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Petrographic Examination of Selected Pottery Vessels from the al-Waṭṭa Quarter, Safed (Ẓefat)

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Introduction

Archaeological excavations in the al-Waṭṭa quarter in Safed (Ẓefat) unearthed a significant pottery collection dated to the Mamluk period (see Dalali-Amos and Getzov, this volume). Twenty-two ceramic vessels of different types, including plain and glazed cooking and table wares, were selected for the petrographic examination (Table 1).

Prior to the petrographic study, the samples were examined under a stereoscopic microscope at magnifications of ×20 to ×40. Then, thin-sections were prepared and examined under a Nikon petrographic (polarizing) microscope at magnifications of ×20 to ×200 and sorted into petrographic groups according to their lithological and technological properties. The description of the thin-sections was made following standard procedure (Whitbread 1986; Orton, Tyers and Vince 1993) and the observed data were compared with the geologic and pedologic settings of the area in the vicinity of the site (Blake and Goldschmidt 1947; Bentor 1966; Ravikovitch 1969; Neev, Bakler and Emery 1987; Levitte and Sneh 2013).[1]

Previous petrographic examinations of contemporary wares from Ḥorbat Manot (Shapiro 2001), Umm el-Faraj (Ben 'Ami) (Getzov, Stern and Shapiro 2016) and Khirbat Din'ila (Shapiro 2014), dated to the Mamluk period, provided comparative material for the analysis.

The Geological Setting of the Vicinity of Safed

The city of Safed is located in the Eastern Upper Galilee, on the northwestern slope of the Safed mountain block. This block is dominated by mountains (the highest being Mount Canaan, 955 m asl), which are traversed by the deep valleys of Naḥal Dalton and Naḥal

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[1] The essential raw materials of a ceramic product are clay, which can be primary—originated while bedrock decompositions are *in situ*, or secondary—sedimentary; water, of which soluble salts can be incorporated in the clay; and non-plastic elements of sand-size that can be naturally present in the clay or added by the potter to improve the quality of the clay paste ('tempers') (Orton, Tyers and Vince 1993:113–117). 'Tempers' can be either natural, such as sand or straw, or artificial, like crushed rock or potsherds ('grog'). The petrographic analysis determines the mineralogical composition of both matrix and tempers, as well as technological aspects of the pottery-making process, such as its firing temperature.

Table 1. The Pottery Samples according to Petrographic Groups

Sample No.	Locus	Basket	Vessel	Petrographic Group	Figure No. (see Dalali-Amos and Getzov, this volume)
1.1	230	2549/2	Bowl	I.1	61:2
1.2	205	2121/3	Bowl	I.1	42:1
1.3	205	2051	Cooking pot	I.3	59:6
1.4	102	1002/1	Bowl	I.1	64:2
1.5	41	103	Bowl	I.1	64:3
1.6	125	1106/3	Jug	II	49:2
1.7	223	2382/2	Bowl	I.1	64:6
2.1	244	2597/1	Bowl	II	41:3
2.2	113	1084/1	Jug	I.1	52:5
2.3	131	1131/1	Bowl	II	41:15
2.4	213	2280/2	Jar	II	45:8
2.5	267	2423	Bowl	II	41:16
2.6	203	2067/2	Baking dish	I.1	58:2
2.7	212	2070/2	Jar	III	47:5
3.1	101	1003/3	Bowl	I.2	65:4
3.2	213	2206	Jug spout	I.2	52:7
3.3	211	2191/5	Bowl	I.2	52:1
3.4	117	1090	Bowl	I.2	52:2
3.5[i]	221/3	2330/1	Juglet		52:6
3.6	231/232	2530/1	Juglet	I.2	52:8
3.7	232	2533/1	Jug	I.2	52:4
3.8	101	1003/1	Bowl	I.2	52:3

[i] Sample 3.5 was not assigned to any of the petrographic groups as its matrix is completely vitrified (firing temperature estimated at 1000º C). Very few silty quartz grains can be seen in the milky greenish gray groundmass. The *terra rosa* nodules can hardly be distinguished by their boundaries or by the presence of larger quantities of silt.

