The Origin of Some Cypro-Geometric Pottery from Tel Dor

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I. INTRODUCTION

AMONG the few sherds of Cypro-Geometric pottery found in Israel are some examples excavated at Tel Dor in an Iron I Age context.[1] The Tel Dor finds are among the earliest Cypro-Geometric ceramics recovered in Israel, and are of high artistic quality. Some of the designs found on these sherds are rare even in the Cypriot repertoire of pottery of this style. The occurrence of Cypro-Geometric vessels at Tel Dor and more generally in Israel in the Iron I Age should further illuminate the relations between Cyprus and the mainland in this period.

Cypriot finds on the mainland are crucial in illuminating the chronology of Cyprus during the Geometric period, which hinges to no small extent on mainland finds made earlier this century; some of these are now being reassessed. An absolute chronology will still depend on typological comparisons with historically defined strata. Thus data gathered from coastal sites and a re-evaluation of the chronological significance of older finds may lead to a better Early Cypro-Geometric chronological framework.

Because of the rarity and potential chronological importance of the Tel Dor finds, it is important to establish their origin in an objective manner. Furthermore, one of the finds appeared to be of less skilled workmanship than other examples, and this raised the possibility that it might be of local manufacture. Consequently, it seemed prudent to test the origin of the sherds by trace element analysis, employing instrumental neutron activation analysis (INAA).[2]

II. THE CYPRO-GEOMETRIC SHERDS ANALYSED BY INAA

The Cypro-Geometric finds from Tel Dor are described in detail elsewhere in this volume,[3] so I shall give only a brief account of them here.

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[1] I would like to thank the staff of the Soreq Nuclear Research Centre for their expert handling of the neutron irradiations; Ruth Borosh for assistance with computations and graphics; and R. Asia for help with electronic instrumentation.

[2] For full details of INAA, see I. Perlman and F. Asaro: Pottery Analysis by Neutron Activation, *Archaeometry* 11 (1969), pp. 21-52.; J. Yellin *et al.*: Comparison of Neutron Activation Analysis from the Lawrence Berkeley Laboratory and the Hebrew University, *Archaeometry* 20 (1978), pp. 95-100; A.L. Wilson: Elemental Analysis of Pottery in the Study of its Provenance: A Review, *Journal of Archaeological Science* 5 (1978), pp. 219-236.

[3] Ayelet Gilboa: New Finds at Tel Dor and the Beginning of Cypro-Geometric Pottery Import to Israel, this volume, pp. 204-218.

Amphoriskos No. 32216: This Early White-Painted I piece is wheel-made. The clay is light brown, showing medium levigation and firing. There are a few small white grits. A practically identical piece is known from Tomb 27 at Kourion-Bamboula. Other parallels are known from Kaloriziki tombs and from Paleopaphos.

Bowl No. 32218/1: A wheel-made Advanced White Painted I bowl of light brown clay, with medium levigation and firing, and a few white grits, some of which protrude from the surface. The ware and decorative colour on this bowl closely resemble those of the amphoriskos described above.

Bowl No. 27788: A wheel-made Advanced Bichrome I bowl with straight, vertical walls, heavy and coarse in character. No exact parallels are known, and bowls with straight vertical walls are rare among Cypro-Geometric pottery of this period. The rarity of this type of bowl, coupled with the coarse walls, suggested that it was of different origin than the amphoriskos and the other bowl.

III. REFERENCE GROUPS OF POTTERY FOR THE MAINLAND

The origin of a particular piece of pottery is established when the composition of the piece is shown to match the composition of a group of pottery whose origin is known, or the composition of clay of known source. By composition is meant the distribution or concentration of the chemical elements present in the pottery. For the purpose of the present study, reference groups from coastal sites in the vicinity of Tel Dor were used, in addition to reference material from Tel Dor itself. Reference groups determined both at the Lawrence Berkeley Laboratory (University of California) and the Hebrew University are employed as the two laboratories are inter-calibrated and employ the same multi-element standard.[4] These reference groups are briefly described:

Tel Mevorakh reference group

Tel Mevorakh is located about four km. south of Tel Dor. Much Iron Age, Late Bronze Age and Middle Bronze Age pottery from this site has been previously analysed by INAA. Some analyses have been published.[5] A reference group of five Iron Age (tenth century B.C.E.) sherds was employed as representative of ceramics produced in the region of Tel Mevorakh. This group consists of Bichrome

[4] See Yellin *et al.* (above, n. 1).

