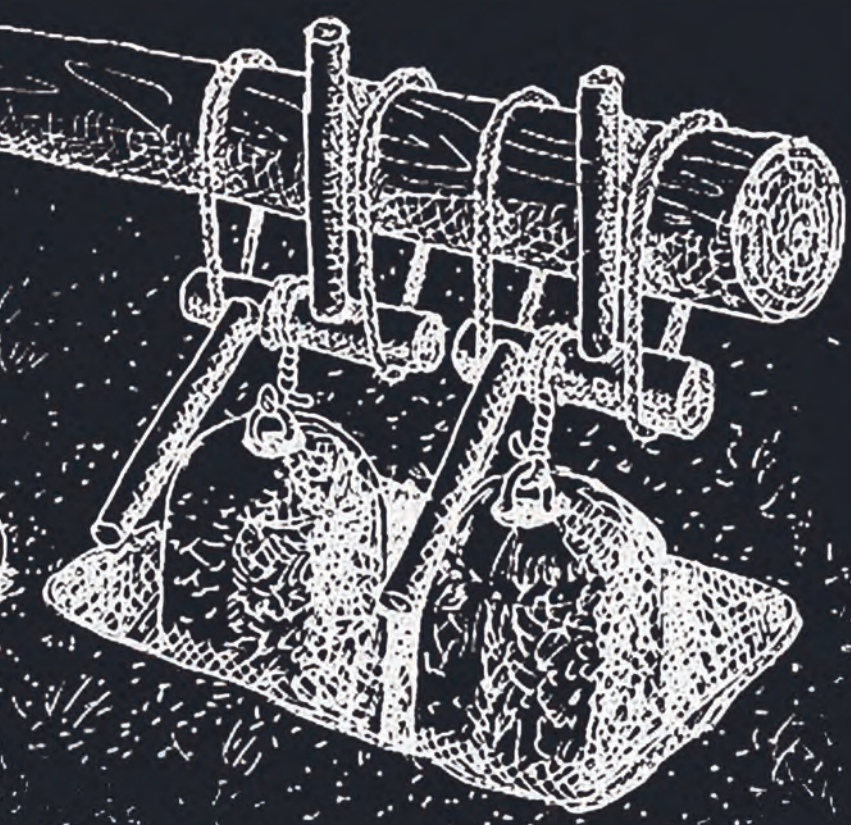
Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

Michael Eisenberg, ʻUzi Ad and Etan Ayalon



Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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Michael Eisenberg, Uzi ʻAd and Etan Ayalon

To Dr. Rafael (Rafi) Frankel (1929–2023)

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Early Byzantine Winepresses and Later Freestanding Winepresses in Southern Israel

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ABSTRACT

The presence of ancient winepresses in the southern coastal plain and desert towns in the central Negev Highlands has prompted decades of academic research concerning the production and trade in wine in these sites in the Byzantine era (4th to 7th centuries CE). Archaeological excavations and surveys continue to reveal winepresses in the area of Elusa as well as in the southern coastal plain where the kilns that produced "Gaza" Wine Jars used for the storage and shipment of wine were located.

In this paper, we will discuss trends in the development of winepresses in the Early and Middle Byzantine periods (4th to mid-6th centuries CE) from the earlier type found inside buildings and the later freestanding type. The later type appears in association with monastic communities throughout the southern coastal plain and in Oboda (Heb. Avdat) in the Negev Highlands, particularly in the Middle and Late Byzantine period (mid-5th to mid-7th centuries CE).

Keywords: Ancient viticulture, economic archaeology, ancient Mediterranean economy, Negev Highlands, Byzantine, wine

INTRODUCTION[1]

Since the mid-19th century, the presence of winepresses in abandoned desert sites in the central Negev, together with c. 3,000 ha. (300,000 dunams) of terraced fields in the surrounding region, have drawn the attention of explorers and archaeologists alike. These sites include Oboda (Heb. Avdat), Shivta, and the main urban center of Elusa (Heb. Halutza), situated just beyond the edge of the Western Negev (Fig. 1). Until recently, freestanding winepresses were recorded near Elusa (2) and on the outskirts of Shivta (2) and Oboda (4) (Negev 1997:7; Mazor 2009).

1 Acknowledgments: The writers wish to thank a number of valuable friends and colleagues who facilitated the preparation of this paper. These include Ilanit Azoulay (IAA), Nili Dvash, the manager of Avdat National Park, Prof. Scott Bucking (De Paul University), Prof. Avner Ecker (Bar Ilan University), Prof. Guy Bar-Oz (University of Haifa), Dr. Daniel Fuks (Ben-Gurion University in the Negev), Dr. Haim Mamalya (IAA) and more.

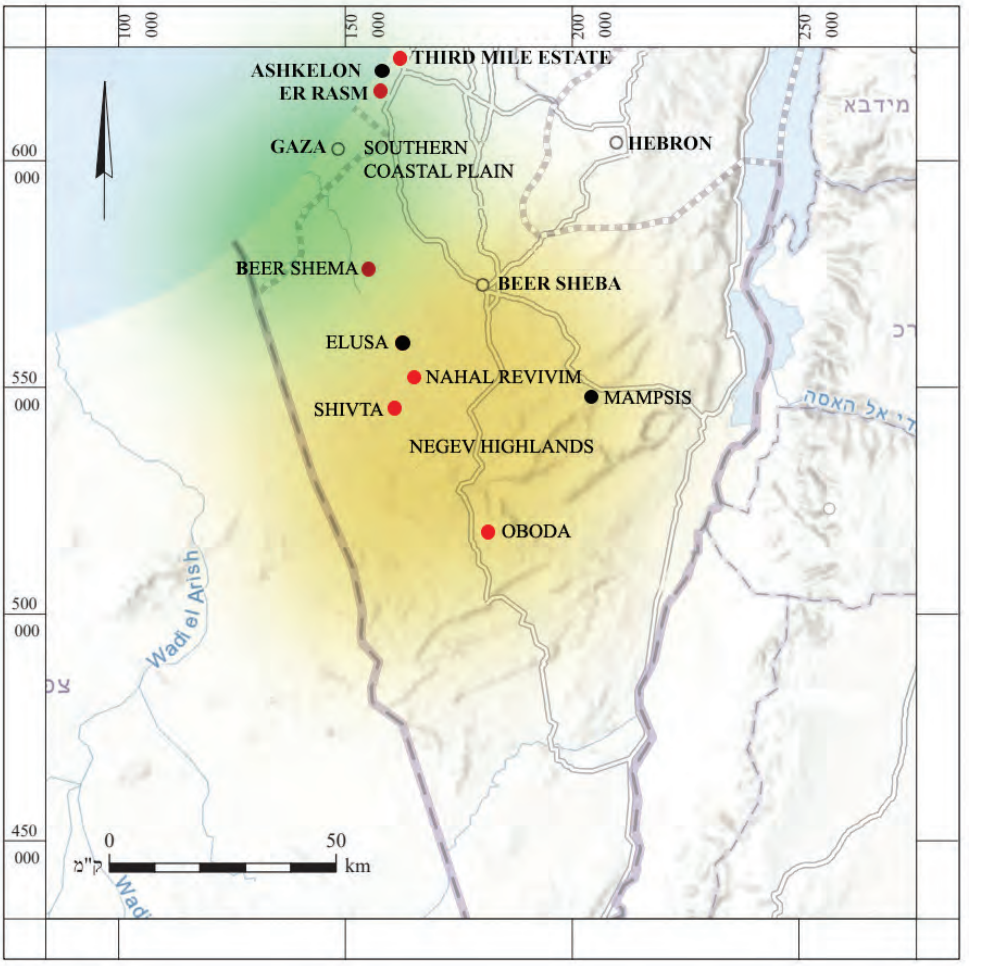

Figure 1: Location map of sites mentioned in the text. Sites with winepresses discussed in the text are marked in red.

Debate has surrounded the context and even the date of large-scale agricultural enterprise in southern Israel. Initial suggestions concerning favorable climatic conditions in the first millennium CE, as proposed by E. Huntington (1911:118) were rejected outright considering the extensive construction of installations used for harvesting run-off by the inhabitants both for agriculture and daily use (Woolley and Lawrence 1914–1915:33; Albright 1958:109–111). Despite later suggestions favoring better climatic conditions (Issar and Govrin 1991:82; Issar and Makeover-Levin 1995:18; Hirschfeld 2004:142–144), continued research has revealed a scene of hyper-arid conditions that the inhabitants were forced to deal with, like modern inhabitants in the Negev Highlands do today (Bruins 1994:307–308; Rosen 2000:55; Erickson-Gini 2010:194–195; 2012:52; Ashkenazi, Avni and Avni 2012:63).

The presence of Nabataean remains of the Hellenistic and Roman periods (3rd century BCE to mid-3rd century CE) in the Negev Highlands, the region through which ran the famed “Incense Road” between Arabia and the Mediterranean basin, received widespread attention due to the work of Avraham Negev, who excavated extensively

in Oboda and Mampsis. Despite his proposal that the Nabataean inhabitants were responsible for the widespread agriculture and urbanization in the region in the late 1st century CE (Negev 1961:133–136; 1963:112–124; 2003:18*), subsequent archaeological research points to this taking place during the Byzantine period, from the 4th through the mid-6th centuries CE (Erickson-Gini 2010:196–199; 2012).

Significant geo-political changes took place in the region at the end of the 3rd century CE, with the transfer of the Tenth Legion Fretensis from Jerusalem to the Red Sea port of Aila (Aqaba) (Tsafrir 1986). This event, together with the construction of two other legionary fortresses near the Dead Sea (Lejjun) and Petra (Udruh) and numerous forts and towers throughout southern Israel and southern Jordan, created a demand for basic goods including wine and grain (Erickson-Gini 2010:196–199). The demand for these goods in this desert region coincides with the beginning of wine production and urbanization in the Negev Highlands. It also coincides with the international popularity of wine from Gaza and Ashkelon, much of which was shipped through the emporium in Alexandria, Egypt since the Early Roman period, and the spread of Christian monasticism around Gaza from the mid-4th century.

THE EARLIEST WINEPRESSES IN THE NEGEV HIGHLANDS WERE NOT FREESTANDING

At present, only two winepresses dating to the Early Byzantine period (4th to early 5th century CE) have been excavated in the Negev Highlands. Both winepresses were uncovered inside rooms of large structures surrounding a central courtyard at Oboda and in the site of Naḥal Revivim (Mashabei Sadeh) located between Oboda and Elusa. At Shivta, a third winepress situated inside a structure near the North Church appears to be associated with the monastic community in the church and the date of its construction, whether Early Byzantine or later, is currently unknown.

Oboda – The early winepress in Oboda excavated by Negev and Cohen was discovered c. 50 m. east of the Byzantine town wall in an area of the site that was abandoned following a destructive earthquake that occurred in the early 5th century CE (Erickson-Gini 2010:91–95) (Fig. 2). Here Negev excavated a building, 15 × 35 m in size with a large central courtyard, that he described as a large farmhouse (Negev 1997:7) (Fig. 3:A). The rooms along the western wing of the building included a kitchen and spaces that were probably used as living rooms. The eastern wing contained a room with the treading floor and collection vat of a winepress, 22.5 × 31 m in size, that opened directly onto the central courtyard (Figs. 4, 5) (Mazor 2009:399, Fig. 70.8, No. 8). Rectangular-shaped storage compartments with stone pavement were revealed above the treading floor. Three compartments extended from the eastern wall of the main structure and two compartments were located in rooms south of the treading floor. A room north of the treading floor that contains an opening onto it probably served as another storage compartment. However, no pavement stones were extant in this slightly irregular-shaped space, which measures c. 2.5 × 4.6 m. In the eastern wing of compartments, measuring 3.5 × 7.2 m, only the central space was paved. The

Figure 2: Aerial photograph of Oboda (Avdat) (credit: INPA).

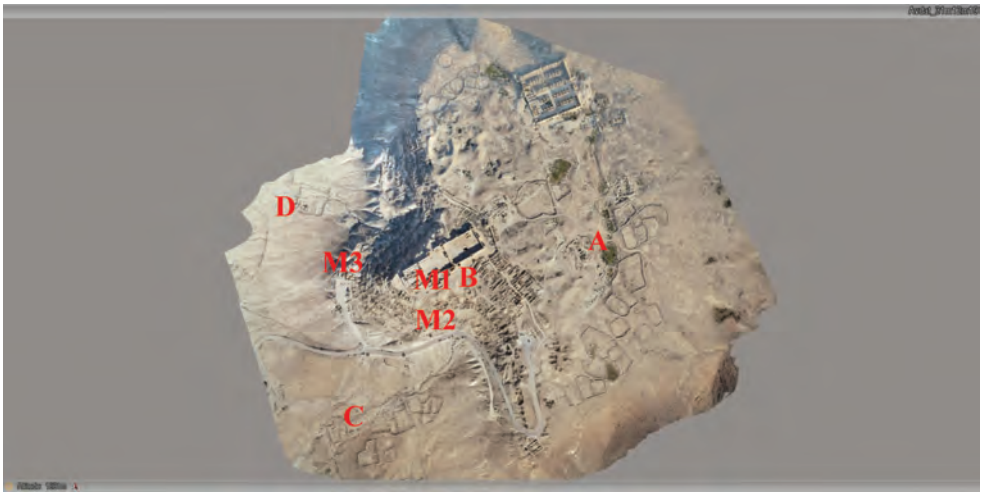

Figure 3: Aerial photograph of Oboda (Avdat), winepresses (A–D) and monastic structures (M1–M3) mentioned in the text (credit: INPA).

Figure 4: Aerial photograph of the Early Byzantine winepress (A) at Oboda (Avdat) (photographer: Lior Schwimer, INPA).

compartments on the southern side of the treading floor, measuring 4.1 × 5.2 m, were paved and separated by a narrow partition wall.

The room with the robbed-out treading floor and the central socket is situated, as mentioned above, along the eastern exterior wall of the main structure. The room measures 4.3 × 5 m in size and the treading floor is c. 0.77 m below the extant remains of the enclosing walls. A smaller room, located west of the treading floor, was accessed from the courtyard. It housed a shallow settling vat connected to a round collection vat, 2 m in diameter and 1.4 m in depth (Negev 1977:28). The floor of the collection vat was made from triangular limestone slabs hewn to fit the space around a central depression (Fig. 6), like those found in the monastic winepress at Shivta (Mazor 2009:399, Fig. 70.4, No. 4; Segal 1986:12, Fig. 9) and the freestanding winepress next to the South Church in Oboda and in the winepress near the North Church at Shivta (Mazor 2009:399, Figs. 70.4 and 70.5, Nos. 4, 5).

A round depression was present in the center of the settling vat. The juice from the treading floor flowed across a stone drain into the settling vat on the south side of the collection vat. The slabs of the treading floor appear to have been robbed out, leaving only the square stone rim of the central socket, used for a screw press in a second pressing of the grapes (*mustum tortium*). The juice from the socket would have flowed under the floor surface directly into the collection vat. Mazor estimated that the settling vat and collection vat could hold up to 4.2 m^3 of pressed juice (Mazor 2009:402; Table 1, No. 8). Negev reported the presence of two large, round

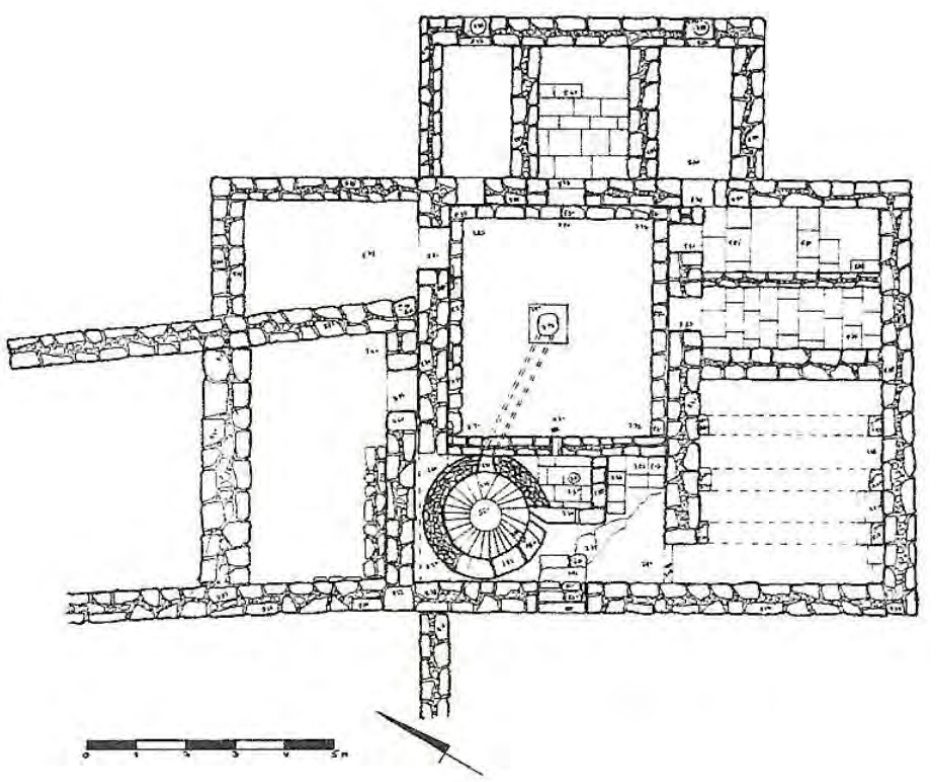

Figure 5: Plan of the Early Byzantine winepress at Oboda (Avdat) (from Mazor 2009).

depressions (jars?) sunk into the ground, south of the southern storage compartment. He suggested that these were used to hold wine jars (Negev 1977:28). One of these can still be seen today.

An extraordinary find, discovered in another part of the building was that of a camel scapula, perforated in one corner, with lines of Greek writing in black ink on either side (Fig. 7). The inscription refers to hiring out camels and donkeys for bringing grapes up from the fields (Negev 1977:28–29; Erickson-Gini 2012:53, Fig. 5). The object was apparently hung by a string in one of the western rooms like another inscribed camel scapula, uncovered in 1999 in the pantry of a building of the late 2nd or early 3rd century located c. 50 m further north (Erickson-Gini 2010:91–93).

Naḥal Revivim – A second winepress was revealed in a salvage excavation near Naḥal Revivim (Mashabei Sade) in 2017 (Fig. 8). The installation was discovered along the southeastern wing of a large building, posited to be a caravanserai of the 4th and early 5th century CE—the same period as the building excavated by Negev in Oboda (Negev 1977:27–28). The stone pavement of the treading floor survived until its northern edge was damaged by mechanical equipment in 2017. The treading floor measures 4 × 4.5 m and was constructed from hard, limestone pavers, sloping slightly towards the room of the settling vat and the collection vat. The collection vat and the settling vat are very similar in position to those at Oboda with the collection vat taking up nearly two-thirds of the room and the settling vat situated in the smaller third (Fig. 9). The collection vat is 2.24 m in diameter and 2.2 m deep. It was completely

plastered with hydraulic plaster and a depression in the center, 1.5 m in diameter and 0.5 m deep was probably used for collecting the juice at the bottom of the vat and for cleaning it. A carved, perforated stone (Fig. 10) found in the excavation appears to have been part of the screw press installed in the socket of the treading floor.

The settling vat measures 1 × 1.2 m in size and like that at Oboda, it also has a round depression, in this case plastered with hydraulic plaster, that could have been used to collect juice into wine jars and for cleaning. No clear remains of storage compartments survived in this structure, which in the Late Byzantine period (mid-6th to early 7th

Figure 6: Photo of the collection vat in the Early Byzantine winepress at Oboda (photographer: Tal Hayut, INPA).

century) went out of use as a winepress and was used for domestic purposes (Erickson-Gini and Mamalya 2022:149*). However, the heavily fragmented plaster surface uncovered at a higher level, c. 1 m above the room of the collection vat, is probably the remains of one of the storage compartments where a coin was uncovered.

Regarding the dating of the site, the coin (a bronze Securitas Victoria type minted in Cyzicus; Reg. No. IAA 172257) dates to 364–375 CE and pottery sherds of the Early Byzantine period were also uncovered there (Erickson-Gini and Mamalya 2022:149*, 152*–153*). Indications of the heated baths in the structure, which include rooms coated

Figure 7: Photo of the inscribed camel scapula (from Negev 1977).

Figure 8: The Early Byzantine winepress in the structure in Naḥal Revivim (photographer: Davida Degen-Eisenberg, IAA).

Figure 9: The collection vat and settling vat in the Naḥal Revivim winepress (photographer: Davida Degen-Eisenberg, IAA).

Figure 10: The carved object used in the screw press at Naḥal Revivim.

with hydraulic plaster and part of a ceramic *tubula* (Erickson-Gini and Mamalya 2022 Figs. 13–14; 159*, Fig. 17) point to it as the site of a caravanserai and not a farmhouse. The walls were constructed using high-quality ashlars and part of a Pompeian-style basalt millstone was uncovered, all of which also suggest the public nature of the building.

Shivta – The winepress in Shivta near the North Church was uncovered in a building dubbed "Insula 1" by the Colt expedition (Fig. 11) (Segal 1986:11–12; Mazor 2009:399, Fig. 70.4, No. 4). The layout of the winepress inside the town near the North Church is very similar to the Early Byzantine winepresses described above. It is made

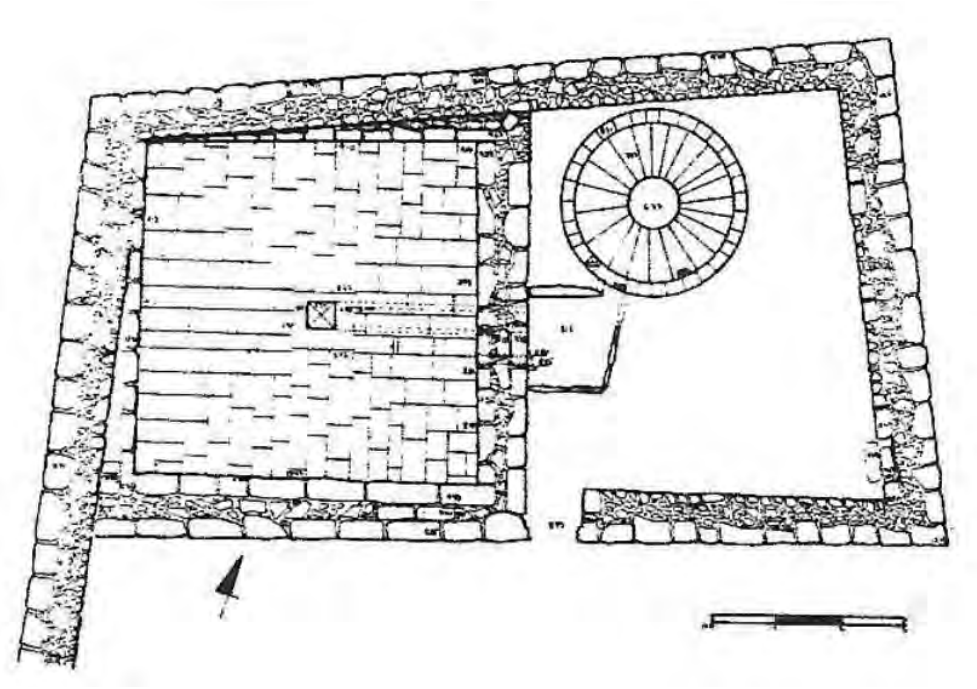

Figure 11: Plan of the monastic winepress in Shivta (from Mazor 2009).

Figure 12: Photo of the monastic winepress in Shivta (photograph courtesy Sky-View).

up of a treading floor, situated next to a large, paved area (marketplace?) leading to the North Church. The treading floor and socket are still intact. The position of the collection vat and settling vat in front of and below the treading floor is nearly identical to that at Oboda and Naḥal Revivim (Fig. 12). No storage compartments are indicated anywhere around the winepress. It was accessed by way of a room along the south and here were found the opening to a cistern and stone installations (mangers?) along the east and west walls (Fig. 13). Mazor estimated that the settling vat and collection vat of the winepress held around 3.6 m^3 of pressed juice (Mazor 2009:402; Table 1, No. 4). The size of the treading floor is larger than those in the early winepresses at Oboda and Naḥal Revivim described above but nearly 10 m^2 smaller than that of the freestanding winepresses recorded at other sites.

FREESTANDING WINEPRESSES

Freestanding winepresses appear to have developed in the next phase of urbanization in the Negev Highlands in the Middle Byzantine period (mid-5th to mid-6th centuries). These winepresses had larger treading floors that were rather standardized in size, averaging 33 m^2 (Mazor 2009:402, Table 1), as opposed to the early winepresses with smaller treading floors in Oboda (16.30 m^2) and Naḥal Revivim (18 m^2).

Four freestanding winepresses have been found at Oboda. These were built following the early 5th-century earthquake when the town became confined to the western edge of the plateau and surrounded by a wall. In this period, a large citadel was constructed, abutting the eastern side of the Early Roman temenos platform and

Figure 13: Photo of the monastic winepress in Shivta (photograph courtesy Sky-View).

two churches were built inside the temenos precinct. The South Church, which was the center of the cult of Saint Theodore, was part of a monastery that included a stable (Figs. 3:M1; 14) (Negev 1997:149; Erickson-Gini 2022b:198–199, Fig. 10). Outside of the South Church, a large, freestanding winepress was constructed. It was first noted by Musil in 1902 (Musil 1907:126, Fig. 92) and later excavated by M. Avi-Yonah and A. Negev between 1958 and 1960 (Mazor 2009:399; Negev 1997:7–8, Fig. 2). In 1992, G. Tahal completed the excavation of the installation and ancillary rooms on behalf of the Israel Antiquities Authority to facilitate its restoration (Tahal 1995:130–133, Fig. 130).

The freestanding winepress next to the South Church was larger than the earlier examples, measuring ca. 66 m^2 (Mazor 2009:402, Table 1, No. 5). The later excavator noted that it was built above the remains of earlier buildings (Tahal 1995:131), which were probably those of structures destroyed in the earthquake in the early 5th century. Compared to the winepresses located north and south below the western slope of Oboda, the one next to the South Church has only one collection vat. The southern (Fig. 3:C) and northern (Fig. 3:D) winepresses were built or renovated to hold two or more smaller collection vats. Recent clearance and consolidation of the southern winepress revealed more details of additions and use (Fig. 15). All three freestanding winepresses appear to have been constructed below or next to a monastic structure with an adjoining stable (Erickson-Gini 2022b:197–199). A fourth winepress near Oboda, excavated by Negev, is rather primitive in appearance and lacks a treading floor. Instead, compartments are built in a circle around an opening leading into

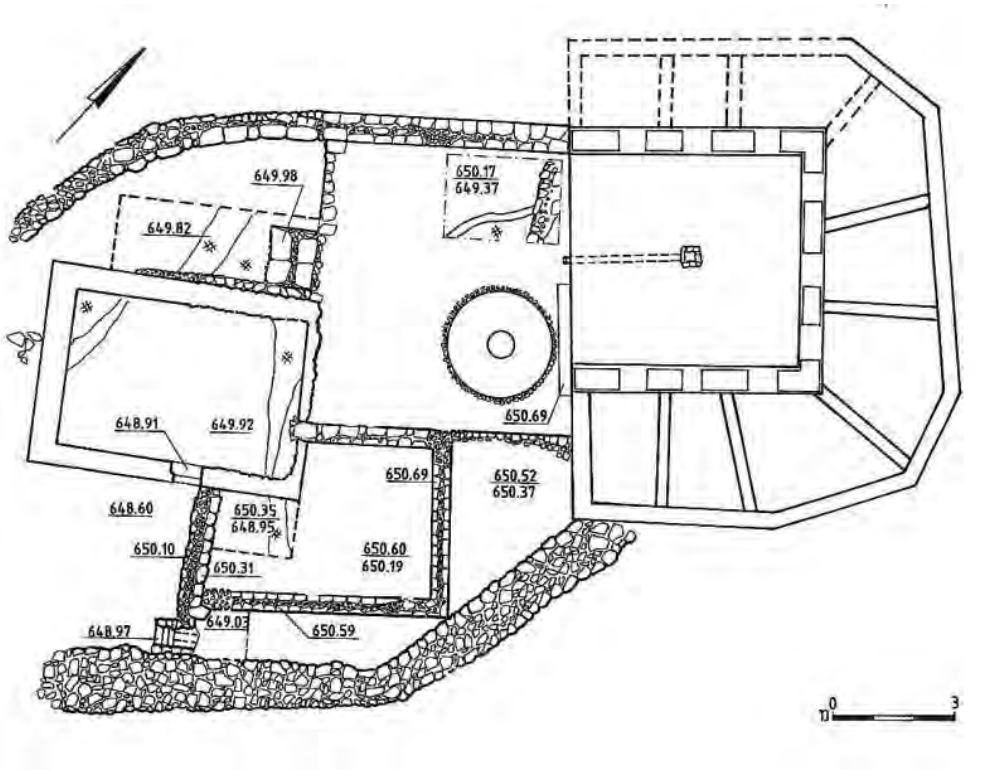

Figure 14: Plan of the freestanding winepress (B) next to the South Church in Oboda (from Tahal 1995).