‘Amud and its tributaries from the north, west and south, and by the Korazim Plateau from the east. The Safed Block seems to be less eroded than the neighboring Mount Meron. Its highest peaks are formed by Eocene chalky limestone and chalk of the Timrat Formation, underlayered by bituminous shales and marls of the Taqiya Senonian Formation, and chalky limestone with flinty facies of the Ghareb Paleocene Formation. Lower, in the deep gorges, crop out hard limestone and coarse crystalline dolomite of the Saḥnin and Bina Cenomanian and Turonian Formations (Blake and Goldschmidt 1947; Levitte and Sneh 2013).

RESULTS

Based on the petrographic examination of the pottery assemblage from the al-Waṭṭa quarter, three petrographic groups were identified.

Group I

Most of the examined samples (15 of 22) belong to this petrographic group (Table 1). They are characterized by a ferruginous silty clay matrix, in which the silt is represented by angular to sub-rounded quartz grains, composing c. 12% of its volume. Minute ore specks are present in smaller-than-quartz quantities, and tiny flakes of dark mica (biotite) and silty oxyhornblende are rare. The group was subdivided into three subgroups.

Subgroup I.1. Seven vessels form this subgroup (Sample Nos. 1.1, 1.2, 1.4, 1.5, 1.7, 2.2, 2.6; Table 1). Their matrix comprises clay minerals that show optical activity from 'slightly birefrigent' to 'passive'. Therefore, the firing temperature of most of the samples of this subgroup is estimated at 800–850º C (excluding Samples 1.2 and 1.4 that were fired at 750–800º C). The firing temperature of Sample 2.6 (baking dish) could not be estimated with certainty since the vessel suffered from reheating while in use, resulting in a variety of colors in the sherd's cross-section. Beginning from the outer surface, the half thin-section is black and only sand-sized components can be identified; toward the inner surface of the vessel, the half thin-section is slightly vitrified.

Sand-sized non-plastic inclusions are fine-grained (0.1–0.4 mm), well-sorted and compose 2–4% of the sherds' volume, except for Sample 2.6, with c. 7% sand. These inclusions comprise mostly rounded to sub-rounded grains of quartz, chalk or chalky limestone, and ferruginous ooliths, some of them with silt-sized quartz nuclei. Rare sub-rounded grains of siltstone with ferric cement are as large as 0.5 × 0.7–2.0 × 1.0 mm, and nodules of pure ferruginous clay are sporadic. Sample 1.5 contains a few sub-rounded grains of chert. All the above-mentioned non-plastics could have been naturally present in the clay or added by the potter. Elongated particles of both sand and silt size, are oriented parallel to the surface of the vessel. This can point to the relatively high speed of the potter's wheel.

Subgroup I.2. The seven vessels included in this subgroup (Sample Nos. 3.1–3.4, 3.6–3.8; Table 1) are characterized by a matrix, in which clay minerals lost their optical properties and, in some cases, are vitrified due to firing conditions. Firing temperature for all the vessels in this subgroup is estimated at more than 850º C. The exception is Sample 3.8, which was fired at about 950º C, resulting in the almost complete vitrification of its matrix.

Non-plastic inclusions are the same as those of Subgroup I.1, but are present in lesser quantities (1–2% of the sherds' volume). Ferruginous ooliths are very rare and rather small (<0.3 mm).