[5] J. Yellin and I. Perlman: Provenance of Iron Age Pottery from Tel Mevorakh, in E. Stern: *Tel Mevorakh* (*Qedem* 9), Jerusalem, 1978, pp. 86-94; J. Yellin: Provenance of Selected LBA and MBA Pottery from Tel Mevorakh by Instrumental Neutron Activation Analysis, in E. Stern: *Tel Mevorakh II* (*Qedem* 18), Jerusalem, 1984, pp. 87-100.

and Coarse Ware ceramics. It was initially judged to be from the vicinity of Tel Mevorakh on the basis of the similarity of its composition to that of ceramics from other nearby sites. The Tel Mevorakh reference group is given in Table 1.

Table 1. Reference Groups for Tel Megadim and Tel Mevorakh.

Element	Tel Mevorakh (5 samples)			Tel Megadim (21 samples)		
	M		S	M		S
Calcium %	14.9	+/−	1.3	10.6	+/−	1.9
Cerium	34.6	+/−	4.7	37.7	+/−	3.2
Cobalt	10.0	+/−	1.4	9.5	+/−	1.2
Chromium	73	+/−	8	74	+/−	7
Cesium	1.8	+/−	0.3	1.4	+/−	0.3
Hafnium	2.84	+/−	0.51	4.60	+/−	0.42
Iron %	2.78	+/−	0.23	2.86	+/−	0.16
Lanthanum	18.2	+/−	2.3	19.0	+/−	1.1
Lutetium	0.23	+/−	0.02	0.23	+/−	0.02
Scandium	11.2	+/−	1.2	9.8	+/−	0.6
Tantalum	0.68	+/−	0.04	0.71	+/−	0.04
Thorium	4.81	+/−	0.47	4.85	+/−	0.27

Values are in parts per million unless otherwise indicated.

Tel Megadim reference group

Tel Megadim is located approximately 17 km north of Tel Dor. There is no evidence of pottery here before the Persian period, but it is expected that pottery from this site or its vicinity will show some similarity in composition to pottery from Tel Dor or its vicinity. The mean composition of a group of 21 Persian period ceramics is given in Table 1. This material was analysed in Berkeley.[6]

Tel Dor reference material

A group of three sherds, consisting of a Hellenistic bowl and two storage jars, was previously reported as coming from the region of Tel Dor.[7] Their provenance was decided on the basis of their correlation in composition with ceramic compositions from other sites nearby, e.g. Tel Megadim. The Tel Dor group is too small to be regarded as a reference group; however, much more pottery from Tel Dor is currently under analysis and preliminary results support the conclusions that the composition of this 'preliminary' Tel Dor group is indeed characteristic of pottery from the vicinity of Tel Dor. For the present study I have relied on reference material from sites other than Tel Dor for provenance assignment.

[6] See Yellin and Perlman (above, n. 5).

[7] D.T. Ariel *et al.*: A Group of Stamped Hellenistic Storage-Jar Handles from Dor, *IEJ* 35 (1985), pp. 135-152.

The chemical compositions of the above reference groups are given in Table 1. For each element shown, M is the mean value and S is the root-mean-square deviation. The latter is a measure of the dispersion in composition.

IV. REFERENCE GROUPS OF POTTERY FOR CYPRUS

Much Cypriot pottery has been analysed by INAA and published. For present purposes, I shall refer to three Cypriot reference groups (Table 2):

The Styllos reference group

This group consists of nine pieces of eighth century B.C.E. White Painted ceramics, analysed at the Lawrence Berkeley Laboratory.[8]

The Kition reference group

This group of MB and LB pottery was reported in connection with INAA carried out on the Tell el-Amarna tablets, and is presumed to reflect local clays. The analysis was performed at the Lawrence Berkeley Laboratory.[9]

The Kalopsidha White Painted and Red Slip reference group

This group consists of 20 sherds (dated to 1700-1600 B.C.E.), including White Painted and Red Slip wares. The ceramics were analysed at the Lawrence Berkeley Laboratory.[10]

Table 2. Cypriot Reference Groups.