Figure 15: Photo of the southern winepress (C) at Oboda after clearance (photographer: Lior Schwimer, INPA).

Figure 16: The freestanding winepress on the western outskirts of Shivta (from Mazor 2009).

a man-made cave (Mazor 2009:399, 401, Fig. 70.9, No. 9). The installation is located nearly a kilometer directly west of the site on the opposite of the Byzantine necropolis and close to fields lining the Naḥal Ẓin basin.

At Shivta, the freestanding winepresses are situated on the outskirts of the town to the west (Fig. 16) and the southeast. Two freestanding winepresses in the Elusa area, including the one in Naḥal Atadim excavated by Mazor (2009:399, No. 1) are located at some distance from the city. Recent surveys in the area around Elusa have revealed the remains of approximately 20 small winepresses located in the agricultural hinterland around the city (Schöne et al. 2023:156, Abb.7). The influx of sand into the area that includes Elusa, Rehovot-in-the-Negev and Sa'adon since the Byzantine period has probably covered the remains of other small winepresses and possibly even larger ones similar to the way in which the Naḥal Revivim winepress was completely hidden from view.

Freestanding winepresses of the Byzantine period continue to be uncovered throughout the Western Negev and in the southern coastal region of Israel. These include a winepress uncovered in the site of Be'er Shema' (Birsama) located northwest of Elusa and Be'er Sheva, in a village or monastic community in the bishopric of Gerar, the site of a church dedicated to St. Stephen (Erickson-Gini, Dolinka and Shilov 2015:209–210; Varga, Lender and Gazit 2019). Here a

Figure 17: The collection vats and settling pool in the freestanding winepress at Be'er Shema' (photographer: Tali Erickson-Gini, IAA).

freestanding winepress was discovered under a layer of windblown sand c. 500 m west of the church and c. 400 m southwest of the Diocletianic fort, near a storeroom filled with bag-shaped storage jars dating to the Late Byzantine period (c. 550–650 CE). This winepress had a relatively small treading floor, measuring 16.8 m^2, and two square collection vats that shared a square settling vat (Fig. 17) (Erickson-Gini, Dolinka and Shilov 2015 Plan 2, Figs. 7–10). The northern collection vat was blocked in the latest period of use and repairs in the walls of the vats were complemented using pottery sherds. A square slab placed on top of the southeast corner of the northern collection vat was carved to hold what appears to have been the narrow base of a "Gaza" wine jar (Erickson-Gini, Dolinka and Shilov 2015:218). The treading floor and some walls in the winepress have been stripped of stones in the Abbasid or Late Ottoman periods (or both).

A small monastic site at the site of Er-Rasm, located c. 2 km southeast of Tel Ashkelon, boasted the remains of a small, elaborately decorated church, a pottery kiln and three winepresses, situated side by side (Fig. 18), the southernmost of which abutted the northern wall of the church (Erickson-Gini 2021). The two northern winepresses appear to have been constructed earlier than the third one, abutting the northern church wall. The floors and walls of these installations were

Figure 18: Three winepresses situated side by side in the monastic site of Er Rasm, Ashkelon (photographer: Davida Degen-Eisenberg, IAA).

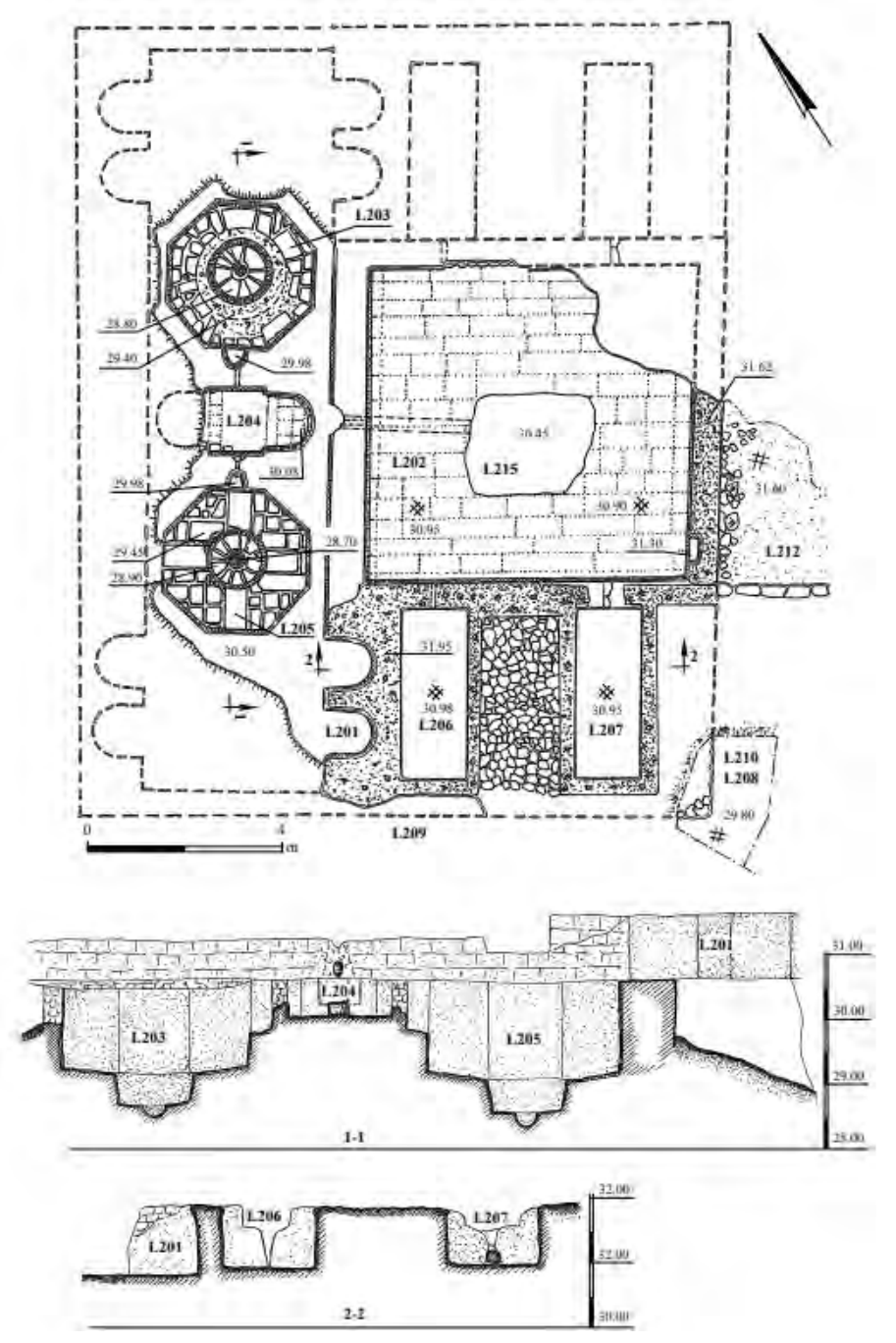

Figure 19: Plan of the winepress with an inscription in the imperial "Third Mile Estate", Ashkelon (from Israel and Erickson-Gini 2013, Plan 6).

almost completely robbed out, making it difficult to determine the exact size of the treading floors. However, they appear to correspond to the average size of many of the freestanding winepresses in the Negev Highlands, c. 33 m^2. The collection vats in the southern winepress are 0.10 m shallower than those of the two northern winepresses, suggesting that the southern winepress was added at a later time in the Byzantine period.

The collection vats in the northern and southern winepresses are square and those of the middle winepress are octagonal like those found in a winepress northeast of Tel Ashkelon, in the "Third Mile Estate" (Fig. 19) (Israel and Erickson-Gini 2013:192–193, Figs. 18–19, Plan 6). All three winepresses have collection vats that are situated on either side of a shallow, oval settling vat like that described in the "Third Mile Estate". Comparisons between the two sites, both located in the hinterland of Tel Ashkelon suggest that local builders were used in the construction of monastic winepresses (Er-Rasm) and those of imperial or private estates (the "Third Mile Estate").

DISCUSSION

The earliest winepresses that have been recorded in the Negev Highlands are those of the Early Byzantine period (4th to early 5th century CE) and these appear in rooms surrounding buildings with large courtyards at Oboda and in a caravansary located next to Naḥal Revivim (Mash'abe Sade; Bir 'Asluj). An inscribed camel scapula discovered in the Oboda structure is important evidence of the cultivation of vineyards next to the site and wine production there in the 4th century CE. A third winepress of this type was also uncovered in a monastic complex next to the North Church in Shivta.

The genesis of viticulture in the Negev Highlands, already well-established in the 4th century CE, may have been triggered by the influx of Late Roman army units into the Negev and southern Jordan at the end of the 3rd and beginning of the 4th century CE during the reign of Diocletian. This dramatic movement into desert regions of the southern Levant within which three Roman legions were re-located created an immediate demand for agricultural products and particularly for wine (Erickson-Gini 2010:198). At the Late Roman / Early Byzantine fort of 'En Hazeva in the Arava Valley—an important military site controlling the road between Mampsis and the copper mining district of Faynan (Phaino)—dozens of "Gaza" wine jars, produced in the southern coastal plain were uncovered.

Freestanding winepresses appear to be an innovation of the Middle and Late Byzantine periods (450–637 CE) in the Negev Highlands at Oboda and Shivta and throughout the southern coastal plain of Israel and the Western Negev. Each of the three freestanding winepresses at Oboda appear to be related to monastic communities with an adjoining stable in the site.

Similarly, freestanding winepresses, often with accompanying pottery kilns that produced "Gaza" or bag-shaped wine jars continue to be discovered all over the southern coastal plain and the Western Negev. The size of the treading floors and number of collection vats of the freestanding winepresses exceed those of the Early Byzantine period. More recently, a survey team from Cologne University has

discovered about twenty small winepresses of simpler kind in the hinterland around the Negev capital city of Elusa (Schöne et al. 2023:156, Abb.7). Continued research in the region will undoubtedly reveal winepresses of the early varieties, many of which were probably robbed out in ancient and modern times and concealed by the movement of sand from North Sinai into the Western Negev. In the Middle and Late Byzantine periods (c. 450–637 CE) the paucity of private dwellings at Oboda stands in stark contrast to the impressive number of terraced, cultivated fields and agricultural watchtowers in the immediate area (Sion, Ashkenazi and Erickson-Gini 2022:53–54). It is probable that cultivation around Oboda peaked at the end of the Middle Byzantine period around the early to mid-6th century and declined in the Late Byzantine period when the site was mostly occupied by monastic elements. Manpower for agricultural production before the decline may have been provided on a seasonal basis by the city of Elusa, which at its peak housed between 8,000 and 10,000 inhabitants (Heinzelmann et al. 2022:238).

THE MONASTIC CONNECTION

It appears that viticulture was firmly established in the Gaza region and as far south as Elusa in early monastic communities by the mid-4th century, as can be seen in texts such as the *Vita S. Hilarionis*, the life of the monk Hilarion, penned by Jerome (1845). Three chapters of this biography deal with Hilarion's miracles while visiting monks working in viticulture, many of which took place immediately before the grape harvest, for instance in Elusa itself, which Hilarion found to be a predominantly pagan city. According to Jerome, Hilarion's blessing on a vineyard resulted in tripling the grape harvest in thirty days (Bucking and Erickson-Gini 2020:51).

Regarding archaeological evidence, a prominent motif in Byzantine mosaics of churches and synagogues of the 5th and 6th centuries in the southern coastal plain is that of grape clusters and vines. A mosaic floor of a church uncovered in Hazor-Ashdod includes scenes of baskets of grapes, gazelles eating grape leaves and clusters of grapes and fleeing dogs and leopards through vineyards (Habas 2020:115–117, Figs. 8–12). Donkeys used for transport associated with the vintage cycle have been found on mosaic floors, for instance in St. Stephen's church in the site of Be'er Shema' where the winepress that was later revealed was described above (Gazit and Lender 1993:275; Habas 2005, 1:216–223), scenes that echo epigraphic evidence provided by the Oboda camel scapula described above. Vines and grape clusters are an integrated part of scenes depicting animals and people on the mosaic floor of St. Stephen's church discovered at Be'er Shema' (Gazit and Lender 1993:274–276; Varga, Lender and Gazit 2019).

Even more impressive evidence includes the transport of "Gaza" wine jars on the back of a camel in a church mosaic revealed in Kissufim in the Western Negev (Cohen 1979; Fuks et al. 2020:5, Fig. 6), and a "Gaza" wine jar which is depicted in secondary use as a dovecote in St. Stephen's church in Be'er Shema' (Gazit and Lender 1993). "Gaza" wine jars of the Middle and Late Byzantine periods (c. 450–637 CE) produced throughout the southern coastal plain of Israel have been discovered in both Eastern and Western Mediterranean coastal sites, in sites along the Nile River in Egypt and sites stretching from the United Kingdom to the coasts of the Red Sea and the Indian

Ocean (Lantos, Bar-Oz and Gambash 2020:61, Fig. 6). The chronology of "Gaza" wine jars—four basic types ranging in date from the 1st through early 7th centuries CE—is based on the well-tried study of the forms and quantities of the vessels discovered at Kom el-Dikka (Alexandria, Egypt) by G. Majcherek (1995). Archaeological evidence from the Negev Highlands points to a steep downturn in their incidence from the mid-6th century CE, possibly in the wake of the effects of the Justinian plague and lower international demand (Fuks et al. 2020; Heinzelmann et al. 2022:274). This drop in wine production is manifest locally in the Negev Highlands in a similar decline in the number of grape pips uncovered in archaeological excavations at Shivta (Fuks et al. 2020:7, Fig. 8). This appears to have stemmed from a decline in demand for the product internationally and a general decline in trade in the Byzantine Empire as can also be seen in a steep decline in the import of very popular fine ware bowls, Phocaean Red-Slipped Ware (also called Late Roman "C" ware), exported from western Asia Minor throughout the Eastern Mediterranean and further west (Bes 2015:130).

The Late Byzantine period in the Negev Highlands and the southern coastal plain (c. 550–650) was characterized by the predominance of monastic communities, many of which appear to have replaced civilian activity. Wine production in the Negev Highlands in this period was apparently centered around self-consumption and the needs of Christian pilgrims passing through the region. In the Negev Highlands, these communities continued to function, providing lodging and travel services for pilgrims traveling to Saint Catherine's Monastery and Jebel Musa identified as the site of Mount Sinai in the Byzantine period, or to smaller shrines like that of Saint Theodosius in Oboda. Rock art in the Negev Highlands attests to the movement of Christian pilgrims in the region to both places during that period (Schwimer and Bucking 2021:111, Fig. 7). Late Byzantine monastic communities continued to exist into the Umayyad period (637–750), albeit with a steep decline in their standard of living, as has been revealed in studies of flora and fauna from middens in the sites of Shivta, Nessana and Elusa (Bar-Oz et al. 2019; Marom et al. 2019; Langgut et al. 2021).

The monastic community at Oboda managed to survive the massive destruction and general abandonment of the town that took place due to a local earthquake in the early 7th century (Erickson-Gini 2014:100; 2022a:192). According to radiocarbon dates, the monastic stable and cave on the southern slope of the site continued to function as late as the 9th century during the Abbasid period (Bucking et al. 2022:758). A larger monastic complex situated on the northwest corner of the western slope, Negev's Byzantine dwelling and the "Saints" cave (Negev 1997:153–169), shows the extensive addition of support walls both inside (Room 7) and outside the dwelling in the wake of the earthquake (Bucking and Erickson-Gini 2020:52, Fig. 36). Similarly, the main gate of the Byzantine citadel on the acropolis was blocked up with building stones to a height of at least 5 courses (Negev 1997:97, Photo 137) as was the southeastern entrance to the atrium of the South Church (the St. Theodore Church). Whether or not the freestanding presses in Oboda continued to function after such destruction, even for personal consumption, is yet unknown.

Regarding other sites in the Negev Highlands, although Mampsis was abandoned at the end of the Late Byzantine period, north of town, a small church and adjoining

courtyard with rooms, probably a monastic structure, appear to have continued to function after the Islamic conquest in 637 CE. Although not yet excavated, the northern wall of the church was reinforced with a revetment wall like those found in sites damaged by the early 7th century earthquake at Sa'adon, Rehovot-in-the-Negev, Shivta and Nessana (Erickson-Gini, Lifshitz and Aladjem 2018:53). Notably, the great city of Elusa was essentially abandoned, and its churches and edifices were being dismantled for building material early in the Abbasid period.

Monastic communities in the southern coastal plain fared much better in the Late Byzantine period and wine production and the production of "Gaza" wine jars continued until at least the end of that period. Evidence from Er Rasm and the "Third Mile Estate," Ashkelon indicates that wine production for export ceased at the end of the Late Byzantine period (*contra* Lantos, Bar-Oz and Gambash 2020:61). A winepress with a marble treading floor (L421) in the "Third Mile Estate" was renovated in the year 590 CE, according to a recently discovered inscription inserted into a floor of one of the collection vats (L429) during conservation work. According to epigraphist Avner Ecker (Bar Ilan University, pers. com.), the inscription indicates that the "Third Mile Estate" was an imperial estate belonging to the Byzantine emperor or his family. The estate itself is unusual compared to nearly every other Byzantine site in the southern coastal plain, the majority of which are monastic communities with wine and wine jars production. While the estate had a kiln to produce "Gaza" wine jars, two winepresses, an oil press and multi-storied storerooms, it also included a bathhouse, a fish pond, cist graves and a barrel-vaulted tomb containing infant burials inside Late Byzantine "Gaza" wine jars (Israel and Erickson-Gini 2013:203, Fig. 30). It is of interest to note the surge in the occurrences of Late Roman 1 jars possibly used for transporting imported wine at the very end of the Late Byzantine period in the Negev Highlands. Several examples of this jar were discovered in South Sinai at Jebal Safafa (Dahari 1994 Fig. 422:5–10) and this suggests a particular connection between the import of this type of jar and monastic life during this period.

CONCLUSION

The presence of winepresses in the Negev Highlands and the southern coastal plain of Israel is a testament to the importance of viticulture and the production of wine for export throughout the Mediterranean Basin and beyond during the Byzantine period. Revenues from the export of wine were responsible for the surprising phenomenon of urbanization of the Negev Highlands in the Early and Middle Byzantine periods (350−550 CE). This includes the vast expansion and construction of the capital city of the Negev, Elusa, which at its peak housed between 8,000 and 10,000 residents and boasted at least nine churches, a large public bathhouse, and a theater with a renowned school of rhetoric. The decline of wine production and export from the mid-6th century CE, possibly in the wake of the Justinian Plague (541−542 CE) induced a steep decline in public and private fortunes throughout southern Israel. From the mid-6th century private property appears to have been transferred to monastic elements throughout that region. Monastic wine production continued to some extent in the

Western Negev and southern coastal plain, possibly even into the early Umayyad period. However, these tiny communities also passed from the scene within a few generations, never to be replaced. Economic decline and the demise of Byzantine control and influence in the early 7th century brought about the abandonment of the great desert city of Elusa, including its churches and monasteries, by the end of the Umayyad period in the mid-8th century.

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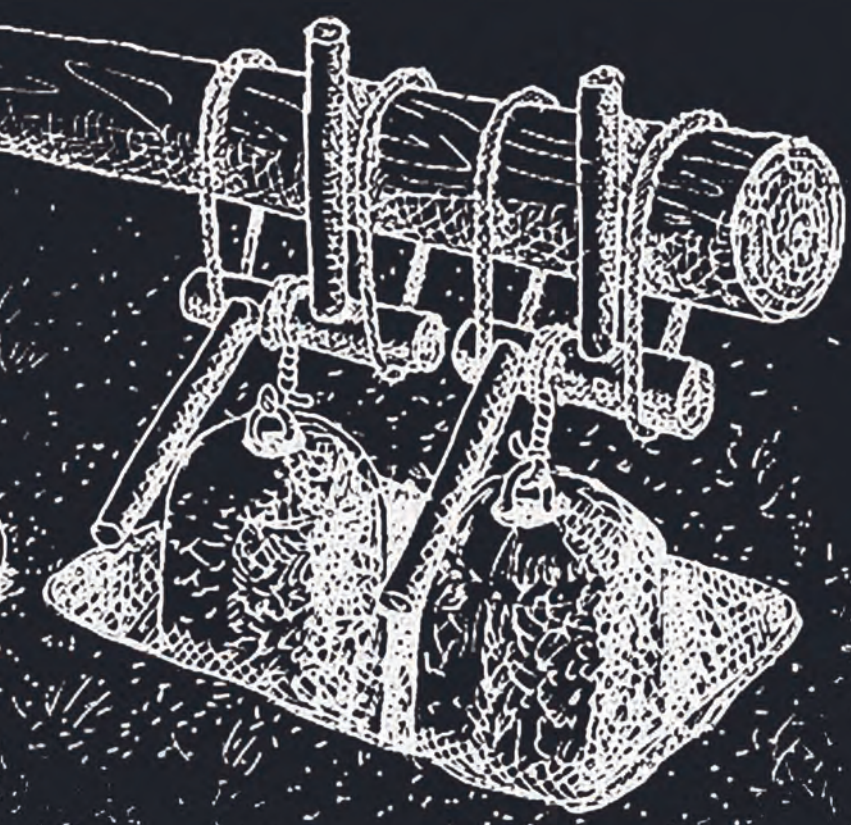
Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

Michael Eisenberg, ʻUzi Ad and Etan Ayalon



Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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Michael Eisenberg, Uzi ʻAd and Etan Ayalon

To Dr. Rafael (Rafi) Frankel (1929–2023)

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Yavne and the Debate on Winepress Technology in Composite Winepresses: Rafael Frankel Revisited

Jon Seligman

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… quanto tamen in potu ingeniosior fuerit apparebit ad bibendum generibus centum octoginta quinque excogitates …

… How much more ingenious … man had been in respect of drink will be made by the fact that he has devised 185 kinds of beverages (wine varieties). (Pliny, NH 14.29)

ABSTRACT

Rafael Frankel's pioneering work on the technology of ancient wine and oil production set the standard for studies in this field for Israel and the eastern Mediterranean. His study, blended from interpretation of historical texts together with detailed knowledge of the archaeological record, provided scholars with an understanding of processes of production of wine and olive oil in antiquity. Specifically for vinification, the pinnacle of technological achievement would be the development of the composite winepress in the Byzantine period, the operation of which led Frankel and others to provide comprehensive explanation based on historical sources, ethnographic observation and analogy, and archaeological analysis. In recent years this understanding has been challenged, especially by Y. Dray and others, largely through the results of experimental archaeology, technological scrutiny and biochemical analysis. Utilising the recent discovery of a huge winery at Yavne, comprising multiple composite winepresses, this article revisits Frankel's insight of the process of wine production in composite winepresses, stridently rejecting Dray's revision, bringing the analysis back to understanding this process through the tools of textual analysis, ethnographic analogy and archaeological method emphasised by Frankel.

Keywords: Composite winepresses, experimental archaeology, Byzantine period, Yavne

INTRODUCTION

During excursions to the beautiful hills surrounding Rafi Frankel's home in Kibbutz Beth Haʿ Emek in the western Galilee, he was fascinated by the remnants of the myriad agricultural installations that dotted the landscape.[1] His intellectual

1 As a teenager, I spent a few months at Kibbutz Beth Ha'Emek in the Hakhshara programme of the Dror-Habonim youth movement. Rafi was one of the Kibbutz 'parents' who adopted us for this period and I was happy to join him on his enthused, but at the time incomprehensible, explanations of the collection of ancient agricultural artefacts he had gathered in the Kibbutz museum and on his surveys in the western Galilee. Rafi was certainly central in my later decision to study archaeology and ultimately, enter the profession.

curiosity in the archaeology of olive oil and wine was piqued by his participation in the survey of Rosh Haʿayin region, under the leadership of Moshe Kochavi between 1972–1973 and later, from 1975, his own surveys in the Galilee. Ultimately this would lead Frankel's pioneering doctorate (1984), in which he intertwined classical texts together with modern interpretations of long overlooked readings from Hebrew exegetic writings on agricultural methods, linking them with contemporary archaeological remains. This work, later revised and published in English (Frankel 1999) has become the standard and most widely quoted reference for all those researching this field, not only in Israel, but around the Mediterranean and beyond. Frankel's work, often in conjunction with other researchers (Frankel and Ayalon 1988; Ayalon, Frankel and Kloner 2009; 2012) provided a clear textual and archaeological classification of winepresses and wine production in the southern Levant. In recent years this has been augmented by individual site studies on wine production, specifically of the Roman and Byzantine periods, advancing our understanding of mass wine production in alternatively named 'improved', 'complex' or 'composite' winepresses. While this paper will use the newly discovered and magnificent winery at Yavne as the primary example (Seligman, Haddad and Nadav-Ziv 2022; 2023), note should be taken of previous similar studies of composite winepresses at Ras Abu Maʿaruf near Jerusalem (Seligman 1999; 2011:280–400), Mishmar Ha-'Emeq (Avshalom-Gorni, Frankel and Getzov 2008), Castra (Yeivin and Finkielsztejn 2009), the Negev highlands (Mazor 2009; Seligman 2020), the 'Third Mile Estate' near Ashqelon (Israel and Erickson-Gini 2013) and el-Khirbe (Nesher-Ramla) (Avrutis 2015), and critical technological analysis, especially that of Yehoshua (Yeshu) Dray (2003; 2006; 2011; 2015; 2024) and others (Hadas 2007a; 2007b; Viezel and Torge 2022).

COMPARATIVE TERMINOLOGY OF THE COMPOSITE WINEPRESS

Comparative reading of the publications by various scholars is often confounded by their use of varied terminologies for the same elements of the press as it relates to their functional understanding of the process of wine making. Furthermore, authors, including myself, have not been consistent in their use of terms for parts of the press, further confusing discussion. The following table pulls together terms used by different researchers. True to the purpose of the article, to revisit Frankel's original understanding of wine making, his terminology, quoted in brackets, is used as the standardised lexicon, followed by applications employed by other scholars.

Frankel / Ayalon	**Dray**	**Hadas**	**Seligman**	**Avrutis**
Improved press	Gat	Composite press	Improved press	Improved press
Composite press	Bet Gitot (בית גיתות)	Bet Gitot (בית גיתות)	Complex / composite press	Composite press

Frankel / Ayalon	Dray	Hadas	Seligman	Avrutis
Compartment / auxiliary or subsidiary treading floor	Treading floor	Upper treading floor	Auxiliary / ancillary floor	Upper platform
Intermediary vat / compartment	Fermentation vat (Gatot – גתות)	Fermentation vat	Compartment	Compartment
(Main) Treading floor	Working surface	Working surface	Treading floor	Treading floor
Single fixed screw press	Single fixed screw press	Single fixed screw press	Single fixed screw press	Screw press
Intermediary vat	Directing vat/ basin	Filtration or settling vat	Filtration vat	Intermediary vat
Collecting vat	Collecting vat	Collecting vat	Collecting vat	Collecting vat

THE COMPOSITE WINEPRESS

Technological development of wine production, towards vinicultural intensification, was required to shift production from autarkic domestic yields to the industrial quantities necessary for the increased demands of the local and international trade in wine from the southern Levant in the Roman, but especially the Byzantine periods. This would require technological innovation to adapt the winepress in aspects of management and spatial organization, while matching the intricacies and efficiency of wine production for new requirements. As its base level, making wine is a simple process. Grapes are trodden or pressed, the collected must is drained, filtered, left to ferment, packaged and drunk as wine. However, transforming the biochemical process of viniculture for industrial magnitude necessitated sophisticated methodological development. The simplest winepresses, dating back at least from the Chalcolithic period, included a treading floor, either using a natural or quarried rock surface, or later, a plastered floor, on which grapes were pressed, the must draining into an adjacent vat (Frankel 1999:51–60, types T1). Primary fermentation took place in the vat, or in containers into which the must was transferred.