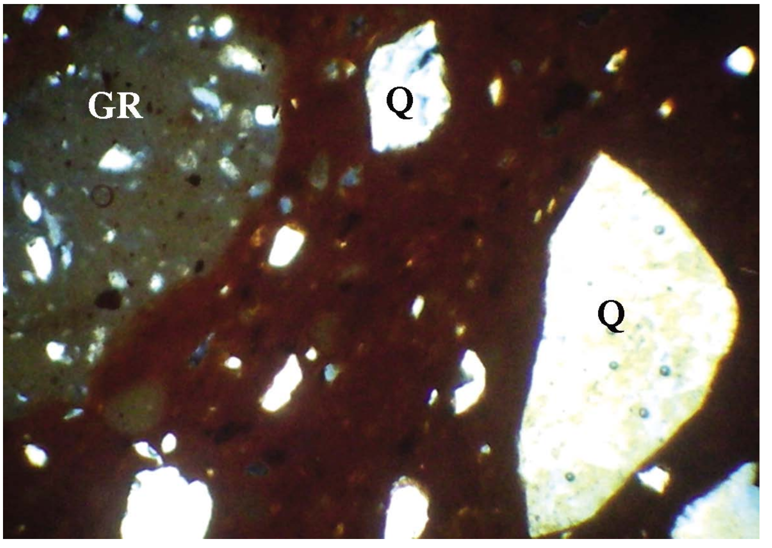

Fig. 1. Sample 1.3 (Group I.3). Magnification ×50, CPL, field width 1.5 mm; Q = angular quartz grain; GR = grog inclusion.

Subgroup I.3. Only one cooking pot belongs to this subgroup (Sample No. 1.3; Fig. 1; Table 1). Its matrix, similar to that of Subgroups I.1 and I.2, contains only 4–5% of quartz silt (all other silt-sized components are the same). Firing temperature here is estimated at 800–850ºC as the clay minerals of the matrix are optically passive and show the first stages of vitrification.

Sand-sized inclusions compose c. 7% of the sherd's volume, and are dominated by quartz, whose grains vary in size between 0.1 and 1.2 mm. Smaller quartz grains are rounded to sub-rounded, and the larger ones are angular to sub-angular, appearing as if the large rounded grains were crushed. Grog varies in size between silt (<0.05 mm) and coarse sand (1.0 × 1.2 mm) size. It is vitrified due to double firing (Fig. 1). Hence, it is safe to assume that the potter deliberately added these materials to the clay. Several ferruginous ooliths and fragments thereof, as well as several chert grains, are also present in the thin-section. These might be natural components of the clay.

The lithology of the vessels attributed to petrographic Group I points to geological formations containing shale and siltstone. The ferruginous ooliths are typical of the Lower Cretaceous formations (Bentor 1966:2). These formations, or the soils developing on top of them, are known to have been used for the production of pottery vessels since the Neolithic period (Goren 1995:302–303) and on through the Early Bronze Age (Greenberg and Porat 1996:15–17), Roman (Wieder, Adan-Bayewitz and Asaro 1994:312, 314; Wieder and Adan-Bayewitz 1999:334) and Crusader (Waksman et al. 2008; Shapiro 2012:107) periods. Outcrops of the Lower Cretaceous formation located closest to the site are in the Ḥananya Valley in Western Galilee, and on the western side of the Ḥula Valley, under the Manara

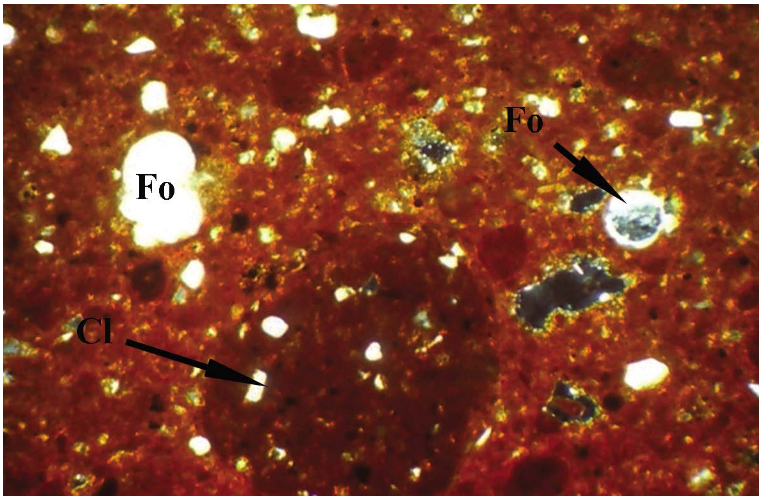

Fig. 2. Sample 1.6 (Group II). Magnification ×50, CPL, field width 1.5 mm; Fo = foraminifera; CL = nodule ferruginous clay.

