To summarize, 74% of the Canaanite Jar corpus (201 examples) were imported from the "Gaza group of Middle Bronze Age sites" in southern Palestine, having been made of the native red loess clay of this region. By contrast, pottery definitely or even possibly originating from Syria or Lebanon is virtually nonexistent in the Dab'a group that was tested.

One amphora definitely was imported from Tell 'Arqa in northern Lebanon, and another possibly derives from Ruweisé along the southern Lebanese coast. Other vessels possibly come from Tell Mardikh/ancient Ebla and Tell 'As in inland Syria, and from Tell Ibn Hani along the north Syrian coast. No meaningful matches, however, were recorded for two major coastal sites, Byblos and Ras Shamra/Ugarit, although Tell Ibn Hani served as the port city for the latter.

The NAA results provide direct evidence for trade, which appears to have been particularly intensive in a unidirectional fashion from southern Palestine to the Nile Delta. As yet, no vessels made of Egyptian clays



have been confirmed from the "Gaza group of Middle Bronze Age sites." This trade was most likely by sea from coastal sites, such as Tell el-'Ajjul, Gaza, or Ashkelon, rather than overland through the Sinai.

Because the Canaanite Jars were duplicated in local Egyptian clays to a limited extent, at least during the Middle Bronze Age, the implication is that the contents of the vessels could not be produced readily in the Egyptian Delta or that imported products were more desirable for other reasons. From later New Kingdom frescos and reliefs, we know that wine was a popular commodity and was transported and stored in Canaanite Jars, which were now made in local Egyptian clays in large numbers (Wood 1987). Canaan, especially the Gaza region, was famous for its wine (Broshi 1984; Stager 1985), so it is not unreasonable to propose that the "Hyksos" of Tell el-Dab'a, who were in close contact with southern Palestine according to the NAA results, imported wine in Canaanite Jars from this region throughout the Middle Bronze Age. Other goods besides wine might also have been transported in the Canaanite Jars. As is well attested (Leonard 1995), olive oil, tree resins, incense, and honey are specialty goods that were shipped in amphoras, in addition to these vessels being used as storage containers for common foodstuffs and even water. Although the preservation of organic remains is poor at Tell el-Dab'a, because of the humid climate and high water table, ongoing chemical investigation has verified the presence of tartaric acid, a principal component of grape wine (McGovern and Michel 1985; Michel, McGovern, and Badler 1993), inside two Canaanite Jars thus far. Although testing negative for the presence of tartaric acid, a plaster-lined basin with associated channels at Tell el-Dab'a, dated to the early New Kingdom, might well have belonged to a winemaking installation (Bietak 1986).

A prevalent theory has been that the "Hyksos" came originally from Lebanon or Syria. Bietak (1987:52), for example, has argued that the people from Byblos in Lebanon emigrated to Egypt and founded the "Hyksos" capital of Avaris at Tell el-Dab'a. If Syria or Lebanon did figure importantly in the rise of the "Hyksos" in the Delta, then more imported pottery from these regions might be expected at Tell el-Dab'a. Recently, Bietak (private communication) has proposed that his original theory be modified, in light of the NAA results, to include a two-stage process, in which the Byblites first traveled to southern Palestine, then moved on to Egypt at a later time.

A Byblite theory can be reconciled in other ways with the NAA results. For example, if the sites in the northern Levant were largely abandoned in late MB IIA, then there could hardly have been trade between this region and Tell el-Dab'a. Or, it could be that whatever was shipped from northern Levantine sites to Egypt (e.g., cedar wood or metals) was not transported

in Canaanite Jars or other Syro-Palestinian pottery types. Such arguments, however, are *a silentio*, and not easily testable. Another possibility is that a clay source exists in the northern Levant, as yet unanalyzed, that is chemically similar to the red loess clay of southern Palestine. If a such a clay were found in the Byblos area, it would dramatically alter the picture based on the NAA results. Yet, the existence of such a clay is very remote, given the high MDPs of the imported southern Palestinian group at Tell el-Dab'a vis-à-vis the "Gaza group of Middle Bronze Age sites" and considering the marked chemical differences of known northern Levantine Middle Bronze Age pottery groups.