From the late Bronze Age in Syria and Cyprus, and from the early Iron Age in Israel, greater efficiency was achieved by secondary pressing of the grapes with a lever, specifically a beam weighed down with stone weights (Frankel 1999:61–67, types T2). With the understanding that greater control over the process could be achieved if pressure from a screw was applied, classical authors, such as Vitruvius (6.6.3) and Pliny the Elder (NH XVIII.74.317), indicate the introduction of the screw press in the 1st century BCE, though the first examples that can be dated from Israel are no earlier than from the Byzantine period (Frankel 1999:86–88, 107–137, type T6). The base for the single fixed-screw press was usually fixed in a mortice cut into a free-standing stone set in a pit at the centre of the treading floor or directly into the bedrock (Frankel

1999:140–146, types Ts81–83). Filtration of the must was also integrated into the architecture of the press, often as an intermediary vat between the treading floor and the collecting vat. This was the technological baseline from which industrial pressing developed to its ultimate level during the Byzantine period. Further innovation for intensification would result with the composite winepress, a technological solution unique to the southern Levant, which, I would contend, was the most advanced industrial process of its time. Some of these apex wineries may have been roofed and enclosed within buildings, and it is these that should be associated with the term 'Bet Gitot' (בית גיתות – literally 'House of Winepresses') that appears in the Jerusalem Talmud (JT Ohalot 18, 13) and the Tosefta (Tosefta Terumot 3, 7) (Seligman 1999:163, note 14; Frankel 1999:186; Dray 2015:191; 2024:92, 123; Ayalon 2024:195–196).

The composite winepress enabled multiple processes to be conducted simultaneously in a single press, aiding mass production (Fig. 1). This was achieved by the addition of three to ten auxiliary treading floors, small semi-circular or rectangular vaulted compartments, rare additional fixed screw-presses, an intermediary filtration or settling vat, leading to multiple collecting vats, and other functional features. The surfaces of the elements of the press, including treading floors, compartments, vats and even working areas, were paved with white mosaic or flagstones to seal the surfaces and help keep the winery as clean as possible throughout processing. As massive quantities of wine could be produced in these facilities, and because of the complexity of the process, new approaches to management were required. For this reason, only larger estates, rich landowners or monasteries had the resources to operate composite winepresses, this probably the reason for their relatively low number and the limited diffusion of these installations to a relatively small geographical area, without extensive distribution to other regions of the Mediterranean littoral. To date, only around 150 composite winepresses have been identified in the southern Levant, the majority inside the boundaries of Byzantine Palestine, with major concentrations on the southern coastal plain, the Judean Shephelah, the Judean hills—especially around Jerusalem—and the Negev highlands, and a small cluster in Transjordan (Frankel 1999:139–148; Avrutis 2015:67–71, table 3.5; Seligman, Haddad and Nadav-Ziv 2023:17–19, table 1).

An Example—The Composite Winepresses at Yavne

As the composite winepresses of the Byzantine period are, by and large, very similar, it suffices, as an example, to present the typical presses found at Yavne, while noting important distinctions at other sites in the following table. These installations invariably included: a large central treading floor, usually paved with a simple white mosaic, with a mortice for a single fixed screw press at the centre; surrounding raised auxiliary floors and compartments of different shapes that connect through ducts to the central floor; and a filtration vat connected to one or two large collecting vats, again of differing forms. These differences are generally regional and architectural variation of little consequence and do not seem to indicate divergence in methods of production.

The extensive salvage excavation of the area to the north-east of Tel Yavne (26.120095° north, 33.028192° east; Haddad et al. 2022) exposed a vast winery estate,

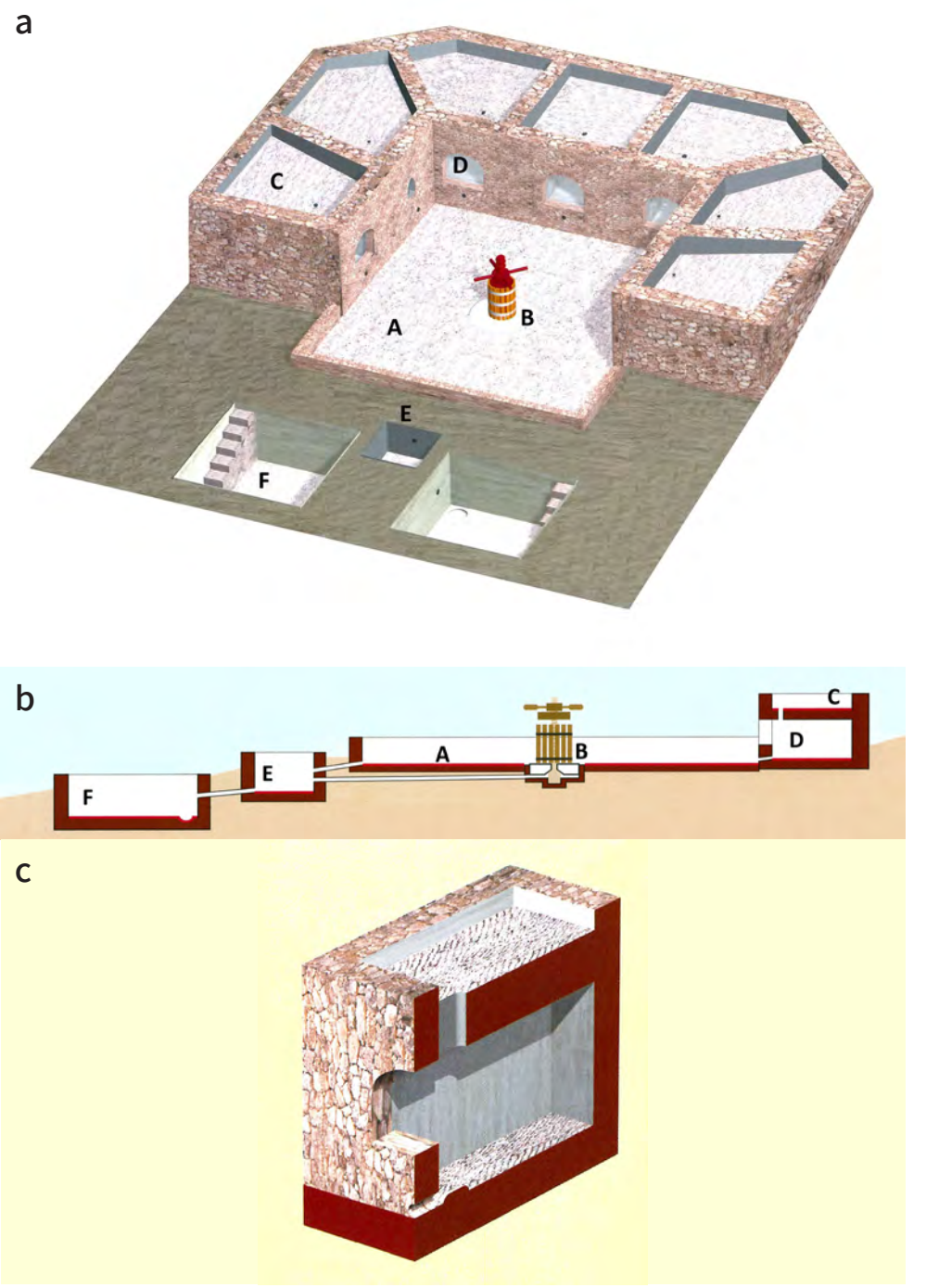

Figure 1a: General sketch of a composite winepress (Based on Hadas 2007b:126–127, original drawing by S. Tamari, courtesy of Kronenberg Publishing Co.)
Nomenclature according to Frankel: (A) Main treading floor, (B) Single fixed screw press, (C) Auxiliary treading floor, (D) Compartment, (E) Intermediary (filtration) vat, (F) Collecting vat
b: Section (Based on Hadas 2007b). For key see above
c: Section of a large vaulted compartment (from Hadas 2007b:126–127, original drawing by S. Tamari, courtesy of Kronenberg Publishing Co.)

consisting of eight winepresses, warehouses and pottery kilns, covering close to a hectare (ten dunams). The winepresses developed and changed during their existence, although the major elements remained the same (Nadav-Ziv et al. 2022:30–35, 38–41; Viezel and Torge 2022; Seligman, Haddad and Nadav-Ziv 2022; 2023). The five large winepresses described here (presses 'A–E') were neatly arranged in a planned industrial structure, with two pathways at the centre, flanked by five huge warehouses set around the central axis, presumably warehouses for empty amphorae before harvesting and filled with wine after initial fermentation (Figs. 2–4).

Efficient processing relied on gravitational flow of the must through the winepress, from the point of entry on the auxiliary floors, down to the collecting vats at the lowest level (Fig. 5). For this reason, the winepresses were cut c. 2 m into the alluvium and underlying aeolianite (*kurkar*) bedrock in order to create a gravitational drop. Steps on the outer edges of each press enabled access to the space surrounding the collecting vats from the surrounding pathways. The walls of the presses were built of well-dressed ashlar blocks, the bases covered with plaster. In the centre of each winepress was a large treading floor (1) measuring 8 x 8 m (all measurements are average), paved with a simple white mosaic. In the centre of the floor, in a pit cut below it, a round limestone base was set with a square morticed socket for a single fixed screw (2) (Frankel 1999:140–145, types Ts81–83). The dimensions of the stone screw bases, with a diameter of 2.5 m, were significantly larger than usually seen in presses at other sites. In press 'A', small apsidal semicircular alcove compartments are found on three sides of the treading floor (Frankel 1999:139, type T801). Later these were

Figure 2: Aerial photograph of three of the large winepresses at Yavne (photograph by A. Peretz, Israel Antiquities Authority).

changed to form vaulted rectangular compartments (Fig. 6). The possibility that this represents technological change from the use of the smaller alcove compartments to larger vaulted compartments is a possibility, though without additional chronological differentiation at other sites for the phenomena, this conclusion is premature. Similar rectangular arched compartments are found on two sides of the central treading floor on all the other presses of the winery, measuring 3 x 1.5 m, and 1.9 m high, also paved with white mosaic (3). The compartments are connected to the main treading floor with a lead duct (Frankel 1999:139, type T8011) (Fig. 7). Above these compartments were auxiliary treading floors, again paved with white mosaic, of which only one partially survived, although the others can be reconstructed through comparison

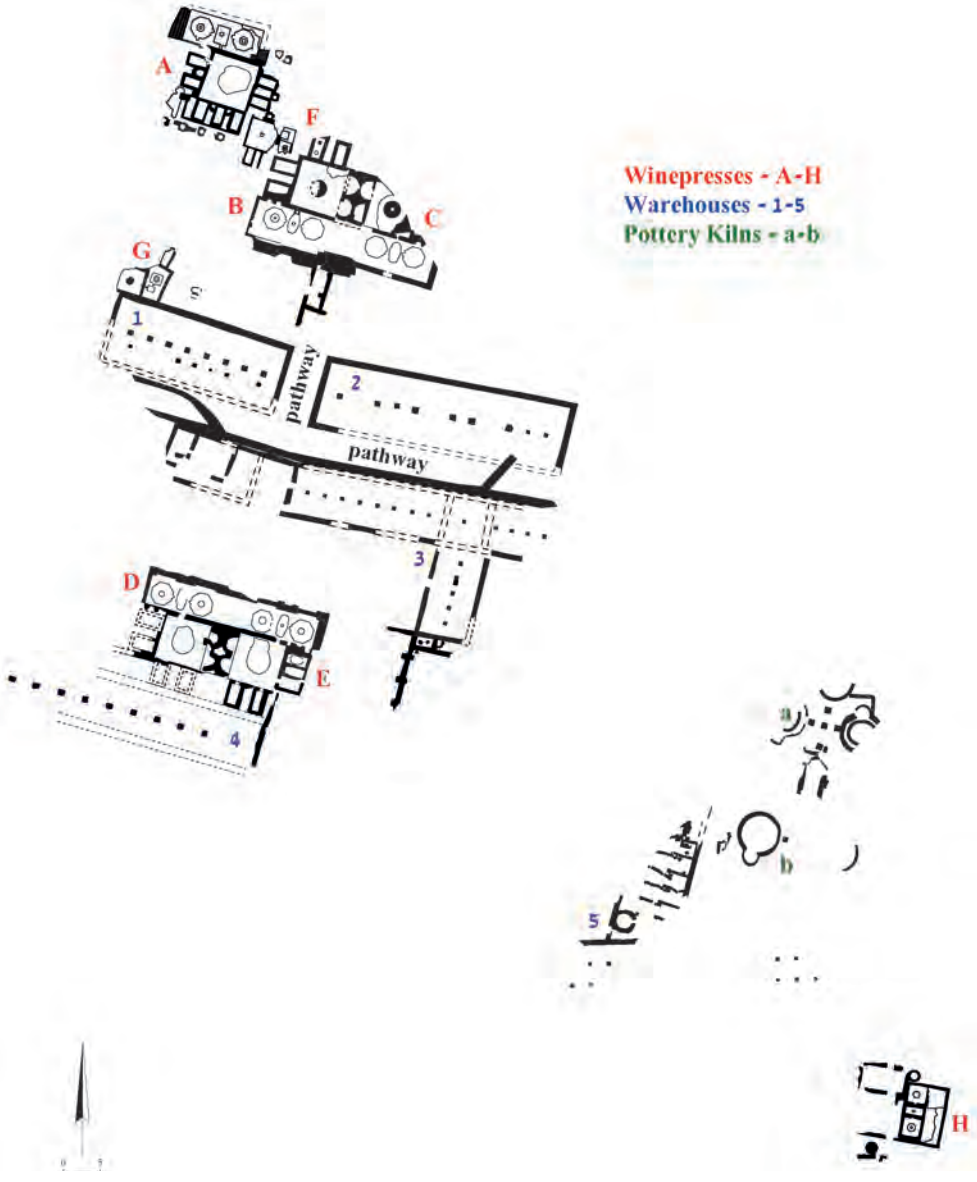

Figure 3: Plan of the winepresses, warehouses and kilns in the industrial estate winery at Yavne (drawing by Y. Gumennaya).

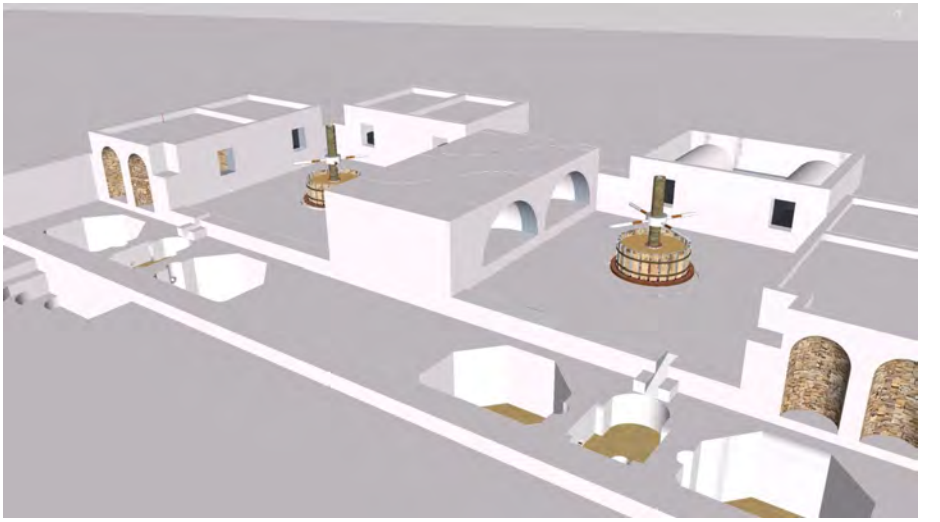

Figure 4: Virtual reconstruction of the winepresses at Yavne (M. Kaplan).

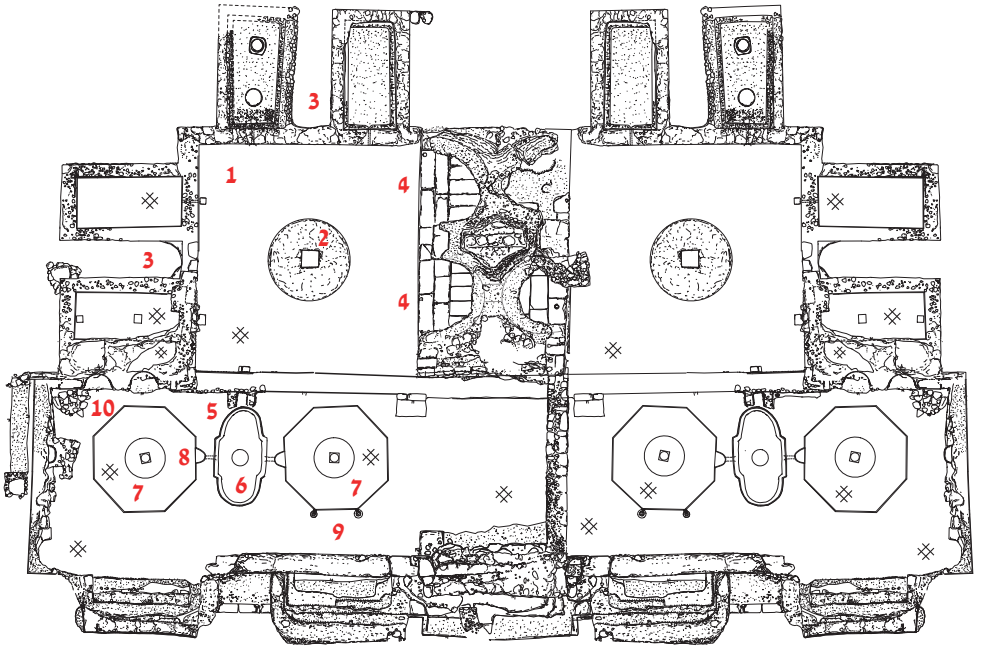

Figure 5: Synthesized plan of the winepresses, the numbers are referenced in the text and in the captions relating to the elements of the winepresses (drawing by Y. Gumennaya).

with other known sites, such as Ras Abu Ma'aruf (Seligman 1999:144–148, 155–158) and Mulabbis (Gudovitch 2009; Frankel 1999:139–140, type T803). One or two drainage holes in the floor allowed the must to flow down into the compartment below. Marble slabs set in the floors of the compartments, directly below these drainage holes prevented damage to the floor. Four of the presses were uniquely built in mirrored pairs, set on either side of a central built divide, with two unique and beautiful, raised, conch-shaped alcoves built of stone and stucco (4). The function of these alcoves remains enigmatic. Between the central treading floor and the collection vats ran a wide plastered channel (5) that led to an oval filtration vat (3 x 1.5 m) (6), set between two identical octagonal

Figure 6: The compartments of winepress A, showing the small semi-circular niche compartments below the auxiliary treading floors blocked and cut by the addition of large vaulted compartments during the second phase of the winepress (photograph by A. Peretz, Israel Antiquities Authority).

Figure 7: Compartment (3) and small section of upper auxiliary treading floor at Yavne (photograph by A. Peretz, Israel Antiquities Authority).

collecting vats (average dimensions: diameter 3.4 m, depth 1.4 m, volume 5 m^3 to height of the duct, 9.5 m^3 to top) (7), which are also paved with mosaic, and with deep sumps at the centre. The lead pipe, from each filtration vat to each collecting vat, was set at the base of a raised semi-circular recess cut into the side of the vat (8), which was also used as an access step into the vat. Marble rings, found on two corners of two of the octagonal vats, were used to support Gazan amphorae while filling the vessels with young wine after initial fermentation (9). In addition, four of the winepresses had semi-circular niches (10) in the side of the raised auxiliary floors and compartments, beside the octagonal collecting vats. These may have been used as storage places for equipment or amphorae.

Table of Variations in Features of Composite Winepresses

The Yavne presses are most similar to composite presses at other sites in the terroir of Gaza and Ashqelon, though some differences, listed below, exist between the installations of this region and other composite winepresses in other areas of the country (Fig. 8).

Feature at Yavne	**Feature variance at selected representative sites**
Main treading floor measuring 8 x 8 m	The main treading floors of composite presses are relatively large, measuring usually between 6 x 6 to 8 x 8 m (Avshalom-Gorni, Frankel and Getzov 2008:59, Table 1)
Main treading floor paved with simple white mosaic	Most presses are paved with white mosaic floors. Some are paved with large flagstones, e.g., in the 'Third Mile Estate' in Ashqelon (Israel and Erickson-Gini 2013:189–194) and in sites in the Negev highlands (Seligman 2020:262)
Single fixed screw at centre of treading floor installed in mortice in a stone base	The mortice attachment for the wooden screw varies between sites with many examples. Single fixed screw presses are unique to the southern Levant (Frankel 1999:145). Some sites, such as Ras Abu Ma'aruf, have more than one screw in a single press (Seligman 1999:146–147)
Four (presses 'B–E') and seven (press 'A') auxiliary floors surrounding treading floor and set above the compartments	Various configurations of the auxiliary floors exist (Avshalom-Gorni, Frankel and Getzov 2008:62–64), the variations seemingly of little importance. At Ḥ. Duran (Reḥovot) (Roll and Ayalon 1981:115), Mishmar Ha'Emeq (Avshalom-Gorni, Frankel and Getzov 2008:56–57, 66*), Hippos (Frankel and Eisenberg 2018:60–62) and in the sites in the Negev highlands the auxiliary compartments are adjacent to the treading floor with no intermediary compartments (Frankel 1999:139, type T802; Seligman 2020:262). The number of auxiliary floors varies, with some sites including up to 11. In a small number of examples (e.g., Tel Hefer – Yannai 2009), the auxiliary floors slope away from the main treading floor, towards individual and separate collecting vats

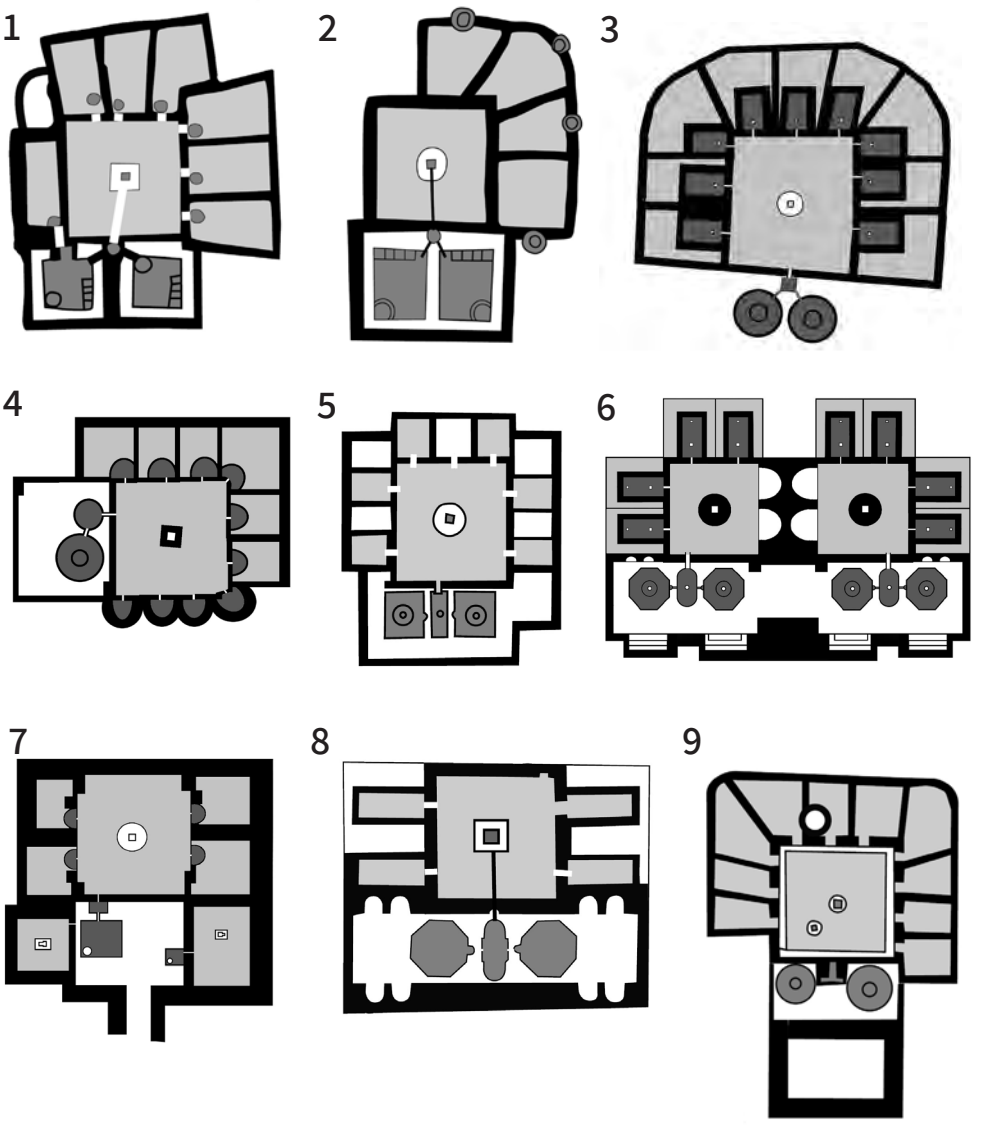

Figure 8: Schematic plans of a selection of composite winepresses (based upon Avshalom-Gorni, Frankel and Getzov 2008:60, Fig. 8). For comparison between the presses, the treading and auxiliary floors are in light grey, collecting vats and compartments in dark grey (drawings by J. Seligman): (1) Castra, (2) Mishmar Ha-'Emeq, (3) Mulabbis (Petah Tiqva), (4) el-Khirbe (Nesher-Ramla), (5) Ḥ. Duran (Rehovot), (6) Yavne – synthesized with data from all the winepresses, (7) Ras Abu Ma'aruf (Jerusalem), (8) 'Third Mile Estate' (Ashqelon), (9) Oboda (Avdat).

Feature at Yavne	Feature variance at selected representative sites
Small semi-circular 'cupola' shaped compartments (press 'A' only) (Frankel 1999:139, type T801)	The number of 'cupola' shaped compartments ranges between 3 to 9. Frankel lists 23 sites though numbers are now higher. Some of these compartments are not connected to the treading floor with a duct (T8011) (Figs. 9, 10)
Large rectangular vaulted compartments below auxiliary floors of presses (presses 2–6)	The number of rectangular vaulted compartments ranges between 3 to 9 (Mulabbis: Gudovitch 2009; el-Khirbe/ Nesher-Ramla: Avrutis 2015).
Conch-like alcoves on one side of the treading floor	This feature is unique to Yavne
Intermediary / Filtration vat	Found in most winepresses, though lacking in some of the Negev highland winepresses
Double octagonal collecting vats with sumps	The number of collecting vats in composite presses varies between one to three. Most sites with large compartments have two vats, while those with smaller compartments usually have only one. The shape of vats can be round, square, rectangular or octagonal
Multiple wine presses in winery/ estate	Multiple composite winepresses in a single winery or estate are typical. Besides Yavne and other examples from the Gaza-Ashqelon terroir (Seligman, Haddad and Nadav-Ziv 2023:3–8), see also Castra (Yeivin and Finkielsztejn 2009), el-Khirbe/Nesher-Ramla (Avrutis 2015), the Negev highlands (Seligman 2020), Si' in the Hauran (Dentzer-Feydy, Dentzer and Blanc 2003), etc.
Close proximity to kilns for amphorae production	Kilns producing amphorae that are part of the winery specifically for the transport of wine are typical of the Gaza-Ashqelon terroir (Seligman, Haddad and Nadav-Ziv 2023:3–8). They are not found in the sites of the Negev Highlands, except for Elusa (Seligman 2020)

Figure 9: Semi-circular niche compartments below auxiliary floors of winepress in area 4 at Ras Abu Ma'aruf (Jerusalem). Note duct in floor of auxiliary floor and at base of the wall fronting the compartment (Seligman 1999:145, Fig. 11. Photograph by S. Mandrea, Israel Antiquities Authority).

Figure 10: Niche compartments below auxiliary floors of winepress in el-Khirbe (Nesher-Ramla) (Avrutis 2015:47, Fig. 2.63). (Courtesy of V. Avrutis and Haifa University).

The Debate on the Wine Production in the Composite Press

With no continuity of production in composite winepresses beyond the 7th to 8th centuries (Hirschfeld 1983:217–218; Ayalon 1997; Avni, Bar-Oz and Gambash 2023; Nol 2023:26–45; Seligman forthcoming), and without a methodological handbook, understanding the process or processes of wine making in a composite press relies largely on archaeological interpretation. While the physical archaeological data forms the baseline for all these analyses, several approaches have been taken to solving the conundrum. Frankel would be the first to tackle this issue, centering his study on detailed interpretation of the classical agricultural texts, such as Mago (through Columella), Cato, Varro, Pliny, Columella, Palladius and the *Geoponica*, explored together with contemporary Jewish sources, especially the Mishna, Talmud and Tosefta, integrated with chronological study of the development of the winepress locally and regionally (Frankel 1984; 1999). Taking a more technological approach, Yehoshua (Yeshu) Dray has criticised his conclusions, his explanation augmented with biochemical investigation by Amos Hadas.