Cliff, both distant c. 15 km as the crow flies from the site, to the south–southwest and north–northeast respectively. More distant outcrops are in the Mount Ḥermon foothills, in the southern Lebanon Range, in the vicinity of Beirut and in Transjordan (Dubertret 1945; Dubertret et al. 1955; Sneh, Bartov and Rosensaft 1998). Accordingly, one of these areas could be the possible place of origin of the vessels of this petrographic group.

The division into three subgroups might imply that the same geologic formations were quarried from different locations, or, that the raw material was prepared using different methods, i.e., it was more carefully sifted or washed for Subgroup I.2, or tempered by coarse non-plastics for Subgroup I.3. Also, the possibility of several pottery workshops can not be ruled out.

Group II

This group comprises five vessels (Sample Nos. 1.6, 2.1, 2.3–2.5; Table 1). Their matrix is ferruginous and slightly calcareous. The clay contains some silty quartz (less than 3% of the volume of the matrix) and c. 5% of foraminifers and fragments thereof (Fig. 2). When identifiable, most of the foraminifers date to the Eocene-Paleocene age; rare specimens are of Upper Cretaceous age (*Heterohelix*). In Sample 2.5 there are two *Echinoidea* spines. Firing temperature is estimated at 750–800ºC as clay minerals are optically passive, but there are no signs of vitrification.

Sand-sized non-plastic inclusions comprise about 5% of the sherds' volume, and are represented by rounded to sub-rounded quartz grains, varying in size between 0.2 × 0.3 and 0.3 × 0.8 mm (except for Sample 2.3, where quartz is absent), and nodules of ferruginous silty clay, ranging between 0.2 and 1.0 mm in diameter (Fig. 2). It seems that dry *terra rosa* soil was added to the clay to improve its quality.

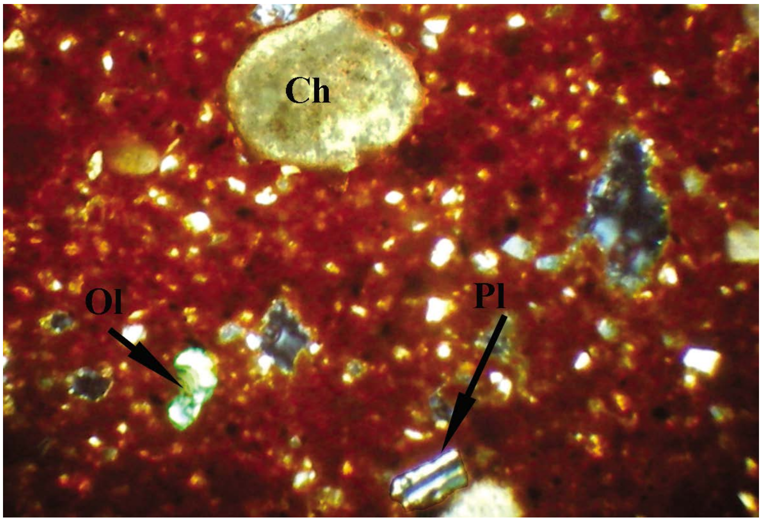

Fig. 3. Sample 2.7 (Group III). Magnification ×50, CPL, field width 1.5 mm; Pl = plagioclase grain; Ol = olivine grain; Ch = chalk ball.

Such a temper-and-matrix composition matches foraminiferous rendzina soils that develop atop Upper Cretaceous to Eocene chalks and chalky limestones, and also the foraminiferous Taqiya marl. This marl is widespread throughout the southeastern Mediterranean (Bentor 1966:72–73) and was intensively quarried for pottery production from the early stages of human activity, such as the Chalcolithic period, and even earlier (Goren 1991; 1992; 2004; Shapiro 2017). In Galilee, it crops out at four spots—near Lavi, near Safed, near Aḥihud and near Ya‘ara (Sneh 2000:3).

