Petrographic Analysis of the Pottery from Naḥal Tut

Amir Gorzalczany

In order to determine the provenance of the ceramic assemblage retrieved at Site VIII of Naḥal Tut in the 1993 excavation season (Alexandre, this volume), nine samples of Persian-period wares were selected for petrographic analysis. The results of the analysis were compared with existing data retrieved from the petrographic database of the Laboratory of Comparative Microarchaeology at Tel Aviv University, as well as further studies on Persian-period sites currently in progress.[1]

The samples were examined following standard laboratory procedures (Goren 1995; 1996a; 1996b) and were compared with data from previous studies pertaining to a number of petrographic families related to varied geological environments both in Israel and the Levant (e.g., Porat 1986–1987; 1989a; 1989b; Goren 1992; 1995; 1996; Greenberg and Porat 1996; Goren, Oren and Feinstein 1995). Typical geological and lithological attributes provide the base for provenance assessment. The petrographic groups as identified at Naḥal Tut are presented in Table 1.

Group A: Ḥamra with Coastal Sand

A cooking pot (Fig. 61:2) represents this group in the samples from Naḥal Tut. The matrix is silty, non-carbonatic and highly ferruginous. The color of the clay is brown to red under Plane Polarized Light (PPL), with a weak optical orientation. The raw material used is the *ḥamra* red soil of the central littoral areas of Israel. This soil, usually a member in coastal formations, appears along the coastal plain of Israel from the area of Ashdod northward (Ravikovitch 1969:22–25; 1981:136–152). The inclusions are mostly quartz grains (dominant, poorly sorted, mostly sand sized) with other minerals (zircon, hornblende and feldspar) appearing in minor quantity. The sand used as inclusion, perhaps after purification (by dilution or sieving), reinforces the coastal origin suggested.

The use of *ḥamra* soil as raw material for the manufacture of cooking pots during certain periods is a well-attested phenomenon.

In early times, from the Early Bronze Age I to the end of the Iron Age (see below), cooking

Table 1. The Petrographic Groups at Naḥal Tut and their Provenance

No.	Vessel Type	Reg. No.	Locus	Petrographic Group	Provenance	Fig. No. (see Alexandre, this volume)
1	Cooking pot	1051/1	115	*Ḥamra* with coastal sand	Coastal plain	61:2
2	Cooking pot	2282	275	*Terra Rosa* and calcite	Local	48:4
3	Storage jar	2262/2	275	*Rendzina*	Local	50:6
4	Storage jar	2384/9	283	*Rendzina*	Local	60:12
5	Storage jar	1194/4	143	*Rendzina*	Local	60:6
6	Bowl	1051/8	115	Coastal sand and tuff	Carmel shore	61:1
7	Pilgrim flask	2049	215	Undetermined	Undetermined	62:10
8	Basket handle	2170/1	283	Ophiolites	Cyprus	60:19
9	Mortarium	1072/1	129	Ophiolites	Cyprus	61:7

pots were made mostly of *terra rosa* with the addition of crushed calcite (Goren 1995:303). From the end of the Iron Age and the beginning of the Persian period a technological development is evidenced when potters begin to use *ḥamra* tempered with coastal sand to produce cooking pots (Goren 1995:303; 1996b:109).

Group B: Terra Rosa and Calcite

A cooking pot (Fig. 48:4) represents this group as well. The matrix is silty and non-carbonatic, ferruginous and is characteristically of a dark reddish brown color under PPL. Temper includes angular crushed calcite crystals. The raw material of this vessel can be identified as *terra rosa* soil, produced by erosion of limestone exposed over mountainous regions within Mediterranean climate, typical of the Judean–Samarian hills, the Carmel hill area and Galilee (Ravikovitch 1981:58).

Calcite has served as temper in cooking pots since very early times due to its expansion rate in heat, which is similar to the typical low-fired clay (Arnold 1985:24–26, Fig. 2.1). This property allowed it to withstand repeated cycles of heating and cooling.

Group C: Rendzina

Three storage jars represent this family at Naḥal Tut (Figs. 50:6; 60:6, 12). The matrix is silty, carbonatic and pale brown to gray under PPL, showing a very weak optical orientation. Chalk constitutes 20% to 30% of the matrix, is rounded and poorly sorted, up to sand-sized grains. Quartz is up to 5% of the matrix. More rare are small, worn out calcite crystals. In some cases the matrix is rich in *foraminifers* and ore minerals. The temper includes dominant, rounded to sub-rounded foraminifer rich chalk (40%–60%), in a wide range of sizes, and limestone.

