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Petrographic Examination of Tiles, Bricks and Mortaria from Legio

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Introduction

Numerous complete and fragmentary ceramic tiles—*tegulae* roof tiles and square floor tiles—as well as bricks, were unearthed in Area B at Legio (Abu-'Uqsa 2016:11–14; see Tepper, this volume: Fig. 2).[1] Of these, eight *tegulae* and two bricks bear Roman legion stamps (see Tepper, this volume: Fig. 3). An initial, naked-eye examination of their fabric revealed that it differs from that of imported *tegulae*, which are known from a number of Roman-period burial sites in Galilee, where they were frequently used for covering ceramic sarcophagi (Aviam and Stern 1997; Shapiro 1997). Since this suggested a different provenance for the Legio assemblage, a petrographic study was conducted with the aim of establishing the mineralogical composition of these *tegulae* and bricks, and suggesting a plausible place for their manufacture.

First, all *tegulae* fragments were examined with the aid of a ×10 magnifying glass for a preliminary assessment of the degree of homogeneity of their fabric composition. Then, 14 specimens were selected for petrographic analysis: eight *tegulae* and two bricks that bear Roman legion stamps (Table 1:1–10); two un-stamped *tegulae* (Table 1:11, 12), whose fabric seemed different in the initial examination; and two mortaria (Table 1:13, 14) unearthed in nearby Kefar 'Otnay, 300 m to the southeast of Legio (Abu-'Uqsa 2016:3–6, Area A), which were examined to provide comparison. Of the stamped *tegulae*, six bear a Legio VI Ferrata stamp (Table 1:1–6) and two more are questionable (Table 1:8, 9). Of the bricks, one bears a Legio II Traiana stamp (Table 1:7) and the other seems to bear a similar stamp (Table 1:10).

Analysis

Thin-sections were prepared and examined under a polarizing microscope at magnifications ranging between ×20 and ×200. The thin-sections were described according to Whitbread's (1986:80) charts and tables. The following parameters were examined: the mineralogy and approximate amount of silt-sized material and optical properties of the matrix; the mineralogy of non-plastic inclusions and their volume; and grain size, shape and sorting. Firing temperature was estimated according to mineralogical changes (Shapiro 2016:83).

The resulting petrographic data was examined against the lithology of the site and its surrounding area, as indicated on geological maps (Sneh, Bartov and Rosensaft 1998) and in geological reports (Blake and Goldschmidt 1947), and as observed in a field survey conducted by the author in the vicinity of the site. Previously examined petrographic thin-sections of Roman-period *tegulae* and mortaria bowls from a number of archaeological sites were used for comparison.

The results of the petrographic examination (Table 1; Figs. 1, 2) indicate that all the sampled items form a homogeneous petrographic group. The matrix is a calcareous fossiliferous clay containing some tiny, opaque stains of iron oxide and a small amount of silt, which comprises basalt-deriven minerals. Some of the microfossil skeletons within the matrix have a ferric filling; in one case (No. 10), they