It is a well-known dictum that "Pots do not equal People." If the NAA results, however, are "pressed" for information about ethnic origins, then a "Hyksos" origin from other parts of the Delta and/or from southern Palestine is sufficient to account for the available evidence. The rapid expansion of the site, and presumably the population, of Tell el-Dab'a suggests that any local population must have been complemented by outside groups. Because major city-states existed in southern Palestine throughout the Middle Bronze Age and because of its nearness to the eastern Nile Delta, it is plausible that groups came from here. The recent discovery of MB IIA levels at Ashkelon has begun to fill in the supposed gap in MB IIA remains in this region. The burial customs of southern Palestine, often a sensitive indicator of ethnic origins, are very similar to those at Tell el-Dab'a. Tombs in both places were made of vaulted mudbrick, and are associated with equid or ass burials. Nevertheless, other kinds of evidence (e.g., paleogenetic and physical anthropological data, contemporaneous texts) are needed, in conjunction with the NAA results, before the issue of population dynamics during the Middle Bronze Age can be definitively resolved.

From wherever the "Hyksos" came from originally, there can now be no doubt that southern Palestine was a major trade partner of Tell el-Dab'a in the northeastern Nile Delta throughout the Middle Bronze Age. Tell Dab'a also maintained contacts with sites a short distance up the Nile in Middle Egypt, but these relations were less important than those with southern Palestine, according to the NAA results. Much more sampling of sites in the Fayyum and farther up the Nile is needed before relationships between the Delta "Hyksos" and Thebes, Nubia, and other areas in Egypt can be better understood.

It is rare that a technical pottery study entails rewriting history or, at least, archaeological hypothesis. But according to the Neutron Activation Analysis results presented here, the very earliest contacts of the "Hyksos" at Tell el-Dab'a were overwhelmingly with southern Palestine and not farther north, and this pattern continued throughout the Middle Bronze Age.

Canaanite Jars were coil-built and subsequently

### Short Excursus on Canaanite Jar Fabrication and Fabrics

turned on a wheel. Their bases were made of slabs of clay that were scraped after drying to produce flat or, more often, slightly convex surfaces. Rims were most often made by folding the uppermost coil to the exterior, thereby creating bulges and ridges that are very diagnostic in distinguishing the styles of the MB phases. Handles were added after drying, and various incised lines and marks, seal and thumb impressions, simple painted geometric designs, and patterned combing completed the production process of some of the vessels.

The pottery wares of the amphoras, as well as the other groups of imported and locally made pottery from Tell el-Dab'a, have been classified macroscopically (up to 10X magnification) according to the so-called Vienna System (Nordström 1986; Nordström and Bourriau 1993). Special criteria and unique alphanumeric categories have been developed for the Tell el-Dab'a pottery (Bietak 1991b: Appendix, pp. 317-333). In addition to the NAA results, which provide a partial test of uniformity in assignments, petrographic analysis should be carried out to define the categories more precisely.

Nearly all the amphoras in the NAA corpus belong to imported ware type IV. IV-2b and IV-2c, denoting reddish-yellow pastes with small to moderate amounts (1-10%) of fine to medium-sized calcite inclusions (0.5-2 mm in diameter), are most common. A reddish paste color (IV-1) is two to three times more frequent

than a yellowish-white paste color (IV-3), both being in other respects similar to IV-2. Considerable amounts (>10%) of large calcite particles (>2 mm) are occasionally attested to for the three paste colors (IV-1-3-d), but no example has minor amounts of fine constituents (i.e., belongs to IV-1-3-a). The wares generally lack organic material. At this macroscopic level, the Tell el-Dab'a imported amphoras are visually indistinguishable from comparable vessels found at other Levantine sites.

Six amphoras out of 274 examples were assigned to Nile alluvial clay type I (Nile B2 in the Vienna System). Subtype I-b2 is a reddish-brown paste, with a considerable quantity of quartz inclusions (ranging in size up to 1 mm) and fine to medium-sized organic matter (up to 3 mm) that probably derives from animal dung. Subtype I-e3, similar in other respects to I-b2, has large straw voids (sometimes exceeding 7 mm in length). Representing an even smaller percentage of the total amphora corpus, three amphoras were assigned to Egyptian marl ware—types II-a, II-c, and II-f (Marls A3, C, and an undefined type, respectively, in the Vienna System). Marl II-a and II-c are usually light reddish or grayish in color, and contain moderate amounts of fine calcite that can be decomposed, creating irregular voids in II-a wares and elongated pores with vitrified streaks in II-c wares. II-f wares, by contrast, are reddish-yellowish, and have no visible calcite inclusions and relatively more quartz and other inclusions.

