UMM EL-QAAB II
Importkeramik aus dem Friedhof U in Abydos (Umm el-Qaab) und die Beziehungen Ägyptens zu Vorderasien im 4. Jahrtausend v. Chr.

VON ULRICH HARTUNG

Mit Beiträgen von
Larry J. Exner, Friedel Feindt, Donald L. Glusker, Yuval Goren, Rolf Kohring, Patrick E. McGovern, Axel Pape, Naomi Porat und Thomas Schlüter

VERLAG PHILIPP VON ZABERN · Gegründet 1785 · MAINZ
The physico-chemical method of NAA has been extensively employed in pottery provenience studies, because of its sensitivity and precision in measuring as many as 51 elements, including rare earths which often characterize a clay source, and because it requires very small samples (10-200 mg) that are non-destructively analyzed. The chemical composition of the 18 pottery samples were determined at the University of Missouri Research Reactor (PMG-series, which denotes the author's first and last names).

Samples were prepared by scraping the surface with a sapphire or silicon carbide tool until the interior fabric was exposed. After soaking in deionized water and brushing the specimens to a fine powder using an agate mortar and pestle, the samples were oven-dried at 85°C. Two aliquots of about 75-100 mg and 200 mg were subjected to short and long irradiations, respectively. The resultant gamma ray data were then processed, incorporating decay corrections, spectrum analyses, and standards, yielding concentrations of 30 elements for each specimen. Following Brookhaven National Laboratory's convention, concentrations are reported as oxides of the elements in the order shown in the Tables 1 and 3. Missouri elemental data were converted to the oxides and intercalibrated with the Brookhaven data by multiplying by the relevant factors using a FoxPro database program on an IBM-PC in MASCA.

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 in which it is assumed that the chemical variation within a given clay source is less than that between different sources. The inclusions in Egyptian and Levantine pottery, whether deriving from the original clay or added as temper by the potter, are generally relatively "pure" (e.g., quartz, calcite, and organic materials) and have a dilute effect on the chemical composition of an ancient sample that is spread across the range of elements.

The author has recently completed a large NAA study of Middle Bronze pottery from the Levant, including 605 pottery and clay samples from the key site of Tell el-Dab'a, the ancient "Hyrkan" capital of Avaris, in the northeastern Nile Delta. To date, 119 pottery and clay samples have been tested from sites in Middle and Upper Egypt (Fig. 1) — Kahun and Dahshur near Lisht, el-Amarna, Abydos, etc. — that range in date from the Old to the New Kingdom (ca. 2500-1570 B.C.). An additional 760 pottery and clay samples from 55 coastal and inland sites of Syria, Lebanon, Jordan, and Israel — including Ras Shamsa/ancient Ugarit, Tell Kazzel, Hama, Byblos, Sidon, Kamid el-Loz, Megiddo, Tell Aphek, Jaffa, Ras Shamra, Bet Shean, Tell Bein Minim, Tell Shema, Tell Shema, Tell Khirbet, Tell el-Fulkhar, Bagh'ah Valley, central Transjordanian plateau — were analyzed by the author using the NAA technique.
### TABLE 2

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### Fig. 1

Eastern Mediterranean region and Egypt, showing some of the sites and regions referred to in the text. The "Gaia group of Middle Bronze Age sites" includes (1) Gaza; (2) Tell el-Ajul; (3) Tell Jemmeh; (4) Tell el-Farah South; (5) Tel Haror; (6) Tell Beit Mirsim; (7) Lachish; and (8) Ashkelon.

have also been analyzed. Previous Brookhavens projects\(^1\), accounting for 1.24% of the clay and pottery samples from 79 more Egyptian and Levantine 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. Egyptian alluvial and marl clays, red loess clays of the southern Palestinian coastal region, yellow limestone-derived clays of the Palestinian Hill Country, Transjordanian siltstones and kaolins, and other clay sources are well represented in the NAA data bank.