Before entering the fray, a few words on the process of fermentation are required. While treading and pressing is clearly identified in the archaeological record of wineries and through their pictorial representation on contemporary mosaics around the Mediterranean, and locally in churches at el-Ḥammam and the Lady Mary monastery, both at Beth Shean; the churches of Sts. Lot and Procopius and St. George at Kh. el-Mukhayyat on Mt. Nebo; Qabr Ḥiram in Phoenicia; the Bishop Sergius church at Umm al-Rasas and the 8th century St. Stephen church at the same site (Hachlili 2009:153), the process of fermentation leaves little physical evidence. The historical sources, ethnographic research and proxy data from modern wine production, clearly show that fermentation required two separate processes. Initial fermentation resulted from the action of natural yeast, which is present on the grape skin and in the environment, transforming grape sugars into ethanol and carbon dioxide over three (Tosefta Terumoth 7.14; Frankel 1999:43) to nine days (Pliny NH XIV.25.124; Thurmond 2006:128–132). The exact fermentation time depended on multiple variables, such as the quantities of sugar, the grape variety and amount of yeast, climate, ambient temperature, etc. The desired end product also influenced fermentation time, with sweeter wines requiring a longer waiting period in the vat (Geop. 7.19; Dodd 2020:57). As the vat could not be disturbed during initial fermentation, the time period would affect the turn-around time for reuse of the press and the vat, leading to a discrepancy in productivity between those who suggest that wineries could be reused 12 times during a season (Dar 1986:153–155), to those who drop this number down to 7 to 9 (Van Limbergen 2015:175) or even once (Dray 2015:195 and personal communication).

According to most reconstructions, on the conclusion of initial fermentation, the new wine was scooped and poured into amphorae for slower secondary or malolactic fermentation for at least six to eight weeks, again greatly dependent on climate, grape variety, temperature, and vinicultural tradition (Brun 2003:49–50; Jackson 2003:242–244). Aging and élevage of the wine, in the stored amphorae, could continue for a number of months or longer (Forbes 1956:133). During this process, the shoulder

of the jars was often punctured with a small hole to permit the gradual escape of fermentation gases. Dray (2015:195) has suggested that secondary fermentation occurred by returning the wine from the collecting vat to the 'fermentation vats' (compartments).

Frankel – Frankel's doctorate in Hebrew (1984), later summary (1997) and book in English (1999) outline his understanding of wine production in the composite winepress (see also Avshalom-Gorni, Frankel and Getzov 2008). His theories are summarised in the following paragraphs.

Though there has been some confusion differentiating olive oil and wine presses, the must of the grape (*Vitis Vinifera L*), being a soft fruit, is easily expressed by treading on the floor of the winepress. A number of terms for the treading floor of the winery appear in the early sources (Frankel 1999:41): *Gat* (גת), *yeqev* (יקב) and *pura* (פורה) in Biblical and Talmudic literature (Isa. 5.2, 16.10; Joel 1,17; Zech. 14.10; etc.), all with equivalent terms (ληνός, προλήνιον, ὑπολήνιον, *calcotorium, torcular, vas vinarius*) in the Greek and Latin literature (Mark 12.1; Matt. 21.33; Cato Agr. 11–12; Pl. Nat. Hist. LXXIV.74.317; Varro RR 1.55.7). Surprisingly, given its central place in viniculture, treading is rarely described, or even considered as part of pressing in the classical texts (Thurmond 2006:121–124), its practice seemingly taken for granted (Frankel 1999:42; 2009:10). The one text specifically detailing treading is the *Geoponica* dating to the Byzantine period (Geop. 6.11; White 1970:xv) which stresses that workers were obliged to remove leaves and rotten grapes, to wash their feet and to be fully dressed to prevent sweat from dripping onto the floor.

Pressing was subsequent to treading, especially in the more advanced installations typical of the Byzantine period. These are described in the sources, even when treading is not even invoked (Cato Agr. 19—though dated to the 1st century BCE) (Humbel 1976; Roll and Ayalon 1981:119–122; Frankel 1999:42; Thurmond 2006:124–128).

Through application of the series of techniques, must and consequentially wine of various qualities could be processed, from the premium to that of lowest quality:

1. First must, *prototropum* or *mustum lixivium*—must that flowed from the grape under its own static weight prior to treading (Pl. Nat. Hist. 14.11.85; Col. RR 12.41).
2. Second pressing, *circumsicium* or *mustum tortivum*—pressing of the pomace or rape (the mash, skins and stalks) after treading of the grapes. This must was collected in a separate vat from that collected from the treading (Cato Agr. 23.4; Varro RR 1.54.3; Col. RR 12.36).
3. After wine, *lora*, δεθεριος or *temed* (תמד)—a low quality wine processed from must by adding water to the pressed grape skins and pressing again (Cato Agr. 25; Varro RR 1.54.3; Col. RR 12.40; Pl. Nat. Hist. 14.12.86; M. ʿOrlah 1.8; M. Maʿaser Sheni 1.3; M. Miqwa'ot 7.2; Reich and Shukron 2010:185–187).
4. Lees wine, *vinum faecatum* or *yayin shmarim* (יין שמרים)—a low quality wine made from the pomace soaked in water (Pl. Nat. Hist. XVI.12.86; BT Baba Batra 96b).
5. Boiled down must, *sapa*, *defrutum*, *caroenum*, *yayin mevushal* (יין מבושל)—very sweet must boiled down to enrich other wines (Col. RR 12.20.2; Pl. Nat. Hist. XIV.11.80; Pall. 11.18; M. Menachot 8.6; Tosefta Ter. 4.4, ʿAvoda Zara 5.6).

6. Raisin wine, ἡλιαστον, *vinum dulce*, *yayin ṣimuqim* (יין צימוקים)—sweet must collected from grapes that had been left to dry in the sun before treading (Col. RR 12.27; Tosefta Menachot 9.9).

After pressing the must underwent primary fermentation in the collecting vat lasting anything between 3 to 9 days at 15° to 20° to metamorphose into wine (Tosefta Terumot 5.8; Pl. Nat. Hist. XIV.25.124; Thurmond 2006:128–132). This practice differed from that in more rainy climes, where this fermentation stage was usually conducted in amphorae or dolia (Frankel 1999:59; Dodd 2020:56–59). Secondary fermentation was conducted at a lower temperature in a cool place, such as the storage buildings at Yavne and other sites (Seligman, Haddad and Nadav-Ziv 2023:12), or a cave, such as in Kh. Yajuz, Jordan (Khalil and al-Nammari 2000:49), lasting for varying periods depending on the characteristics of the wine.

Must could be further expressed by use of a beam (lever) weighed down with stone weights set over the fruit collected in frails, wooden frames or coiled rope at the pressing point. While this method had origins in the Iron Age the technique continued in use through to the Byzantine period (Frankel 1999:62, 146). The introduction of screw technology would revolutionise the effectiveness of pressing, both for oil and wine, increasing the efficiency of production and the quantities that could be processed (Frankel 1999:141–145). As the pressing of the grape always required less pressure than that necessary for olive oil production, the type of screw was adapted in accordance with the applied pressure. Thus, the single fixed screw press was commoner in wineries, being a wooden screw anchored to the floor in a mortice of varying shapes cut into the bedrock or into a heavy base stone set in the centre of the treading floor to enable comfortable movement of the worker around the press (Frankel 1993:113). This development, unique to Byzantine winepresses of the southern Levant, was illustrated on mosaic representations in churches in Kh. el-Mukhayyat near Mount Nebo (Saller and Bagatti 1949:60, Pl. 18.1) and at the church of St. Christopher at Qabr Hiram near Tyre (Renan 1864:607; 1875 Pl. XLIX). In Talmudic texts, the screw is known as a '*lulav*' (לולב) (e.g., JT 'Abod. Zar. 5.14, 45b; Frankel 1999:192–193), though it is absent from classical texts, probably as it was unique to the southern Levant (Frankel 1997:82).

A wooden pressing board, set around the screw would have been lowered by a turning nut, pressing the pomace collected below in a wooden grille (*regula, galeagra*) or inside a coiled rope (Col. RR 12.52.10, 12.54.2; Hero Mech. 3.16; Brøndsted 1928:107; Forbes 1955–1964, III:134–135; Frankel 1999:147–148). Some of the presses included a pipe beneath the screw which drained under the floor directly into one of the vats to prevent swelling or rotting of the wooden screw.

To increase the capacity of the winery a number of modifications in size and technology were adopted including multiple auxiliary treading floors and screw presses (Frankel 1999:138–158; 2009:2–3, 8). The first improvement was the addition of mosaic or flagstone paved auxiliary treading floors raised above, or to the side, of the central treading floor. As noted above, some included small alcove niches below, some large vaulted compartments and others were connected directly to the main treading floor. According to Frankel, these auxiliary floors and compartments are

termed *mishtaḥ shel ʻalim* (floor of leaves – משטח של עלים) (BT Taharot 10.4–5) in the Talmud and *tabulatum* in the classical sources (Cato Agr. 64.1–2; Col. RR 12.52.3–4).

The placing of these auxiliary floors around the main treading floor shows they were utilised for functions prior to primary treading. After delivery from the vineyard, the clusters of grapes were cleaned of leaves and other contaminants. According to Frankel (1999:139–140) and others (Hirschfeld 1983:212; Seligman 1999:163) the main purpose of these floors was as spaces to let grapes stand temporarily to partially dry for the preparation of first must (*prototropum* or *mustum lixivium*), the juice dripping from the upper auxiliary floor through a duct to the compartment below or remained to make raisin wine. These compartment vats were connected to the main treading floor with a gutter, which was blocked with a stopper to enable fermentation within them. No sumps for the collection of dregs and residue exist in these compartments, and the suggestion that this indicates that the skins were likely not pushed down through the small duct from the higher auxiliary floors seems logical (Gudovitch 2009:206). This, if correct, would be a clear indication that the compartments were dedicated to the fermentation of white or tawny wines. After fermentation the wine could flow over the main treading floor to the collecting vat or could be decanted directly into amphorae. Other suggestions exist for the function of the smaller niche compartments, including as storage vats for additives to the must (Frankel and Ayalon 1988:41; Frankel 1999:139) or as storage of pomace for distillation (Sidi, Amit and ʻAd 2003:261). Where compartments were built without auxiliary floors, these small compartments probably were used to store additives to modify the flavour of the wine or possibly, based on ethnographic comparison with traditional processes observed to produce grape-honey (*dibs*), to store marl used in the clarification of wine during processing (Ben Yaʿakov 1985).

In some winepresses, especially in the Negev, seven to eleven large rectangular or trapezoid auxiliary floors were arranged around a central treading floor and at the same level, connected to it by a wide opening (Mazor 2009; Seligman 2020). These compartments were probably used to store grapes prior to treading, to regulate the speed of work on the main floor, to allow the development of first must or to sweeten them by letting the grapes partially desiccate for a few days. Still, proper prevention of flow of first must to the main treading floor would have been a challenge and the function of these auxiliary floors is not entirely clear.

The must after pressing usually flowed through a lead, a ceramic or a built pipe, or an open duct to an intermediary vat for filtration or settling. Intermediary vats with outlets connecting to the larger collecting vats at the top of the wall were used to clarify the must, any dregs or residue slipping to the bottom, while intermediary vats with the outlet at the bottom were used for sieving (Frankel 2009:2). Blocking the outlets enabled flow into one of the large collecting vats for initial fermentation. These vats reached a capacity of 10 m^3 and more. After 3 to 5 days the young wine would be decanted into amphorae and the vat vacated for reuse. This directional flow into the collecting vats made separation of different quality wines, from the different processes outlined, relatively simple.

The pomace and unpressed grapes were then moved to the main treading floor for treading, while new grapes were brought to the auxiliary floors. In a continual

process the must flowed, via the intermediary filtration vat, to one of the collecting vats. While initial fermentation continued in one of the collecting vats, the pomace could be squeezed in the screw press and the liquid collected separately in the other vat, and so on. Given that the regular harvest season in Palestine lasts around 50 days, the continual pressing, fermenting and filling of amphorae could be repeated around 12 times during the pressing season (Dar 1986:153–155).

This availability of multiple auxiliary floors and compartments, sometimes multiple screw presses and at least two collecting vats, all essential elements of the composite press, allowed continual use of the pressing facilities while the main collecting vat was out of operation during initial fermentation. Similarly, the multiple auxiliary floors meant that different stages of pressing for first must could be conducted simultaneously, and grapes from a number of vineyards or even varieties could be processed separately. Multiple production units allowed continuous pressing and fermentation during the busy harvest season.

It should be noted that this scheme of wine pressing has been largely accepted by many scholars, including this author (Seligman 1999; 2011:380–400; 2020; Seligman, Haddad and Nadav-Ziv 2023; Frankel and Ayalon 1988; Sidi, Amit and ʻAd 2003:261).

Dray – Largely based on Yehoshua Dray's practical experience of experimental archaeology and reconstruction of ancient technologies, he rejected Frankel's understanding of the technology of the composite winepress as a mistaken representation of the bio-chemical process of wine making, extrapolated incorrectly, in his view, from the mechanical methods of olive oil pressing (Dray 2003; 2006; 2011; 2015; 2024).

His revised understanding of the process of wine making in these presses is founded directly on an experimental pressing conducted in 1996 at the composite winepress at Castra (Yeivin and Finkielsztejn 2009), during which Dray produced large quantities of wine in accordance with his proposal, leading him to state that 'traditional reconstructions of the winepress do not stand' (Dray 2015:191, 197–198).

According to this proposal, the parts of the press are renamed to follow a revised functional understanding. The large central mosaic paved 'treading floor' is termed a central 'working surface', sloping towards the collecting vats, upon which the work of the press was organised, with no treading of the grapes conducted on its surface. At the centre of this surface is a stone base for a fixed screw press. The size of the 'working surface' was determined not by requirements for treading, but rather by the number of 'fermentation vats' (the 'compartments' according to Frankel) set around it.

The 'fermentation vats' that surround three sides of the 'working surface' are rectangular chambers, set at a higher level than the 'working surface', with a hole close to the base of the dividing wall between them and the surface. Relying on the example from Castra, which is almost identical to the Yavne presses, the vat is vaulted with an opening in the roof and a 'window' in the front wall, to enable loading and removal of grapes and pomace. Above the 'fermentation vat', in some cases, was an 'upper treading floor', equivalent to the 'auxiliary floors' in the previous section. This floor was drained through a small aperture in the floor into the vaulted vat below. In a rather confusing explanation, Dray indicates (2015:194–195, Fig. 5), that the small

alcove niches, where they existed, such as at Ras Abu Ma'aruf (Seligman 1999), Mazor (Sidi, Amit and 'Ad 2003) or the early phase of press 2 at Yavne, were set below the 'fermentation vats' connected via a hole in the roof of the niche, which was used to drain wine (not must) fermented with the skins on the upper surface directly into amphorae (Fig. 11).

On the lower side of the 'working surface' is a 'directing vat' (Frankel's intermediary vat), being a shallow basin connected with a pipe or gutter from the working surface and pipes at its base leading to the two square, round or octagonal collecting vats. The purpose of this vat was only to direct liquid to the collecting vats.

With this revised terminology of the parts of the winepress, the production of wine as proposed by Dray needs to be detailed (Dray 2015:195; 2024:111–118). It should be noted that given the fact that the terroir of Gaza and Ashqelon specialised in the production of white wines (Mayerson 1993:169–170; Seligman, Haddad and Nadav-Ziv 2023:2), Dray specifies that the process he describes as being associated with composite wineries was designed specifically to produce red wine, leaving the must with the grape skins during fermentation on the upper treading floors to impart colour and stringency into the wine.

Grapes, brought from the vineyard, were placed on the upper treading floors. The grapes were only lightly crushed under foot, not to express must, but to break the skin and allow the wine yeasts to be in contact with the interior of the grape to commence fermentation. The must and pulp were pushed through the small duct into the fermentation vat below, after which the duct between the upper treading floor and the vat was sealed. In cases where no upper treading floor existed, treading was conducted inside the 'fermentation vats' up to the level of the opening. The grape mash was then left for a number of days, the duration depending on environmental conditions and sugar content of the grapes, to ferment. Carbon-dioxide released

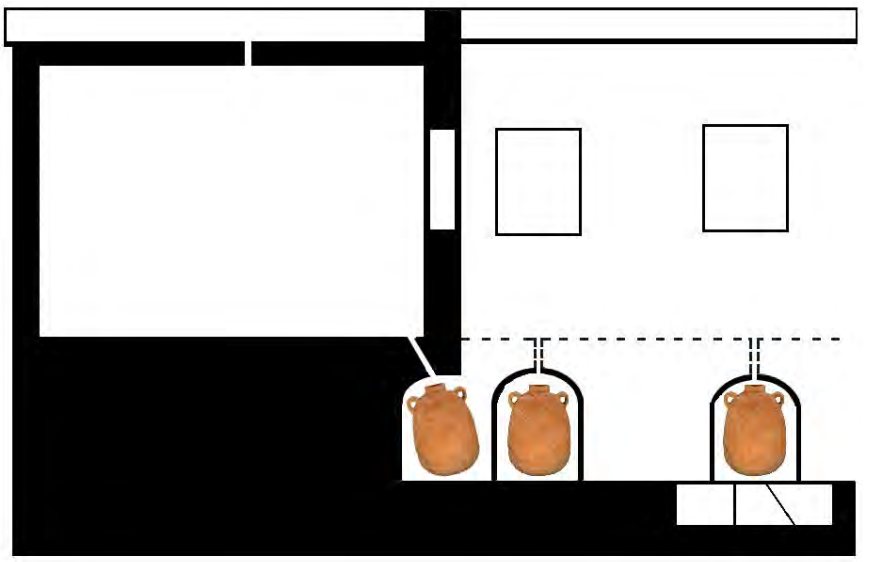

Figure 11: Dray's proposal for the filling of amphorae in the semi-circular niches (based on Dray 2015:195, Fig. 5).

during fermentation escaped through the opening on the front of the vats, with grape skins floating above the liquid sealing it to prevent its oxidation. After initial fermentation, the pipe at the base of the vat was unblocked. The new 'free-run wine' flowed from the vat, over the 'working surface', through the 'directing vat' to one of the collecting vats. From here the wine was transferred back to the 'fermentation vats' for élevage and aging (Dray 2024:127), at which stage the window fronting the 'working surface' was sealed to prevent spoilage during secondary fermentation. The 'directing vat' (intermediary vat) was not used for filtering or settling as the free-run wine was clear and did not need to be filtered.

Prior to returning the wine to the 'fermentation vat' (compartment), pomace left behind was removed through the opening to the working surface and transferred to the screw for pressing. The squeezed liquid was then directed separately to the second collecting vat. Dray notes that wineries with small alcove niches only process a single collecting vat, as the need to let the 'self-running wine' flow over the working surface was not required, as the niches were used as a device to let wine pour from the upper treading floor directly into jars for secondary fermentation.

Must derived from the second pressing of the skins and pulp in the screw press, no more than 10–15% of the total quantity of liquid, was collected separately in one of the collecting vats. As it contained some pomace and suspended particles, it needed to be clarified with marl, which settled in the sump at the floor of the collecting vat.

Adopting a proposal applied at Ras Abu Ma'aruf (Seligman 1999:163, note 14) that associates composite winepresses with the Talmudic name 'Bet Gitot', Dray (2015:191; 2024:92, 123, 131) proposes using this term as a collective name for all presses of this type. He also accepts an earlier assertion by Rahmani (1991:105) and Seligman, that at least some of these presses were covered by a roof and were not open-air structures as is usually reconstructed (Dray 2015:194, Fig. 8; 2024:131, Figs. 51–53; Ayalon 2024:195–196; Fig. 12). However, his suggested reconstructions seem overstated and include massive superstructures not justified by any known remains.

Hadas – Amos Hadas, as an agronomist specializing in soil and environmental studies, but without archaeological training, approached the subject of ancient wine production through the lens of biochemistry (Hadas 2002; 2007a; 2007b; Hadas and Sneh 2005). Hadas correctly stressed that archaeological commentators failed to address biochemical issues of viniculture, including rapidity and temperature control of the fermentation process; prevention of spoilage through fungal, bacterial or zoological infestation; and oxidization or vinegarisation of the wine (also see Jackson 2003:251–254).

Hadas stated that winepresses with auxiliary floors, but without compartments (fermentation vats in his studies), such as at Ḥ. Duran or in the Negev highlands, should be defined as improved winepresses, differentiating these from composite winepresses, which he also named 'Bet Gitot' (JT Ohalot 18, 13; Tosefta, Terumot 3, 7), specifically presses with auxiliary floors raised above large compartments (Hadas 2007b:124–130), such as those at Yavne, Castra and Mulabbis. It is noted that, for both, the use of hydraulic plaster and mosaic surfaces found in composite presses, was essential in the prevention of fungal and bacterial spoilage as these surfaces could be kept clean during production (Hadas 2007b:122).

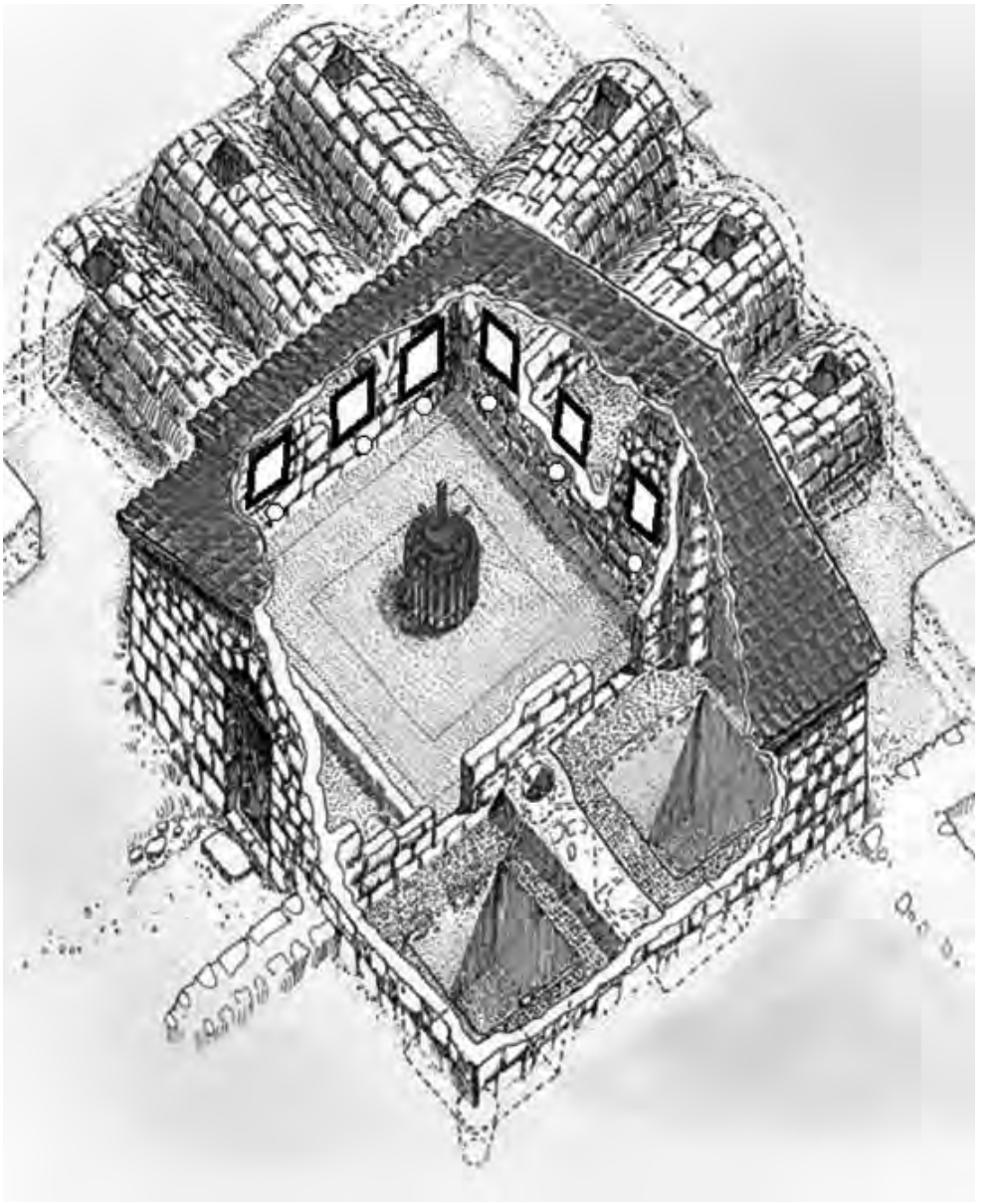

Figure 12: A Byzantine composite press built inside a building (Courtesy of Y. Dray, from Dray 2015:197, Fig. 8).

Hadas composed a detailed analysis of the chemical process of fermentation, with emphasis on the methods used to dissipate heat resulting from the activation of yeast during fermentation. Noted is the requirement to control the process of fermentation to prevent spoilage through the mortality of yeast that transformed the grape sugars into alcohol at temperatures higher than 35°C. His insight of the production of wine in the composite press, toes a line between Frankel's and Dray's explanations (Hadas 2007a:155–158; 2007b:114–130). Hadas, seeming reluctant to enter the archaeological debate, makes the discussion confused and at times, inconsistent. In his view, part of the fermentation took place on the auxiliary treading floors prior to letting the

must flow into the vats. This enabled the dissipation of damaging heat by opening up a large surface area of the must and pomace mash during the rise in temperature caused by initial fermentation, also indicating that proper fermentation in the deep collecting vats with limited open surface area was restricted because the difficulty to dissipate yeast damaging temperature. Furthermore, Hadas notes that the method proposed by Frankel and Ayalon was more suitable for the production of white wines, in that the wine fermented separately from the pomace, while his proposed method is suitable for both red and white varieties.

Hadas accepted the assertion that multiple simultaneous processes were possible in the press to ensure processual flexibility and efficiency, including the use of the auxiliary floors and the main central floor for both treading and partial initial fermentation before letting the liquid flow into the collecting vat/s. According to this interpretation, the use of the auxiliary floors and the compartments for treading and fermentation of first must wine (*prototropum* or *mustum lixivium*) integrates ideas from both Frankel, Ayalon and Dray. To make quality wines, grapes with a high sugar content and strong taste were required. This necessitated harvesting when the grapes were very ripe and slightly dry. Ripe grapes, brought from the vineyard, were piled on the auxiliary treading floors to further dry for a few days. Static pressure and the withering of the grapes would initiate fermentation, the must dripping into the compartments / fermentation vats below through the duct in the floor. After a few days treading of the grapes proceeded and the resulting must flowed into the compartments. Fermentation relied on yeasts naturally occurring on the grapes themselves and had to be slow, to prevent a sudden rise in temperature which would spoil the wine. The thick walls of the compartments were essential to provide the essential static support for the compartments and auxiliary floors, but also to protect the valuable liquid from oxidization and vinegar bacteria (*Acetobacter*), and especially to maintain a constant temperature. During this process the window fronting the compartments would have been sealed, the developing wine protected from spoilage by the generation of carbon dioxide within the closed compartment. The must in the shaded and cool compartments could ferment gradually for up to two weeks as the natural yeast content was low and the sugar content high, producing a wine of variable sugar and alcohol levels because of the difficultly to control fermentation temperature. In general, the lower the temperature, the dryer the wine and higher the alcohol content.

After cleaning the main treading floor and the collecting vats, the stoppers of the ducts at the base of the compartments were released, and the quality first-wine flowed over the main treading floor to the filtration vat and into the collecting vat. The wine was left for a short time in the vat to let any solids and clarifying marl sink into the sump at the floor of the vat.

On the main treading floor, the mass of lower graded grapes, mixed with the pomace mash from the upper floors left after treading, was crushed under foot to produce red wine. In Hadas's understanding, fermentation took place on this floor because of the large surface area and shallow depth which would have mitigated a quick temperature rise during the process. After initial fermentation, this wine would

also be filtered before pouring into one of the collecting vats. Third grade wines could be produced from pomace and any liquid released using the screw press, before being gathered separately in one of the collecting vats.

After filtration and settling, the wine did not stay long in the collecting vats. This wine, separated by grade, was quickly transferred into amphorae and taken for storage and aging.

CONTINUING A DEBATE WITH MULTIPLE UNKNOWNS – FRANKEL VS. DRAY

As Frankel observed, "Our knowledge as regards the methods used to produce wine and oil is derived from four main sources. The first of these are the ancient written sources, especially the works of the Roman writers… Of particular importance in our case are the Hebrew and Aramaic Biblical and Talmudic sources as these reflect the situation in ancient Israel itself. The second source consists of the ancient pictorial depictions… The third source is the pre-industrial evidence, installations using traditional methods… The final source is… the archaeological remains. As the wooden and other perishable parts of the installations from archaeological contexts usually do not survive attempts at reconstruction must inevitably be based on the evidence from the other three sources… In other aspects also only by integrating the knowledge derived from all four sources can the full chronological, technical and cultural significance of the evidence be assessed and understood" (Frankel 2009:1).