Group III

This petrographic group is represented by one jar (Sample No. 2.7; Fig. 3; Table 1). Its matrix is ferruginous clay with tiny ore specks, silty plagioclase and quartz, with lesser quantities of iddingsite and olivine. Silt comprises about 7% of the volume of the matrix, and the firing temperature is estimated at 750–800ºC based on the optical passivity of the clay minerals of the matrix.

Sand-sized inclusions are c. 5% of the volume of the sherd, and comprise mostly chalk balls ranging between 0.1 and 0.4 mm (Fig. 3). Rounded and subrounded (0.2–0.3 mm) grains of basalt, the minerals derived from it, and shell fragments with a well-visible lamellar inner structure, are rare in the thin section.

It is plausible that the raw material used for these pottery vessels was the Basaltic Brown Mediterranean soil, to which some chalk powder could be added by the potter to improve the quality of the clay. This soil originates from the erosion and weathering of the Pliocene-Pleistocene and/or Miocene basalts that are characterized by olivine altered to iddingsite, and many iron oxides (Williams-Thorpe et al. 1991:34–35), and are common in the Jordan Valley of Upper Galilee, the Golan Heights, the Korazim Plateau, around the Sea of Galilee and in the hilly area confined by Mount Adami in the north and Naḥal Ḥarod in the south (Ravikovitch 1969; Sneh, Bartov and Rosensaft 1998).

CONCLUSIONS

The petrographic examination of the Mamluk-period pottery assemblage from al-Waṭṭa, Safed, revealed that most of the vessels are not of local provenance. The nearest outcrops of the Lower Cretaceous—suggested as parent materials for the vessels assigned to Group I—are in the Ḥananya Valley and below the Manara Cliff; however, no pottery workshops are known to have operated there during the Mamluk period. Other, more distant, outcrops for the Group 1 material are in the Mount Ḥermon foothills, in the southern Lebanon Range, near Beirut, and in Transjordan. Therefore, a pottery workshop of this date should be seeked for in one of these locations.

Based on the geological environs of Safed (Levitte and Sneh 2013), a local provenance is suggested for petrographic Group II. A comparison between the thin-sections of samples from vessels assigned to Group II in Safed to thin-sections of samples of Mamluk-period pottery from Khirbat Din‘ila, Umm el-Faraj and Ḥorbat Manot, reveals a high degree of similarity, thus supporting the existence of a local pottery workshop.

The Basaltic Brown Mediterranean soil, suggested as the raw material for Group III, points to a source in the Jordan Valley of Upper Galilee, the Golan Heights or the Korazim Plateau.

REFERENCES

Bentor Y.K. 1966. *The Clays of Israel: Guide-Book to the Excursions (The International Clay Conference, 1966, Jerusalem, Israel).* Jerusalem.

Blake G.S. and Goldschmidt M.J. 1947. *Geology and Water Resources of Palestine*. Jerusalem.

Dalali-Amos E. and Getzov N. This volume. Remains from the Mamluk Period in the al-Waṭṭa Quarter, Safed (Ẓefat).

Dubertret L. 1945. *Carte géologique de Beyrouth (1:50.000)*. Beirut.

Dubertret L., Keller A., Vautrin H., Birembault C., Heybroek H.F., Canaple G., Combaz A., Mandersheid G. and Renouard G. 1955. *Cartes géologiques du Liban 1/200 000: Avec notice explicative*. Beirut.

Getzov N., Stern E.J. and Shapiro A. 2016. Umm al-Faraj (Moshav Ben ‘Ami). *HA–ESI* 128 (October 2). http://www.hadashot-esi.org.il/Report_Detail_Eng.aspx?id=25068&mag_id=124 (accessed September 4, 2017).

