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Petrographic Examination of Selected Vessels from Tel Bira

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Seven pottery vessels retrieved from the Middle Bronze Age IIB–C site at the foot of Tel Bira (see Feig, this volume) were selected for petrographic analysis, with the aim of identifying the production sources of significant types (Table 1).

Thin sections were prepared and examined under a Nikon petrographic microscope at magnifications of ×20–×200, following standard procedure (Whitbread 1986). The mineralogical composition of the non-plastic inclusions in the fabric was determined, and the data was compared with the geological settings of the excavated site and its vicinity, and with petrographic thin-sections of pottery from a number of archaeological sites in northern Israel.

Geology and Lithology in the Vicinity of the Site

Tel Bira is situated on the border of the ʿAkko plain and the western Galilee hills (80–120 m asl), which were formed by tectonic activity followed by erosion processes. The site, at the foot of the western slope of Givʿat Yavor (80 m asl), sits on limonitic chalk of Ghareb formation and marl of Taqiye formation. The eastern slope of Givʿat Yavor comprises nari chalk and Kabri marl of the Aḥihud member of the Menuḥa formation, both of them part of the Mount Scopus group of the Senonian Age (Sneh 2008). On the west, the tell borders the Quaternary alluvium of the ʿAkko plain.

About 1 km northeast of Tel Bira, the Miocene-Pleistocene conglomerates of the Bet Nir formation are exposed, and at approximately the same distance to the north, there are outcrops of clays and chalks of the Paleocene Taqiye formation. Pedologically, the site is also on a border—between alluvial and colluvial-alluvial calcareous soils, the Mediterranean brown forest soils, and mountainous rendzina soils enriched with lime (Ravikovitch 1969). About 1 km to the west, these soils are replaced by the vertisoils (brown alluvial soils) that

Table 1. Thin-Section Samples

Sample No.	Vessel	Locus	Basket	Fig. No. (see Feig, this volume)	Petrographic Group and Provenance
1	Bowl	137	1090/11	20:5	1—Local to Tel Bira
2	Bowl	137	1090/4	20:7	1—Local to Tel Bira
3	Figurine	209	2039	21:1	2—Local to Tel Bira
4	Bowl	137	1090/6	20:3	3—Coast between ʿAkko and Rosh Ha-Niqra
5	Bowl	137	1090/1	20:6	3—Coast between ʿAkko and Rosh Ha-Niqra
6	Bowl	137	1091/10	20:9	3—Coast between ʿAkko and Rosh Ha-Niqra
7	Jug	150	1126	16:1	4—Northern coast of Syria

cover most of the ʻAkko plain. *Terra rossa* soil appears about 2 km to the east, on top of the hills of the western Galilee. About 1 km south of Aḥihud the perennial Ḥilazon stream runs west toward the Mediterranean, supplying the water necessary for pottery manufacture.

Results and Discussion

Four petrographic groups were identified.

Group 1. Two bowls belong to this group (B1090/11 and B1090/4; Table 1:1, 2). Their matrix is clean and dense, ferruginous and a little calcareous, with rare occurrences of silty quartz, tiny nodules of ferruginous clayey material and silt-size carbonate material (Fig. 1). Non-plastics are represented by occasional rounded limestone grains, chalk balls and nodules of ferruginous clay. All these vary in size between 0.3 and 0.8 mm and account for no more than 3% of the sherd's volume. Firing temperature is estimated as 700–750ºC.

The raw material for this group probably originated in the local vertisoils of the ʻAkko plain (personal observation; Ravikovitch 1969), with some ferruginous clay admixed. The high density of the sherd and the well-levigated matrix indicate skilled potters, who knew how to manipulate the ceramic paste (i.e., levigation, sifting, soaking etc.) to produce a high quality product. Although no Middle Bronze Age kiln has been found in the vicinity of Tel Bira, there is no doubt about the local provenance of these bowls.

Group 2. One fragment of a figurine belongs to this group (B2039; Table 1:3); it has a ferruginous and rather silty matrix with some tiny opaque specks of iron oxide. The silt is mostly quartz, with lesser quantities of carbonate material and rare plagioclase.

Non-plastc inclusions are represented by a few fine (0.2–0.4 mm), rounded quartz grains and several coarse grains (0.8–2.0 mm) of chalk, limestone and ferruginous silty clay (Fig. 2). It is not possible to say if this small quantity of inclusions was not sifted out of the original clay, or was added to it. Some rounded and elongated voids surrounded by grayish aureole are the only evidence of organic material that was added to the paste, intentionally or not, and burnt-off during firing. Taken in conjunction with a thick gray core, the aureoles also point to reducing atmosphere during firing at an estimated temperature of 700–750ºC.

Terra rossa soil from the nearby hills, with no added temper (Ravikovitch 1969), seems to have been used in the manufacture of this figurine. Local production is therefore assumed.