Among the inclusions are rounded balls of *terra rosa*, containing silt-sized heavy minerals and quartz grains. The *terra rosa* balls, which appear in a wide range of sizes, are silty and non-carbonatic, ferruginous and characterized by a dark reddish–brown color, almost isotropic (see above, Group B).

The raw material, of which this group is manufactured, is *rendzina* soil (Goren 1995: 303), which is the result of erosion and attrition of Senonian and Eocene chalk rocks and marly chalk in Mediterranean climate areas, averaging pluvial precipitation of 500–700 mm a year. In Israel the *rendzina* soils are largely concentrated in the northern part of the country: in Upper Galilee, in the vicinity of Naẓerat and particularly in Ẓefat (Ravikovitch 1969:87–88; 1981:19–20). Often both *rendzina* and *terra rosa* outcrop side by side in very close intercalation.

The immediate geological environment at Site VIII in Naḥal Tut includes all the above mentioned components (Sneh, Bartov and Rosensaft 1998). All the minerals and soils mentioned occur within the range of profitable exploitation of raw material by potential local potters (Vita-Finzi 1978:83–88; Jarman 1972; Browman 1976; Arnold 1985:49, Fig. 2.5). Therefore, nothing prevents the identification of the *rendzina/terra rosa* group at Naḥal Tut as of local manufacture.

Group D: Coastal Sand and Tuff

One bowl represents this group (Fig. 61:1). The matrix appears in grayish-brown color under PPL. The non-plastic components are a mixture of pyroclastic rocks, sedimentary rocks and coastal sand. The main temper component are abundant angular to sub-angular quartz crystals, poorly sorted, mostly sand-sized.

Rounded limestone crystals (few), sized 200–250 μ are noted, as well as occasional angular to sub-angular plagioclase (rare), sized up to 180 μ. The inclusions include unique Late Cretaceous volcanoclastic tuffs and their derived minerals, characterized mostly by pyroclastics of basic composition like Juvenile ejecta, xenoliths, and xenocrysts, as well as basaltic flows in a minor role. The only area in Israel where such volcanic activity took place is Mount Carmel and the adjacent areas of the Umm el-Faḥm ridge, as well as at minor spots in the Western Galilee (Sass 1968; 1980). In this area 12 pyroclastic volcanoes were identified and the center of nine of them recognized. The parts of the volcanoes are represented by vent deposits, proximal flanks and distal flanks, each one of them exhibiting a characteristic color ranging from black to yellow, reflecting different degrees of argillization (Sass 1980:8).

The above-described phenomenon cannot be confused with any other volcanic activity in the Southern Levant area. Therefore, the Carmel ridge and the Umm el-Faḥm area are the natural candidates for this vessel's origin. On the grounds of the abundance of coastal sand among the non-plastic fabric components, and since Naḥal Oren and other rivers drain the mentioned components into the coastal plain of the Carmel area, the Carmel shore is proposed as favorite source for the raw material of this bowl.

Group E: Ophiolites

Two vessels, a mortarium (Fig 61:7) and a basket-handle storage jar (Fig. 60:19) represent this group.

The matrix is rather carbonatic, pale pink to yellowish under PPL. Few calcite crystals are discernible, together with silty sized heavy minerals, such as oxyhornblende, olivine, pyroxene, feldspar and mica minerals. 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, schist, and rock fragments, including schist and volcanic-originated minerals as hypersthene. Other igneous rocks and their derived minerals are gabbro, serpentine, dolerite and peridotite.

The lithological combination described above is absolutely alien, foreign to the area of the Levant south of Latteqiyeh. It fits adequately the description of zones where ophiolitic complexes are found. According to the plate tectonics model, 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 includes a thin layer of oceanic sediments (radiolarian chert, clay), overlying basalts, dolerite complexes, gabbros, peridotites and pyroxenites. The ophiolites experience metamorphism, which often produces greenschist and amphibolite facies.

