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Petrographic Analysis of the Persian-Period Pottery from Ḥorbat Malṭa

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The petrographic analysis was conducted on 26 samples of Persian-period wares from the 1993 excavation season at Ḥorbat Malṭa (see Covello-Paran, this volume). The samples represent most of the Stratum II vessel types found at the site. The results were compared with existing data from the petrographic database of the Institute of Archaeology of Tel Aviv University and other studies currently in progress of Persian-period sites.[1]

The samples were examined following standard laboratory procedures (Goren 1995; 1996a; 1996b), which enabled comparison with data from comprehensive studies of defined petrographic families related to different geological environments in Israel and the Levant (e.g., Porat 1986–7; 1989a; 1989b; Goren 1992; 1995; 1996a; 1996b; Goren, Oren and Feinstein 1995; Greenberg and Porat 1996). The typical geological and lithological attributes of each sample provide the basis for the assessment of its provenance (Table 1).

Group A: Ḥamra

Two cooking pots represent this group. The matrix is silty, non-carbonatic and highly ferruginous. The color of the clay is red under plane-polarized light (PPL), with a weak optical orientation, and the inclusions are mostly poorly sorted, sand-sized quartz crystals. Other minerals (augite, zircon, hornblende and feldspar) appear in small quantities. The raw material is the red *ḥamra* soil of the central littoral areas of Israel. This soil, usually a member in coastal formations, is distributed along the coastal plain of Israel from the area of Ashdod northward (Ravikovitch 1969:22–25; 1981:136–152). The sand temper, perhaps purified by dilution or sieving, reinforces the proposed coastal origin.

Ḥamra soil was never a first choice for potters, as its use involved the extra work of sieving the sand. The vessels obtained were almost always fragile and easily broken. For this reason it is common to find such vessels in non-functional use, such as tomb offerings in cemeteries excavated along the central coastal plain, e.g., Palmaḥim at the mouth of the Soreq River (Singer-Avitz and Levy 1992:12*–14*). However, the use of this soil as raw material for cooking pots is a well-attested phenomenon during certain periods (see below).

From the Early Bronze Age I up to the end of the Iron Age, cooking pots were made mostly of *terra rosa* soil with the addition of crushed calcite (Goren 1995:303). Calcite is best suited for tempering cooking pots due to its expansion rate under heat, which is similar to the typical low-fired clay (Arnold 1985:24–26, Fig. 2.1). This property allows the vessel to achieve a remarkable thermal shock resistance so as to withstand repeated cycles of fast heating and cooling. Different rates of expansion between the hot exterior and the colder interior of the vessel cause cracks due to gaps in tensile strength, bringing about the eventual collapse of the vessel. Calcite, however, presents other technical problems to the potter, because at firing temperatures of 900ºC calcite decomposes into calcium oxide.

From the end of the Iron Age to the beginning of the Persian period, a type of technological development seems to have taken place. Quite suddenly, potters began to use *ḥamra* tempered with coastal sand rather than *terra rosa* with crushed calcite to produce cooking pots (Goren 1995:303; 1996b:109).

