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Archaeological and XRF Analysis of a Byzantine Weight from Hippos Sheds New Light on the Transition from Christian to the Islamic Rule*

MICHAEL EISENBERG

ALEXANDER IERMOLIN

University of Haifa

SARIEL SHALEV

University of Haifa

ABSTRACT: A unique Byzantine brass weight found in Antiochia Hippos (Sussita), bearing a concealed cross and an unfamiliar feature on its reverse, helps reveal some of the changes that occurred in Hippos during the transition between the Byzantine and Early Islamic periods. The weight illuminates the local Byzantine and post-Byzantine metrological weight systems, as well as the administrative and religious relationships between the Christian city of Hippos and Umayyad Ṭabariya, the capital of the region. Discovered in the debris of a church destroyed in the earthquake of 749 CE, it is among the first archaeologically dated Byzantine weights used during the Umayyad period.

INTRODUCTION

HIPPOS (SUSSITA) is located 2 km east of the Sea of Galilee, opposite Tiberias, which sits on the lake's western shore (fig. 1). The city was founded on the crest of Mount Sussita by the Seleucids around the middle of the second century BCE and was named by them Antiochia Hippos (figs. 2–3).¹

The Golan, including the region of Hippos, has been the focus of several studies of the Byzantine–Early Islamic period, based mainly on inscriptions, surveys and some excavations conducted in the region (Gregg and Urman 1996; Ben-David 2016).

Hippos' narrative did not differ from that of many other cities of the Byzantine period in the region of Syria-Palaestinae. As early as the middle of the fourth

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1 For the historical geography of Hippos, see Dvorjetski 2014.

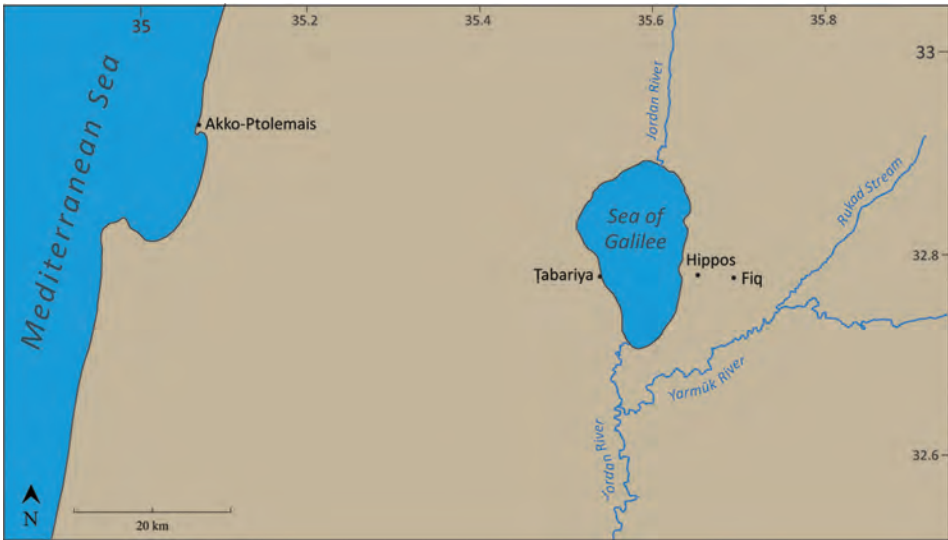


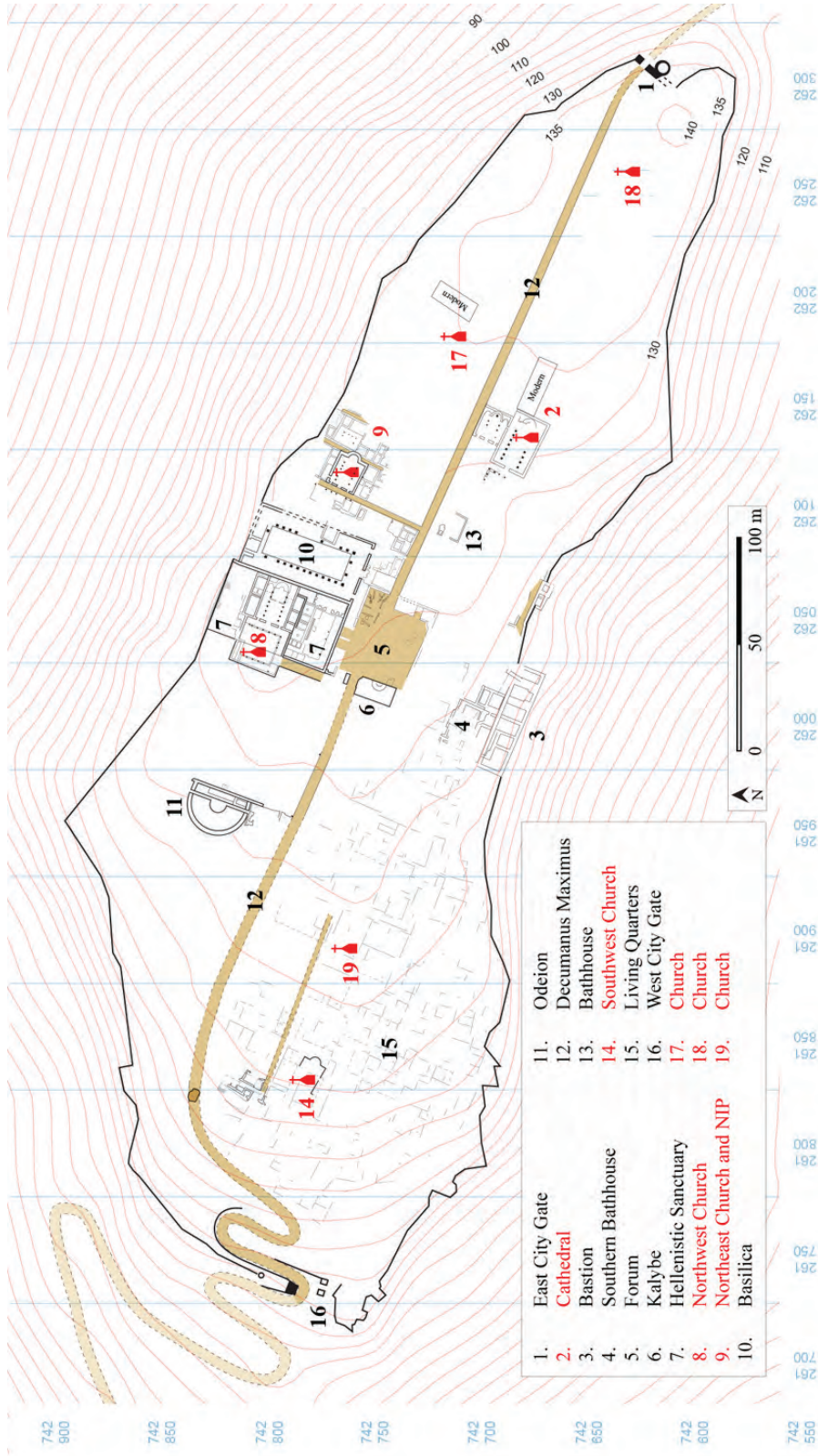
Fig. 1. Orientation map (drawn by Anat Regev-Gisis)