Such complexes are found in Cilicia, northwest Syria and Cyprus (Whitechurch, Juteau and Montigny 1984). Further west, ophiolites are common in the Aegean zone. Most of the Naḥal Tut samples are heavy bowls and mortaria. Similar vessels examined in petrographic and NAA analyses at Tell el-Ḥesi, proved to have been made in a limestone–ophiolitic outcrop environment (Bennett and Blakely 1989:199–203). Recently, similar Persian-period vessels have been checked petrographically at sites, such as Apollonia-Arsuf (Gorzalczany 1999: 186), Yavne-Yam (Gorzalczany 2005), Tel Mikhal (Gorzalczany, this volume [b) and Tel Yaʿoz (Gorzalczany, this volume [a]).[2] In all of these sites the lithological evidence is homogeneous and almost identical to that of Naḥal Tut. It seems to point toward Western Cyprus or the Aegean area as the source of raw material, and this is the provenance suggested for the vessels from Naḥal Tut as well.

SUMMARY AND CONCLUSIONS

The pottery assemblage sampled at Naḥal Tut consists, from a petrographic point of view, of five groups. As expected, there is a major *rendzina/terra rosa* group, which includes storage jars. Due to the natural geological environment at the site and the potential raw material available to the potters, nothing precludes the definition of this group as of local manufacture. A bowl with a Carmel Coast provenance may also be considered local.

Cooking pots can be discussed as of two groups, one of *terra rosa* and crushed calcite and the second of *ḥamra* soil and tempered with sand inclusions. The combinations are due to technical considerations. The first seems to be the earlier technique. The fact that the vessels were found together can indicate a transitional phase when both techniques were in use simultaneously, between the late Iron Age and the Persian period (Goren 1995:303; 1996b:109).

Since the site at Naḥal Tut is firmly dated to the very end of the Persian period on the grounds of the numismatic evidence, it is conceivable that this technological development occurred later than previously assumed.

The imported vessels could be divided into two groups: The first is the close range import, almost local, which is assigned a provenance from the Carmel Coast. A bowl represents the group at Naḥal Tut. The long-range import group consists of a mortarium and a basket-handle jar. The volcanic and ultra-basic minerals in both matrix and temper suggest an ophiolitic environment, which best fits the Aegean Area or Western Cyprus. It is noteworthy that apart from local families traced here, there are no inland-originated materials among the vessels sampled. The lack of pottery originating from the Negev, the Judean hills country, the Shephelah or other regions of Israel is conspicuous. It seems that the trade or exchange patterns at Site VIII of Naḥal Tut were overseas oriented, at least at the very end of the Persian period. This picture concurs with that of a Persian- period site recently checked petrographically: Kh. Malta in Lower Galilee (Gorzalczany, Forthcoming).

NOTES

[1] This report is part of my M.A. thesis (Tel Aviv University). My supervisor, Y. Goren kindly assisted me during the present study. The data presented here is preliminary. I would like to thank Yardenna Alexandre for allowing me to sample the pottery from the Site.

[2] The petrographic analysis of the Persian-period pottery from Tel Mikhal (excavated by Jonathan Rand and the author in 1996; Gorzalczany, this volume [b]) and Tel Yaʽoz (excavated by Raz Kletter and Orit Segal in 1998; Gorzalczany, this volume [a]) was carried out. A rather similar picture emerges from the data, and a Cyprus-Aegean provenance is suggested for the mortaria sampled at both sites. The author is indebted to Raz Kletter for his kind assistance in sampling the ceramic assemblage from Tel Yaʽoz and his useful comments.

REFERENCES

Alexandre Y. This volume. Naḥal Tut (Site VIII): A Fortified Storage Depot from the Late Fourth Century BCE.

Arnold D.E. 1985. *Ceramic Theory and Cultural Process.* Cambridge.

Bennett W.J. and Blakely J.A. 1989. *Tell el-Hesi* III: *The Persian Period (Stratum V)* (ASOR Excavation Reports). Winona Lake.

Browman D.L. 1986. Demographic Correlations of the Wari Conquest of Junin. *American Antiquity* 41:465–477.

Goren Y. 1992. Petrographic Study of the Pottery Assemblage of Munhata. In Y. Garfinkel ed. *The Pottery Assemblage of the Shaʽar Hagolan and Rabah Stages of Munhata (Israel).* Paris. Pp. 329–360.