Table 1. The Petrographic Groups and their Provenance

No.	Vessel Type	Reg. No.	Locus	Petrographic group	Provenance	Fig.*
1	Mortarium	1143/2	151	(D) Ophiolites	Cyp/Aegean	40:11
2	Mortarium	1184/4	171	Undetermined	Cyp/Aegean?	40:9
3	Mortarium	1215/1	171	(D) Ophiolites	Cyp/Aegean	40:17
4	Mortarium	1361/3	163	(D) Ophiolites	Cyp/Aegean	40:14
5	Mortarium	1380/10	178	(D) Ophiolites	Cyp/Aegean	40:16
6	Mortarium	1519	203	Undetermined	Cyp/Aegean?	40:18
7	Heavy bowl	1700/1	250	(D) Ophiolites	Cyp/Aegean	40:23
8	Krater	1717/2	250	(C) Taqiya?	Phoenician coast?	41:3
9	Cooking pot	1348/1	171	(A) *Ḥamra*	Coastal plain	41:6
10	Cooking pot	1516/4	235	(A) *Ḥamra*	Coastal plain	41:7
11	Storage jar	1400	178	(B) Rendzina/*terra rosa*	Local	44:4
12	Storage jar	1132/1	111	Undetermined		44:1
13	Storage jar	1459/1	161	(D) Ophiolites	Cyp/Aegean	44:2
14	Storage jar	1516/3	235	(B) Rendzina/*terra rosa*	Local	44:3
15	Storage jar	1640/2	235	(D) Ophiolites	Cyp/Aegean	43:10
16	Storage jar (holemouth)	1405/3	178	(B) Rendzina/*terra rosa*	Local	42:5
17	Storage jar (holemouth)	1380/2	178	(B) Rendzina/*terra rosa*	Local	42:4
18	Small jar	1292/5	179	(B) Rendzina/*terra rosa*	Local	42:13
19	Small jar	1122/1	126	(B) Rendzina/*terra rosa*	Local	42:12
10	Storage jar	1400/1	178	(B) Rendzina/*terra rosa*	Local	42:10
21	Oil lamp	1386/6	166	(C) Taqiya	Phoenician coast	46:2
22	Oil lamp	1746/2	250	(C) Taqiya	Phoenician coast	46:3
23	Jug	1727	250	(B) Rendzina/*terra rosa*	Local	45:1
24	Juglet	1723/4	250	(C) Taqiya	Phoenician coast	45:6
25	Amphora	1145/1	153	(B) Rendzina/*terra rosa*	Local	45:13
26	Amphora	1380/4	178	(B) Rendzina/*terra rosa*	Local	45:10

* see Covello-Paran, this volume

Group B: Rendzina/Terra Rosa

This group includes ten vessels: seven storage jars, one jug and two amphoras (Table 1: Nos. 11, 14, 16–20, 23, 25, 26). The clay is silty and carbonatic, characterized by a pale brown–grayish color, and exhibits weak optical orientation. The most common component in the silt is chalk (rounded and sub-rounded, up to 20–30% of the matrix). Very few (2–5%) quartz grains appear, and even more rare are rounded, worn-down calcite crystals. Some *foraminiferida* are present in the matrix as well as very few heavy minerals and ores.

The non-plastic components are dominated by rounded to sub-rounded nummulitic chalk (up to 60%), very poorly sorted in a wide range of sizes, and some limestone. In many cases it is possible to discern ‘ghosts’ of straw or other vegetal matter intentionally added as temper. Olivine (very rare) is present, mostly altered to iddingsite. In one case geode quartz was discerned. Also among the inclusions are rounded balls of *terra rosa* containing silt-sized heavy minerals and quartz grains. The *terra rosa* balls, which are characterized by a dark, reddish brown color and appear in a wide range of sizes, are silty and non-carbonatic, ferruginous and almost isotropic.

The raw material of this group can be identified as a combination of *terra rosa* and rendzina soils (Goren 1995:303). *Terra rosa* soil, which is the product of the erosion of limestone rocks exposed over mountainous regions within the Mediterranean climate, is distributed widely in the Judean–Samarian Hills, the Mount Carmel area and the Galilee. Rendzina occurs mainly as a result of erosion and attrition of Eocene and Senonian chalk rocks and marly chalk in Mediterranean climate zones with an average pluvial precipitation of 500–700 mm a year. In Israel, rendzina soils are concentrated mostly in the north of the country: Upper Galilee, around Nazareth and especially in the vicinity of Safed (Ravikovitch 1969:87–88; 1981:19–20). Very often rendzina and *terra rosa* soils are found side by side in very close intercalation.

The immediate geological environment of Ḥorbat Malṭa (the southern bank of Naḥal Ẓippori, northwest of Nazareth) includes all the above-mentioned components (Sneh, Bartov and Rosensaft 1998) within a range enabling profitable exploitation by local potters (Jarman 1972; Browman 1976; Vita-Finzi 1978:83–88; Arnold 1985:49, Fig. 2.5). Therefore, the rendzina/*terra rosa* group at Ḥorbat Malṭa should be considered a local product.