The Old World database on the MASCA computer alter- gethers comprises 60,000 samples, most of which were analyzed at Brookhaven. The database has excellent temporal and spatial coverage of many regions of the Near East and Mediterranean, including Egypt, the Sudan, Greece, Cyprus, Israel and the West Bank, Jordan, Lebanon, Syria, Iraq, Iran, and parts of Turkey. Of most relevance to this study are Levantine and Egyptian pottery and clay groups belonging to the Bronze and Iron Ages. A range of univariate and multivariate algorithms – means and standard deviations, and correlational, clustering, and principal components analysis of a range of elements – are used to define local chemical groups of ancient pottery, with widely divergent samples (outliers) being excluded. Archaeological and geological criteria are also important in refining and testing these groups, whether well-defined pottery types, clays from specific geochemical regimes, clay beds within a single deposit, etc. 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 geographic extent of a local group is reasonably assumed to have been within a 2–10 km radius of a site during the Bronze and Iron Ages, when they were probably not transported over longer distances. The Old World database was searched for the closest chemical "matches" to the eighteen Abydos wine jars in mean Euclidean distance (MDE) space (defined as the square

root of the mean of the sums of the differences between the log elemental concentrations of any given pair of samples. Although correlational effects are excluded from this calculation, excellent results can be obtained with the fifteen elements — sodium (Na), potassium (K), cesium (Cs), rubidium (Rb), barium (Ba), scandium (Sc), europium (Eu), thorium (Th), hafnium (Hf), manganese (Mn), cobalt (Co), chromium (Cr), iron (Fe), samarium (Sm), and ytterbium (Yb), as the oxides — because the variance in the MED approaches zero as the inverse of the number of variables. An MED of less than 0.08 has been empirically determined to be indicative of group membership as a chemical "match." The majority of the Abydos jars have MED's that exceed 0.08, generally falling within the range of 0.10 to 0.15, nearest sample in the data base, and consequently have been assigned uncertain proveniences (indicated by a question mark in Table 1). Pending more sampling, the pottery types of the nearest samples and the sites and regions from which they were recovered are potentially important in determining the origin of the Abydos jars. It must also be appreciated that statistically some samples with questionable proveniences are always to be expected, because of natural variability in clay beds, clay preparation by ancient potters, and the analysis itself. 

Some previous, the largest sub-group of Abydos jars with MED's less than 0.08 is that for the southern Palestinian Hill Country. PMG488 and PMG847 are very close to one another, as well as to a group of modern clays that were prepared by potters in Hebron (DBH860, DBH850, DBH851, DBH851, and DBH851), from equal parts of Hebron red "field" loess clay and yellow marl clay from Arab, north of Hebron, and some added sand from the Gaza region and salt from the Dead Sea. Only somewhat farther afield are PMG489, PMG848, and PMG849. The southern Jordan Valley sub-group (PMG431 and PMG446; possibly PMG485) is closest to a local pottery group (MED 0.072) from Tell el-Fukair2, at the mouth of the Wadi Shu’ib in Transjordan, and Chocolate-on-white Pottery (MED 0.082) from Kateret es-Samra3, south of the mouth of the Wadi (Tell el-Fukair) Transjordan (data as yet unpublished). The latter was found in association with pottery wasters4, implying local production. Indeed, a Chocolate-on-white pottery (PMG489) from Kateret es-Samra, which had been misfired, was chemically closest to a Middle Bronze Age cooking pot (PMG487) of presumed local manufacture at Tell Nikrin. The single example (PMG412) representing the northern Jordan Valley is closest to a Chocolate-on-white vessel (MED 0.07) from Beth Shan5, at the juncture of the Jezreel and Jordan Valleys. The latter, in turn, is most similar to probable locally produced Chocolate-on-white pottery, including later debased types, from Tell Abu al-Khaza6, north of the mouth of the Wadi el-Yabis in Transjordan and less than 10 km from Beth Shan. Four Abydos jars (PMG411, PMG412, PMG413, and PMG484) are possibly from the northern Transjordanian plateau, since they are most similar to local samples from Tell el-Fukair2 in this region. Yet, the "possible matches" are too distant (MED 0.092–0.117) to be certain, until more analyses of clays and pottery from other sites are carried out. 