century CE, Hippos became the seat of a bishopric and subsequently the location of at least seven churches, highlighting the Christian character of the city and of the majority of its citizens (figs. 2–3). Most of these churches, built during the Byzantine period, continued in this role during the Early Islamic period (seventh to mid-eighth centuries CE) up until the destruction of the city in the earthquake of 749 CE, after which the place was never resettled.²

Four of Hippos' churches have been excavated and dated (fig. 2: nos. 2, 8, 9 and 14); another one was partially excavated in the early 1950s, but its findings were not published (fig. 2: no. 17), while the remaining churches have only been identified during surveys and have still not been dated.

It is important to emphasize that Christian worship at Hippos continued up until the earthquake of 749 CE, just a year before Umayyad rule of the region was supplanted by that of the Abbasids. Furthermore, as an archaeological site, Hippos evinces no destruction that can be associated with the Early Islamic conquest of the region. The weight discussed below, the focus of this paper, corroborates the non-destructive nature of the political transition between two regimes in the region, as it provides material evidence for the continuation of Christian worship within the context of the new Islamic rule.

2 For a description of the excavation seasons of Hippos, see Segal *et al.* 2014. For an historical overview of the Byzantine period at Hippos and its churches, see Dvorjetski 2014: 61–63. For the city's decline between the late Byzantine and the Umayyad periods, see Eisenberg 2016.



- | | | | |
|-----|--------------------------|-----|-------------------|
| 1. | East City Gate | 11. | Odeion |
| 2. | Cathedral | 12. | Decumanus Maximus |
| 3. | Basilion | 13. | Bathhouse |
| 4. | Southern Bathhouse | 14. | Southwest Church |
| 5. | Forum | 15. | Living Quarters |
| 6. | Kalybe | 16. | West City Gate |
| 7. | Hellenistic Sanctuary | 17. | Church |
| 8. | Northwest Church | 18. | Church |
| 9. | Northeast Church and NIP | 19. | Church |
| 10. | Basilica | | |

Fig. 2. Plan of Hippios, showing main excavation areas and churches (drawn by Anat Regev-Gisis and Michael Eisenberg)



Fig. 3. Aerial view of the centre of Sussita Crest with main excavation areas marked (photograph by Michael Eisenberg)

WEIGHTS AND COINAGE DURING THE TRANSITIONAL PERIOD

During the Byzantine–Islamic transition (*c.* 636–680 CE) and the Umayyad pre-reform period (*c.* 680–690s CE), weights and coinage relied a great deal on the previous Byzantine systems.³

In some cases, Christian symbols and portraiture of Byzantine emperors that adorned many official objects still in use were left unaltered; others were modified, and at times entirely covered; the weight discussed here is one such example, found during excavations of Hippos of the Decapolis in which the cross on its obverse was concealed by a metal paste.

The city of Ṭabariya became the Umayyad capital of Jund al-Urdunn and among the most important mints during Umayyad rule of the region (Avni 2014: 71–93; Bone 2000: 53, 150, 308–312; Walmsley 2007: 74–77, and see, for

3 For a more precise dating of the various stages and mints in gold, silver, and copper coins, see Bone 2000: 11–12; for an in-depth summary of the administrative history of Umayyad Syria derived from copper coins, see Bone 2000: 308–312; for a summary of weights and measures from Byzantium and Islam, see Heidemann 2012; for the studies of the Byzantine monetary economy, see Henny 1985; for ‘Abd al-Malik’s monetary reform, see Ilisch 2010.

example, some of the coins found in Ṭabariya: Bijovsky and Berman 2008: 63, 90). It is therefore not surprising that among the 55 coins found (until 2013) at Hippos that are dated to the Early Islamic period (636–750 CE), the predominant mints that could be identified were those of Ṭabariya (10 coins).⁴

THE WEIGHT FROM HIPPOS

Discovery and Physical Description

During the 2013 excavation season, a brass weight of six *oungiai* (ounces) was found on a floor of a partially excavated room.⁵ This room is in what had been until then the northernmost excavated part of the winery complex of the Northwest Church Complex (NWC), just north of a large room with a mosaic-paved floor (Locus 210W) belonging to the winery complex (figs. 3–4; Młynarczyk and Burdajewicz 2014: fig. 256 on p. 196, 215).