Element	Kition (15 samples) M		S	Kalopsidha (20 samples) M		S	Styllos (9 samples M		S
Calcium %	11.1	+/−	1.2	12.4	+/−	1.2	13.3	+/−	1.3
Cobalt	21.8	+/−	1.1	25.5	+/−	1.8	27.5	+/−	1.4
Chromium	377	+/−	50	273	+/−	27	275	+/−	22
Cesium	3.2	+/−	0.4	2.6	+/−	0.4	3.5	+/−	0.4
Hafnium	3.0	+/−	0.3	2.3	+/−	0.3	2.4	+/−	0.1
Iron %	4.43	+/−	0.29	4.85	+/−	0.26	5.20	+/−	0.28
Lanthanum	19.4	+/−	1.2	14.8	+/−	0.7	16.4	+/−	0.8
Scandium	20.2	+/−	1.4	20.7	+/−	1.2	22.5	+/−	1.3
Sodium	1.35	+/−	0.12	1.29	+/−	0.15	1.04	+/−	0.08
Tantalum	0.64	+/−	0.05	0.44	+/−	0.03	0.51	+/−	0.04
Thorium	6.04	+/−	0.45	4.35	+/−	0.30	5.03	+/−	0.36

Values are in parts per million unless otherwise indicated.

[8] See Yellin and Perlman (above, n. 5).

[9] M. Artzy, I. Perlman and F. Asaro: Alasyia of the Amarna Letters, *Journal of Near Eastern Studies* 35 (1976), pp. 171-182.

[10] See Artzy, Perlman and Asaro (above, n. 9).

Table 3. Composition of the Cypro-Geometric Sherds from Tel Dor.

Element	Sherd No. 27788	Sherd No. 32218/1	Sherd No. 32216
Calcium %	13.9	12.2	4.4
Cerium	35.1	39.7	34.6
Cobalt	9.29	23.4	20.0
Chromium	85.6	489	371
Cesium	1.63	3.54	3.0
Hafnium	2.8	2.79	3.5
Iron %	2.99	4.68	4.04
Lanthanum	17.8	18.2	14.8
Lutetium	0.23	0.41	0.38
Scandium	13.3	23.1	19.2
Sodium	0.69	1.16	0.96
Tantalum	0.72	0.74	0.56
Thorium	4.37	5.59	5.21

Values are in parts per million unless otherwise indicated.

V. RESULTS AND CONCLUSIONS

The composition of the three Cypro-Geometric sherds considered here are given in Table 3. The statistical measuring errors for each of the elements shown are much smaller than the dispersion in composition exhibited by the reference groups and are omitted for brevity's sake. More elements than shown in Table 3 were measured, but the diagnostic elements shown were limited to those given in the published reference groups, since elements that are not given in these groups cannot be used to test the statistical hypotheses that a particular find does or does not belong to a group.

It may be noted first that Amphoriskos No. 32216 and Bowl No. 32218/1 show greater similarity to each other than either shows to Bowl No. 27788: in fact the composition of Bowl No. 27788 is completely different from that of Nos. 32216 and 32218/1. Compare, for example, the values of cobalt, chromium, iron and scandium.

I will discuss Bowl No. 2778 first. Table 4 gives its composition, along with the reference groups from Tel Mevorakh and Tel Megadim. In the last column of Table 4, under d(TM), appears in the deviation of each element of the sherd from the corresponding element in the Tel Mevorakh group, measured in units of S, the root-mean-square deviation. For the deviations observed, the probability is very high that sherd No. 27788 is made of the same clay as the Tel Mevorakh group. In other words, the deviations are statistically insignificant. Fig. 1 shows graphically how well sherd No. 27788 matches the Tel Mevorakh group. The horizontal line separating the two shaded areas represents the mean value for the element shown, and the width of each shaded area is one root-mean-square deviation. There is no shaded area for the individual sherd. When the shaded area of the group overlaps the value for a sherd, this shows that for this particular element the values are statistical-