An origin of two Abydos jars (PMG416 and PMG418) from the central Transjordanian plateau is also suggested by MED's of 0.091 and 0.113 to samples from Sahab7, south of Amman, and the Baq‘ah Valley8, northwest of Amman, respectively. Again, more sampling and testing are needed to firm up the picture. Perhaps, the two most intriguing samples in the Abydos NAA corpus are PMG485 and PMG846. The latter match numerous pottery sherds from Petra, which are of local origin9, in the MED range of 0.075–0.084. Possibly, the Petra clay source extends northwards, where it might have been exploited by a late Chalcolithic/Early Bronze Age people at a site more hospitable to growing grapes and which is, as yet, unrepresented in the NAA database. Alternatively, the climate in the Petra region might have been more temperate at this time, as it was during the Neolithic period at Beidha and Tell Basta. One sample (PMG409) was very likely exported from Southern Palestine to Abydos. Although the closest sample was at an MED of 0.088, every "possible match" below MED 0.13 — some 10 examples altogether — was from the coastal region of southern Palestine, which extends inland to the lower Shophelah. Most of these matching samples are Canaanite Jars that were imported into Tell el-Dab'a in the northeastern Nile Delta from the "Gaza group of Middle Bronze Age sites" (Fig. 1), some of which have been chemically determined to contain resinized wine10. The numerous MED matches for PMG446, the clay sealing, in the 0.06-0.08 range show unequivocally that it is made of Nile alluvial clay.

2 A. Leonard, Jr., in BASOR 135, 1979, pp. 53-61.
3 Personal communication, A. Leonard, Jr.
4 Unpublished, field nos. 215.044.271, Lines II.28, Level I, University of Pennsylvania Museum no. 29-105-462.
### Table 3: Neutron activation analyses of Tomb U-1 jar sealing

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1. The composition of the elemental oxides are cited as weight percentages (ppm) or parts per million (ppm).

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**Fig. 1** Dendrogram of analyzed Tomb U-1 Syro-Palestinian type jars, and major Levantine and Egyptian local compositional groups.

E-1 and E-2 indicate that the entry should be multiplied by 0.1 or 0.01, respectively. The first left-hand column gives the mean Euclidean distance to a node on the dendrogram, which is displaced horizontally in direct proportion to the mean Euclidean distance. The second left-hand column gives the order of hierarchical cluster formation, which is not always the same as a nearest neighbor ordering in mean Euclidean space (see Table 4 and text). For abbreviated group names, see text and Figs. 1.

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**Fig. 2** Mean Euclidean distance in decreasing order of left to right in each row, going from top to bottom.
The organic contents of the tomb U-j syro-palestinian type jars: Resinated wine flavored with fig

By Patrick E. McGovern, Donald L. Glusker, and Larry J. Enker

Three of the Abydos jars from chambers 7 and 10 were tested for organic compounds, viz., excitation nos. 7/18 (Cat. no. 1), 10/21 (Cat. no. 8), 10/115 (Cat. no. 116; NAA no. PMG417, see P. E. McGovern in Appendix 2, and Table 1). The targeted compounds were tannate/tartaric acid (characteristic of grape products, including wine) and the terpenoids of tree resins. The archaeochemical laboratory of the Museum Applied Science Center for Archeology (MASCAL) of the University of Pennsylvania Museum employs complementary analytical techniques—infra-red spectrometry (IR), liquid chromatography, and wet chemical analyses—to determine the presence/absence of these and other organics. After the sand filling had been removed from the jars, rings of a yellowish/brownish flaky residue, which were slanted off from the horizontal, were seen on the interiors (e.g. pl. 84, no. 398). They are best interpreted as the remains of a liquid that had gradually evaporated, with materials on the surface of the liquid agglomerating to form the rings.