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The vast majority of the pottery samples in this NAA study were run at Brookhaven National Laboratory between 1984 and 1986 under contract DE-AC02-76CH-00016 with the U.S. Department of Energy. Additional samples have recently been analyzed at the University of Missouri—Columbia Research Reactor (MURR), under the direction of M. D. Glascock, with support from the Department of Energy and National Science Foundation grants (BNS-8801707 and DBS-9101016). Statistical evaluation of the data, employing the battery of programs developed at Brookhaven, were carried out on the University Museum VAX computer, with the support of P. Chase. More recently, a dedicated PC, equipped with both the Brookhaven programs and the GAUSS programs written by H. Neff

at MURR, has been used. The map and other graphics were prepared by P. Zimmerman of MASCA using CANVAS 4.0 on an Apple Macintosh computer.

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### Special Dedication

A larger neutron activation program of analyses focusing on the "Hyksos" during the Middle Bronze Age, of which this study on Canaanite Jars is a part, was begun by the late Mrs. Joan Huntoon. Joan chose this subject for her Ph.D. dissertation at Columbia University in the Department of Art History and Archaeology, under the supervision of Professor Edith Porada. She participated in several seasons at Tell el-Dab'a/Avaris in the northeastern Nile Delta, the long-term project of the Austrian Archaeological Institute in Cairo under the direction of Dr. Manfred Bietak, where she collected ware samples from a range of Syro-Palestinian pottery types, many of which were presumably imported to the site. She also traveled to museums and archaeological sites in many European and Middle Eastern

countries, to assemble material from other key Eastern Mediterranean sites. Back at Brookhaven National Laboratory, she assiduously processed the samples for NAA, and had already carried out a considerable amount of background research when her health went rapidly downhill and she died in the Fall of 1987. Since Patrick McGovern had long collaborated with Joan and Gar Harbottle at Brookhaven, with the both concurrence and avid support of Drs. Porada and Bietak, he undertook, in collaboration with Dr. Harbottle, to complete the research that Joan had begun. It is with great affection for Joan, and in recognition of the excellent piece of research that she initiated, that we dedicate this "first-fruit" of the Hyksos Neutron Activation Analysis Project to her.

### Notes

1. For example, precise physicochemical characterization of a range of archaeological materials from an archaeological site, locational analysis, ethnoarchaeology, paleogenetics, and many other approaches have proved invaluable in reconstructing craft activity and organization, socioeconomic structure and development, ethnic affiliations, foreign relations, diet and disease, and so forth (see McGovern 1989, 1995).

2. The dates cited in this chapter follow the so-called middle chronology of Weinstein (1992) and Kitchen (1987), for the start of the New Kingdom/Late Bronze Age.

3. This study is a summary version of a chapter for a monograph now in preparation, *The Foreign Relations of the "Hyksos": A Neutron Activation Study of the Middle Bronze Pottery from Tell el-Dab'a (Ancient Avaris)*, Untersuchungen der Zweigstelle Kairo des Österreichischen Archäologischen Institutes, Vol. 9, Vienna. This publication will provide full particulars for each pottery vessel (registration numbers, archaeological context and stratum, *comparanda*, illustration, NAA data, and provenience assignment based on MED and MDP). The vessels included in each local NAA group will also be documented, together with a more in-depth treatment of

the statistical evaluation of NAA data.

4. Compare the stacking of the amphoras in the hold of the Uluburun Kaş shipwreck, a Late Bronze merchantman that sunk off the southern coast of Turkey (see Pulak 1988; Bass et al. 1989).

5. Information on sample preparation, irradiation procedures, and processing of gamma ray spectra can be found in Abascal, Harbottle, and Sayre 1974; Harbottle 1976; Weigand, Harbottle, and Sayre 1977; and Glascock 1992.

6. The mean Euclidean distance (MED) is defined as the square root of the sum of the squares of the distances between the log elemental concentrations of any given pair of samples.

7. "Possibly from southern Palestine" indicates that the closest match in MED multidimensional space is a sample from the "Gaza group of Middle Bronze Age sites," which is within a distance of 0.08–0.10 from the Tell el-Dab'a sample. Samples of questionable provenience that are possibly from some site or region are potentially important, but more sampling and further study are needed before any definitive conclusions can be drawn.

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