The Northwest Church (fig. 2: no 8), located 30 m north of the forum, has been completely excavated. It measures 26 × 40 m, including its side wings.



Fig. 4. Hippos, the Hellenistic Compound and the Northwest Church; circle marks the find-spot of the weight (photograph by Michael Eisenberg)

4 For the conspectus of Hippos coins until 2011, see Berman 2014: 298; for the conspectus until 2014, see Bowlin, in press.

5 The Hippos Excavations Project is directed by M. Eisenberg on behalf of the Zinman

Its construction dates from the end of the fifth to the beginning of the sixth centuries.⁶ During its final phase of use, at the end of the seventh and the first half of the eighth centuries, the space occupied by the church was modified mostly to accommodate civic functions, while only the eastern portions of the structure remained dedicated to religious use until the destruction of the complex in the earthquake of 749 CE.⁷

The room in which the weight was discovered was destroyed during the 749 earthquake, and the location of the weight on its floor raises the possibility that the room remained in use up to its destruction. Its southern portion had previously been excavated, but some earth still covered the northern part of the room where the weight was found. As noted, this room had been part of the church's winery located to the north and south of the church (Frankel and Eisenberg 2018).

The weight is almost square with beveled edges (figs. 5–8) and is 43 mm in height, 45 mm in width and 10 mm thick, with a mass of 158.85 g. Bendall (1996: 29–38) designated the group to which this weight belongs as 'Square Commercial Weights'. The weight is almost completely intact, except for several small scratches on its obverse and a few small segments missing from its silver inlay.

Obverse (figs. 5, 6, 7, 8). — The obverse of the weight is decorated with a radiating arch, composed of 23 arch stones, extending from one side of the weight to the other, and set above two columns crowned with Corinthian capitals. Beneath the centre of the arch is a cross erected on a semi-circular base. Such a representation typically symbolized the cross on Golgotha in the Church of the Holy Sepulchre. A cross above a semi-circular or stepped podium within an arch or *aedicula* is often depicted on Byzantine bread stamps, weights, chancel screens and various small finds, and is interpreted as the True Cross above Golgotha in the Church of the Holy Sepulchre.⁸

Institute of Archaeology, University of Haifa. The site is part of Sussita National Park, excavated under Israel Antiquity Authority license for 2013 no. G-30/2013, National Parks Authority permit no. 3009/13. The weight (B7435) was discovered during the 2013 excavation season by B. Bowlin, the delegation's numismatist, when operating a metal detector. For the report on the 2012–2014 excavation seasons, see Eisenberg and Schuler, in press, and the annual Hippos-Sussita Excavation Reports (2012–2014) in the Israel Antiquity Authority archives.

- 6 Ovadiah (2014) rejects this late dating and suggests that the first phase of construction took place during the first half of the fifth century CE.
- 7 The NWC and its complex were excavated during the first nine years of excavations at Hippos (Młynarczyk and Burdajewicz 2014).
- 8 For discussion and further references, see Israeli and Mevorah 2000: 135, 138; for several examples and interpretations, see Clermont-Ganneau 1896: 407–410; for the motif, see also Callegher 2008: 166 and n. 10.



Fig. 5. The obverse of the weight before it was fully cleaned, with patina (photograph by Michael Eisenberg)

Also displayed on the obverse is the denomination of the weight, 6 ounces, designated within the arch by the letters $\Gamma\Theta$ to the left of the cross. To its right is an S with a short line slightly inclined from the vertical within the upper curve of this letter. This is the *stigma*, the late antique shape of the numeral 6. Above each of the two cross arms is an almost identical six-petalled rosette. Similar rosettes, but with a silver inlay in their centres, are located in each of the upper corners of the design. In various places on the obverse of the weight there are punch-marks about 1 mm in diameter. Some appear to have been made accidentally, but others are positioned more or less symmetrically and are clearly part of the decoration. There is a series of two punch-marks, one on each side of the adjacent element,



Fig. 6. The obverse of the weight after it was fully cleaned (photograph by Michael Eisenberg)

flanking the upper arm of the cross, its right and left arms, as well as its semi-circular base. Series of three punch-marks are observed above the apex of some of the radiates that span the upper side of the arch (but are visible only in the photograph taken before the weight was fully cleaned (fig. 5), and are not depicted in the drawing (fig. 8). Only while working did we realize our good fortune in having completely documented the weight before beginning the second phase of conservation, i.e., the full chemical cleaning of the weight. That is because the patina, which was removed during the second phase, had emphasized several tiny decorations that were barely visible, if at all, after the chemical cleaning.