1. Chemical preparation of the samples

The yellowish/brownish flaky residue inside the three jars was largely calcium carbonate, because it readily dissolved in weak hydrochloric acid (HCl) with vigorous bubbling, to give light yellowish solutions. When evaporated to dryness, the material from jar no. 7/18 and 10/21 had a very pungent, even vile odor, as is characteristic of long-chain fatty acids. By contrast, the flaky residue inside jar no. 10/115 yielded a material which smelled of caramelized sugar. The residue inside jar no. 10/22 differed from the others in being visibly heterogeneous. A very fine brownish fraction dissolved in HCl without bubbling, and, when evaporated to dryness, had no odor. Numerous small brownish, semi-transparent particles and a few transparent brown flakes could be separated from the bulk of the residue. When treated with weak hydrochloric acid, the interiors of the particles dissolved, without bubbling, and yielded a deep yellowish solution; the exteriors of the particles remained as dark reddish to black shells, which collapsed, when touched, to a gummy residue.

The solids that remained after acid treatment and evaporation to dryness were then extracted with methanol using an ultrasonicicator (two 20-min periods), evaporated to dryness, and analyzed by diffuse-reflectance Fourier-transform IR spectrometry and high-performance liquid chromatography (HPLC).

2. Infrared spectrometric results

Diffuse-reflectance IR is a versatile technique, which has the advantage that very little material is required (1-10 mg) and, unlike transmission IR spectrometry, an optically transparent potassium bromide wafer does not have to be prepared. A Nicolet DMB instrument, with a 25D data processor, was used in taking measurements at 4 cm⁻¹ resolution. Spectra were then deconvolved at 8 cm⁻¹ for library storage, searches, and printing. The IR spectra of residues from jar nos. 7/18 and 10/115 (Fig. 1) clearly show the presence of calcium tannate, along with a hydrocarbonic component. By comparing the IR spectrum of synthetic calcium tannate with the Abydos jar residue spectra, it can be seen that medium intensity absorption bands in the 1540-1560 cm⁻¹ range coincide. Other bands, characteristic of calcium tannate, at 3442, 1385, 1277, 713, 596, and 555 cm⁻¹ also support this interpretation. The broad absorption band centered at about 3496-3535 cm⁻¹ results from water of hydration. The hydrocarbon stretch bands near 2920 and 2850 cm⁻¹ point to another component, in addition to calcium tannate, which was identified as a tree resin by the liquid chromatographic analyses (below).

Although characteristic absorption bands for calcium tannate are present, the IR spectrum of the flaky residue from jar no. 10/22 has hydrocarbonic absorptions with magnitudes that are markedly less than those of the other two jars (see Fig. 1). Moreover, the sharp, intense absorptions at 1630, 1542, 1427, 1369 and 1348 cm⁻¹ in the 10/22 residue are correlated with the methanol-insoluble fraction of a modern red wine (Fig. 1), and are most likely due to polyphenolic aromatic compounds, such as tannins and anthocyanins that give wine most of its color and taste. As also seen in Fig. 2, these compounds were concentrated in the numerous gummy particles of jar no. 10/22 residue, although they are also detectable in the bulk residues of 7/18 and 10/115.

3. Liquid chromatographic results

Comparable methanol extracts of the jar residues were also analyzed by HPLC. Samples were run at ambient temperature on a Hewlett-Packard HP-1090, with extensive software for data handling and manipulation. Methanol extracts were passed through a 2.5 mm × 4.6 mm silica column at a flow rate of 2.0 ml/min, with methanol as the solvent. Ultra-violet absorptions were measured over a range from 200 to 400 nm, using detectors that were most sensitive at 210, 234, and 260 nm. Samples volumes ranged from 2.0 to 10.0 μl, depending on the concentration of organics in the unknown. All the Abydos jar samples showed a sharp early peak at about 1 min retention time, and a second peak composed of several overlapping, unresolved peaks starting about 1.4 min and finishing at about 1.7 min (Fig. 1). The ultraviolet spectrum of the main flaky fraction of three jars is very similar to that of calcium tannate at the same retention time (1.64 min), as seen for jar no. 10/21 in the right-hand inset to Fig. 2, thus confirming the identification by IR (above). In the left inset, the ultraviolet spectra of the same sample is compared to a sample of terebinth tree resin (Pistacia atlantica Desf.) from the 4th century B.C. Uluburun shipwreck (Table no. 4) at a retention time of 1.54 min. In combination with the marked IR hydrocarbon absorptions of the methanol extracts from jar nos. 7/18 and 10/115, this tree resin is best supported by the HPLC data as compared with other resins (e.g. pine, myrrh, and frankincense) in our database. Terebinth tree resin is predominantly comprised of triterpenoid compounds.