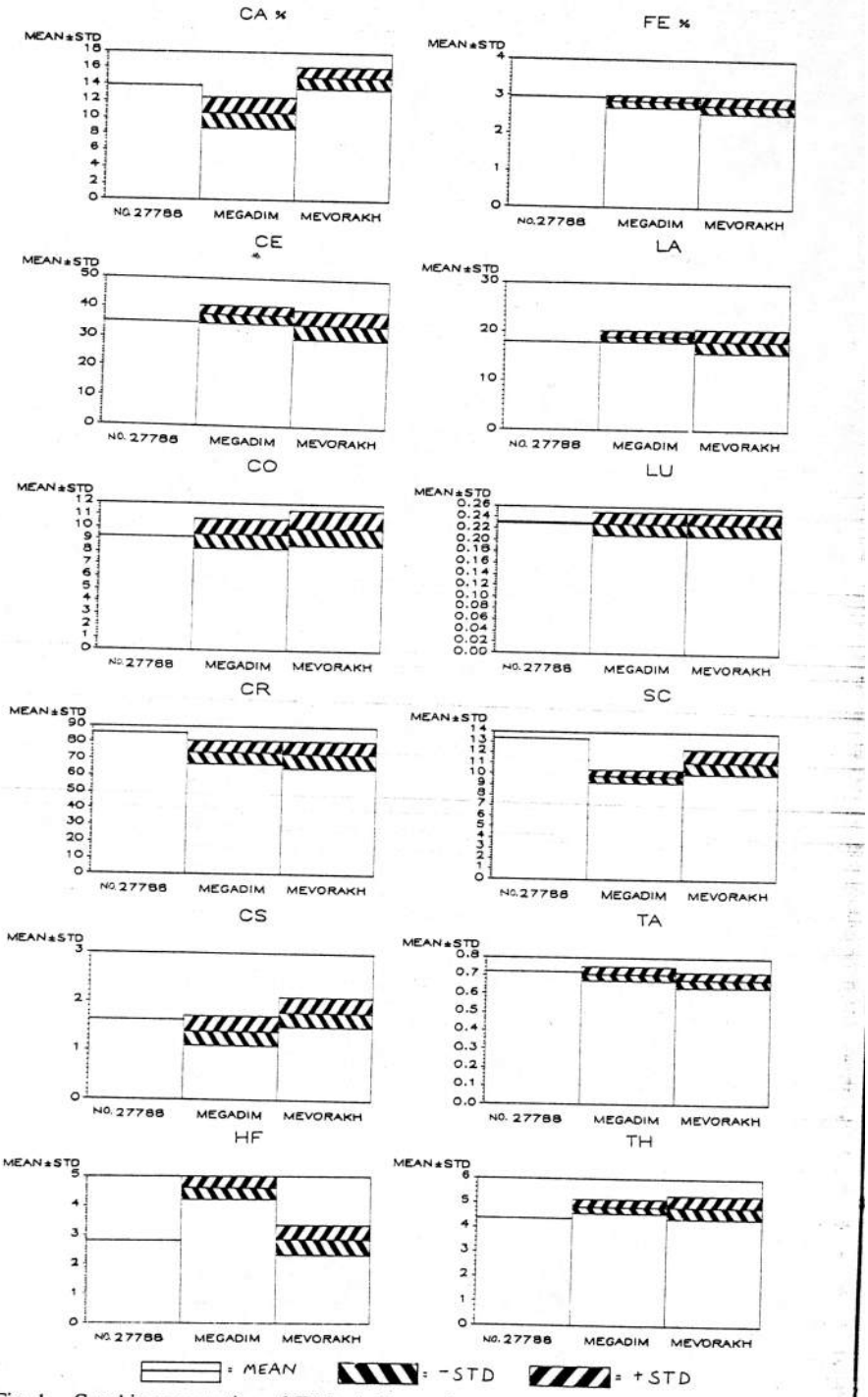

Fig. 1. Graphic presentation of Table 4: Comparison of Sherd No. 27788 with the Tel

Table 4. Comparison of Sherd No. 27788 with Tel Megadim and Tel Mevorakh Reference Groups.