Table 1. Inventory of the Thin-Sections

No.	Item	Locus (Area B)	Basket	Figure No.		Stamp	Legion	Thin-Section No.	Estimated Firing Temperature (ºC)	Temper (%)	Description
				See Tepper, this volume	See Abu-'Uqsa 2016						
1	*Tegula*	26	172	3:1		LEGV[IFER]	VI	2.2	800–850	9–10	Fine and coarse basalt grains (up to 3.5 mm); a single milky, carbonate fragment (1 mm); few rounded, dark brown pellets of silty *terra rossa* soil (1–2 mm)
2	*Tegula*	20	154	3:2		LEGV[I]F	VI	2.3	800	7	Foraminifer skeletons have a carbonate or ferric filling; coarse basalt grains (up to 3.5 mm)
3	*Tegula*	23	184/1	3:3		[L]EGV[I]	VI	1.6	850	14	Unvitrified core, indicating a rather brief firing; fine and coarse (up to 1.4 mm) basalt inclusions; a few carbonate particles (up to 1 × 4 mm)
4	*Tegula*	27	170	3:4		[LEGV]IFE	VI	3.3	750	<5	Fine temper is almost absent; sporadic coarse inclusions (0.7–3.8 mm) of rounded basalt grains (some are eroded), sub-rounded fragments of biogenic chalk (some are bituminous or ferruginous), shell fragments with a well-defined lamellar structure, and dark brown, almost opaque, rounded and sub-rounded fragments of an ore component (iron oxides?)
5	*Tegula*	5	126	3:5		[LEG]VIFE	VI	2.1	800	11	Fine and coarse basalt grains (up to 4.3 mm); elongated shell fragments (up to 3.5 mm long) with a well-defined lamellar inner structure; fragments of milky carbonate of biogenic origins (1.5–2.3 mm); one large (2 × 2 mm) lump of pure clay
6	*Tegula* (Fig. 1)	20	163	3:6		[LEGVIF] ER/R	VI	2.4	800–850	12	Coarse basalt grains (up to 8 mm); a few silty, ferruginous *terra rossa* pellets
7	Brick	31	188	3:7		LEGII[TR]	II	1.5	800–850	18	Microfossil skeletons have a carbonate or ferric filling; fine and coarse (0.7–1.3 mm) basalt inclusions
8	*Tegula* (Fig. 2)	30	177	3:8		LEG[	VI?	3.4	750–800	12	Fine and coarse (up to 3.8 mm) basalt inclusions; some clay nodules, biogenic chalk balls and opaque, very dark brown fragments (up to 0.8 mm)

Table 1. (cont.)

No.	Item	Locus (Area B)	Basket	Figure No.		Stamp	Legion	Thin-Section No.	Estimated Firing Temperature (ºC)	Temper (%)	Description
				See Tepper, this volume	See Abu-'Uqsa 2016						
9	*Tegula*	10	152	3:9		LE[	VI?	1.3	800–850	17	Some of the microfossil skeletons were refilled with iron oxides; a considerable amount of rounded voids, uniform in size; a considerable amount of fine inclusions, suggesting the presence of chalk powder that disappeared during the firing; several coarse basalt grains (up to 2 mm); sub-angular carbonate and crushed bituminous limestone, partially decomposed due to firing conditions
10	Brick	23	184/2	3:10		LEG[	II?	1.4	800	15	Some of the microfossil skeletons have a silica filling; fine sand, mostly rounded quarts and chert; lesser amounts of basalt-derived minerals, shell debris, volcanic glass and tuff particles; coarse inclusions are absent
11	*Tegula*	19	149	2:5				3.1	900–950	6–8	Light yellow clay; greenish and milky under the microscope; highly vitrified matrix; very porous, almost crumbling, possibly the result of a burst effect of carbonate decomposition while firing at high temperatures; coarse basalt grains (1–4 mm)
12	*Tegula*	19	149/1	2:7				3.2	750	5	Sporadic carbonate (1.3 mm) and basalt (0.8 mm) grains; very coarse temper is absent
13	Mortarium	Area A, 6	123/11		2:6			1.1	>750–800	7	Some of the microfossil skeletons were refilled with iron oxides; coarse and poorly sorted basalt grains (0.5–2.5 mm)
14	Mortarium	Area A, 6	123/9		2:5			1.2	850	10	Coarse basalt grains (0.7–1.0 mm); some biogenic chalk fragments (0.5–0.7 mm)

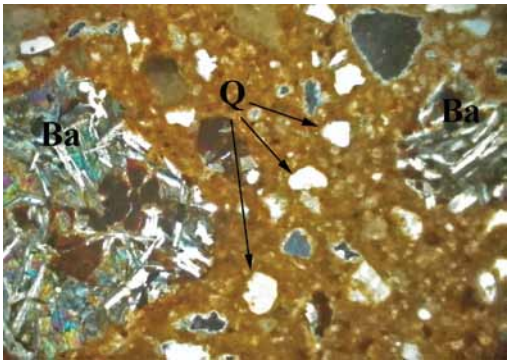


Fig. 1. *Tegula* 6: field size ~1.5 mm, cross-polarized light; Ba = basalt, Q = quartz.