Reverse engineering of any process, with multiple unknowns, partial manuals, complex understandings on the meanings of ancient texts and, in this case, technological traditions lost through the collapse of the wine industry in the Levant in the Early Islamic period, inevitably produces a multitude of contradictory interpretations. With thousands of excavated wineries in the Levant and around the Mediterranean, it is no surprise that hundreds of different wines are noted in classical sources, differentiated by origin, terroir, colour, taste and additives (Fitton Brown 1962; Frankel 1999:198–206; Hadas 2007b:158–162; Dzierzbicka 2018:194–226, 253–392; Dodd 2020:59–64; Komar 2020:62–127). Around sixty variates are noted in the Mishna alone (Paul 1975; Ayalon, Frankel and Kloner 2012:23). Clearly multiple different methods were used to produce wines, making the task of connecting winepresses with specific wines almost impossible.

Given the above, Frankel, in my view largely correctly, critised Dray's reconstruction of the process of wine production in the composite press, especially recording his failure to integrate insight drawn from the written and pictorial sources (Avshalom-Gorni, Frankel and Getzov 2008:57–58; Frankel 2009:12, note 2). For instance, in his most recent article Dray (2024:122) not only rejects the pressing of grapes underfoot, represented in multiple renditions on mosaics and ancient paintings, as no more than a 'symbolic rendering', but also fails to mention the specific description of this procedure in sources such as *Geoponica*.

As noted previously, Dray's revision of our understanding of the process of wine production in composite presses is founded on the results of his archaeological experiment to (re)produce wine on the composite press at Castra in 1996 and the integration of modern vinicultural methods (Dray 2024:111–112; Ribéreau-Gayon et

al. 2006:327–395). While his theories, based on the success in making wine at Castra, have gained traction (see for example, Hadas 2007b:114–130; Viezel and Torge 2022), they need to be meted against some of the lacunae of experimental archaeology.

We should conceive experimental archaeology as an interpretative system giving meaning to the archaeological record through the generation of an analogous reconstruction of past behavior. In any experiment of this sort, a gap exists between it and the reconstructed reality of past actions or processes (Callahan 1999). While a proposed rendering may well be physically understood, feasible, and the results seemingly relevant for archaeological interpretation, there can be considerable divergence between the experiment and an actual process of the past. This creates a clear deviation of approach between a laboratory experiment, based on reproducible scientific principles with control of variables, and what is known as an 'actualistic' experiment, where a hypothetical scenario is tested using potentially authentic materials and conditions but with a lack of first-hand knowledge of the tested process and/or without real scientific control (Coles 1973:13–15; Schenck 2011:90–92; Outram 2008:2; Gentile 2022). Furthermore, when it comes to reconstructive wine making in the composite winepress, one of the major pitfalls of experimental archaeology has been an absence of academic context and limited reference to primary sources. As Frankel himself noted, "… it must be stressed that although experiments in which ancient installations are actually operated are of great importance their success does not prove the way in which they functioned neither does their failure prove the opposite" (Frankel 2009:12, note 2). Certainly, wine can be produced using the methods applied at Castra, but if this was the wine produced or the actual method used in the Byzantine period is another question altogether.

1. In the following analysis I have drawn from Frankel's own critique and have added some of my own. The experimental reconstruction of the operation of the winery at Castra and the later interpretations of both Dray and Hadas, emphasise quite specifically the production of red wines, that is wines originating from darker varieties of grapes fermented together with the mash of grape skins that impart colour derived from red anthocyanin pigments present in the skin. While red wines were certainly produced in significant quantities in ancient wineries, it should be stressed that ancient sources often paid limited attention to the colour of wine (Fitton Brown 1962:193–194). Colours, when recorded, refer to white (*albus*), yellow (*fulvus*), dark (μέλας), black (*niger*) and sanguine wines. Indeed, the best known quality wines, including the famous terroir wine of Gaza and Ashqelon, were white (λευκός, *blandoque*) in colour (e.g., Cato Agr. 106; Pliny NH XIV.80; Corippus 63, 104) or tawny (κῐρρός), a yellowing resulting from oxidation of various components of white wine. For most classical production, the must was quickly run off the skins for fermentation, well before colouration of the wine. Red wine, often probably referred to as dark or black wine, was considered generally to be of a lower quality, typical of lesser lees wine (*vinum faecatum*). With this marked preference for white wines in the classical and Byzantine periods (Bouvier 2000:118; Tchernia 1990:65; Komar 2020:77–79, 120–122; Harutyunyan and Malfeito-Ferreira 2022:12–14), such as that produced on the composite winepresses in the hinterland of Gaza, Ashqelon

and Yavne, the importance of experimental production of specifically red wines in these wineries, and the emphasis given to its production by Dray and Hadas, loses traction. Clearly free-run must was rapidly separated from the pomace and not left to ferment on the surface of the auxiliary treading floors, as proposed, quite purposely to prevent the colouration of the wine and avoid tannic stringency that typifies red wine production. If, as is supported by the historical sources, white wine was the main product of these wineries, then the very *raison d'être* of Dray's proposal becomes obsolete, as no holding of the must and pomace for fermentation on the upper 'treading floors', as required for red wine, was necessary.

2. Dray suggests that the must and partially trodden pulp were pushed down from the auxiliary treading floors into the compartments (fermentation vats) through the opening in the auxiliary treading floors. These small openings measure no more than 8–10 cm in diameter, an aperture hardly suited for this process as they would be constantly clogged with pulp, making the process labourious and inefficient. If indeed the proposal was tenable, one should expect that a wider opening would simply have been utilized.
3. It was proposed that grapes were placed on the 'treading floors' (auxiliary floors) for fermentation. However, this suggestion is workable only for some composite winepresses. At sites with 'treading floors' (auxiliary floors) surrounding the 'working surface' (main treading floor) at the same level, but with no 'fermentation vats' (compartments), such as in the Negev highlands, it was impossible to block off the 'treading floor' from the 'working surface'. This made fermenting the grapes for red wine (or any wine for that matter) on the 'treading floor' unfeasible as the liquid could not be contained.
4. Large treading floors had been one of the two features of historical simple winepresses. With the addition of new elements, such as auxiliary floors and compartments, it is likely these modifications were added to improve function, rather than make previous processes defunct. However, Dray's explanation removes the original function, and the size of the space he termed a 'working surface' was determined only by the number of surrounding 'fermentation vats'. Conversely, the builders of wineries invested large effort paving these surfaces with mosaic and setting them at the heart of the installations, their only function now being, rather strangely, to let fermented wine flow over them to the collecting vat, and to provide space to circumambulate around the screw press. As Frankel correctly notes, "In fact in Dray's method the large treading floors and the enormous collecting vats of many wineries are in effect superfluous" (Frankel 2009:12, note 2). That and more, the wine from the 'fermentation vat' flows, according to Dray, to the collecting vat, only to be labouriously and immediately returned, seemingly jar by jar, to the same vat for secondary fermentation. In my view, this interpretation lacks merit.
5. According to Frankel and Ayalon, the intermediary vats had a function to filter must or wine, prior to pouring into one of the collecting vats, quite possibly aided by the use of thorny burnet (*Sarcopoterium spinosum*) to catch the skins floating in the must, a process evident from ethnographic evidence (Ben Ya'akov 1978:17; Ayalon,

Frankel and Kloner 2012:28). Dray's assertion that these vats were only used to direct flow into one of the collecting vats, makes them functionally redundant. Any liquid could flow directly from the 'working surface' (main treading floor) through a pipe or duct into the collecting vat without any need to be directed through an intermediary directing vat. Furthermore, these vats are also found in winepresses with a single collecting vat (e.g., Ras Abu Ma'aruf: Seligman 1999; Mazor: Sidi, Amit and 'Ad 2003) where no multi-directional flow to the collecting vats was required. Clearly they had a function, the filtration or settling of the wine before entering the collection vat for fermentation being the most logical.

6. The large size and often beautiful construction of the collecting vats themselves, such as the octagonal vats at Yavne, becomes almost meaningless if they are no more than a very temporary container for wine before being laboriously ladled into jars. Collecting vats are one of the original features of simple winepresses and their original function was likely maintained, as the locus for initial fermentation of must pressed on the large main treading floor. Frankel provides a Talmudic source for this procedure, "the fermenting collecting vat and how long does it ferment? Three days" (Tosefta Terumot 7.15), this supporting the reason for two vats to enable fermentation in one while the other vat was filled with newly pressed must. Furthermore, if one of the collecting vats was only required for the must derived from the screw press, which according to Dray (2024:114) only comprised 10–15% of the total liquid, there seems no need for it to be of equal size to its neighbour, destined to contain free-run wine, making up 85–90% of the total.
7. Composite presses mark a major advance in the technology of viniculture. As we have noted, the major purpose was to greatly enhance yields through the multiplicity of processes during the busy harvest season. Thus, the halting of production, by filling the compartments for months during the harvest season for secondary fermentation and aging of wines, when this could equally be conducted in amphorae, while closing down the winepress for further production, lacks credibility. In previous papers the possible rates of wine production have been computed, detailed and discussed (Seligman 1999:164; 2011:396–398; 2020:269–270; Seligman, Haddad and Nadav-Ziv 2023:15; Van Limbergen 2015:176–180). All these estimates are based on the assumption of technological, production and profit maximization, a basic principle of all economic theory (see for example Cournot 1897:44; Smith 1937:423), through the filling and emptying of the vats between 7 to 12 times during the season. Dray's proposal (2015 and personal communication) that the 'fermentation vats' (compartments) were sealed and used only once each year, is a dramatic ten-fold (at least) yield reduction that diminishes annual production to miniscule volume in relation to previous estimates. This stands in full contradiction to well established economic theory (see also Harutyunyan and Malfeito-Ferreira 2022:11). In my view, this unfeasible drop in annual yield, and as a consequence, revenue, cannot be supported and would reduce production from industrial to boutique levels.
8. All researchers have noted the crucial importance of the gravitational flow of liquid between the elements of the press (Frankel 2009; Dray 2011:89; 2015:198; 2024:119). However, Dray's proposal that the wine was transferred back from

the collecting vat into the 'compartments' or 'fermentation vats' for secondary fermentation (Dray 2024:127) contradicts this proposition and, paradoxically, his own assertion. His idea does not rely on gravitational flow, quite the opposite, it required labourious transfer of huge amounts of wine, ladled and scooped into jars, and then poured back into the fermentation vats. This proposition is illogical, contrary to production efficiency and should be rejected.

9. The function of the smaller alcove niches (compartments) below the auxiliary floors in many composite presses, e.g., Ras Abu Ma'aruf, Nesher-Ramla, etc., which are clearly different, at least in dimensions, from the large, vaulted compartments, has produced a variety of interpretations. Frankel (1999:139–140; 2009:2) referred to them quite ambiguously, suggesting they were used to store additives or marl for clarifying the must, or to collect separately must that seeped down from the auxiliary floors above (also Hirschfeld 1983:212; Rahmani 1991:105).

   Both Frankel (Avshalom-Gorni, Frankel and Getzov 2008:62) and Dray (2015:194, Fig. 5; 2024:116–117, Fig. 32) have suggested that amphorae could be placed in these niches, below the duct from the auxiliary floor to let must pour directly into them.

   In many excavations, only the outlines of these niches were extant. However, when complete they were shown to be covered with hydraulic plaster, with a wall built up to half the height of the front opening, and with a duct at their base that led to the main treading floor. The height of the open window varies, from 0.35–0.45 m at Ras Abu Ma'aruf (Seligman 1999 Plans 1 and 5), to 0.60–0.75 m in winepress F-495 at el-Khirbe (Nesher-Ramla; Avrutis 2015:42–54, Fig. 2.58). Maneuvering bag shaped jars (LRA 5), with an average height of 0.40–0.50 m, or Gazan amphorae (LRA 4), with an average height of up to 0.80 m, to be filled with must pouring down from the upper floor, would have been cumbersome when the jars were empty, but virtually impossible when full without spilling their contents. Clearly these niches were not used for filling jars. Their architecture, and especially the duct at the base, shows they were vats to receive the must from the auxiliary floors, their use identical to the larger compartments such as those in Yavne.

10. The term 'Bet Gitot' from the Jerusalem Talmud (JT Ohalot 18, 13) and the Tosefta (Tosefta, Terumot 3, 7) has correctly been applied to composite presses (Seligman 1999:163, note 14; Frankel 1999:186; Dray 2015:191; 2024:92, 123; Ayalon 2024:195–196). However, we should be careful when using this terminology as a general appellation for these presses. Composite winepresses characterise estates and monasteries in areas dominated by large Christian populations, and are markedly almost absent from Jewish Galilee and rarer in areas with a Samaritan population (Avrutis 2015:66). Thus, the use of a Talmudic nomenclature for these installations skews the historical and archaeological evidence that associates composite winepresses pointedly to production by Christian secular and religious elites. While we do not know how these winepresses were named by their operators, the application of Talmudic 'Bet Gitot' seems presumptuous.

    Another presumptuous use of Talmudic terminology presented by Dray is the illustration of the layout of the main treading floor surrounded by compartments

of 'Bet-Gitot' as similar to that of tomb complexes, dated largely to the Second Temple period (Dray 2015:192; 2024:123). This proposal, based it seems only on the similarly of the contours of the two, draws on an isolated quote from the Tosefta (Tosefta, Ohalot 15:6) (איזה הוא חצר הקבר זו הגת שהמערות פתוחות לתוכו) translated by Neusner as, "And what is the courtyard of the tomb? That is the floor (*gat*) to the midst of which the caves open…" (Neusner 1977:121). The word '*gat*' is interpreted by all major Talmudic scholars simply as the floor or courtyard fronting the tomb, not as an illusion to the shape of the winepresses, most of which date centuries after the tombs to which Dray addresses his comparison, and at least two centuries after the composition of the Tosefta. This cursory reinterpretation of one of the known definitions for the word '*gat*', must surely be founded on better etymological foundations and does not warrant an archaeological conflation based on visual similarity.

Rafi Frankel set the foundations for the archaeological study of wine and olive oil presses almost two generations ago, illuminating field data with a detailed study of the historical agricultural treaties, particularly those in the Mishnaic and Talmudic sources. Many of his proposals have stood the test of time, and I would contend, including his understanding of the apex technological advancement in viniculture, the unique composite winepresses of the southern Levant. The debate on the operation of these presses, especially between Frankel, Kloner, Ayalon and myself on one side, and Dray and Hadas on the other, has scientific implications beyond an academic difference of opinion, for it deals with the way in which we handle historic and archaeological data, and the inferences drawn from it. Revisiting Frankel's ideas, some thirty years since my first discussions with him during the excavation of the composite winepresses at Ras Abu Ma'aruf in Jerusalem, have provided an opportunity to reconsider the debate, and to restate his ideas, now reinforced in light of the major developments in our understanding of these installations following the excavations on multiple sites in southern and central Israel, and most recently, the magnificent winery at Yavne.

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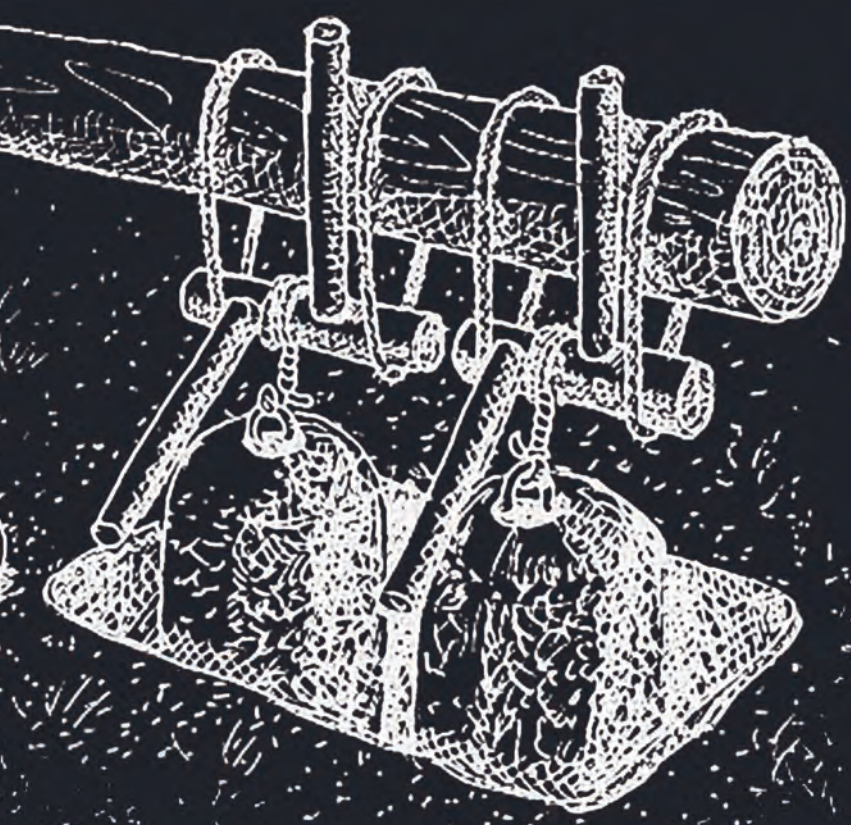

Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Olive Presses from the Roman Period at Majduliyya and their Significance for Understanding Olive Oil Production in the Rural Golan

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ABSTRACT

Olive press remains dating to the Roman period were discovered at Majduliyya in four different areas. The installations, all of basalt, include a crushing basin, four lever-press weights of two different types and two bases of direct-pressure screw presses. All four areas were excavated, suggesting the use of the direct-pressure screw press as early as the third century CE. In addition, they shed light on the economy of a rural site in the Golan and have methodological implications for quantifying the number of presses at a site based on surveys.

Keywords: Majduliyya, Golan, Roman, olive press, rural

INTRODUCTION

Olive press remains, especially from the Roman and Byzantine periods, have been found throughout the Land of Israel, shedding light on this important ancient industry, especially on topics related to typology, chronology, and technology (e.g., Frankel, Avitsur and Ayalon 1994; Frankel 1999). Olive press remains, mostly discovered in surveys, have been documented at many sites in the Golan, mainly in its western, central and southern parts. Ben David (1998) systematically documented olive press remains at 60 sites, including measurements and typology. In subsequent surveys, remains were found at approximately 20 additional sites (Hartal 2012, Section 7.1, Map 20). These remains, at about 80 sites, are thought to date mainly to the Roman and Byzantine periods.

Following the olive harvest, the two main work stages in oil production were crushing and pressing. Basalt remains of the crushing and pressing processes in the Golan include crushing stones, crushing basins, weights and bases of direct-pressure screw presses. Crushing basins and crushing stones remained similar throughout the Roman and Byzantine periods while pressing elements changed over time.

Despite the many discoveries of such remains in the Golan, only a few have been excavated facilitating a more precise chronology of the time of their use. Two areas with olive presses were excavated at Gamla, one from the 1st century BCE

(Goren 2010:123–129) and the other from the 1st century CE (Yavor 2010:98–106). Another three were dated to the Byzantine period (4th–6th centuries CE) at the sites of En Nashut (Ben David 1998:5–12; 2009a), Giv'at Ha-Yi'ur (Ben David 1998:12–20; 2009b), and at the monastery at Kursi (Tzaferis 1983:15–17).[1] Olive presses excavated at Hippos have been dated to the Late Byzantine/Umayyad period (Frankel and Eisenberg 2018:58). No olive presses dating to the 2nd–3rd centuries have been previously excavated in the Golan until the excavations at Majduliyya.

Remains of stone installations connected to olive pressing are of course evidence of this industry at a site. Since most of the olive press remains in the Golan are known only form surveys, methodological questions concerning the location of these presses at a site arise, especially the extent to which scattered olive press remains found in surveys are indicative of different presses in the area where they were found,[2] whether they functioned coevally and the extent to which olive oil was for local consumption or exported.

At Majduliyya, which was settled in the Roman period but not in the Byzantine period, remains of olive presses were found in four areas (B, R, S and P). This provided an opportunity to address questions concerning the number of presses at a site as well as determining technological changes, especially the appearance of the direct-pressure screw press.

THE SITE

The village of Majduliyya is located in the southern Golan about 15 km north of the *polis* of Hippos. The excavations at the site have focused on daily life in rural Golan during the Roman period, revealing a synagogue, pottery kilns, olive presses and residential areas (Osband and Arubas 2020).[3] Nearly 100 readable coins have been uncovered at the site from excavations and surveys, the majority dated to the Roman period. The latest Roman-period coins date to the 3rd century, up to 270 CE. The pottery at the site also dates mainly to the Roman period. The excavation results, pottery and coins suggest that the site was established in the 1st century BCE and abandoned in the late 3rd century. There is no evidence of a 4th-century settlement or any occupation in the Byzantine period. The site was briefly settled in the Abbasid and Mamluk periods but only in limited areas.

The Location of the Olive Presses at the Site

Four areas with olive press remains, all of basalt, were first discovered in surveys of the site (Fig. 1). Remains of a direct-pressure screw press in the northwestern area (Area S) were first found in previous surveys of the Golan and were identified as connected

1 The olive press remains from the excavation at Fiq were described only briefly (Kastenbaum 1983:5).

2 For example, crushing basins found at different areas of a site likely are evidence of multiple olive presses. However, a crushing basin and weights found at different areas of a site might have been moved or might reflect multiple olive presses.

3 This research was funded by a grant from the Israel Science Foundation no. 1348/21.

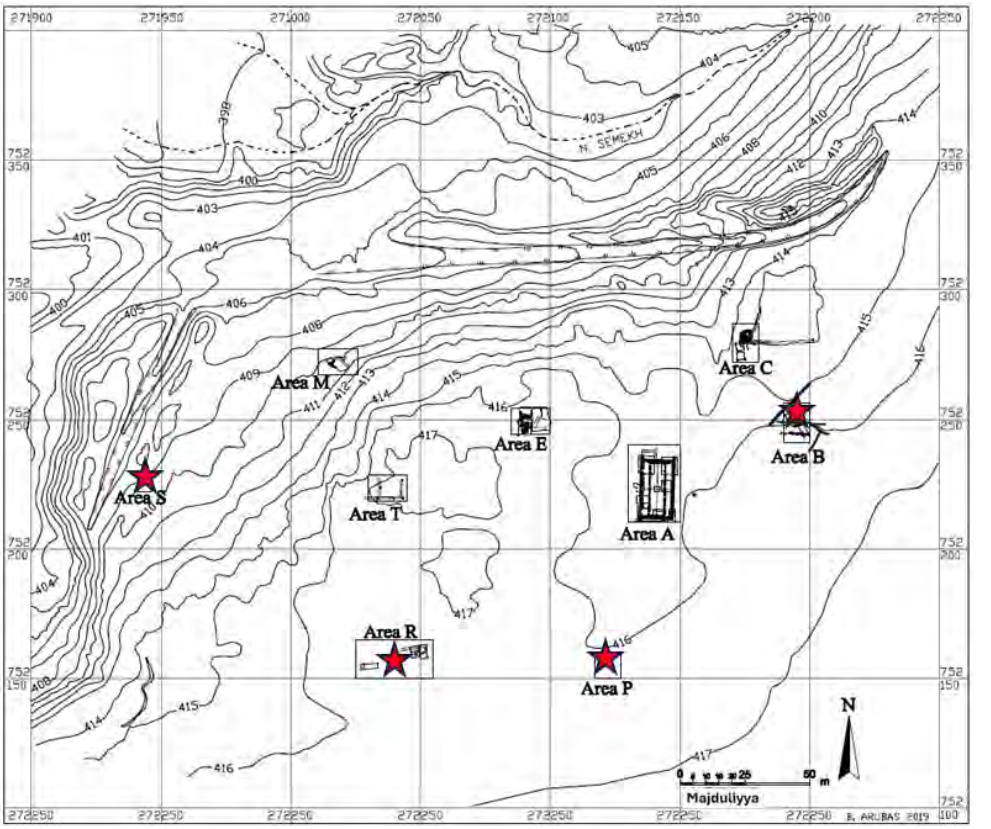

Figure 1: Plan of Majduliyya; areas with olive press remains are marked in red (B. Arubas).

to olive oil production (Ben David 1998:28). In more recent surveys and during the excavation of the site the additional remains were found in different areas around it. Since habitation at the site did not continue into the Byzantine period, it provided an opportunity to focus on the Roman period. Overall, following excavations, four lever weights, two bases of screw presses, and one crushing basin were found. The excavation results from the various find-spots are briefly summarized below.

Findings in Area B

The top of a weight (B-1) was first found in a survey east of the synagogue (Fig. 2). Its height is 0.62 m and the bottom measures 0.65 x 0.65 m. An additional weight (B-2), on its side, was revealed in the excavation next to the first one; its height is 0.85 m and the bottom measures 0.75 × 0.40 m (Fig. 3). Each weight has an inverted-T shaped hole at its top. The pottery found beside and underneath the weights is from the Roman (mainly Late Roman) period. A fairly large quantity of storage jar sherds was found there compared with other areas excavated at the site. A wall was found south of the weights; however, it is unclear whether it was part of the original complex or a room added later. The discovery of two weights next to each other along with the storage jar sherds suggests that these objects were found *in situ* or very near their original location. These weights conform to Type 5.3.2 of Ben David's (1998:43, 47) typology.

Figure 2: Weight B-1 (M. Osband).

Figure 3: Weight B-2 (M. Osband).

Findings in Area R

Area R was divided into east and west sections. In Area R East, the top of the base of a direct-pressure screw press (R-3), tilted downward, was found in a survey, with only a few centimeters visible. The base (Fig. 4) was slightly broken on the sides but otherwise preserved, measuring 1.45 × 0.86 m with a height of 0.40 m.

Figure 4: Direct-pressure screw press R-3 in Area R East (Y. Appel).

An unusually large quantity of storage jar sherds was found in the excavation around the base of the press. There is no evidence for the use of open-air presses in the Golan (Ben David 2009c:95) and therefore, since no floor or room were found, the base seems to have been moved from nearby. Rooms with stone floors were found next to the base, which was found outside them (Fig. 5), and had apparently been moved slightly from its original location in one of the rooms. One of them directly to the north measures about 10.5 × 4 m which places it similar to other olive oil press rooms (Ben David 1998:44; 2009c:95). The pottery and coins suggest a 3rd century date for the final use of this press that was abandoned along with the village. The press conforms to Type 7.3.2 of Ben David's typology (1998:41, 48).

In Area R West (Fig. 6), about 15 m west of Area R East, a weight (R-1) was discovered in the survey; its height is 0.65 m and the bottom measures 0.55 × 0.44 m. In the excavation around it, the remains of an additional broken weight (R-2) were found, only part of the top of which was uncovered, and therefore the measurements are incomplete. The olive press weight was found inside what seemed to be a depression, perhaps a channel for the weights (Ben David 1998:55, Fig. 40). No clear architecture was found surrounding the weights, but a wall to the northwest might be associated with them. It is not yet clear whether the screw base and the weights were part of the same overall complex and whether they functioned at the same time since these are two different methods of pressing. Both weights have a horizontal hole at the upper part and are closed on top. These conform to Type 5.1.2 in Ben David's typology (1998:43, 47) and are rare in the Golan (see below).

Figure 5: Orthophoto of Area R East with rooms and stone floors near screw press (A. Wiegmann and B. Arubas).

Findings in Area P

In Area P a round crushing basin (P-1) was found, cracked into three parts (Fig. 7). It has an inner diameter of 1.17 m and a height of 0.37 m. The central square sunken socket measures 0.20 × 0.20 m. The wall has a thickness of 6–10 cm and projects 9 cm above the floor of the basin. Nearby part of a hewn basalt stone (P-2) with a shallow depression was found (Fig. 8), maybe part of a collecting vat. We excavated using a backhoe around the basin due to the hardpacked clayey soil, which was extremely difficult to excavate by hand. No pottery or remains of other structures were found and therefore the crushing basin and the nearby stone with a shallow depression seem to have been found not *in situ* but outside the settled area. The crushing basin conforms to Type 3.2 of Ben David's (1998:54) typology.

Figure 6: Weights R-1 and R-2 in Area R West (M. Osband).

Figure 7: Crushing basin P-1 in Area P (M. Osband).

Findings in Area S

In Area S the direct-pressure screw base (S-1), which was discovered in surveys prior to the excavation, was found resting above its surroundings on a mound of fill consisting of soil and rocks (Fig. 9). The measurements were reported previously by Ben David (1998:41). The press base measures 1.75 × 1.10 m with a height of 0.24 m.