Goren Y. 1995. Shrines and Ceramics in Chalcolithic Israel—The View Through the Petrographic Microscope. *Archaeometry* 37:287–305.

Goren Y. 1996a. The Southern Levant in the Early Bronze Age IV: The Petrographic Perspective. *BASOR* 303:33–72.

Goren Y. 1996b. Principles of the Petrographic Study of Archaeological Finds and the Application of this Method in the Archaeology of Israel. *Qadmoniot* 29 (112):107–114 (Hebrew).

Goren Y., Oren E. and Feinstein R. 1995. The Archaeological and Ethnoarchaeological Interpretation of a Ceramological Enigma—Pottery Production in Sinai (Egypt) During the New Kingdom Period. In A. Lindahl and D. Stilborg eds. *The Aim of Laboratory Analyses of Ceramics in Archaeology.* Stockholm. Pp. 101–120.

Gorzalczany A. 1999. Petrographic Analysis of the Persian Period Pottery, A Preliminary Report. In I. Roll and O. Tal eds. *Apollonia-Arsuf, Final Report of the Excavations* 1: *The Persian and Hellenistic Periods* (Tel Aviv University Institute of Archaeology Monograph Series No. 16). Tel Aviv. Pp. 185–189.

Gorzalczany A. 2005. Petrographic analysis of Persian Period Pottery from Yavneh-Yam, Preliminary Report. In M. Fisher ed. *Yavneh, Yavneh Yam and its Surroundings*: *Historical and Archaeological Researches*. Tel Aviv (Hebrew). Pp. 209–216.

Gorzalczany A. This volume (a). Petrographic Analysis of the Persian-Period Ceramic Assemblage from Tel Ya'oz.

Gorzalczany A. This volume (b). Petrographic Analysis of the Tel Mikhal (Tel Michal) Pottery.

Gorzalczany A. Forthcoming. Petrographic Analysis of the Persian-Period Pottery at Khirbat Malta—A Preliminary Report. *'Atiqot.*

Greenberg R. and Porat N. 1996. A Third Millennium Levantine Pottery Production Center: Typology, Petrography and Provenance of the Metallic Ware of Northern Israel and Adjacent Regions. *BASOR* 301:5–24.

Jarman M.R. 1972. A Territorial Model for Archaeology: A Behavioral and Geographical Approach. In D.L. Clarke ed. *Models in Archaeology.* London. Pp. 705–733.

Porat N. 1986–1987. Local Industry of Egyptian Pottery in Southern Palestine During the Early Bronze I Period. *Bulletin of the Egyptological Seminar* 8:109–129.

Porat N. 1989a. Petrography of Pottery from Southern Israel and Sinai. In P. de Miroschedji ed. *L'urbanisation de la Palestine à l'âge du Bronze Ancien: bilan et pespectives des recherches actuelles* I. London. Pp. 169–188.

Porat N. 1989b. *Composition of Pottery: Application to the Study of the Interrelations Between Canaan and Egypt During the Third Millennium B.C.* Ph.D. diss., The Hebrew University. Jerusalem.

Ravikovitch S. 1969. *Manual and Map of Soils of Israel.* Jerusalem (Hebrew).

Ravikovitch S. 1981. *The Soils of Israel: Formation, Nature and Properties.* Tel Aviv (Hebrew).

Sass E. 1968. Geology of the Umm el Fahm Area, Northern Israel. *Israel Journal of Earth-Sciences* 17:115–130.

Sass E. 1980. Late Cretaceous Volcanism in Mount Carmel, Israel. *Israel Journal of Earth-Sciences* 29:8–24.

Segal O. Kletter R. and Ziffer I. This volume. A Persian-Period Building at Tel Ya'oz (Tell Ghaza).

Sneh A., Bartov Y. and Rosensaft M. 1998. *Geological Map of Israel 1:200.000.* Jerusalem.

Vita-Finzi C. 1978. *Archaeological Sites in their Setting*. London.

Whitechurch H., Juteau T. and Montigny R. 1984. Role of the Eastern Mediterranean Ophiolites (Turkey, Syria, Cyprus) in the History of Neo-Tethys. In J.E. Dixon and A.H.F. Robertson eds. *The Geological Evolution of the Eastern Mediterranean.* Oxford. Pp. 301–317.