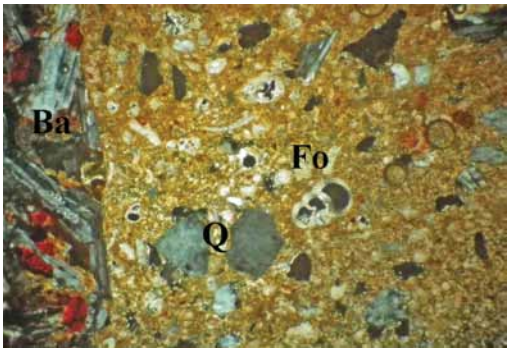


Fig. 2. *Tegula* 8: field size ~3 mm, cross-polarized light; Ba = basalt, Q = quartz, Fo = foraminifera.

have a silica filling. Some of the examined samples have a matrix that is partially or almost completely vitrified (e.g., Table 1: Nos. 13 and 14, respectively).

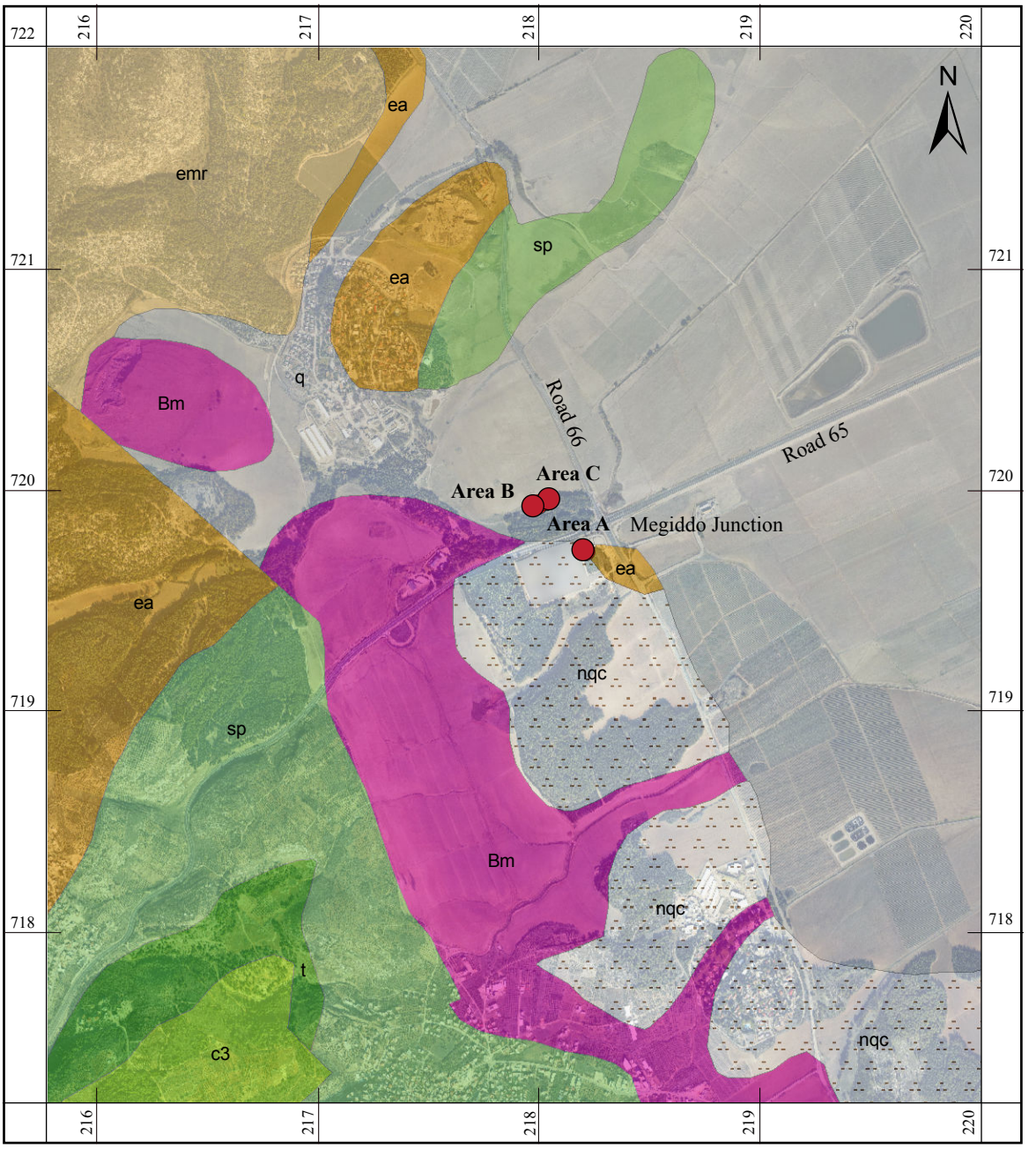
The non-plastic material comprises 2–18% of the volume of the sherds and appears mainly in two sizes: fine sand grains and coarse inclusions. The fine sand grains, ranging from 0.15 to 0.30 mm in size, are evenly distributed in the sherd and predominantly comprise rounded quartz; sub-angular to angular olivine, plagioclase and pyroxene; and sub-angular to sub-rounded ore-mineral grains. Additional sand-sized materials are rounded to sub-rounded basalt grains, which appear in only some of the sections, and angular pieces of chert, which are rare. Chalk balls are also present, but some disappeared as a result of the high firing temperatures, leaving only a void.