Figure 8: Crushing basin (in back) and stone P-2 with a shallow depression in Area P (M. Osband).

Figure 9: Screw press-bed S-1 and wall in Area S (M. Osband).

This area, a few meters from the edge of the site, was damaged in the 1980's when a nearby reservoir was constructed. The area north of the press was bulldozed and stones were moved.

A small-scale excavation took place around the press base, where remains of a wall were found which did not seem to be associated with it. In addition, some of the soil underneath the base is the same as that to the north where fine clay was mined for the construction of the nearby reservoir, and differs from the surrounding dark, hard grumusol. The pottery from the excavation dates to the 3rd century, but unlike the screw base in Area R, the pottery sherds were similar to those of surrounding areas where residential buildings were found. An aerial photo of the area prior to the modern-day damage suggests that the press base was originally situated a few meters away to the north and had been moved, most likely when the site was damaged. This would explain why it does not align well with the wall, as well as the different dirt and the lack of press-related finds. Unfortunately, the modern damage precludes determining the original location of the press.

DISCUSSION

The Economy of Majduliyya: A Case Study of a Roman-Period Village in the Rural Golan

The remains of the olive oil presses at Majduliyya, three of which may have been used coevally in the 3rd century CE, demonstrate that olive oil production was an important industry at the site. As noted above, many sites in the western, central and southern Golan revealed oil press remains. Pollen from the Birket Ram crater lake has also shown that olive cultivation peaked in the Golan in the Roman and Byzantine periods (Schwab et al. 2004; Neumann et al. 2007).

Majduliyya is located at the meeting point between the rocky lower Pleistocene Dalwe Basalt and the deeper, less rocky soils of the Pliocene Cover Basalt (Mor 2012), providing opportunities for various agricultural endeavors. Over the generations, wheat fields, olive groves, vineyards and pastures have existed side by side in the Golan. Olive cultivation is easy to discern even after thousands of years due to the stone remains of production installations in the area of the settlement; however, it must be remembered that the agricultural landscape in the distant past was diverse, and in contrast to olive oil and wine production, many other types of cultivation leave few remains (Meir 2020:33–40).

Pottery production is another industry that has left evidence from the Roman period at Majduliyya and other rural Roman-period sites in the Golan (Osband 2014; Adan-Bayewitz, Ben David and Osband 2021). To date, three kilns have been discovered at Majduliyya. The two in its eastern part are, as noted, close to the lever weights found in Area B. It is not clear that there was a connection between the two industries, given that Majduliyya revealed no evidence of storage jar production but only of cooking vessels. Different specialists could have produced olive oil and pottery, but it is also possible that the same individuals produced both of them, the latter perhaps in the off-season when time allowed (Adan-Bayewitz 1993:236). It is also possible that olive press pulp was used as fuel for the kilns (Adan-Bayewitz 1993:235).

It is not clear if the olive oil produced in the central and southern Golan at this time was mainly for local consumption or was also exported to other regions. The distribution of storage jars produced in the central and southern Golan could provide evidence for the trade of olive oil if this commodity was transported in the jars. A study of Golan-produced storage jars showed that these had a limited distribution and did not reach the Galilee in any significant numbers (Osband 2014; Osband, Adan-Bayewitz and Glascock 2018), and even within the Golan, the storage jars seem to have been traded mostly locally, close to the production sites. This might be less surprising considering that olive oil production was common at sites in the Galilee. There is almost no evidence of olive oil production in the northern Golan or in the Hauran as these areas seem to not have been suitable (Ben David 1998:46) and olive oil would need to have been imported into these areas. Storage jars of types common in the central and southern Golan are uncommon in the northern Golan. A study of storage jars further to the east could prove a more comprehensive answer.

One aspect that has not been well studied is the quarrying source for the pressing installations. A chemical analysis of basalt architectural items used at Majduliyya and the nearby *polis* of Hippos showed that different quarries were used for each site (Osband, Eisenberg and Ferguson 2024). As part of this study, part of a crushing basin still *in situ* at its quarrying spot two kilometers to the west of Majduliyya, above the Samekh Gorge, was chemically compared with architectural items from the Majduliyya synagogue, as well as three olive press-related stones (the above-mentioned two direct-pressure press bases R-3 and S-1 and crushing basin P-3). Majduliyya would be the nearest site to which items from that quarry could be moved. Some sites are closer as the crow flies, but they would have required descending and ascending steep slopes, while the stones could be transported directly to Majduliyya over a fairly level area.

No connections were found between the Majduliyya stones and the area above the Samekh Gorge. The crushing basin from Area P and the press base from Area R were similar in composition to each other and to the architectural stones from the synagogue, whereas the press base in Area S was different. This is of course a small sampling, and further items should be analyzed. Still, this suggests that while the Area P crushing basin and Area R screw press base both came from the same basalt outcrop as that used in the synagogue (or outcrops of similar chemical composition), the Area S press base came from a different basalt outcrop and that none of the sampled stones came from the area further to the west by the Samekh gorge. The intended destination of the crushing basin found above the Samekh Gorge is unclear.

Press Types and the Dating of the Direct-Pressure Screw Press

The weights discovered in Areas B and R West come from lever-and-weight presses which were common from the Hellenistic period to modern times. Lever presses first appeared in the Land of Israel in the early Iron Age and were the only presses in use until the introduction of the screw press, but they persisted in use alongside more sophisticated devices into modern times as well (Frankel 2012:115). Ben David found that in the western central Golan in the Early Roman period, only lever weights were

used, while later in the Roman and Byzantine periods, both types could be found (Ben David 2005:206–209).

Two types of lever weights were found at Majduliyya. In Area B, both are trapezoidal with an inverted T-shaped hole in the upper part. In Area R the weights have a perforated horizontal hole and are closed on top. This latter type is rare in the Golan and may have only been used in the late Hellenistic and Roman periods. Examples of lever weights with a perforated horizontal hole are known from only a few other sites in the Golan (Ben David 1988:43, Table 5.1.2): in Area B at Gamla (4), dated to the 1st century BCE, and from surveys at Dabura (4), Dora (1), and Dahatmiyya (1) (Fridman 2023:178).

The direct-pressure screw presses and lever-weighted presses are found to have been used simultaneously, as an assortment of different types of presses was used to extract the oil and producers were rather conservative throughout the various periods (Ayalon 2015:100), making technological changes and adaptions a slow process. Frankel has noted the popularity of the direct-pressure screw press in the lower Galilee and Golan and has suggested that their more common use in those regions compared to others may have been due to the use of basalt, which was less suitable for piers and more useful as screw bases (Frankel 2012:124). They have been dated mainly to the Byzantine period (Frankel 1999:132–134; Decker 2008:80–82), and until now were thought to have come into use mainly in the 4th century CE (Lewit and Burton 2019:100). The excavated screw press at En Nashut was operated from the 4th to the 6th century CE (Ben David 2009a) and at Giv'at Ha-Yi'ur the screw press was in use from the 4th to the beginning of the 6th century CE (Ben David 2009b). In Majduliyya, the two direct-pressure screw presses could not have dated later than the latter part of the 3rd century CE, which is the date for the abandonment of the village based on numismatic and ceramic evidence (Osband and Arubas 2020; Eisenberg and Osband 2024:167). This suggests the earliest evidence to date for the use of this type in the Golan and possibly in the Land of Israel.

QUANTIFYING OLIVE PRESSES BASED ON SURVEY EVIDENCE—A METHODOLOGICAL POINT

The results from Majduliyya raise important questions as to the value of quantifying presses at a site based on a survey, as it is not certain whether they were moved, nor is it clear if presses were used coevally. The initial surveys of Majduliyya identified only a single press. Subsequently, further intense surveys and excavations revealed additional press remains, suggesting the presence of three or four installations at the site. Ben David suggested that the evidence in the Golan points to an increase in the number of presses at sites in the Byzantine period—about 4.5 times greater than their presence in the Early and Middle Roman periods (Ben David 2005:206–209). Interestingly, this rise in the number of presses in the Byzantine period coincides with a decrease in the number of sites during the Roman period (Eisenberg and Osband 2024).

In comparison with other Roman-period sites (i.e., sites that existed in the Roman period and did not continue into the Byzantine period) in the western central and

southern Golan, the olive press installation remains at Majduliyya make a relatively high number. These results suggest that more intensive surveys and, of course, excavations may reveal more Roman-period olive press remains at other sites.

The results from the excavation also elicit questions as to the extent to which the press remains were found in their original location. Olive pressing was usually performed indoors inside rooms or caves (Elitzur 1986; Avitsur 1994:105; Rosenson 1996:116–118). This may have been to allow for working even when it rains, prevent the robbery of equipment and oil, as well as allow for work at night. Note that no rooms clearly designated for pressing were found at Majduliyya. However, we suggest that even when such rooms are not found, the location of the presses at the edge of the village (Ben David 2009c:95) along with a large quantity of storage jar sherds indicate that the remains are indeed in or near their original location. The multiple weights found next to each other at the edge of the site may also be an indication that the pressing remains are *in situ*.

Uncertainty persists as to when the crushing basin in Area P and the press base in Area R East were moved (the base in Area S seems to have been moved recently, as noted above). No finds suggest the use of these particular presses in the Abbasid or Mamluk periods, and there is no archaeological evidence of the use of olive presses in the Mamluk period anywhere in the Golan (Ben David and Osband 2023). There is evidence in the Golan for the transfer of architectural stones between sites in modern times (Osband and Ben David 2024). The synagogue at Majduliyya and its architectural stones were dismantled and broken after it was abandoned. It is not clear if this happened in antiquity or in modern times, and the same goes for the moving of parts of the press installations. It is clear that the end of the olive oil industry at Majduliyya coincides with the abandonment of the village, which was part of a regional decline in the Late Roman period (Eisenberg and Osband 2024).

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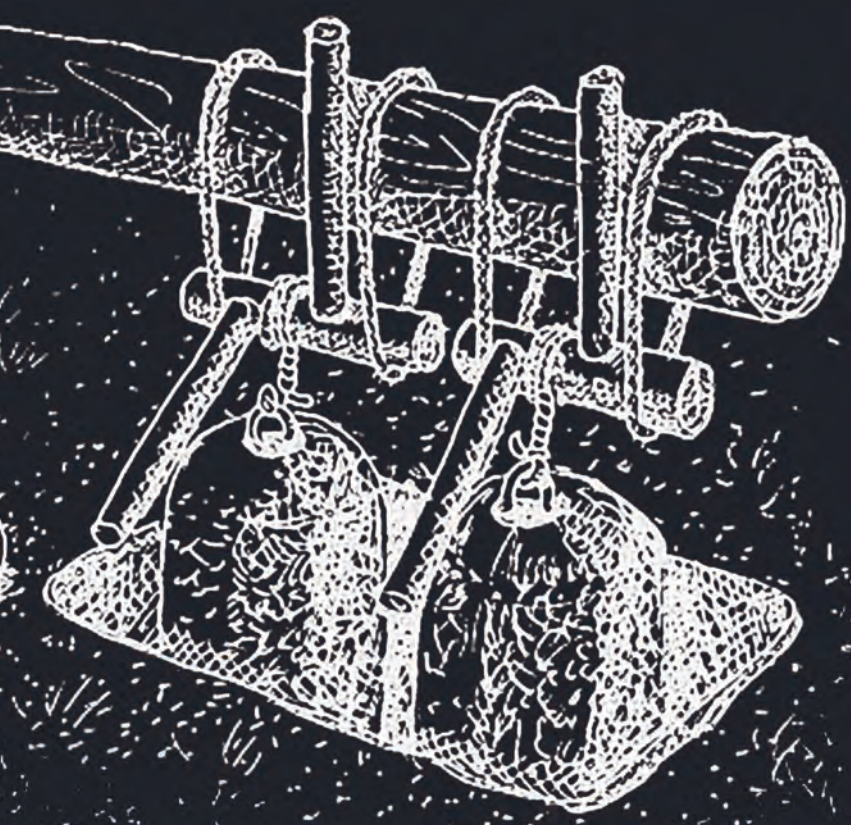
Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

Michael Eisenberg, ʻUzi Ad and Etan Ayalon



Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

Editors:
Michael Eisenberg, Uzi ʻAd and Etan Ayalon

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אוניברסיטת חיפה UNIVERSITY OF HAIFA

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Agricultural installations in Korazim

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In memory of Rafi Frankel, a lovely person and a teacher

ABSTRACT

The village of Korazim, situated on a basaltic slope northwest of the Sea of Galilee, was inhabited from the 2nd century BCE to the 11th century CE, with its significant synagogue constructed around 400 CE. This article consolidates previously unpublished data and presents new excavations focusing on the cornerstone of Korazim's economy: olive oil and wine production. Four olive presses, one winepress, and related features identified within the village, offer insights into its local structure and economy, as well as its regional significance within the broader context of the Jewish Galilee and Golan.

Z. Yeivin excavated three olive presses, but their documentation remained partial and unpublished. These are discussed here based on existing records and field observations. Furthermore, a newly excavated olive press and a winepress with a decorated mosaic are presented for the first time in this article.

Korazim's resemblance to nearby Capernaum is striking, particularly in terms of the technical elements of the installations and the overall lifespan of the village. Additionally, the village's connection to the Golan region is evident through shared technical features in olive and wine production, as well as cultural affiliations. This commonality extends to the utilization of basalt stone, emphasizing the regional interconnectedness of these areas.

Keywords: Korazim, olive oil production, wine production, Byzantine Galilee, agricultural installations, Jewish villages, subsistence economy

INTRODUCTION[1]

Archaeological investigations at the Korazim synagogue began in 1905 directed by Kohl and Watzinger (1916:41–58). Subsequent excavations were undertaken by Ory in 1926, although no formal publication followed. In later decades, Yeivin revisited the site during the 1960s and 1980s, focusing not only on the synagogue (Yeivin 2000), but also on various residential structures, though full publication of these excavations remains pending (Yeivin 1966; 1973; 1982; 1984; 1993). During 2020, we conducted

1 I would like to thank the three readers of the article, E. Ayalon, N. Getzov and M. Eisenberg, for their substantial corrections and suggestions that significantly improved it.

several probes in the synagogue, resulting in redating and further understanding of its stages (Kohn-Tavor and Arubas 2023).

The village, constructed primarily of local basalt stone, contains extensive remains of walls scattered across its 120-dunam area. Notably, four olive oil presses and additional installations have been identified within the ruins, namely (Fig. 1): the western, northern, southeastern, and southwestern presses (nos. 1–4), along with four surface-level crushing stones (nos. 5–9), unrelated to a specific olive press. Yeivin's investigations led to the exposure of the western, northern, and southeastern presses (nos. 1–3), of which the western is publicly presented; the description below draws from details from initial publications, archival records and field observations. [2]

In the current campaign, as part of renewed excavations in the village (Kohn-Tavor 2019), attention was directed towards the southeastern olive oil press (no. 3), which has undergone cleaning, while the main chamber of the southwestern press (no. 4) has been newly exposed. Additionally, the discovery of a mosaic prompted further exploration, resulting in the discovery of a decorated wine press (no. 10). [3] Below, we present detailed accounts of these discoveries, with a brief description of the remaining olive presses, which are yet to be formally published (refer to appendix 1 for precise measurements).

THE OLIVE PRESSES

Yeivin's excavations at Korazim uncovered three distinct olive presses (Yeivin 1966), each offering valuable insights into regional ancient agricultural practices.

The Western Olive Press (no. 1, Area M; Fig. 2; Yeivin 1983): Located in an elongated room supported by arches and later monolith pillars, this press showed evidence of two or three construction phases, corresponding to the presence of two superimposed floors. Yeivin's examination noted the presence of both a northern and southern direct-pressure screw press-beds, with the former embedded into the higher-level floor, likely falling out of use in the 5th–6th century. A plastered collecting vat accompanied the southern screw press, indicating a later phase of operation. The crushing basin pieces lay scattered in the room, and were repositioned on a surface that might have been their original position. As both screw presses were positioned on opposite sides of the crushing installation, we propose that all stages of production likely utilized both screw press-beds simultaneously. The absence of a clear reason for abandoning one press suggests their concurrent use was feasible. While two screw press-beds are uncommon, they are not unprecedented in similar contexts.[4]

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2 I would like to thank Y. Tzionit and the workers of the archive for their kind assistance and permission to use the data.

3 The excavation, permit B-480/2019, was conducted by the author under the auspice of Ariel University. It was initiated by Dekel Segev, Korazim National Park manager, and financed by Keren Rakefet. I thank David Ben Shlomo, Dror Ben-Yosef, Iosi Bordowicz, Eran Meir, Chaim Ben David and Benny Arubas; Lilach Robinson (registration), Abu Hmed and the workers from Focus Construction, Katja Epelbaum (pottery drawing), Omri Yagel, Yakov Shmidov and Benny Arubas (plans).

4 Two lever presses make sense, as their pressing time is longer than the screw press, which can add pressure easily.

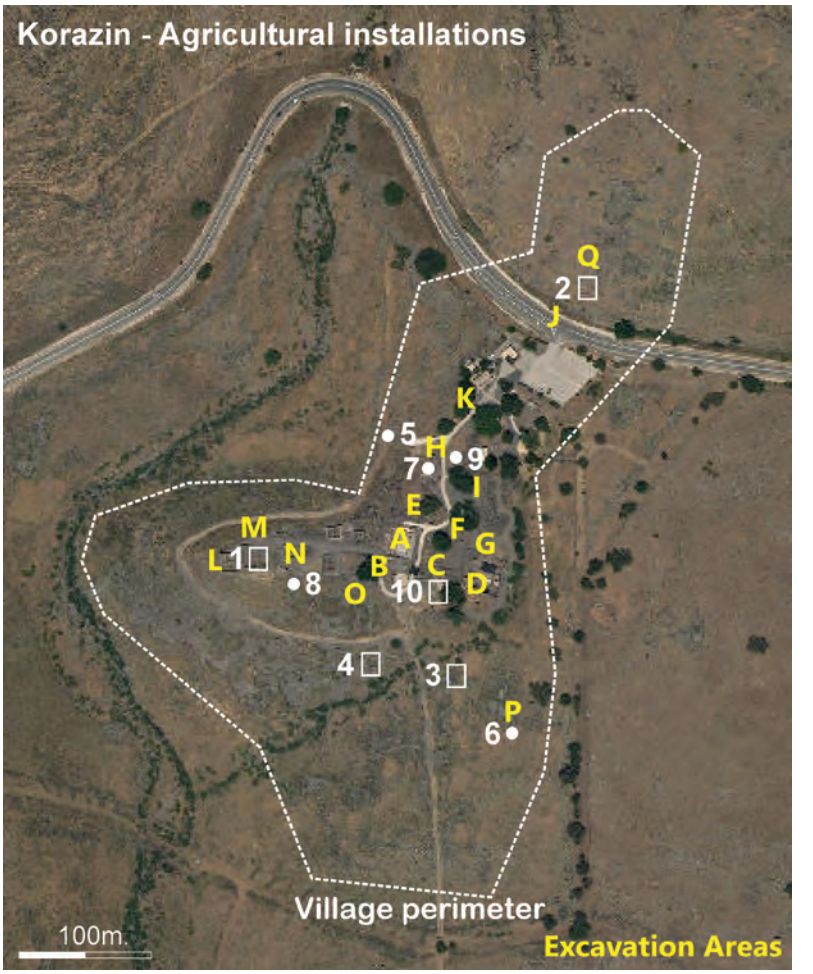


Figure 1: Agricultural installations in Korazim. The dotted line marks the village's realm (drawing A. Kohn-Tavor).

Figure 2: The Western olive press (No. 1), looking southwest (photo A. Kohn-Tavor).

Notably, the discovery of an Ottoman Rashaya al-Fukhar jar near the southern press suggests its continued use for pressing, even without a screw mechanism, suggesting longevity and adaptability of such installations.

The Northern Olive Press (no. 2, Area Q, Fig. 3): According to a preliminary report (Yeivin 1984), this press was located in a rectangular room (5 × 8 m) within a larger building complex (34 × 34 m). Constructed with boulders resting on bedrock and featuring an arched roof, the press included a large crushing basin positioned on the western side. A press-bed, incorporating mortices for the screw frame, drained into a basalt collecting vat. Two floors, constructed from beaten earth and pebbles, were discerned. Some olive pits were found in the vat and on the floor. Pottery dating to the 2nd century CE represents one of the earliest contexts identified at Korazim, providing crucial chronological insight into the site's occupation history (but see reservations below).

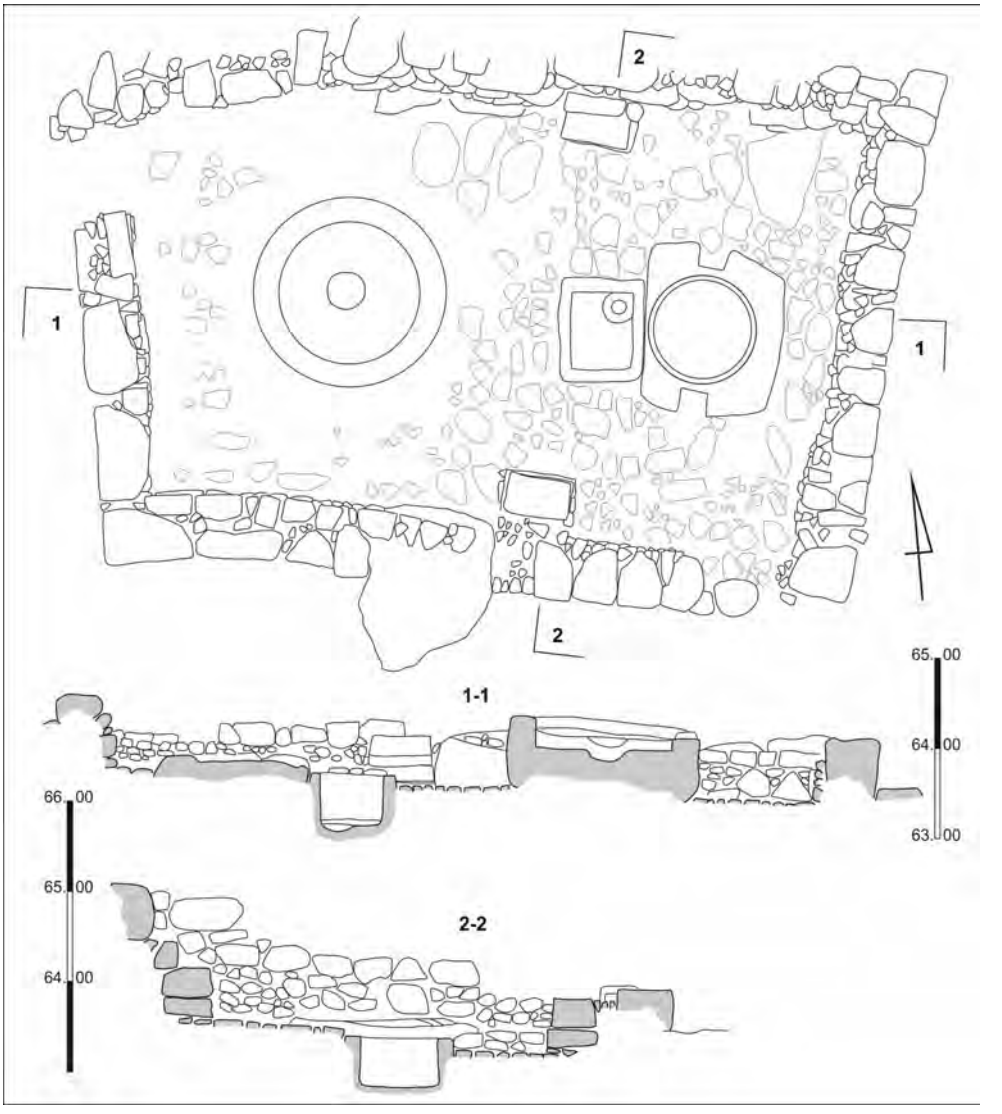


Figure 3: The Northern olive press (No. 2), on the southwest corner of the unexcavated complex (prepared for publication J. Rosenberg).

The Southeastern Olive Press (no. 3, Area P, Figs. 4, 5): Embedded within an unexcavated complex, this press featured distinctive architectural elements, including two massive supporting pillars—a rarity in Korazim. The crushing basin had a rounded projecting socket; both the crushing wheel and the crushing basin were found broken. The press-bed has a plastered collecting vat adjacent to it. Yeivin's findings suggested an early cessation of activity, contradicting the village's presumed construction period in the 3rd–4th century. The presence of Byzantine-style press-beds in the Golan (Ben David 1998:47–48) further complicates the interpretation of this installation.

The Southwestern Olive Press (no. 4, Figs. 6–9), excavated by the author in 2018, presents a complex architectural configuration and a rich assemblage of artifacts spanning multiple centuries:

The structural remnants, characterized by large boulders and sets of long beams set head to tail (0.80 m long), match construction methods observed elsewhere on the site. The pressing room, although excavated, lacks a discernible entrance, presumably located within the unexcavated portion of the east wall. The south wall's possible function as a closure between arch pilasters remains speculative.

The pressing apparatus consists of a high crushing basin with an elevated projecting socket. The crushing wheel (no. 1) was found broken to its south.[5] Another crusher (no. 2) was found beneath it, with no visible reason for discarding it.

Figure 4: The Southeastern olive press (No. 3), looking northeast (photo A. Kohn-Tavor).

5 It was lifted during the excavation, and mended by Yehontan Orlin and the Nature and Parks Authority (NPA) restoration team at 2023.

On the west side of the room, a screw press-bed remained intact. A plastered collecting vat (below, no. 1) drained it to the north. Its bottom had been cut into the rock, and the upper part consisted of small stones with plaster, containing pottery shards. It features a small depression in the corner for effective oil collecting. Another chiseled stone collecting vat (no. 2) found just south of the room suggests possible disuse or replacement.

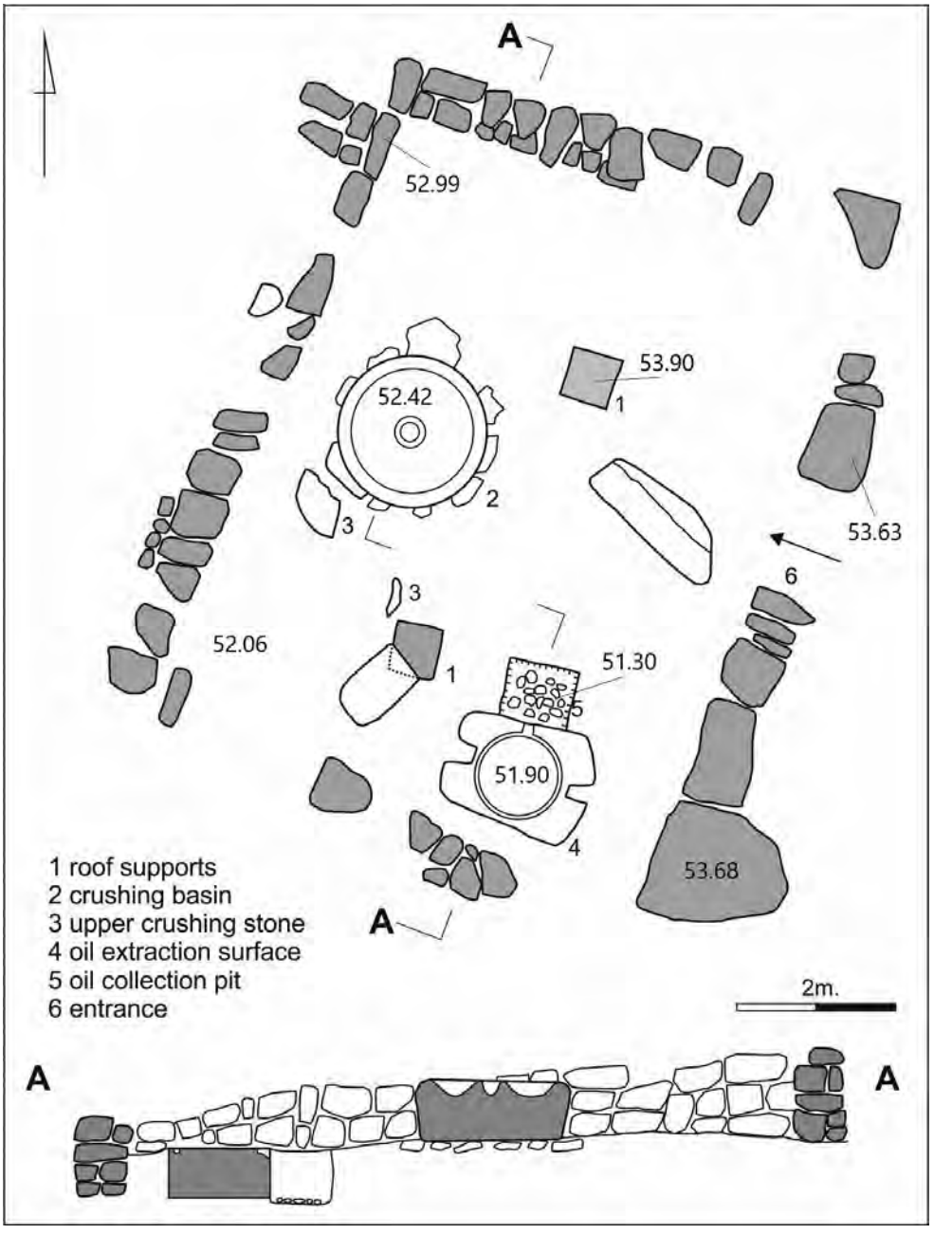


Figure 5: The Southeastern olive press, plan adapted from Yeivin's unpublished documentation (prepared for publication J. Rosenberg).