Group C: Taqiya

Three vessels—two oil lamps and a juglet (Table 1: Nos. 21, 22, 24; and possibly a krater, No. 8)—represent this group. The matrix is a light, foraminiferal calcareous clay (marl) in which silty quartz is noted (1–2%), pinkish to orange in color under PPL. Rounded concentrations of iron oxides (limonite) also appear, sparsely distributed. Temper includes sub-angular to rounded quartz crystals (dominant) and rare angular flint, as well as *Amphiroa* sp. Algae, a fossil guide of the Quaternary coast that often appears *in situ* in beach rock formations (Sivan 1996:99). The presence of this fossil in two samples of this group strongly suggests a coastal origin.

The raw material is identified as marl from the Taqiya Formation dated to the Paleocene Age (Bentor 1966:72–73). This clay, which is highly suitable for pottery production, has been widely used in the ceramic industry, especially in the Negev area (Goren 1995:302). Its distribution is widespread throughout the Levant. Outcrops are exposed in the Judean Desert, the northern Negev, the western region of Samaria and the Judean anticlinorium, and even as far as Morocco, Turkey and Egypt, where it is known as Esna Shales Formation (Bentor 1966:73). For this reason, it can not be relied on for a definitive provenance assessment.

This is not the case, however, with the particular combination of Taqiya marl and the non-plastic assemblage described above, which is distinctive. The coraline alga *Amphiroa* sp. Algae, typical of coastal beach rock dated to the Paleocene, occurs in Israel in the recent bioclastic Pleshet and Kurdane Formations (Buchbinder 1975; Sivan 1996:48–53).

In addition, the relatively small amount of coarse quartz grains (coastal sand), very common along the Israeli seashore but decreasing sharply in quantity from Haifa northward, suggests a northern coastal source. Finally, the Senonian or Eocene flint observed in the samples completes the picture. This specific combination points to the only geographical environment that presents, in close proximity, outcrops of Taqiya marl, widespread sub-recent to recent calcareous marine sediments (beach rocks) and Senonian and Eocene flint and chalk of more inland origin. This area, usually defined as the Phoenician Coast, is the Lebanese and Syrian littoral, in particular between Beirut and Lattaqiyeh (Sanlaville 1977:165–167).

The petrographic analysis of this family of vessels fits the description of a group of coarse-ware vessels found in 1980 at Tel Sasa and also attributed to the northern littoral area of Israel and Lebanon (Cohen-Weinberger and Goren 1996:82). Moreover, a rather significant group of vessels found *in situ* inside pottery kilns at Sarafend (Lebanon) were recently analyzed petrographically. The results show a remarkable resemblance with this group from Ḥorbat Malṭa (Bettles 2003; pers. comm.). Other vessels that can be attributed to this petrographic group were recently uncovered at Apollonia-Arsuf

(Gorzalczany 1999:186) and Yavne-Yam (Gorzalczany 2005).

Group D: Ophiolites

Seven vessels—five mortaria and two storage jars (Table 1: Nos. 1, 3–5, 7, 13, 15)—represent this group. The matrix is rather carbonatic, pale pink to yellowish under PPL. A few calcite crystals are discernible, together with silt-sized heavy minerals such as oxyhornblende, olivine, pyroxene, feldspar and mica. Carbonatic oolites are present both in the matrix and among the inclusions. The non-plastic components, which are coarse, include a rich variety of minerals and rock fragments: quartz, limestone and schist as well as arkose, which includes schist and minerals of volcanic origin such as hypersthene. Other igneous rocks and their derived minerals include gabbro, serpentine, dolerite and peridotite.

The lithological combination described above is foreign to the area of the Levant south of Lattaqiyeh. It fits the description of zones where ophiolitic complexes are found. According to the plate tectonics model (Mazor 1994:502), ophiolites are presumed to represent an oceanic crust that has been pushed, pressured and thrust against a continental plate. At the end of the process an ophiolite eventually comprises a thin layer of oceanic sediments (radiolarian chert, clay), overlying basalts, dolerite complexes, gabbros, peridotites and pyroxenites. The ophiolites undergo metamorphism, which often produces greenschist and amphibolite facies.