The coarse inclusions range between 0.5 and 8 mm in size and comprise mainly rounded to sub-rounded grains of alkali olivine basalt, which are poorly sorted and unevenly distributed within the sherd. In many cases, some coarse basalt grains are present also on the lower surface of the *tegulae*, apparently as a result of being laid to dry atop a layer of very coarse basaltic sand. Carbonate material (i.e., biogenic chalk or soft limestone), fossil shell debris and *terra rossa* nodules—all under 1.2 mm in size—are sporadically present in some of the samples.

DISCUSSION AND CONCLUSIONS

Judging by the quantity and the quality of the non-plastic inclusions that have been observed in the studied assemblage, it is argued that the fine-sized inclusions were added prior to kneading the clay, whereas the coarse basalt grains were added at the very end of this process. Despite this difference, both are classified here as temper—material deliberately added by the potter. At the same time, chalk, shells and *terra rossa* are apparently an original component of the clay, and thus, are not classified as temper.

The lithology of the examined assemblage closely corresponds to the geological environment of Legio. Eroded basalt and biogenic chalk and limestone, as well as clay beds and soils that have developed over these formations, are found in rather close proximity to the site (Fig. 3). The distinguishable microfossils allow us to suggest that the Senonian-Paleocene Age marls of the Mount Scopus Group were used as raw material for the matrix. These formations are present at a distance of 1.0–1.5 km to the north and southwest of the site. The Miocene basalt flows, which are found as close as 300 m west of the excavation, were the source of the coarse inclusions. The roundness of the fine inclusions—basalt and minerals derived from



Alluvium (Holocene)

Conglomerate units, undivided (Neogene Quaternary)

Lower basalt and part of intermediate basalt (Miocene)

Maresha formation (Middle Eocene)

'Adullam formation (Lower Eocene)

Mount Scopus Group (Senonian Paleocene)

Bina formation; Derorim, Shivṭa and Neẓer formations; Ora and Gerofit formations (Turonian)

Sakhnin and Yanuḥ formations; Weradim formation; Tamar formation (Cenomanian)

Excavations

Fig. 3. Geological map of the site's vicinity (after Sneh, Bartov and Rosensaft 1998).

basalt—suggest a provenance in a streambed crossing basalt outcrops. Naḥal Qeni, which runs from east to west along the foot of the hill on which the site of Legio is situated, fits this description.