4. Chemical spot test results

A third analytical technique also confirmed the presence of calcium tannate in the flaky residues of all three Abydos jars. In a specific, wet-chemical test, HCl-dimethyl and concentrated sulfuric acid are used to convert tartaric acid/tannate to an compound that exhibits a characteristic green fluorescence under UV light. Ground-up portions of the flaky residue from each jar, when treated with the test reagents, gave positive results.

5. Discussion

The chemical attestation of calcium tannate inside three of the Abydos jars in chambers 7 and 12 provides strong evidence that these jars, and probably many of the other Syro-Palestinian type jars from the tomb, contained wine. The
convert wine to vinegar, besides masking any offensiveness of taste and smell. Wine and tree resins figure importantly in the Egyptian pharmacopoeia, since both have anti-microbial properties. Ancient Egyptians need not have had a scientific understanding of the effects of these natural products to appreciate their beneficial properties. Developing a medicamentum or preservative to prevent wine from spoiling must have been an important priority even before Pliny the Elder and Columella wrote about it in the 1st century A.D.

Terebinth resin has been described as the "queen of resins" and "one of the most persistent drugs in history." It was already well established as a wine additive in the Neolithic period, and its use continued to expand in later periods throughout the ancient Near East and Egypt. The terebinth tree has been and is widespread and abundant in the Middle East, occurring even in desert areas of Egypt, and a single tree, which can grow to as much as 12 m in height and 2 m in diameter, can yield up to 2 kg of the resin. In recent times, it has been used to make chewing gum in Greece and to prepare perfume in the eastern desert of Egypt. In "turpentine" odor and taste, which was not as concentrated in the resin as in the distillate commonly known by this name today, was evidently not considered to be offensive.

The chemical confirmation of wine in many of the Syro-Palestinian type jars in Tomb U-j was further corroborated by archaeobotanical investigation (see appendix by E. Farnott, S. Har-El). To recapitate, 47 of 207 jars contained grape pips, generally between 20 and 50 pieces, and several completely preserved grapes were also recovered. Eleven vessels had remains of sliced figs, which had been perforated, string together, and probably suspended in the liquid. Although a fig additive is otherwise unattested in ancient Near Eastern and Egyptian wine, it might have served as a sweetening agent or for special flavoring; by cutting up and stringing out the fig segments, more of the wine would come in contact with the fruit. Fresh, whole grapes were probably added for the same reasons. Figs, like grapes, are also an excellent source of yeast for natural fermentation. The presence of terebinth acid or calcium salt in the chemical analyses was not dependent on the presence of grape remains, since one sample tested was from a jar that yielded only fig seeds and a second sample was from a jar with no archaeobotanical materials.

With an average volume of 6 to 7 litres for each of the projected 700 wine jars in tomb U-j, the king could have drawn upon some 4,500 litres in his afterlife. Where had such a large quantity of wine been produced? Abydos, located almost 400 miles up the Nile in an extremely dry terrain, did not support vineyards during this period. In the Nile Delta, grape remains of predynastic and Early Dynastic date are thus far very sparse, having been confirmed only for Basket 16 in the central Delta and Tell Ibrahim Awad to the east. The stopped and sealed "wine jars" found in Dynasty 1 and a cemetery at Abydos and Soqoura, which are of Egyptian type and made of Nile alluvial clay, suggest that a native Egyptian winemaking industry had begun to develop by this time, but the Abydos jars predate this period.