Such complexes are found in Cilicia, northwestern Syria and Cyprus (Whitechurch, Juteau and Montigny 1984). Further west, ophiolites are common in the Aegean zone. Most of the samples belonging to this group at Ḥorbat Malṭa are heavy bowls and mortaria. Similar vessels from Tell el-Ḥesi, examined by both petrographic and NAA analyses, proved to have been made in a limestone–ophiolitic outcrop environment (Bennett and Blakely 1989:199–203).

Similar vessels of Persian-period date have recently been examined under the petrographic microscope at several sites such as Apollonia-Arsuf (Gorzalczany 1999:186), Yavne-Yam (Gorzalczany 2005:213), Tel Mikhal (Gorzalczany 2006b) and Tel Yaʻoz (Gorzalczany 2006a).[2] At all of these sites, the lithological evidence is homogeneous and almost identical to that from Ḥorbat Malṭa. It seems to point toward a western Cyprus or Aegean Sea source for the raw material, and this is the provenance suggested for the Ḥorbat Malṭa Group D as well.

Summary and Conclusions

The pottery assemblage sampled at Ḥorbat Malṭa can be divided, from a petrographic point of view, into four groups. As expected, there is a major rendzina/*terra rosa* group, which includes mostly amphoras and storage jars. Due to the natural geological environment at the site and the potential raw material available to the potters, nothing precludes a definition of this group as a local product.

Cooking pots comprise a separate group made of *ḥamra* soil tempered with sand inclusions due to technical requirements.

The imported vessels can be divided into two groups: Group C is the middle-range import, assigned a provenance from the littoral area of Syria, Lebanon or northern Israel, known as the Phoenician Coast. This group consists of two oil lamps and a juglet, and perhaps a krater tentatively added to the group based on crushed foraminifers observed in the sample.

The long-range imports, Group D, consist of mortaria and a heavy bowl. Due to the volcanic and ultra-basic minerals observed in both matrix and temper, an ophiolitic environment is suggested as the source of the raw material and therefore as the vessels' provenance. The area that best fits this description is the Aegean Sea region or western Cyprus, which corresponds with the results of sampling conducted by the author at several sites.[3]

Also of significance is the kind of material that was not found within the Ḥorbat Malṭa assemblage. Apart from the apparently local group, it should be noted that there are no traces of material of inland origin among the vessels sampled. The absolute lack of pottery produced in the Judean Hills, the Shephelah, the Negev or other regions of Israel is noteworthy. It seems that the import-trade-exchange patterns at the site were directed overseas or toward the Phoenician Coast, at least during the Persian period.

NOTES

[1] This report is part of my M.A. thesis (Gorzalczany 2003) under the guidance of Yuval Goren, who kindly assisted me throughout all the stages of the present study. The data presented here is preliminary and a final report will be released. I am grateful to Karen Covello-Paran, who allowed me to sample the pottery from Ḥorbat Malṭa.

[2] The petrographic analysis of the Persian-period pottery from Tel Mikhal (excavated by Jonathan Rand and the author in 1996) and Tel Yaʽoz (excavated by Raz Kletter and Orit Segal in 1998) is still in progress. However, a very similar picture emerges from the preliminary data, namely a Cypriot-Aegean provenance for the mortaria sampled at both sites. The author is indebted to Raz Kletter, who kindly allowed him to sample the ceramic assemblage from Tel Yaʽoz (Gorzalczany 2006a).

[3] The sampled mortaria vessels, especially from Persian-period coastal sites such as Tel Mikhal, Apollonia, Tel Yaʽoz and Yavne-Yam, show a remarkable resemblance with the site material. Nevertheless, at inland sites like Jerusalem (the City of David) and Be'er Shevaʽ, the situation seems to be rather similar. The author is deeply grateful to Alon de Groot and Zeev Herzog for their assistance in sampling the ceramic assemblages of the last two sites.

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