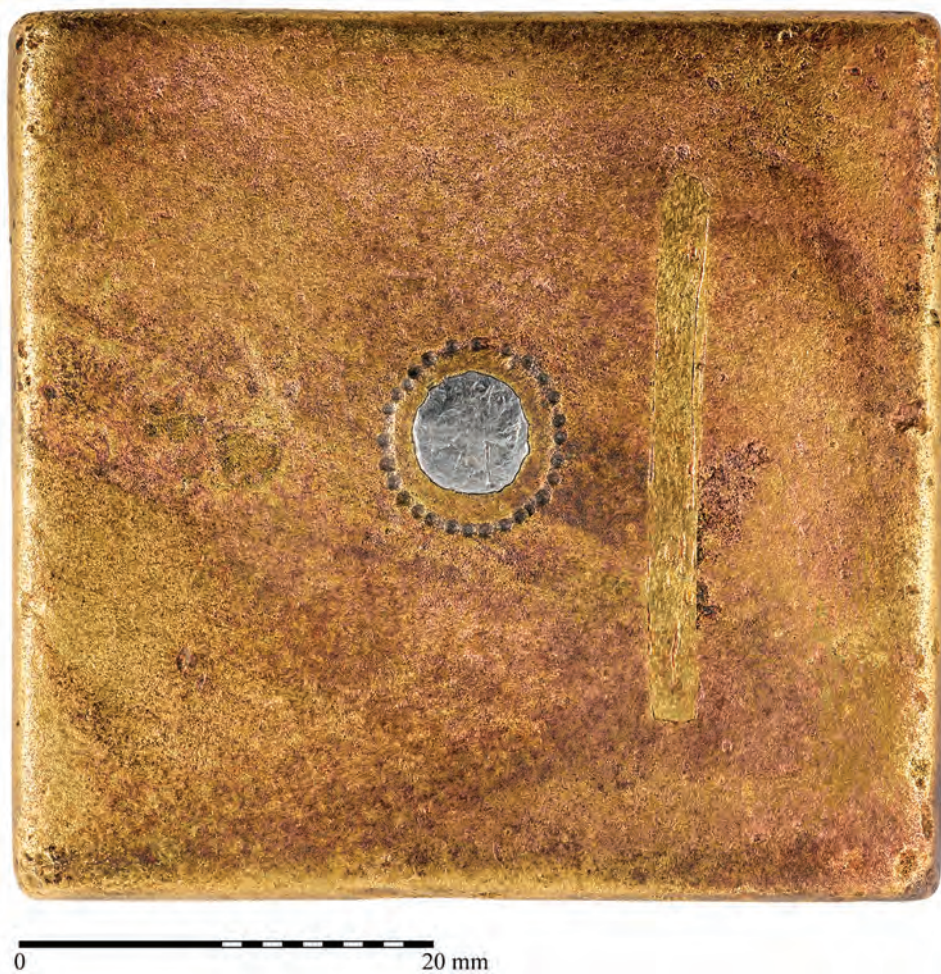


Fig. 7. The reverse of the weight after it was fully cleaned (photograph by Michael Eisenberg)

Similarly, while the lead/tin mask was fully visible both before and after the chemical cleaning, the areas emphasized by it were different.

The weight is made of brass with some of the engraved decorations inlaid in either silver (e.g., the Γ , S, and cross) or copper (e.g., the arch and columns).

During the initial conservation work, it was observed that the area of the cross, including the upper parts of the Γ and S, were covered by a whitish 'mask'.⁹ To

⁹ The weight's conservation work was performed by A. Iermolin in the Conservation Laboratory of the Zinman Institute of Archaeology at University of Haifa. The first

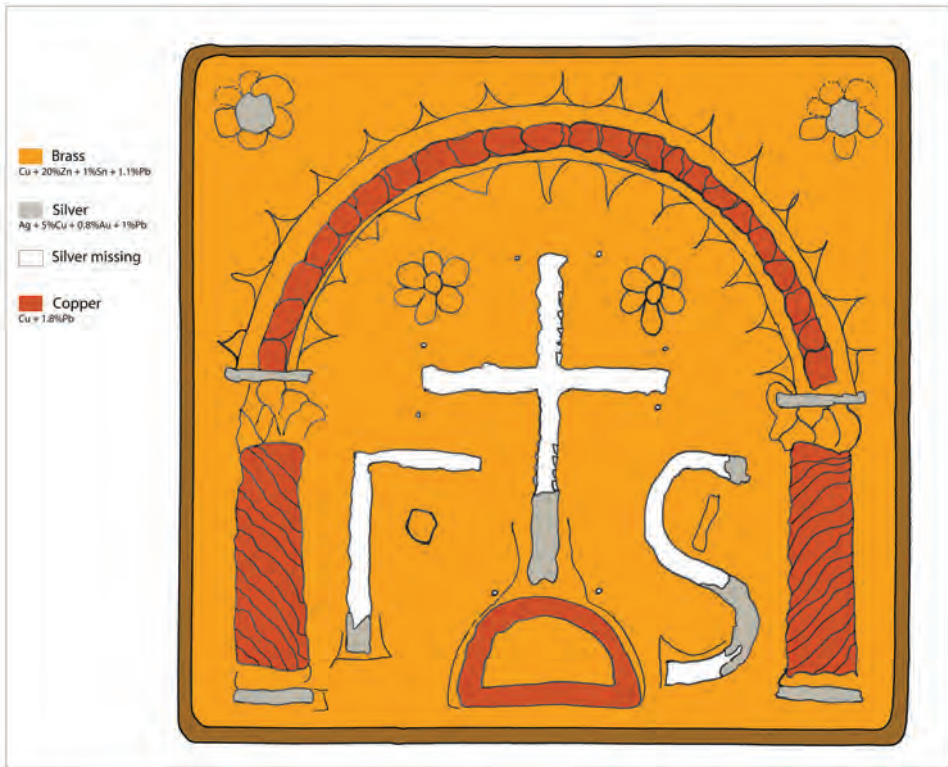


Fig. 8. Drawing depicting the obverse of the weight with legend describing its metallic composition based on the main chemical analysis (drawn by Michael Eisenberg)