Since the wild grape never grew in Egypt, is it possible to know when the first grapevines were transplanted to the Nile Delta? The answer to this question is vital for understanding the prehistory of an industry that eventually spread over the entire Delta, to the large western oases, and even to towns on the upper Nile where the climate would seem to preclude viticulture. Moreover, it has far-reaching implications for the consolidation of one of the earliest literate civilizations. The domesticated grapevine could only have come from some region of the Levant that was already exploiting it, and many specialists—farmers/horticulturists, transippers/traders, pottery-makers, and, above all, vintners—would have been involved in and essential to the establishment and success of the developing industry. The grapevine hierarchy itself, showing a grapevine trained to run along a trellis or arbor, indicates that the Early Dynastic viticulture was quite sophisticated.

Neutron Activation Analysis (NAA) of 18 Syro-Palestinian type jars from Tomb U-j (see Appendix 2) constituted a major step forward in understanding how viticulture might have been transferred from Palestine to Egypt. As discussed elsewhere in this monograph, the Abydos wine jar corpus is dominated by bottle-shaped jars with narrow mouths, which would have been easier to stopper and better suited to long-distance trade. Differences in fabric, shape, decoration, and other features suggest that they originated from more than one place. The best typological parallels, especially for the handled jars, are examples from greater Palestine. Tel ‘Erani in the southern coastal plain, Lachish in the nearby lowlands, Megiddo in Jezreel Valley, Jericho in the Jordan Valley, Beth-shether in the eastern shore of the Dead Sea, and Lebun on the southern Transjordanian plateau. How-

The HPLC results pointed to another component of the residues that make it virtually certain that the Abydos jars originally contained wine. The addition of terebinth tree resin to wine, in the fashion of modern resins (which now contains either pine or sandarac resin), served in part to disturb and inhibit the growth of bacteria (Acetobacter) that

1 AEM, 4, pp. 16-18.
3 For this reason, which derives from a northern African tree (Terraclisia articulata), see AEM 4, pp. 313-318.

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ever, exact parallels for the bottle-shaped jars that lack handles do not occur in Early Bronze Age I Palestinian assemblages (ca. 3300–3000 B.C.), which are contemporaneous with the Abydos tomb. Possibly, this absence is due to the relatively small number of sites that have been excavated in the southern hill country of Palestine and in Transjordan. One might also propose that a specialized trade in wine would demand a special container that would therefore be found at relatively few sites.

To summarize the NAA results (see appendix 2), no identifiable Egyptian clay was used to make the jars. The 18 jars tested all came from Palestine: 1 from southern Palestine (the coastal region extending into the lower Shephelah), 5 from the southern Hill Country, 4 from the Jordan Valley, 4 probably from northern Transjordan, 2 from central Transjordan, and 2 from southern Transjordan. While the NAA study represents a small proportion of the jar corpus, the results point uniformly to a region of Palestine where earlier (Chalcolithic) archaeobotanical evidence exists for grapevine transplantation and presumably larger scale production of wine. In Early Bronze Age I, only these specific areas of Palestine have yielded what have been classified as domesticated grape pips and berries, namely, "En Besor near Gaza, Jericho in the southern Jordan Valley, Bab edh-Dhra on the eastern shore of the Dead Sea, and Jawa in northern Transjordan".

One of the clay sealings associated with the Abydos jars was also analyzed by NAA, and it was found to be composed of Nile alluvial clay. This finding indicates that before the jars were deposited in tomb U-j a final stoppering and sealing process took place in Egypt, perhaps at Abydos or, alternatively, at a site in the Delta where the wine entered Egypt before being transported to the south.

A two-stage process in the Early Bronze I interactions between Egypt and Palestine may be proposed to account for the Abydos wine jars and the start of a native winemaking industry shortly thereafter. In the first phase, increasing Egyptian demand for horticultural products, especially grapes/wine and perhaps olive oil, spurred trade in these goods. Cultivation of the fig, one of the additives in the Abydos wine jars, had probably also had begun in Palestine by this time. Once a market for wine had developed in Egypt, a second stage of interaction was possible: the transplantation of grapevines to the Delta and the production of wine, probably under the tutelage of foreign specialists.