Element	Sherd No. 27788	Tel Mevorakh (5 samples) M	S	Tel Megadim (21 samples) M	S	d(TM)*
Calcium%	13.9	14.9	1.3	10.6	1.9	0.8
Cerium	35.1	34.6	4.7	37.7	3.2	0.1
Cobalt	9.29	10.0	1.4	9.5	1.2	0.5
Chromium	85.6	73	8	74	7	1.6
Cesium	1.63	1.8	0.3	1.4	0.3	0.6
Hafnium	2.8	2.83	0.51	4.6	0.4	0.1
Iron %	2.99	2.78	0.23	2.86	0.16	0.9
Lanthanum	17.8	18.2	2.3	19.0	1.1	0.2
Lutetium	0.23	0.23	0.02	0.23	0.2	0.0
Scandium	13.3	11.2	1.2	9.8	0.6	1.8
Tantalum	0.72	0.68	0.04	0.71	0.04	1.0
Thorium	4.37	4.81	0.47	4.85	0.27	0.9
Average deviation						0.7

Values are in parts per million unless otherwise indicated.

* d(TM) is the deviation in units of S of the sherd from the Tel Mevorakh group.

the same. For the sherd to match the group, it is necessary for about two-thirds of the elements in the sherd to be overlapped by the shaded areas; no more than 5% of the elements in the sherd should be more than twice a shaded area (2S) away from the group mean. On the basis of the data shown in Table 4 and Fig. 1, Bowl No. 27788 originates somewhere in the region of Tel Dor — Tel Mevorakh. It may also be observed that the composition of No. 27788 is unlike any composition of definite Cypriot origin (see Table 2).

In Table 5 and Fig. 2, Bowl No. 32218/1 is compared with reference groups from Kition and Kalopsidha. It is evident that there is no match between No. 32218/1 and the Kalopsidha group, as the average deviation is 3.5 (the average deviation for a good match is about 1). Nor does the sherd match the Styllos group, though the situation is less clear with respect to the Kition group. There, the average deviation is 1.3, a good indication that the compositions are close and may have the same origin; however, the distribution of the deviations leaves something to be desired. In this case it would have been useful to have more parameters (elements) for the reference groups. It is, however, possible to state that Bowl 32218/1 is Cypriot and very likely has an origin geographically close to, if not identical with, the origin of the Kition reference group. It should be added here that the composition of No. 32218/1 is unlike any composition of definite mainland origin.

The similarity in composition between Amphoriskos No. 32216 and Bowl No.