enable us to better understand the decoration, and in particular this mask, which covers the central part of the weight's face, conservation was conducted in two stages: mechanical cleaning (fig. 5) followed by full chemical cleaning (fig. 6). Having examined the surface during the various stages of lab conservation and after analyzing the observed data, we were able to conclude with a high degree of probability that the mask was composed of lead and tin and was deliberately added some time after the original production of the weight in order to conceal the main and central symbol — the cross. The masking was probably a practical solution adopted with the passing of the local administration from Christian to Islamic authorities, thereby allowing the continued use of the weight.

conservation phase included only mechanical cleaning. Following it, the first XRF analysis has been conducted. In the second phase the weight was fully cleaned chemically to its final state, while washing away all chemical remains. Following this stage the final XRF analysis has been carried out.

Reverse (fig. 7). — The most prominent element on the reverse side of the weight is a round silver inlay, 6 mm in diameter and 0.6–0.7 mm thick, located in its centre and protruding 0.2 mm above the surface (figs. 7, 9). The silver inlay is recessed into the brass and is encircled by 28 punch-marks made more or less concentrically in the surrounding metal (fig. 7). The silver inlay itself bears several lines, but these are apparently just scratches and were not intended as a signature or monogram. It seems that the silver inlay was cast during the original production of the weight, and it is obvious that it was meant to be seen and identified as a silver inlay. To determine the structure of the weight, in particular the reverse dimensions of the silver and the extent to which it is recessed into the brass, non-intrusive examinations were made using radiography.¹⁰ The



Fig. 9. Weight's radiography imaging (imaging by Izhak Hershko and Dan Breitman)

¹⁰ Conducted by I. Hershko and D. Breitman using micro-focus system and ultra-sonic imaging conducted by Z. Shmul using Scanning Acoustic Microscope (figs. 9–10).

examinations revealed that the round silver inlay was set into a small, rounded and grooved recess.

In the corpus of archaeological finds, we have been unable to locate identical silver or other metallic sealings or decorations like the one on the reverse of the weight from Hippos.¹¹ Lead calibration on the reverse of weights is a well-known phenomenon from later periods up to modern times; however, it has not previously been attested to on weights of brass or bronze from the Byzantine period. The fact that the inlay is made of silver raises several questions regarding both its function and the selection of the metal. It may have served as mere decoration or, alternatively, it may have been the artisan's signature or a mark made to adorn a complete set of weights and scales.

Initially we suspected that the silver inlay was used for fine calibration. However, its mass is less than 2 carats (400 mg); a mass so small would have been very difficult to calibrate and was essentially superfluous, as the weight was not intended for small-scale weighing (of course this depends on what metals were measured, i.e., for gold higher accuracy was required).

Embedded in the brass to the left of the silver inlay is a gold-coloured strip, 2.3 mm wide and 26.1 mm long (figs. 7, 9). The strip, which runs along its length more or less parallel to the right edge of the weight, is centred longitudinally between its top and bottom edges. This strip contains slightly more zinc and less tin and lead than the weight's brass matrix (see details below). While it is possible that the strip was added after the original manufacture of the weight, it is more likely, judging from the absence of any visible alternations on the weight's surface, that the strip was inlaid during its first phase. The strip is prominent in the radiography imaging (fig. 9), which reveals no sign that it was meant to repair any fault in the weight. The strip is almost symmetrical and, as with the silver round inlay, may have been a calibration sign at various stages of the weight's use or perhaps a kind of personal signature of the artisan.¹²

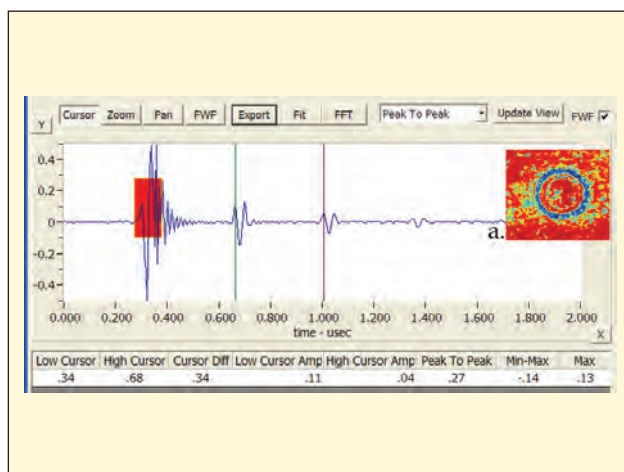
Sections of the weight's silver inlay are missing. Interestingly, this is the case only within the masked area, i.e., the cross and upper parts of the omicron and S (figs. 5–6, 8). Intuitively, we would expect that the silver inlay to have survived in a better state within the area 'protected' by the mask. The fact that just the opposite is the case seems to suggest that the delicate silver inlay was deliberately chiseled out and removed just before the mask was applied. We surmise that this was done in order to maintain the original mass of the weight once the mask material had been applied to completely hide the cross.