Goren Y. 1991. *The Beginnings of Pottery Production in Israel: Technology and Typology of Proto-Historic Ceramic Assemblages in Eretz Israel (6th–4th Millennia B.C.E.)*. Ph.D. diss. The Hebrew University. Jerusalem (Hebrew; English summary, pp. 6*–19*).

Goren Y. 1992. Petrographic Study of the Pottery Assemblage from Munhata. In Y. Garfinkel. *The Pottery Assemblages of the Sha'ar Hagolan and Rabah Stages of Munhata (Israel)* (Les Cahiers du CRFJ 6). 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. 2004. Technological Study of the Ceramic Assemblage from Nevè Yaraq, Lod. *'Atiqot* 47:51–55.

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.

Levitte D. and Sneh A. 2013. *Geological Map of Israel 1:50000*; *Sheet 2-III (Zefat)* (Geological Survey of Israel). http://www.gsi.gov.il/eng/?CategoryID=253&ArticleID=760&dbsAuthToken (accessed September 4, 2017).

Neev D., Bakler N. and Emery K.O. 1987. *Mediterranean Coasts of Israel and Sinai: Holocene Tectonism from Geology, Geophysics and Archaeology*. New York.

Orton C., Tyers P. and Vince A. 1993. *Pottery in Archaeology.* Cambridge.

Ravikovitch S. 1969. *Soil Map 1:250000 Israel, North* (Survey of Israel). Jerusalem.

Shapiro A. 2001. Petrographic Analysis of Sugar Vessels from Lower Ḥorbat Manot. *'Atiqot* 42:311–315.

Shapiro A. 2012. Petrographic Analysis of the Crusader-Period Pottery. In E.J. Stern. *'Akko* I, 1. *The 1991–1998 Excavations: The Crusader-Period Pottery: Text* (IAA Reports 51/1). Jerusalem. Pp. 103–126.

Shapiro A. 2014. Petrographic Study of Selected Mamluk-Period Pottery from Khirbat Din'ila. *'Atiqot* 78:105–112.

Shapiro A. 2017. Petrographic Examination of Intermediate Bronze Age Storage Vessels from Murḥan, a Site in the Ḥarod Valley. *'Atiqot* 89:29–34.

Sneh E. 2000. The Stratigraphy of the Western Galilee: Field Trip 1. In S. Wdowinski ed. *'Field Trips Guidebook' of the Annual Meeting of the Israel Geographical Society*. Ma'alot (Hebrew).

Sneh A., Bartov Y. and Rosensaft M. 1998. *Geological Map of Israel 1:200000, Sheet 1* (Israel Geographical Society; 4 sheets). Jerusalem.

Waksman S.Y., Stern E.J., Segal I, Porat N. and Yellin J. 2008. Elemental and Petrographic Analyses of Local and Imported Ceramics from Crusader Acre. *'Atiqot* 59:157–190.

Whitbread I.K. 1986. The Characterization of Argillaceous Inclusions in Ceramic Thin Sections. *Archaeometry* 28:79–88.

Wieder M. and Adan-Bayewitz D. 1999. Pottery Manufacture in Early Roman Galilee: A Micromorphological Study. *Catena* 35:327–341.

Wieder M. and Adan-Bayewitz D. 2002. Soil Parent Materials and the Pottery of Roman Galilee: A Comparative Study. *Geoarchaeology* 17:393–415.

Wieder M., Adan-Bayewitz D. and Asaro F. 1994. Source Materials, Micromorphology, and the Provenance of the Storage Jars from Roman Galilee. In A.J. Ringrose-Voase and G.S. Humpreys eds. *Soil Micromorphology: Studies in Management and Genesis (Proceedings of the Ninth International Working Meeting on Soil Micromorphology, July 1992, Townsville, Australia)* (Developments in Soil Science 22). Amsterdam. Pp. 307–316.

Williams-Thorpe O., Thorpe R.S., Elliott C. and Xenophontos C. 1991. Archaeology, Geochemistry, and Trade of Igneous Rock Millstones in Cyprus during the Late Bronze Age to Roman Periods. *Geoarchaeology* 6:27–60.