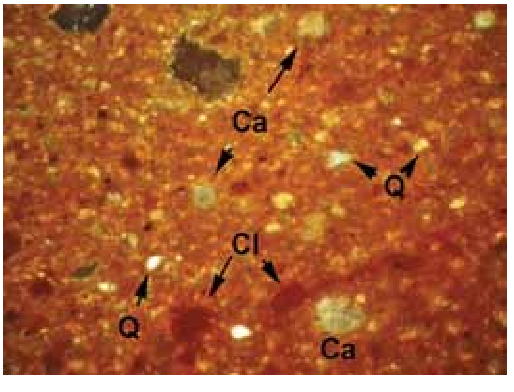

Fig. 1. Group 1, microphotograph of a thin section (bowl, Table 1:1). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz, Ca = carbonate material, Cl = clay.

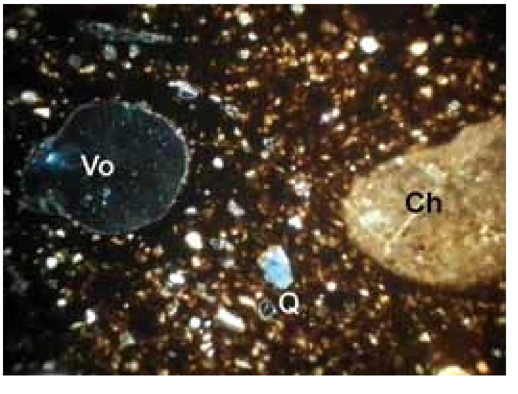

Fig. 2. Group 2, microphotograph of thin section (figurine, Table 1:3). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz, Ch = chalk, Vo = void.

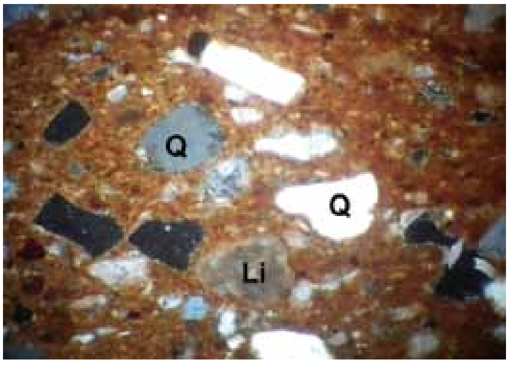

Fig. 3. Group 3, microphotograph of a thin section (bowl, Table 1:4). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz, Li = limestone.

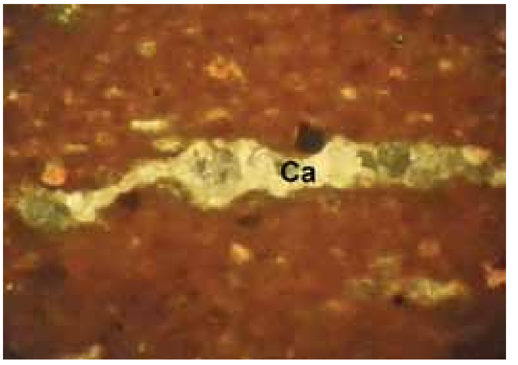

Fig. 5. Group 3, microphotograph of a thin section (bowl, Table 1:5). Photograph width 1 mm, magnification ×50, plain polarized light. Ca = calcite filling a crack.

Fig. 4. Group 3, microphotograph of a thin section (bowl, Table 1:5). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz, Vi = vitrified surface of the vessel.

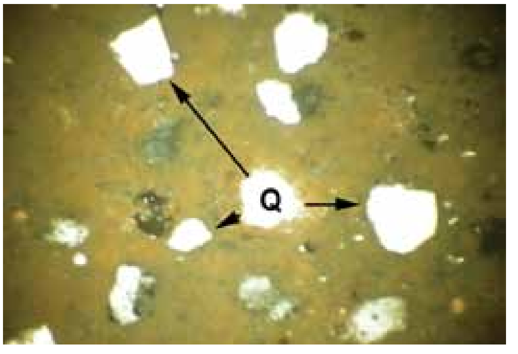

Fig. 6. Group 3, microphotograph of a thin section (bowl, Table 1:6). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz.

Group 3. The three bowls in this group (B1090/6, B1090/1, B1091/10; Table 1:4–6) have a calcareous ferruginous matrix, with small quantities of silty quartz and very dark brown to black opaque specks of iron oxide. Non-plastic inclusions—mostly quartz, with the rare occurrence of chert and limestone grains, and with aquatic shells fragments—account for about 12–15% of the sherd's volume, and may therefore be intentionally added temper. The grains are sub-angular to rounded, with a size range of 0.2–0.5 mm (Fig. 3). Larger chalk bodies and dark, reddish brown silty nodules of *ḥamra* soil (diam. c. 1 mm) are sporadically present.