After its full cleaning, the mass of the weight was 158.85 g. Its denomination

11 Sealing was identified on the *Exagia Solidi* of the fifth century CE as well (Stiegemann 2001: 264, no. III.69).

12 Similar strips were found on several Byzantine weights, sometimes with the inlay lost (e.g., Rácz 2014: pl. 52.2).

Fig. 10. A-scan of the weight's reverse generated by a Scanning Acoustic Microscope; measurements around the area of 0.3 mm (highlighted by the red rectangle) indicate surface reflection; measurements around 0.7 and 1.0 mm indicate the reflection from the bottom of the silver inlay; inset to the right (a): a C-scan of the round silver inlay on the weight's reverse side (scan by Zvia Shmul)



of 6 *oungiai* means that 1 *oungia* = 26.48 g. Bearing in mind the weight's good state of preservation, it is likely that this mass is very close to the original mass. Any discrepancy between the two can probably be attributed to the loss of a small amount of mass (probably no more than 2 g) from the mask itself over the course of time, as well as the thin layer of corrosion that was removed during conservation.

Taking these data into account, we can conclude that the original mass of the weight was approximately 160 g. Based on this we can surmise that a *litra* (pound) of about 320 g was used at Hippos during the Byzantine period. Regarding the question of whether a rigid imperial system of weights or a less fixed regional one was in use, we favour the latter contention, basing our opinion on the discovery at several sites of various weights of different masses. It appears, therefore, that there was no one absolute mass for the Roman–Byzantine pound, but rather a variety of regional ones (Bendall 1996: 6–7; Callegher 2008: 167–167; Entwistle 2002: 611; Holland 2009: 26). Following the reforms of Caliph 'Abd al-Malik ibn Marwan (r. 685–705 CE), in addition to the introduction of the new Umayyad administrative system, some changes were made in the system of weights. However, the changes from the Byzantine *litra* to the Umayyad *raṭl* (pound) did not endure and were regional. It appears that, in most cases, the local systems of weights from the Byzantine period continued to be used (Heidemann 2012: 144).

Known Parallels

Six-*oungiai* brass and bronze weights are among those of the largest denominations (Holland 2009: 26). Weights similar to the one from Hippos, bearing a cross within a wreath or beneath an arch, are well known and well dated

to the Byzantine period, usually from the fourth to the sixth centuries CE. Most of the Byzantine weights known to us had no clear context when discovered, having originated on the antiquities market. Consequently, their dating is rather uncertain. Nevertheless, some such weights do come from secure archaeological contexts, and a general typology might be suggested (Entwistle 2002: 612–613; in press). Following are some parallels to the Hippos weight:

1. A *6-oungiai* copper-alloy weight. A square weight with bevelled edges, it depicts a cross on a semi-circular base positioned beneath an arch erected on two columns; a Γ and S flank the cross from both sides. Both upper corners bear a rosette. The provenance of the weight is the eastern Mediterranean, dating from the fourth to sixth centuries CE. British Museum 1921, 6-17, 1 (Entwistle 2002: fig. 6).
2. A *6-oungiai* copper-alloy weight. A square weight with bevelled edges, it depicts a Latin cross within a wreath; a Γ and S flank the cross. The provenance of the weight is the eastern Mediterranean, dating from the fifth to the sixth centuries CE. British Museum 1938, 10-4, 4 (Entwistle 2002: fig. 4).
3. A *6-oungiai* weight found in Baysan (Nysa-Scythopolis) and published by Khamis was, like the one from Hippos, discovered among the debris from the earthquake of 749 CE. This weight is similar to many Byzantine–Umayyad disc-shaped weights of the sixth–eighth centuries CE (Miles 1962). It bears an Arabic inscription of Saʿīd b. ʿAbd al-Malik (first half of the eighth century CE), but it is not clear whether this was a Byzantine weight completely reworked and used during the Umayyad period or an Umayyad-period weight (Khamis 2002: 143–147, 153).

X-Ray Fluorescence (XRF) Analysis of the Weight

The principal aim of the XRF analyses we conducted was to examine the materials and procedures that were applied to the weight and to reconstruct a possible narrative for this object from its casting and original surface decoration, to its subsequent masking, and finally to its burial in the debris of the 749 CE earthquake.

Quantitative compositional analyses were conducted using a Niton XL3t 900 analyzer equipped with a portable ED-XRF instrument with beam diameters of 8 mm and 3 mm, and a Jordan Valley EX-Calibur bench-top XRF with beam diameters of 2 mm and 1 mm.¹³ When performing our quantitative calculations,

13 The XRF analyses were conducted in the Lab for Archaeological Materials at the University of Haifa and in the Department of Physics at the Weizmann Institute of Science.

we used the measured intensities of the emitted and collected X-ray peaks and then calibrated the results by suitable standards of 40% Zn brass, Sterling (Ag + 7.5% Cu) and pure silver.

It seems that many of the published metal Byzantine weights are classified as being of bronze. Whenever these weights are composed of copper alloyed with tin, we accept this classification. Whenever the term brass is used, this means that the weight was composed of copper alloyed with zinc. The ambiguity starts when the copper is alloyed with both tin and zinc. In the case of the weight under discussion here, the composition is unambiguously one of brass. Often the term 'high zinc brass' is used to describe the composition of similar weights (containing no less than 15% Zn, with the presence of no other significant metals), like the one from Hippos.¹⁴

The quantitative compositional results of the analyses were as follows:

- The yellow gold-like matrix that constitutes the bulk of the weight is made of low brass (copper + zinc) with traces of tin and lead (Cu + 20% Zn + 1% Sn + 1.1% Pb). With this quantity of zinc, the melting and solidification temperature is *c.* 1,000° C. The as-cast microstructure of this kind of solid brass is usually of a single alpha phase, shining yellow in colour, ductile and malleable in its mechanical properties (figs. 6–7). The gold-coloured strip on the left side of the reverse (fig. 7) is made of similar brass, containing slightly more zinc and less tin and lead (Cu + 21.5% Zn + 0.7% Sn + 0.8% Pb).
- The silvery round inlay (*c.* 6 mm in diameter) on the weight's reverse and the two silvery white inlays designed as small circles (2 mm in diameter) and strips (2, 1.5 and 1 mm wide) on its obverse were all made of relatively pure and soft silver, containing less than 7.5% copper and traces of gold and lead (Ag + 5% Cu + 0.8% Au + 1% Pb) (figs. 6–7). Levels exceeding 5% of copper that were occasionally measured on the thin silver strips on the obverse might reflect some attenuation and/or the influence of the immediately adjacent brass matrix, given that these same measurements revealed relatively higher amounts of zinc.
- The red columns (4 mm in width), arches and strips (2, 1.5 and 1 mm in width) are all made of pure copper with some lead (Cu + 1.8% Pb) (figs. 6, 8).
- The dark (originally greyish-silver in colour) round spot (masking) in the middle of the obverse (*c.* 25 mm in diameter) covering the cross was found to be made of lead and a tin alloy with a composite Pb/Sn ratio of $\approx 2/1$ (figs. 5–6).

14 We wish to thank D. Hook of the British Museum for clarifying the terminology used in the catalogues of the museum's large Byzantine weight collection.

Production and Decoration of the Weight

Casting. — The slightly trapezoidal shape and the compositional properties of the brass show that it could have been cast in an open or flat covered mould; it was then polished to its final flat, rounded-angle, gold-like coloured surface. The mould could have been made of different materials: One possibility is a simple, traditional, rectangular limestone depression, like the moulds used to cast dies for coins (although an intensive heat mould made in limestone can only be used for several cycles of casting), or a clay mould could have been used. Alternatively, a simple iron mould might have been used or possibly a more complex one like the one described in detail in the early twelfth-century CE manual by Theophilus in *The Art of the Metalworker* (III.16, 27).

All post-casting mechanical and thermal operations performed of the brass weight are based on standard theoretical metallurgical knowledge and the Cu/Zn phase diagram (e.g., Pollard and Heron 1996: 196–211 and bibliography therein). Due to the known metallic composition of the brass, after casting the weight was initially composed of alpha dendrites. The hardness of the surface might well have reached 167 Hv, close to three times the hardness of fully tempered 20% zinc brass and over twice that of as-cast copper (on the production of copper alloy weights, see Weber 2006).

Marking and chasing of the surface. — Following filling and polishing, the flat surface was marked for chasing after which the major decorative motifs were chased. All inlaid circles were drilled; the cross, letters, base, columns and arch, were all grooved along the outer lines of each design element. Marking and chasing tools are described in detail by Theophilus, as are the ones of modern metal craftsmen by Untracht (Hawthorne and Smith 1963: chapters 11–14; Untracht 1975: 11–119). Toward this end, the decorative lines to be filled by a metallic inlay needed to be grooved. Observation of the chased lines under higher magnification reveals that the chisel blade used to perform the grooving was sharp and with a rectangular section and struck with small, consecutive strikes at an angle of *c.* 40 degrees, made from outward in toward the craftsman. This method of chasing creates a series of sharp consecutive triangles that are deepest at their heads and shallower at their bases. This same technique was subsequently used to fix the metallic inlays in place by folding back the excess metal at the tips of the triangles.

The drilling was probably done to slightly wider diameters inside the grooves, below the surface of the weight. If so, this is not visible because of the intact inlays that entirely cover these inner structures.

Silver inlay. — The round depressions on the obverse and reverse sides of the weight were either filled with molten silver or perhaps inlaid with cold and hammered silver. Most likely the latter method was used, as this was the method

used on the rest of the inlaid silver strips on the obverse, which were definitely cold-inlaid by hammering silver wire. The low (*c.* 5%) copper content of the silver left the silver soft with a maximum hardness of between 25–50 Hv when annealed, depending on the exact amount of copper. The production of such silver wire for Persian traditional crafts is described by Wulff (1966: 42–45) and, more generally, by Untracht (1975: 43–46). The soft annealed silver wire was then placed in the middle of a line grooved into the brass surface and hammered.

Copper inlay. — The copper was probably inlaid using the same technique described above for inlaying silver. Here, the craftsman probably used an annealed, slightly thicker wire made of unalloyed copper with the addition of some lead to make it even softer than the 65 Hv of the cast copper. This copper wire would not have had to exceed 2 mm in diameter. In that case, the columns supporting the arch (each 4 mm wide) could have been inlaid using two parallel wires. This might explain the adoption of the chiselled, angular groove decoration technique. Such a technique could provide a means of fastening the wide copper inlay, as well as accommodating the bead-like punched decoration of the thinner copper-inlaid parts. The tradition of this decorative technique, inlaying silver and copper wire in a brass matrix, was further developed in the Islamic world (Ward 1993).

Final decoration. — After having finished the cold hammering and cutting, chasing, filing and polishing the silver and copper inlays, a final decorative stage involving engraving and punching the surface above the copper inlays and surrounding decorative elements. Following this stage, the weight was ready for use.