Quartz sand is the only component that is not characteristic of the region's geology. The most plausible source for this sand is the Mediterranean coast, about 25 km west of the site. Nevertheless, transporting quartz sand from the seashore to Legio could not have been difficult, since the site is situated beside one of the most important junctions in the well-developed transportation system of the Roman province of Iudaea (Tsafrir, Di Segni and Green 1994:21, Map 4).

Finally, by comparing the lithology of the examined *tegulae* with the petrographic composition of similar finds from Loḥame Ha-Geṭa'ot, el-Makr, Ḥorbat Kenes, Denya (Haifa) and Ḥorbat Qav (Shapiro 1997), and the lithology of the mortaria from nearby Kefar 'Otnay with that of kraters from Aḥihud (Avshalom-Gorni and Shapiro 2015:74–75, 84) and Tel Dover[2] and of the Northern Syrian mortaria from Khirbat el-Shubeika (Avshalom-Gorni 2002:227, 229–230, Fig. 19:1; the thin-sections were not published), we conclude that the Legio assemblage is distinctly local, and differs from the other assemblages mentioned above. We thus suggest that the Legio camp included a pottery workshop—yet to be found—that met the needs of the engineering corps of the legion, not only in producing *tegulae* and bricks, but also in the production of floor tiles and ceramic water pipes, such as those unearthed in recent excavation at Legio (personal observation; Yotam Tepper, pers. comm.).[3]

NOTES

[1] I would like to thank Hanaa Abu-'Uqsa and Yotam Tepper for allowing me to examine and publish samples from this assemblage.

[2] My study of the petrographic analysis of the pottery assemblage of the Roman–Byzantine periods from Tel Dover will be published in the future.

[3] I would like to thank Yotam Tepper for showing me around his excavation and for sharing with me the unpublished finds it yielded.

REFERENCES

Abu-'Uqsa H. 2016. Kefar 'Otnay and Legio: Remains from the Roman and Early Byzantine Periods. *HA–ESI* 128 (January 20) http://www.hadashot-esi.org.il/images//Legio-Uqsa.pdf (Hebrew; English summary, pp. 33–35; accessed April 6, 2016).

Aviam M. and Stern E.J. 1997. Burial in Clay Sarcophagi in Galilee during the Roman Period. *'Atiqot* 33:151–162 (Hebrew; English summary, p. 19*).

Avshalom-Gorni D. 2002. Excavations at Khirbet el-Shubeika 1991, 1993: The Pottery. In Z. Gal ed. *Eretz Zafon: Studies in Galilean Archaeology.* Jerusalem. Pp. 227–245 (Hebrew; English summary, 186*–187*).

Avshalom-Gorni D. and Shapiro A. 2015. A Pottery Workshop at Aḥihud and Its Relationship to the Jar Industry in the Northeastern Zevulun Valley and Western Galilee during the Roman Period. *'Atiqot* 83:67–92.

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

Shapiro A. 1997. Petrographic Analysis of Roman Clay Sarcophagi from Northwestern Israel and Cyprus. *'Atiqot* 33:1*–5*.

Shapiro A. 2016. Petrographic Examination of the Ceramic Vessels from Tel Shunem (Sulam). *'Atiqot* 84:63–68.

Sneh A., Bartov Y. and Rosensaft M. 1998. *Geological Map of Israel 1:200,000. Sheet* 1 (GSI). Jerusalem.

Tepper Y. This volume. Legio: Roof Tiles and Bricks Bearing Roman Legion Stamps.

Tsafrir Y., Di Segni L. and Green J. 1994. *Tabula Imperii Romani: Judaea-Palaestina; Eretz Israel in the Hellenistic, Roman and Byzantine Periods; Maps and Gazetteer.* Jerusalem.

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