Figure 6: The Southwestern olive press (No. 4) and its surroundings, looking south (photo A. Kohn-Tavor).

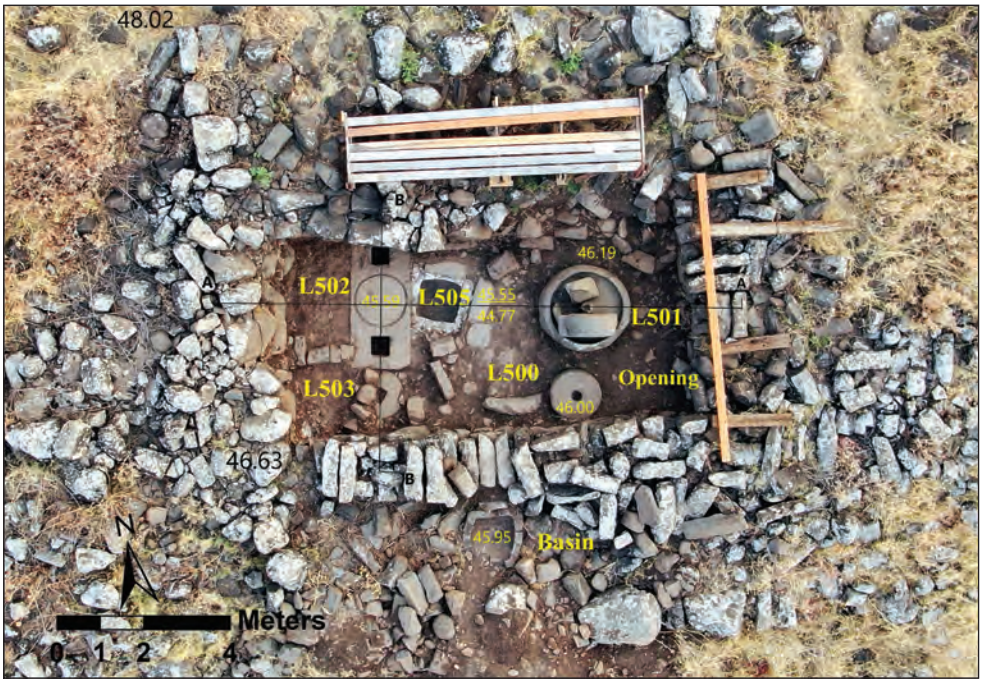


Figure 7: The Southwestern olive press, plan (A. Kohn-Tavor).

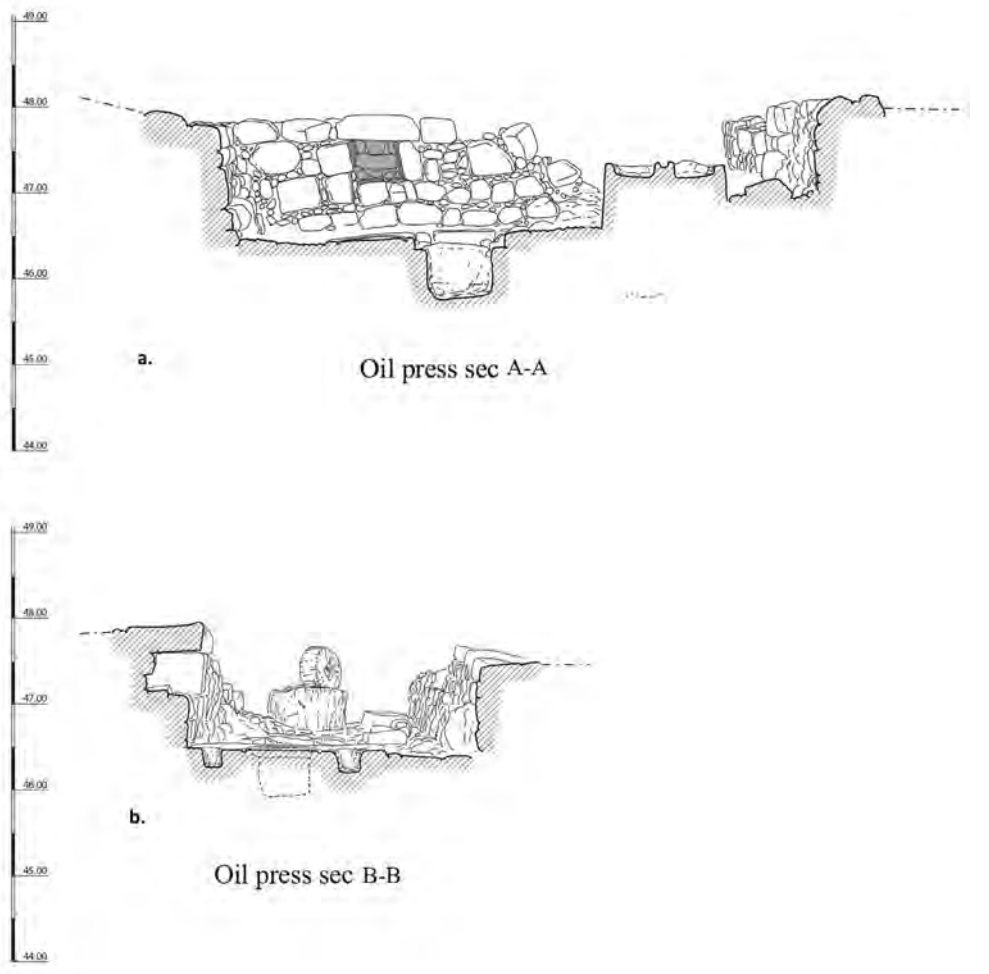


Figure 8: a-b. The Southwestern olive press, sections (drawing Y. Shmidov).

Noteworthy architectural features include a square niche in the north wall (0.50 × 0.60 m, 0.55 m above floor level). Across it, incorporated into the floor, lies another crushing wheel (no. 3; 2.75 m apart), possibly serving as a base for a lever and screw press (Ben David 1998:56, type 6), which was later replaced by the screw press.[6]

The ceramic assemblage retrieved from the room spans the Late Roman to the Byzantine periods (2nd–3rd to 6th–7th century CE; Fig. 10), with notable examples such as Late Roman Red Ware bowl CRS1, attributed to the 4th to 5th century CE, and PRS3 bowl, dated to the 6th to 7th century CE. It appears that the Roman fragments predate the construction of the architectural feature under scrutiny. This interpretation is supported by the discovery of a fragment of a casserole, dating to the 5th to 6th century CE, embedded within the plaster of the vat. However, we must consider the possibility that such inclusion may signify subsequent repairs rather than the initial construction phase. The assemblage comprises predominantly domestic ceramic types, with a

6 I thank Nadav Bertan of the NPA restoration team for the suggestion.

Figure 9: The Southwestern olive press, looking northwest: notice the wall niche, and the discarded collecting vat at the bottom of the photograph (photo A. Kohn-Tavor).

limited presence of jars—an unexpected composition for an industrial installation (and compare Ben David 1998).[7]

Of six recognizable coins, five date to the 4th century (latest 395-408 CE), and one dates to the early 2nd century CE (see Appendix 2). These coins match the percentage of coins found in Yeivin's excavations in the Synagogue and in the village.[8]

The abandonment of the olive press during or after the Byzantine era contrasts with the village's viability in later centuries, raising questions regarding the installations' functional history.

Subsequent modifications to the room, including the construction of a partition and the closure of an installation in the southwest corner (L503), resulted in the cessation of pressing operations. The stone debris from the walls contained pottery shards from the Crusader or Mamluk periods. A considerable amount of crudely made pottery vessels (Fig. 10:12) likely represent sugar cones, though they lack bases and differ in material from other sugar vessels found in nearby refineries. These findings suggest a potential adaptation of the facility for small-scale sugar production, a hypothesis that warrants further investigation.

Uncontextualized Crushing Stones: Two crushing basins appeared on the surface, one unfinished stone located in the northwest side of the village (no. 5, Fig.

7 I wish to thank Yeal Arnon, Sharia Friedman and Mechael Osband for their helpful observations.

8 Donald Tzvi Ariel, unpublished report at IAA archive; same data is retrieved from the synagogue: Kloetzli 1970; Meshorer 1973; Ariel 2000. I wish to thank Danny Syon for his identification.

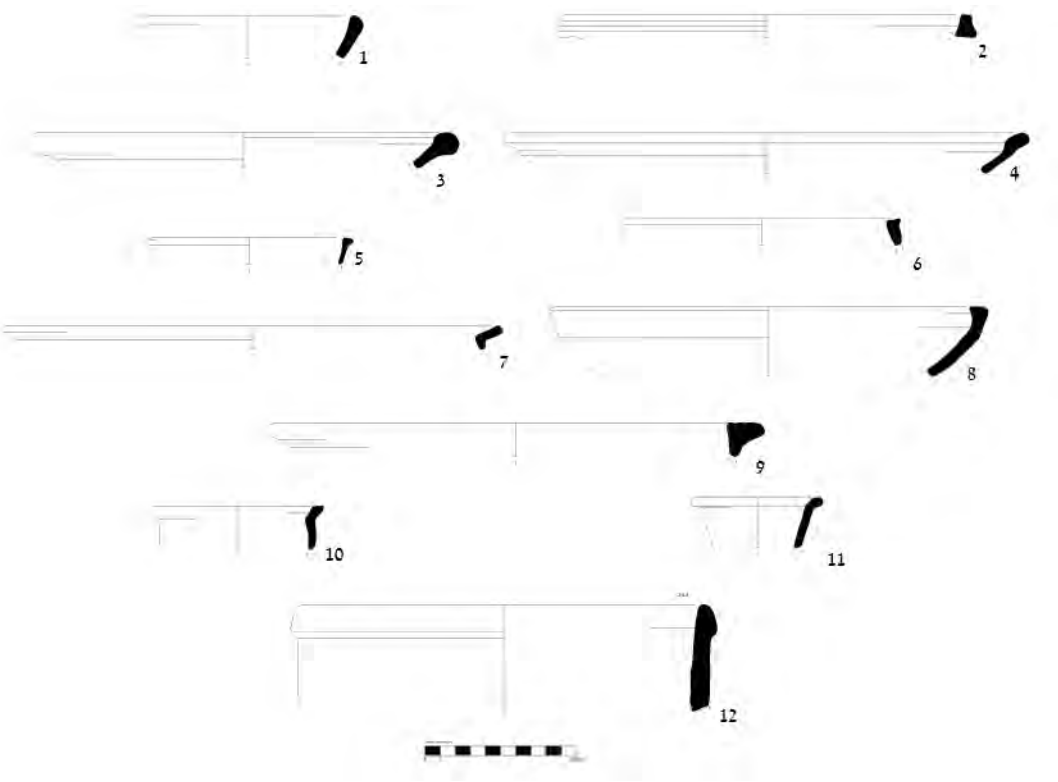


Figure 10: The southwestern olive press, pottery (drawing K. Epelbaum)

No.	Reg.	Description	Type
1	5030/1	Fine orange	LRRW bowl, ARS 99
2	505/5023/1	Fine orange	LRRW bowl, LRC 3
3	500/5001/1	Fine orange, red slip	LRRW bowl, LRC 10b?
4	500/5005/6	Orange, white grits	Cooking bowl, Kefar Hananya Form 1E
5	500/5005/1	Red, white grits	Cooking bowl, Kefar Hananya Form 1B
6	505/5022/1	Red, white grits	Cooking pot, Kefar Hananya Form 4C/4D
7	500/5000/4	Red, white grits	Cooking bowl, Kefar Hananya Form 3A
8	505/5005/2	Grey, white grits, plaster	Casserole
9	500/5000/2	Orange, red slip	Basin, CRS 7
10	500/5001/5	Orange	Jar, Cafarnao ANF 11?
11	505/5023/5	Red, white grits, plaster	Jar, Cafarnao ANF 11?
12		Crude pink, big white and orange grits	

Figure 11: An unfinished crushing basin (No. 5) at the northwest side of the village (photo A. Kohn-Tavor).

11) and the other on the southeastern side (no. 6, Fig. 12). Additionally, a press-bed appears in Yeivin's report beneath a floor in the northern room of building H (no. 7), indicating the presence of an earlier unexcavated olive press. Near the top of the western quarter, south of area N, lies a large unfinished crushing wheel (no. 8, Fig. 13), while another broken crushing wheel (no. 9, Fig. 14) stands at the site entrance.

DISCUSSION: THE OLIVE PRESSES IN KORAZIM

The Korazim olive presses should be analyzed within the broader context of contemporary basalt olive presses in the Golan Heights—a region known for extensive olive oil production during the Roman and Byzantine periods (Ben David 1998). Unlike many olive oil presses in the Golan located on the outskirts of villages, those in Korazim are integrated into the village structure, suggesting either their role as an intrinsic part of the construction or that the expansion of the village incorporated existing presses; this could be proven only by excavating more dwelling houses in the village.

The abundance of olive presses discovered in Korazim indicates the central role of olive oil production in the village's economy, similar to other contemporary sites in the Golan. The basalt highlands provided ideal conditions for olive cultivation. Estimates based on data from the Golan (Ben David 1998:45, 49–51) suggest that Korazim may have possessed around 1500–2000 dunams of olive groves, with each press capable of producing 11–15 tons of oil per season.

The rounded, projecting sockets of the crushing basins (Ben David 1998 type 3.2) match northern Israel style, particularly prevalent in the west-central Golan region near Korazim. Similarly, the structure and size of the screw press-beds correspond to regional norms.

Although few collecting vats have been uncovered in the Golan, some share the square shape observed in Korazim (Ben David 1998). The construction of these vats, either built or chiseled, conforms to the properties of hard basalt rock, as opposed to limestone, which can be quarried into bedrock. Notably, The Korazim collecting vats are generally larger than the Golan counterparts.

Figure 12: A crushing basin (No. 6) at the southeast side of the village (photo A. Kohn-Tavor).

Figure 13: A large unfinished crushing wheel/basin (No. 8) near the western quarter (photo A. Kohn-Tavor).

Figure 14: A crushing stone (No. 9) at the north side of the site (photo A. Kohn-Tavor).

The chronological development of olive production at the site can be traced through several indicators. The absence of olive press lever weights at Korazim suggests a likely absence of olive oil production during the Hellenistic and early Roman periods (Ben David 1998:41–44). The presence of an ad-hoc installation utilizing a reused crushing wheel in the southwestern oil press may indicate an early Byzantine or Roman period introduction of this technology, although this remains an isolated instance rather than indicative of a broader regional trend.

The direct-pressure screw press, which dominates Korazim and the Golan, is considered an early Byzantine invention. The earlier dates reported by Yeivin in Korazim stand as an exception (Ben David 1998:42–44). Given the general scarcity of such early contexts in Korazim, the presence of this particular assemblage raises the possibility of an error or misinterpretation.

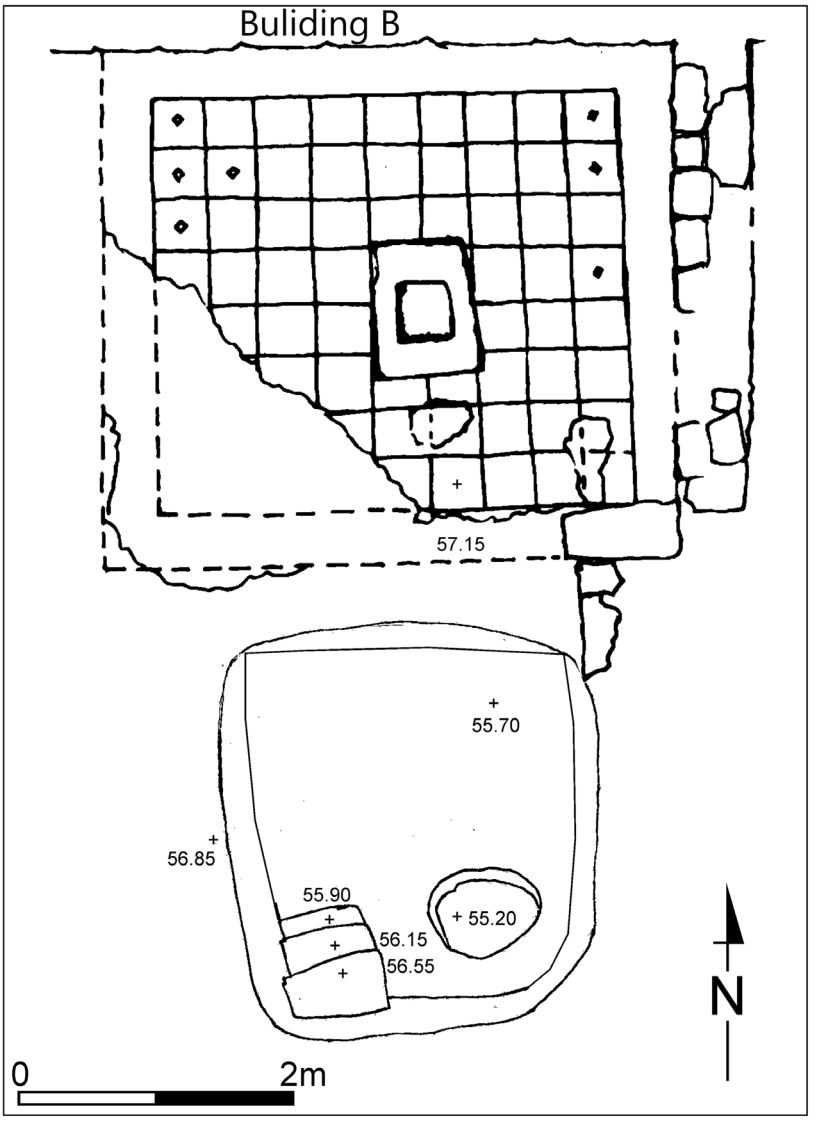
The screw press-beds found at Korazim conform to two main Golan types: they are of types "with open fixation niches and side drainage" (Ben David 1998 type 7.3.2), and "with square fixation holes" (Ben David 1998 type 7.4.1). The technical aspects of olive press construction are influenced by the local basalt stone and cultural-regional connections, as evidenced by their alignment with Jewish population practices (Ben David 1998:48).

THE WINEPRESS

Conservation efforts in March 2019 led to the discovery of a mosaic and subsequent unearthing of a winepress located south of Structure B. This represents a complex press, featuring a decorated mosaic floor and consisting of a treading floor with a screw base and a collecting vat (no. 10 in Fig. 1; Figs. 15–18).[9]

Figure 15: The winepress, looking west (photo A. Kohn-Tavor).

9 The excavation, permit G-19/2019, was conducted by the author under the auspice of Ariel University. It was initiated by Dekel Segev, Korazim National Park manager, and financed by Keren Rakefet. I thank David Ben Shlomo (Ariel University), Dror Ben-Yosef,



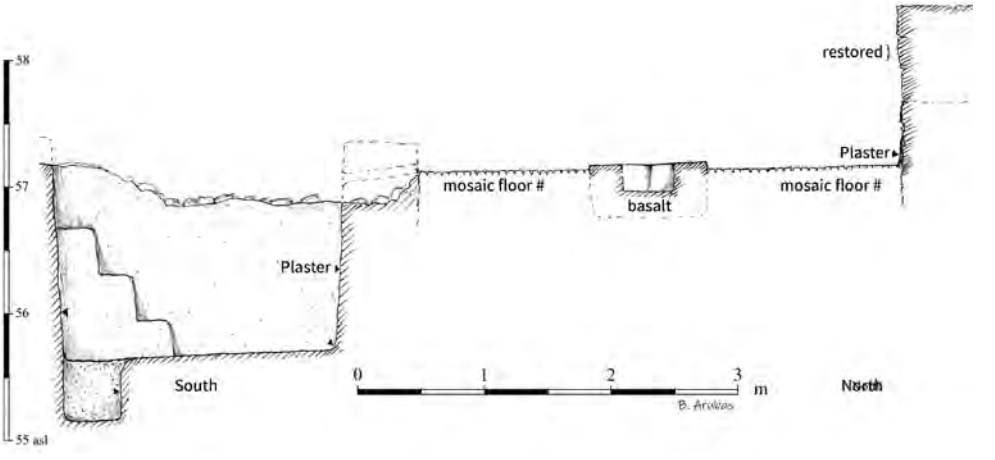


Figure 16: The winepress, plan and section (drawing J. Rosenberg and B. Arubas).

The treading floor, measuring 3.75 × 4.2 m, features a preserved geometric mosaic pattern laid upon a white plaster substrate supported by bedrock. A stone screw base of the Hanita-type with a fixing mortice (Frankel 1997 Fig. 13A) for a secondary pressing screw, crafted from basalt stone, is incorporated within the mosaic—a base type typical of the north.

The decoration features a checkerboard pattern (8 × 9 squares) placed at a 45-degree angle to the edges of the surface, created using a single row of black stones. In the center of each square lies a smaller square of 9 black stones, and within it a square of 4 red stones (Fig. 17). The pattern is surrounded by white borders of stones aligned with the edges of the surface. A similar pattern also appears at a Byzantine winepress at Ein Tzippori (Milevski and Getzov 2014 Fig. 26). In the southeastern corner, the missing edges of the mosaic approach a lengthened stone, possibly placed as a repair.

Most of the collecting vat (Fig. 18), approximately 5 m³ in volume, remains intact, constructed from rough stones bound with white plaster and incorporating pottery shards. Access to the vat utilized a narrow staircase in the southwestern corner, with a sump located to the south. Heavy rubble filled the vat, likely to originate from nearby building walls.

The winepress's northern and eastern sides are abutted against the southern wall of Structure B and a projecting wall, respectively, indicating potential roofing. Remnants of additional walls suggest auxiliary rooms or structures surrounding the press, indicating a more extensive architectural complex yet to be fully revealed.

Subsequent modifications to the winepress, including placing a single line of hewn stones installation atop the mosaic and evidence of a burnt roof beam, likely occurred after the facility ceased operation. The few pottery shards found on the

Figure 17: The decorated mosaic of the treading floor (photo A. Kohn-Tavor).

Iosi Bordowicz, Tzvika Tzuk (NPA), Eran Meir, Chaim Ben David and Benny Arubas; Lilach Robinson (registration), Abu Hmed and the workers from Focus Construction. The plan was prepared by Jay Rosenberg and Benny Arubas.

Figure 18: The vat, looking west (photo A. Kohn-Tavor).

treading floor (not drawn) date to the 8th century, up to 749 CE, indicating when the installation went out of use. As mentioned, the facility no longer served as a press at this stage. The presence of pottery shards dating up to the 10th century CE within the collecting vat, such as glazed cooking vessels, indicates an extended period of disuse and gradual accumulation of debris.

DISCUSSION

Due to the difficulty of cutting and carving basalt, the construction of the winepress in Korazim involved building rather than hewing, diverging from practices common in limestone-rich regions. Consequently, the winepress was integrated into the settlement, positioned close to the residences of vineyard owners. The decorative mosaic flooring suggests its central location within the settlement, serving as a visual focal point for the inhabitants.

A comparable basalt winepress, albeit less preserved, was identified at the Bab al-Hawa site in the northern Golan Heights (Assis 2016). Surveys conducted in the basaltic vicinity of Korazim by Y. Stepansky (Kfar Nahum Map Survey, unpublished data), as well as in the broader Golan Heights region, have yielded minimal evidence of carved presses. The surveyors suggest that additional built presses exist but are not visible on the surface (Hartal 2013, Section 7.2: Presses). This differs from limestone regions, where carved presses are more prevalent.

The discovery of the winepress in Korazim marks the first evidence of vine cultivation in the area, suggesting that additional presses may exist on the site awaiting discovery. Based on its typology, the winepress is attributable to the Byzantine period. Its cessation of use in the early 8th century CE aligns with broader trends indicating a decline in wine consumption and production during that period (see recent studies by Fuks et al. 2020; Dray 2024).

CONCLUSION: KORAZIM AS AN AGRICULTURAL VILLAGE

The discussed installations provide valuable insights into the agricultural infrastructure of ancient Korazim, illuminating its inhabitants' technological advancements and socio-economic practices across different periods of occupation.

Olive oil production formed a cornerstone of Korazim's economy, with estimates suggesting that over 70% of the village's produce was sold. This economic reliance on olive oil likely contributed to the prosperity of Korazim during the late Roman and Byzantine periods (Hirschfeld 1997; Ben David 1998:52–53; Hartal 2013 4.14.2; Leibner 2009:404), as evidenced by the limited remains from earlier periods discovered in the site (Yeivin 1993). The investment in a new and elaborate synagogue around 400 CE (Kohn-Tavor and Arubas 2023) further demonstrates the village's economic prosperity, with similarities observed in nearby Capernaum's olive presses, suggesting privately-owned facilities operated by specific families (Mattila 2015:234–237, 251).

A significant question concerns the date of usage of the oil presses. Unfortunately, we lack reliable data for the dating of the olive presses Yeivin excavated. The southeastern oil presses discussed above were definitely in use until the late Byzantine period. Despite a general population decline in the Galilee and the Golan during the Byzantine period (Leibner 2009), Korazim and neighboring Capernaum continued to thrive.

Those sites continued throughout the Early Islamic period, potentially due to their proximity to the capital of Jund el-Urdun, Tabariya. This continuity appears in recent excavations at building D, dating to the Abbasid and Fatimid periods (Kohn-Tavor 2019).

While olive oil production predominated, grains were likely also cultivated and processed in Korazim, as indicated by the numerous grinding stones scattered throughout the ruins and references in the Jerusalem Talmud (Menaḥot 85a). However, physical evidence primarily supports olive oil production, with wine presses likely existing but yet to be fully uncovered (see also Hartal 2013). Grains likely served as a self-consumed crop, while olive oil and wine formed the backbone of the village's subsistence economy.

Korazim's agricultural focus positioned it between the Jewish Galilee to the west and the Jewish Golan to the east. Further excavations may reveal the relative contributions of different agricultural products to the village economy, further illuminating Korazim's role in ancient society.

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APPENDIX 1: OLIVE PRESS PARTS FROM KORAZIM (TYPES ACCORDING TO BEN DAVID 1998), WITH MEASUREMENTS (IN M.)

1. Western olive press:

Crushing basin, type 3.2.5: diam. 1.70, height 0.45, wall 0.15, socket diam. 0.30
Crushing wheel, type 3.8.1: diam. 0.95, hole diam. 0.18, square hole 0.23
North press-bed, type 7.3.2.2: 1.25 x 1.90, drainage diam. 0.94
South press-bed, type 7.4.1: 1.15 x 1.30, drainage diam. 0.93
Collecting vat: 0.75 x 0.90, depth 0.70 (app. 500 L.)

2. Northern olive press:

Crushing basin, type 3.2: diam. 2.05, height 0.40, wall 0.25, socket broken
Crushing wheel missing
Press-bed, type 7.3.2: 1.60 x 1.80, drainage diam. 1.15
Chiseled collecting vat: 0.65 x 0.85, depth 0.45 (app. 250 L.)

3. Southeastern olive press:

Crushing basin, type 3.2: diam. 1.80, height 0.60, wall 0.20, socket broken
Crushing wheel type 3.8.1: ? (broken)
Press-bed, type 7.3.2: 1.25 x 1.90, drainage diam. 1.00
Collecting vat: 0.70 x 0.80, depth 1.00(?) (app. 550 L.)

4. Southwestern olive press:

Crushing basin: diam. 1.90, height 0.80, wall 0.15, socket diam. 0.25
Crushing wheel 1, type 3.8.1: diam. 1.00, hole diam. 0.21, square hole 0.23
Crushing wheel 2, type 3.8.1: diam. 0.88, hole diam. 0.18, square hole 0.21
Crushing wheel 3, type 3.8.1: diam. 1.00, hole diam. ?, square hole 0.26
Press-bed, type 7.4.1: 1.05 x 2.38, drainage diam. 0.94
Collecting vat 1: 0.75 x 0.78, depth 0.78 (app. 400 L.)
Collecting vat 2: 0.70 x 0.70, depth 0.50 (app. 250 L.)