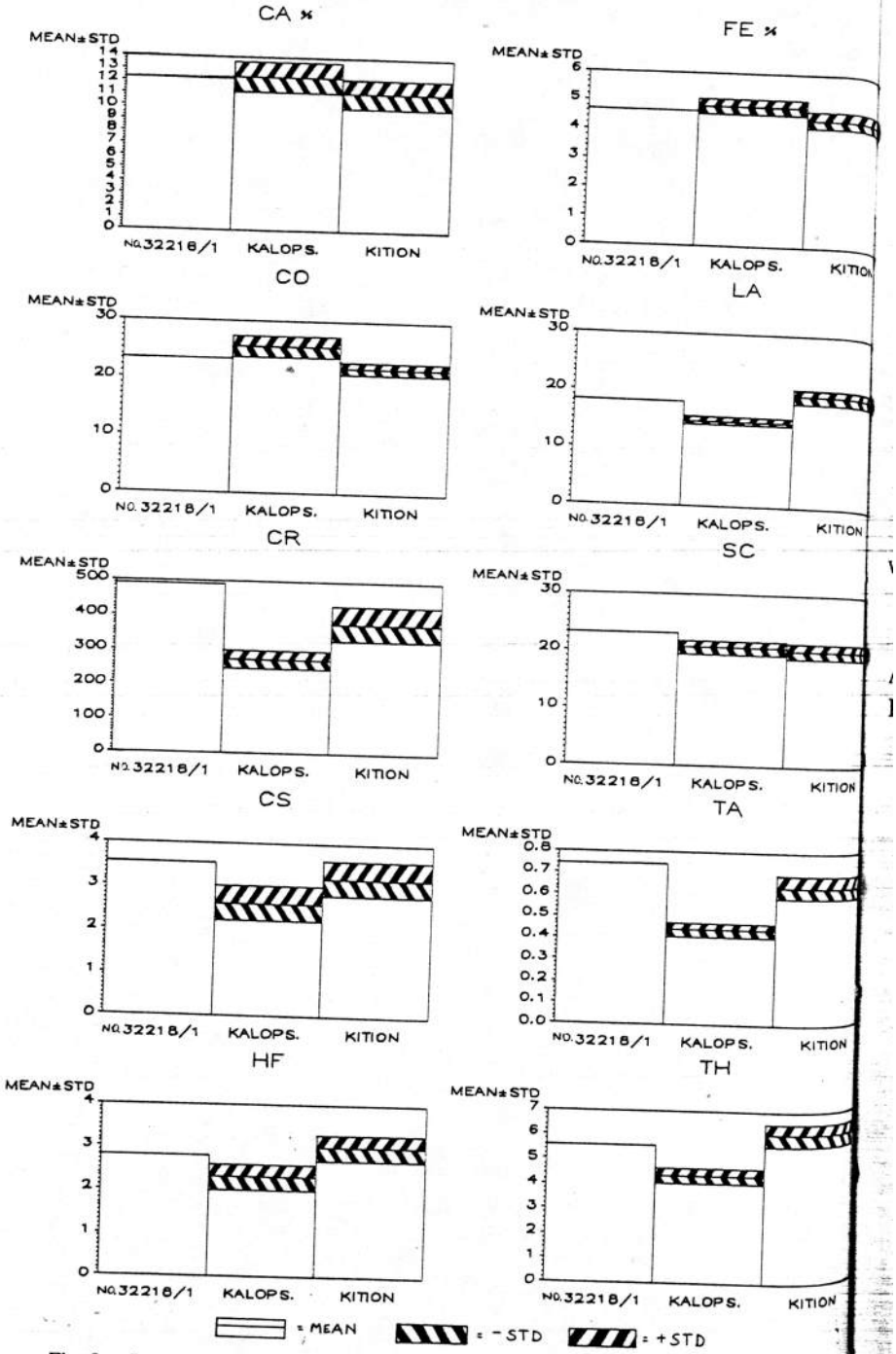

Fig. 2. Graphic presentation of Table 5: Comparison of Sherd No. 32218/1 with the Kition and Kalopsidha reference gro

Table 5. Comparison of Sherd No. 32218/1 with the Kition and Kalopsidha Reference Groups.

Element	Sherd No. 32218/1	Kition (15 samples) M	S	Kalopsidha (20 samples) M	S	d (Kit)	d (Kal)
Calcium %	12.2	11.1	1.2	12.4	1.2	0.9	0.2
Cobalt	23.4	21.8	1.1	25.5	1.8	1.4	1.1
Chromium	489	377	50	273	27	2.2	8.0
Cesium	3.54	3.2	0.4	2.6	0.4	0.8	2.4
Hafnium	2.8	3.0	0.3	2.3	0.3	0.7	1.7
Iron %	4.68	4.43	0.29	4.85	0.26	0.9	0.6
Lanthanum	18.2	19.4	1.2	14.8	0.7	1.0	4.8
Scandium	23.1	20.2	1.4	20.7	1.2	2.1	2.0
Tantalum	0.74	0.64	0.05	0.44	0.03	2.0	10.0
Thorium	5.59	6.04	0.45	4.35	0.30	1.0	4.1
Average deviation						1.3	3.5

Values are in parts per million unless otherwise indicated.

On the basis of the above evidence, I conclude that Bowl No. 32218/1 and Amphoriskos No. 32216 are Cypriot, and that at least the former sherd came from Kition or its vicinity. Bowl No. 27788 comes from the region of Tel Dor.