Later surface alterations. — Some time after the weight's original manufacture, several significant mechanical and chemical alterations were deliberately made to it. First, at some point, the silver inlay of the arms of the cross and the upper parts of both flanking letters were chiselled out from a circular area with a radius of *c.* 25 mm, so that the original groove-decorated brass surface was exposed. A hot liquid material, two parts lead to one part tin, was then carefully applied to the freshly exposed surface so that the carvings of the cross and the upper parts of the two letters were completely covered. After polishing, a smooth, shiny, silvery-grey circle was obtained in the middle of the weight.

This lead- and tin-based material is still in use, mainly for soft soldering or brazing (e.g., Untracht 1975: 178–179). It is used in 38–40% Sn+Pb, mainly by plumbers, and is called 'wiping solder'. The analyzed mask material (2 Pb/1 Sn) becomes entirely liquidized at around 280° C and completely solidifies at 183° C.

In the case of the weight from Hippos, the temperatures required to start melting the brass surface (*c.* 1,000° C), the copper (here, *c.* 1080° C), or the

silver (which here remains solid to temperatures slightly exceeding 900° C) were all approximately four times greater than the temperature at which the liquid material applied to the weight's obverse completely solidifies. For this reason, the Pb/Sn material was so suitable for covering without causing any visible damage.

DISCUSSION

The weight discussed here is the most elaborate among the 31 metal weights found so far at Hippos that date between the Hellenistic and Umayyad periods. It is quite possible that the weight was an official one used by the administration of the city or that of the Northwest Church, although there is no proof for such a weight having served in this capacity (i.e., Holland 2009: 32–33; Tobias 2017: 186f. pl. 104; for a discussion of the issuing authorities, see Bendall 1996: 11).

In 545 CE, in the so-called collections of *Novellae Constitutiones* code, Justinian I issued an edict granting taxpayers permission to receive weights and measures for commodities to be entrusted to the Praetorian Prefect and Eprach, and coinage weights of gold, silver and bronze from the *Comes Sacrarum Largitionum*. The weights were to be stored in the most important church of each city:

‘We order that those who collect public taxes shall use proper weights and measures in order not to injure Our taxpayers in this respect. Where, however, taxpayers believe that they have sustained loss through the weights and measures employed by collectors, they shall be permitted to receive from the Most Glorious Prefects [the praetorian prefects] others intended to weigh or measure articles in kind delivered as taxes, and from the Most Glorious Count of the Imperial Largesses, those used to weigh gold, silver, and other metals; and the said weights and measures shall be kept in the church of each town, and shall be exclusively employed in the determination of the quantities of articles to be delivered by taxpayers, as well as in the apportionment of the tributes, the payment of soldiers, and other matters of this description.’

(*Novellae Constitutiones*, novel 128, chapter 15, Scott 1932: 116)

The high degree of craftsmanship involved in producing the weight, in particular its fine and elaborate inlay and its findspot in a central church at Hippos, are, in our opinion, factors that may attest to its having served as an official weight of Hippos. Such a weight, kept in the hands of church officials at Hippos, must have been under a more rigid urban standardization than any other weight. One should bear in mind that the Northwest Church was located in the centre of the city. In this respect, we must keep in mind that a central city church had a crucial

administrative role in collecting taxes, especially from the sixth century onward (Brandes 2002).

Moreover, a large winery complex and the remains of an olive press were found to be part of the church complex.¹⁵ Thus, it came as no surprise to discover a weight in an industrial context such as this. The weight may have been part of a set of scale and weights belonging to the church; if so, the gold-coloured strip or the round silver inlay on its reverse may have been the calibration mark or a decorative mark specific to all items of the set — although this is difficult to argue, because this is the only weight of the ‘set’. The mask concealed the cross and if indeed the weight served as one of the city’s official weights, the city may have allowed it to be kept and used during the Umayyad Caliphate not only for inner city trade but in relation to the Umayyad administration as well.¹⁶

We might conjecture that this weight graphically illustrates precisely where we can draw the line between the relative freedom of religion and tolerance that characterized Umayyad rule and the demands of official metrology. Both coins and weights served as tools of religious and sovereign propaganda, displaying, as they do, symbols of religion and rule, i.e., cross, Golgotha, church and the emperor’s portrait and power. This being the case, if we bear in mind that the weight may have been used in local and regional markets, and thus likely came into contact with representatives of the Umayyad administration from the nearby capital of Jund al-Urdunn (Ṭabariya), the need to hide symbols belonging to the previous rule and its religion on such artifacts should come as no surprise. There was no need to conceal the symbols of daily Christian life in Hippos. At least four churches continued to function in the city during the Umayyad period, and a large basalt cross *acroterion* adorned the Northwest Church just a few metres south of where the weight was discovered (Młynarczyk and Burdajewicz 2014: fig. 282 on p. 208 and p. 211).

The weight discussed here is a unique and important artifact that provides an invaluable glimpse into the missing narrative for the transition between Christian Byzantine and Islamic Umayyad rule, not to mention the metrological system in Umayyad Syria.

While this weight from Hippos is the first known Byzantine weight to have had a later mask added to hide the cross, one cannot help but wonder whether similar weights discovered at this and other sites might have been completely cleaned without anyone noticing the ‘ugly’ mask covering parts of the main ornamentation.

15 For a discussion of the wine and olive industries adjacent to the NWC complex inside the Hellenistic Compound, see Segal and Eisenberg 2004; Frankel and Eisenberg 2018.

16 A unique set of Byzantine weights and scales with their original box has been found in Egypt. The larger denomination is a square weight of 6 *oungiai* (Bendall 1996: 4).

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