The estimated firing temperature is different for each bowl. Sample B1090/6 has a slightly vitrified surface, possibly due to brief dipping in salt water just before firing, and the estimated firing temperature for it is 700–750ºC. Sample B1090/1 has a more pronounced surface vitrification, with a well-defined vitrified layer, 0.2–0.4 mm thick (Fig. 4), and the estimated firing temperature for it is close to 800ºC. Tiny cracks in this sample were filled post-depositionally with crystalline calcite (Fig. 5). A firing temperature of above 900ºC is estimated for sample B1091/10, because its matrix is completely vitrified, milky and greenish in transmitting polarized light (Fig. 6), and only

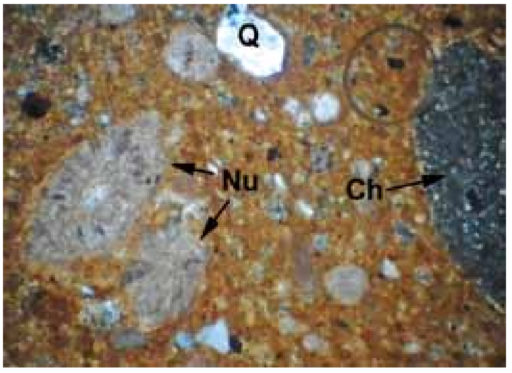

Fig. 7. Group 4, microphotograph of a thin section (jug, Table 1:7). Photograph width 1 mm, magnification ×50, plain polarized light. Q = quartz, Ch = chert, Nu = nummulites.

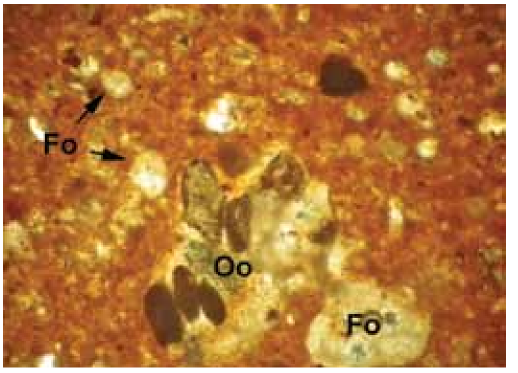

Fig. 8. Group 4, microphotograph of a thin section (jug, Table 1:7). Photograph width 1 mm, magnification ×50, plain polarized light. Fo = single foraminifers and foraminiferous chalk, Oo = oolithic limestone.

voids indicate the previous presence of carbonate inclusions, which were completely burnt off.

The brown-red sandy soils along the coast between ʻAkko and Rosh Ha-Niqra (Ravikovitch 1969) are most probably the origin for this group, with some calcareous material admixed into the paste. Nevertheless, the quartz sand that was part of the non-plastic components is characteristic of the coast south of ʻAkko (Nir 1989:12–15; Yannai, Gorzalczany and Peilstöcker 2003:105). The vitrified surface of the vessels was produced by pre-firing dipping in sea water (Rice 1987:88; Orton, Tyers and Vince 1993:115–116; Shapiro 2012:105, 125).

All three bowls could have been manufactured within the northern coastal plain of Israel. The samples show a high degree of petrographic similarity to thin sections of vessels from the pottery kilns that were excavated at Akhziv (Avshalom-Gorni 2006) and from the pottery kiln that was surveyed at Khirbat Masref (Frankel and Getzov 1997), as well as a bowl from ʻAkko (Shapiro 2012). Although the kilns in Akhziv and Khirbat Masref date to the Late Roman–Byzantine periods, and the bowl from ʻAkko to the Crusader period, I consider the comparison valid, demonstrating that the same sources of raw materials were used throughout the ages in the area between ʻAkko and Rosh Ha-Niqra.

Group 4. One jug belongs to this group (B1116; Table1:7). It is characterized by a calcareous matrix containing small quantities of silty feldspar and tiny opaque specks of iron oxide. There are also several silt-sized quartz grains. The non-plastic inclusions in this sample fall into one of two categories: fine-sized grains (0.1–0.3 mm), which are mostly foraminifers and chalk with (rare) rounded quartz, calcareous ooliths, nummulites (Fig. 7) and sub-rounded to rounded grains of volcanic glass; coarse-size grains (0.7–1.0 mm), which are foraminiferous chalk, oolithic chalk (Fig. 8), crystalline limestone, chert and fossiliferous shells fragments. Altogether, the non-plastic inclusions constitute about 5% of the volume of the sherd; they could be a natural occurrence in the clay (the fine fraction), or may have entered it by chance (the coarse fraction). Due to the optical properties of the matrix and the carbonate minerals, firing temperature was estimated as maximum 700ºC.

The lithological affinities suggest that the source for this group was probably a sea shore of nummulitic limestones, which is part of a drainage system that carries rounded grains of volcanic glass. The closest area to Tel Bira that matches these requirements is the Mediterranean coast of Syria to the north of Jableh (Mikhailov and Ponikarov 1986).

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