5. Crushing basin, type 3.2: diam. 1.25, height 0.65, wall 0.25, socket diam. ? (Unfinished)

6. Crushing wheel type 3.1.1: diam. 1.65, height 0.40, hole diam. 0.20, square hole 0.20

7. Pressing stone below area H: unknown

8. Unfinished crushing wheel/ basin by area N: diam. 1.85, height 1.05

9. Crushing wheel type 3.8.1: diam. 0.93, height 0.40, hole diam. 0.23, square hole 0.23

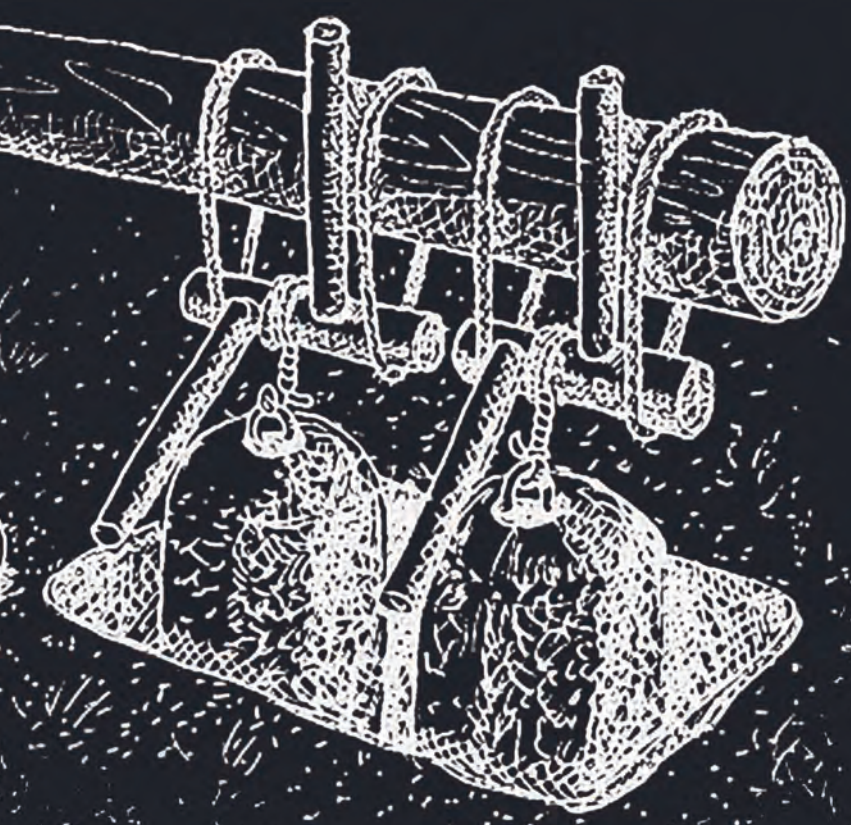
APPENDIX 2: COINS FROM THE SOUTHWESTERN OLIVE PRESS

No.	Locus	Basket	Date
1	500	5006	104/105 CE
2	500	5003	4th C. CE
3	500	5002	4th C. CE
4	500	5007	319 CE
5	Surface	5009	395–408 CE
6	501	5014	?
7	502	5010	Probably 4th C. CE
8	501	5013	?
9	502	5011	worn?

Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

Michael Eisenberg, ʻUzi Ad and Etan Ayalon



Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

Editors:
Michael Eisenberg, Uzi ʻAd and Etan Ayalon

To Dr. Rafael (Rafi) Frankel (1929–2023)

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אוניברסיטת חיפה UNIVERSITY OF HAIFA

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Millstone Finds from the Mediterranean Coast of Israel

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ABSTRACT

Israel's shores have been an active shipping route for the past 5,000 years. Intense storms that break out without warning and the absence of shelters for ships have led to many vessels being distressed over the years, swept ashore, and wrecked near the coast. Hundreds of shipwreck assemblages were discovered during surveys and excavations along the Mediterranean coast of Israel since the 1960s, including ones containing millstones. Among these were cargoes of Pompeian-type millstones (donkey mills), water mills, flat rectangular slabs used for grinding, and rectangular hand-operated millstones of the Olynthus type. Many stones were not used, indicating that they were transported on ships as cargo, while others were likely used for grinding by the sailors. Most of the stones are made of basalt. Additionally, concentrations of millstones that were reused as weights for anchoring and stabilizing mobile slipway facilities for launching and hauling ships were surveyed, with others serving as improvised anchor weights when the ship encountered distress. Two quarries discovered along the northern coastline of Acre were surveyed and discussed, where millstones were produced from coarse-grained beachrock, and were likely transported by ships.

Keywords: Millstones, Mediterranean Coast of Israel, ancient shipwrecks, cargo

INTRODUCTION[1]

The eastern Mediterranean coast has witnessed important events in human history, and the coast of Israel is rich with archaeological remains left behind by ancient civilizations, cultures, and episodes. The coastal waters of Israel have

1 We wish to thank Rafael (Rafi) Frankel for his help in identifying the millstones, the University of Haifa and the Israel Antiquities Authority for their institutional support, the Underwater Exploration Society of Israel, the archaeologists Assaf Yasur-Landau, Shelley Wachsmann, Kurt Raveh, Kobi Sharvit, Nimrod Getzov and Etan Ayalon, Reuven Amitai for his support in funding the study of the coins from Megadim and Ariel Berman for the identification of the Mamluk coins from Megadim, the divers Dani Moskowitz, Alex Yacoboviz, Yossi Eilon, Shlomi Katzin and Haim Sali for their help in the underwater operations, and the Horizon 2020 Research and Innovation Program, ILIAD 101037643 project, for their support, Etan Ayalon and Michael Eisenberg for their comprehensive review and useful notes, which considerably improved the article.

served as an active shipping route connecting various cultures for over 5,000 years. The physical conditions along the coast and the state of the sea made navigation challenging and dangerous. The 200 km long Israeli coast is straight and lacks natural shelters for vessels, except for three artificial harbors built at Atlit (8th century BCE), Acre (2nd century BCE), and Caesarea Maritima (end of the 1st century BCE) (Galili, Oron and Cvikel 2018). Additionally, there are partly submerged *kurkar* (sandstone) ridges forming small islands some 100 to 600 m offshore, creating partly protected natural anchorages. These natural formations provided temporary shelter for ships during overnight stops, waiting for favorable winds or for unloading and loading goods and passengers, but they could not offer adequate protection from winter storms.

Unpredicted storms create waves reaching heights of ten meters. Many vessels found themselves in distress, drifted ashore and wrecked in the surf zone. These harsh and unfavorable sea conditions dictated the nature of ancient maritime activity along the coasts of Israel. The waves near the shore broke apart the wooden hulls of the wrecked ships, and their remains were scattered on the coast and shallow sea bottom (Galili, Oron and Cvikel 2018; Galili et al. 2024). It is likely that some of the cargo from the ships was salvaged in ancient times, and wooden parts were collected and reused by residents near the shore. Heavy objects such as anchors, metal and stone cargo, remained on the seabed and were covered by sand soon after the wreckage. The layer of sand that covered the remains protected them from marine erosion and decay and prevented salvaging in ancient times. In recent decades the underwater archaeological remains have been under threat due to human activities, primarily sand mining, construction, and development. These activities have caused changes in the shoreline and the seabed, disrupting the balance of sand along the coast. A shortage of sand has led to the exposure of ancient shipwrecks and cargoes that had been covered by it and protected on the seabed for many years. The shipwreck sites are damaged by erosion and treasure hunting, but their exposure also enabled their discovery.

Since the 1960s, underwater excavations and surveys have been carried out by the Underwater Exploration Society of Israel (until 1982; hereafter UESI), the University of Haifa and the Israel Antiquities Authority (IAA). The excavations and surveys have uncovered cultural assets of great value representing a significant and unknown part of the history of the Land of Israel and the Mediterranean basin. These include submerged prehistoric settlements, harbors and anchorages as well as shipwrecks with lost cargo, weapons and tools. The archaeological remains shed light on human activity along the coasts, including navigation, trade, fishing and invasions. They contribute to the understanding of the material culture of coastal settlements, the relationships between them and their interaction with the sea (Galili, Oron and Cvikel 2018).

In this article, we describe and discuss the millstone finds recovered off the Israeli coast as well as coastal quarries, where millstones were extracted. It should be noted that grinding stones recovered in submerged prehistoric settlements off the Carmel coast are not included in this article and were comprehensively described and discussed in Galili and Nadel (in press).

THE MILLSTONE FINDS

Millstones discovered on the seabed in Israel can be divided into four categories: 1) Stones that were transported as cargo onboard ships; 2) Stones that were likely used by the mariners; 3) Quarries for extracting millstones, utilizing the coastal beachrock; and 4) Concentration of basalt millstones discovered near the shoreline, likely used for secondary purposes (Fig. 1). The finds are described below, with details of the site and other finds associated with the ships that carried the millstones, location, and registration number of the assemblage in the underwater survey maps.[2]

A Cargo of Basalt Water Millstones from Atlit (Survey map 7, Assemblage no. 15)

In 1966 a cargo of at least 35 round basalt millstones and two iron anchors was discovered by members of the UESI in the Atlit navy base (Fig. 1). The site was briefly mentioned in the Atlit Survey Map (Ronen and Olami 1978:62, site 109).

The site (coordinates[3] 193310/733446) is located 120 m offshore, some 1200 m south-west of the Atlit peninsula with the Crusader castle on it. The stones were documented on the sea bottom by navy seal divers, guided by the UESI members. Thirty-five basalt millstones, partly covered by sand, were scattered on a rocky sea bottom at a water depth of 6–9 m (Figs. 2, 3). The site covers an area of 20 x 15 m (Fig. 4). However, it may be larger, and additional stones may be covered by sand further to the west. Twenty-one of the stones are lying with their upper part upwards, while the rest are lying upside down. The divers reported that a cluster of iron anchors stuck together was located south of the millstones site. These may have been carried onboard as cargo or as reserve anchors. These anchors were never documented.

Five of the stones and two iron anchors were retrieved. The anchors were displayed in the navy base, and two millstones are displayed in front of a house built by the British expedition during the 1930s excavations east of the Crusader castle (Figs. 5, 6). Two millstones were given to a diving club at Achziv, and another one was given to a nightclub in Jaffa.

2 The underwater survey project has been carried out by E. Galili, documenting the key underwater and coastal archaeological sites along the Mediterranean coast of Israel. The data has been collected during more than 60 years of underwater archaeological research. The survey describes and maps the sites discovered along the Israeli coast from 1960 to 2024. The database is in the form of an Excel table and a GIS platform. It is an essential tool for managing and protecting the underwater cultural resources, which is used by researchers (e.g., archaeologists, historians), planners, government and municipal authorities. The Israeli coast is divided into nine survey maps, in which the archaeological assemblages are numbered. The characteristics and nature of each assemblage are summarized, including location, type of site (e.g., submerged settlement, harbor, shipwreck, coastal installation), water depth, kind of sea bottom, accessibility, protection by law, main risks threatening the site, importance of the site and selected relevant publications.

3 All coordinates are in Israeli Transverse Mercator (ITM).

Figure 1: Key map of sites mentioned in the text (E. Galili).

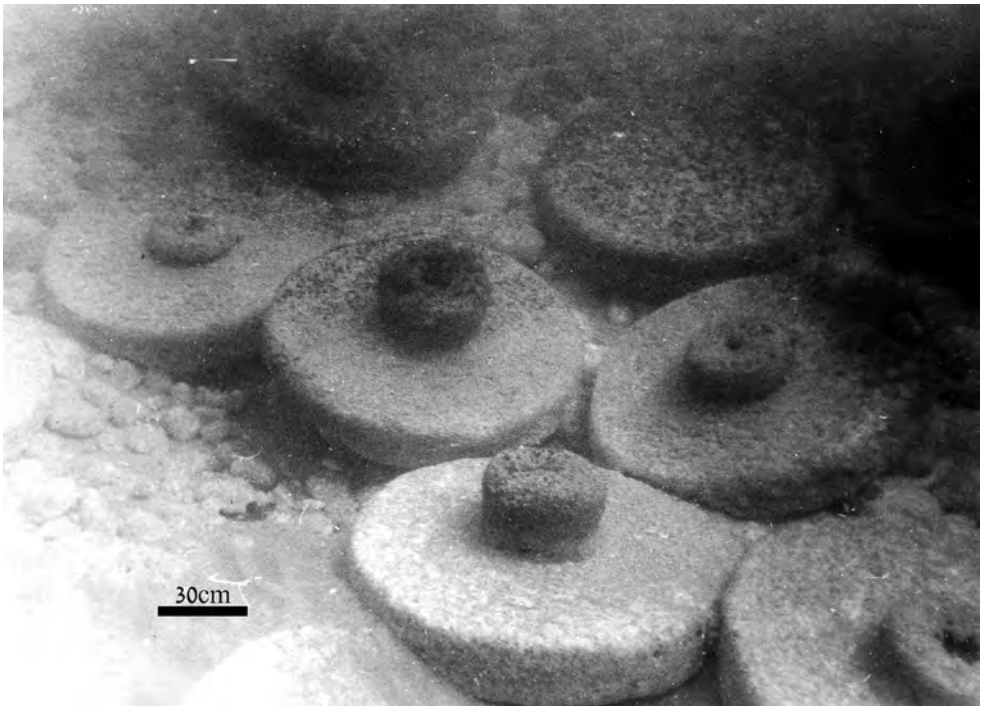

Figure 2: Atlit: The cargo of water millstones as found on the sea bottom (UESI).

Figure 3: Atlit: Divers tying one of the millstones intended to be retrieved (UESI).

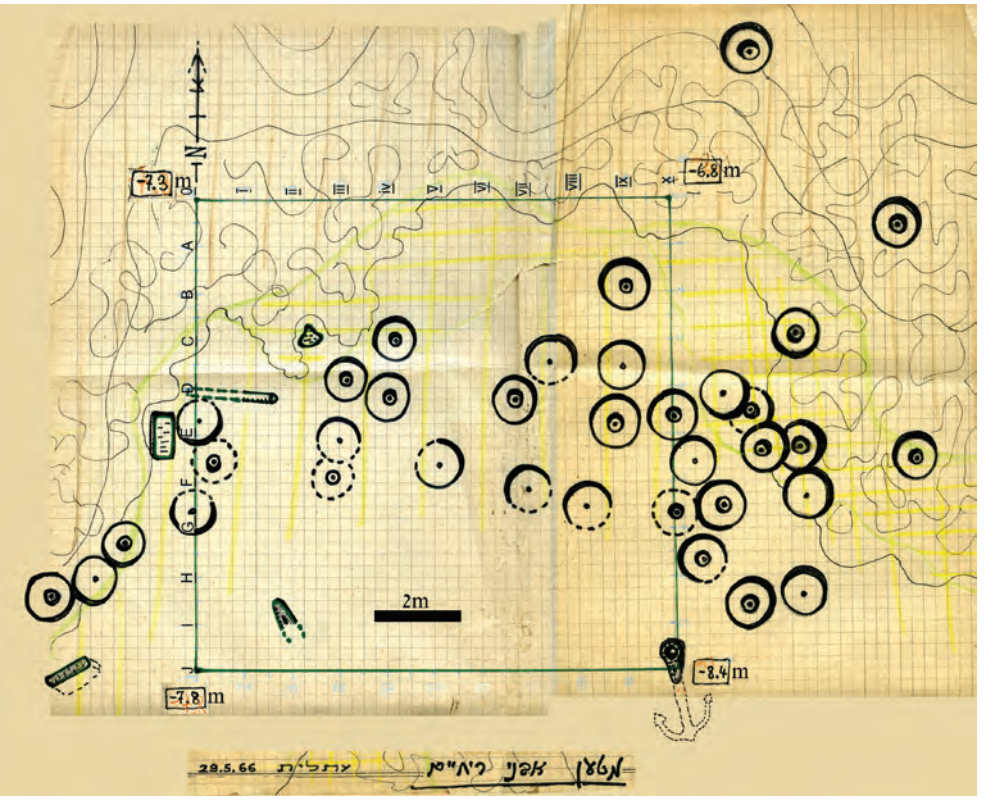

Figure 4: Atlit: Plan depicting the distribution of the millstones on the sea bottom (UESI).

Figures 5, 6: Two basalt water millstones retrieved from the site displayed at the front of the building intended to be the Atlit Museum (currently a beach club in the Atlit Navy base) (E.Galili).

The millstones: All millstones are made of basalt, they are round (1.20 m in diameter, 0.18 m thick), with a flat lower side and a cylindrical protrusion (0.30 m in diameter, 0.20–0.25 m high) on their upper side. All stones have a round, circular hole in their center ("eye"; 0.15 m in diameter), with straight walls. All are of the upper stone type, which in the flour mill rotated on the lower, flat stone embedded in the floor.

The anchors: Two working iron anchors (anchors used onboard) were recovered from the site. One (2.30 m long) has two arms and the remains of a wooden stock attached to the upper part of the shank (Fig. 7). This may suggest that the anchor was in use while lost. The other is a four-armed grapnel (2.50 m long), which was concreted to one of the millstones (Fig. 8). In addition, two groups of two-armed iron anchors (four anchors in each group) were reported by the divers: one group was found among the millstones, and the other was located at some distance south of them. The anchors from these two groups were concreted and attached to each other and were probably not in use as working anchors. Judging by their proximity to the millstones and the lack of other wrecks in the vicinity, these anchors may be attributed with high certainty to the same ship.

Discussion: The distribution of the millstones and the anchors on the sea bottom suggests that they were carried aboard a medium-sized sailing ship, which drifted ashore, probably during a storm, and was wrecked close to the coast. According to Ronen and Olami (1978), the ship size was estimated to be a few hundred tons, and it was dated to the 14th–17th centuries CE. A pair of unused basalt millstones similar to the ones from Atlit was recovered from a Mamluk shipwreck off Megadim dated to the early 15th century CE (see below). Two grapnel anchors made of iron, similar in size and shape to the ones recovered from the Atlit millstones wreck were documented in a 15th-century shipwreck assemblage from Atlit North Bay (Galili and Rosen 2014) and left at sea. The typology of the anchors and the millstones, and the lack of anchor chains, confirm the dating of the ship to the 14th–17th centuries CE when both such millstones and such anchors were in use. The origin of the basalt is yet to be checked. However, in the 11th century CE Cairo Geniza, an export of millstones originating from the Horan via the Israeli coast to Egypt is mentioned in letters of Jewish traders (Prof. S.D. Goitein, personal correspondence 1967; Fig. 9). According to Goitein one of the letters describes an export of 20 such stones imported to Egypt. Thus, the basalt millstones may have been produced in the Horan using local basalt, transported to the Israeli coast by camels (Avitsur 1976:82), and uploaded on a sailing ship on their way to a customer, probably in Egypt, who ordered them.

A Cargo of Unused Donkey (Pompeian Type) Millstones from Herzliya (Survey Map 3, Assemblage No. 8)

In November 1999, the citizen Zvi Hen reported on stone artifacts located on the seabed in the Sharon municipal beach in Herzliya (coordinates 181400/676900) (Fig. 1). An underwater survey conducted by E. Galili on behalf of the IAA uncovered a cargo of donkey millstones (Pompeian, 'hourglass' type) made of basalt. The finds were exposed due to a shortage of sand resulting from the construction of the Herzliya marina, some 1200 m to the south. The findings were mapped and photographed,

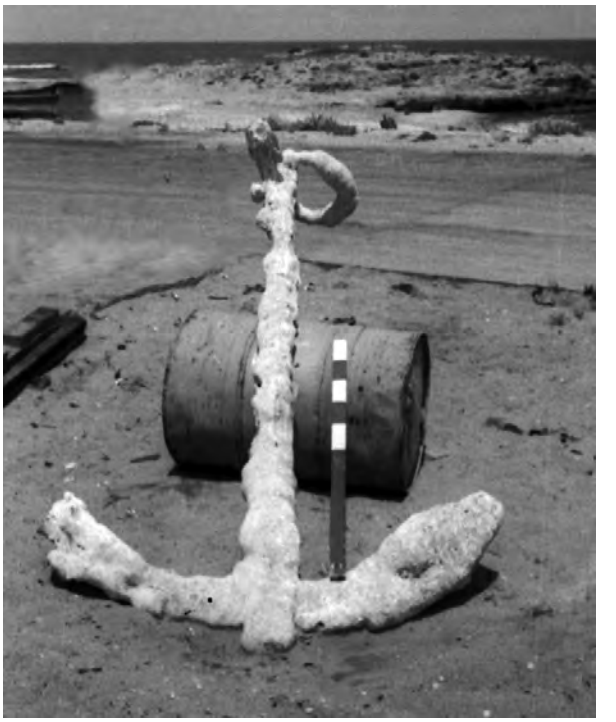

Figure 7: Atlit: A two-armed iron anchor retrieved from the site (UESI).

Figure 8: Atlit: A grapnel iron anchor retrieved from the site (UESI).

UNIVERSITY of PENNSYLVANIA
PHILADELPHIA 4

The Graduate School of
Arts and Sciences
ORIENTAL STUDIES

6 בפברואר 1967

למר אלישע לינדר
קיבוץ מעגן מיכאל
שלום וברכה:

אודה לך מאד, לכשתמסור לי פרטים נוספים על הגילוי של 40 אבני ריחיים בסירה מחתה לקרקע הים ע"י עתליה, שקראתי עליו בהארץ מיום 6 בינואר.

אני חוקר את כתבי הגניזה הקהיריה, ובין סחורות היצוא של א"י במאה האחה עשרה אני מוצא אבני ריחיים חוראניים, ובמכתב אחד נזכרה דוקא הכמות של 20 אבני ריחיים, ואפשר הכוונה לרכב ושכב, כלומר ס"ה 40 אבן. והמהני, אם זאת היתה אולי כמות סטנדרדית. עמנואל בן-דור כותב לי, שהסירה שנמצאה היא מתקופת נפוליאון. זה לא היה משנה הרבה, שהרי ההנאים לא נשתנו. אך אפשר שבידיעה בהארץ הכוונה לסירה אחרת. מכל מקום, אם יש פנאי, נא להודיעני. כידוע לך, אני נמצא במוסד, שמתעניינים בו הרבה בצורה זו של ארכואולוגיה מתחת למים.

בברכת כל טוב,

ש.ד.גויטיין

ענה נא לדירתי הפרטית:

PROF. and MRS.
S. D. GOITEIN
6035 North 12th Street
Philadelphia, Pa. 19141

Figure 9: A letter written by S.D. Goitein to Elisha Linder from the UESI, following the news about the millstone's cargo from Atlit. The Geniza letter mentioned here, written by a Jewish trader, deals with a cargo of millstones sent from the Israeli coast to Egypt.

and the site was surveyed by divers using an underwater metal detector (Galili and Rosen 2007). The site is located c. 300 m south of the Apollonia Castle site, at a depth of 3–4 m and about 100 m offshore. The cargo of millstones was lying on a flat rocky seabed and scattered over an area of about 6 x 6 m, and one upper stone was found at c. 30 m southeast of the main concentration (Figs. 10, 11).

The millstones: Four upper biconical stones and six lower conical stones were clustered together. The lower conical stones (height 0.85 m, diameter 0.80 m, weight 395 kg) have slightly curved sides and a flat-topped conical shape with a shallow depression on the bottom (Fig. 12). The upper biconical ("hourglass" shape) stones (height 0.57 m, diameter 0.60 m, weight 250 kg) feature two square socket protrusions, positioned opposite each other, sometimes with a slight deviation, which lack the characteristic horizontal holes used to stabilize the wooden shaft (For details see Galili and Rosen 2007, table 1; cf. Frankel 2003a:47; for a Roman relief showing this *modus operandi* see Peacock 2013 Fig. 5.7). It is evident that the process of carving the stones was not completed. The absence of holes in the socket protrusions and the coarse roughness in the active parts of the millstones indicate that they had never been used.

Figure 10: Herzliya: Divers documenting the cargo of basalt Pompeian millstones (E. Galili).

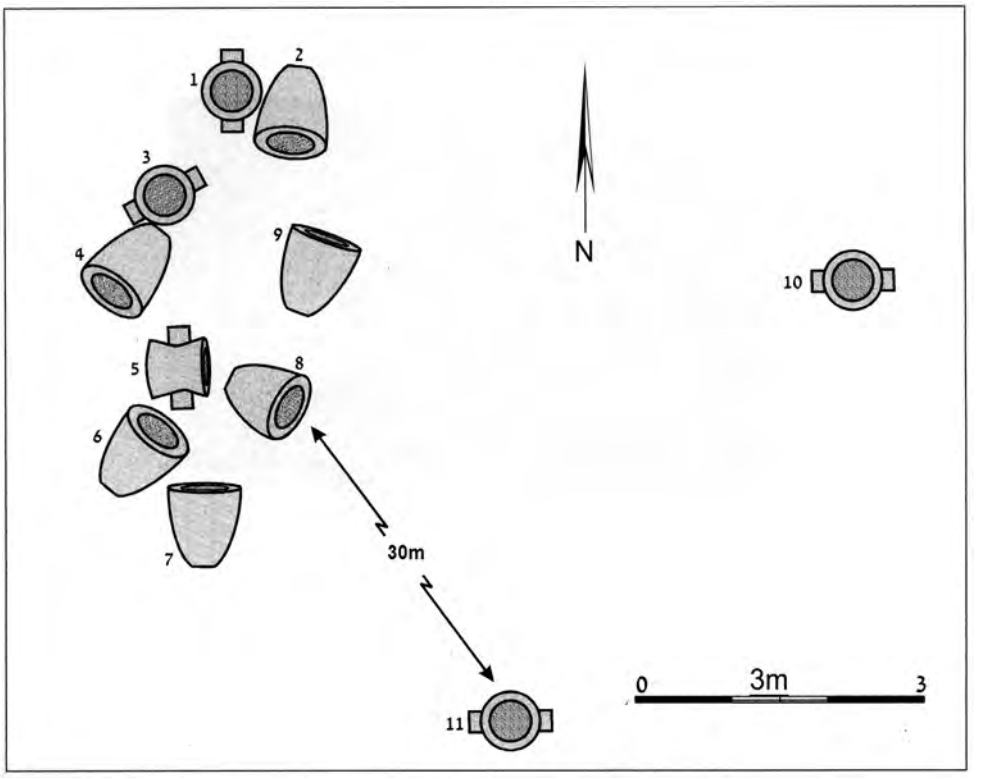

Figure 11: Herzliya: Plan depicting the distribution of the millstones on the sea bottom (E. Galili).

The nails: Among the stones, 13 nails and nail fragments made of bronze were discovered, all having a square cross-section. The nails have a flat head and are bent and deformed to varying degrees because of forces that developed during the wreckage. All the nails can be divided into several groups: A. Size 8–9 cm (three nails); B. Size 0.10–0.11 m (five nails); C. Size 0.125 m (one nail); D. Size 0.16 m (one nail). Additionally, four nail fragments were recovered. The thickness of the nails' shafts at their thickest point beneath the head ranges from 5 to 6 mm.

The anchors: About 20 m southwest of the concentration of millstones, a two-armed iron anchor (2 m long) was discovered, with a rope ring 0.20 m in diameter. The anchor's stock was joined to the shank, suggesting that while lost it was a working anchor. One arm was embedded in the seabed while the other was broken. The base of the anchor points westward, and the rope-tying ring faces toward the shore. Near the millstones, several fragments of pottery vessels with small ear handles, probably cooking pots, were found, possibly belonging to the ship's galley (kitchen). The lower conical stone number 2 and upper biconical stone number 10 were retrieved from the sea and brought to the storage of the IAA (Fig. 12).

Discussion: The nails (most probably originating from the hull of the wrecked ship) and the cargo indicate that a medium-sized merchant ship (c. 20–25 m long) carried the millstones. The origin of the millstone cargo could have been from the northern Israeli coast, Lebanon, Syria, Turkey, or even from a more distant origin. The millstones were probably on their way to the southern coast of Israel or to Egypt. In antiquity, while sailing empty, ships used to carry ballast stones for their stability. Occasionally, sailors would replace these ballast stones with cargo referred to as "paying ballast," i.e., ballast that could be later sold. It is likely that the ship carried wheat from Egypt northwards. After unloading it, the sailors probably uploaded millstones quarried in the northern territories (where there are basalt stone sources near the coast) as paying ballast, on their voyage back to Egypt. Based on the square-sectioned nails, which were common during the Roman and the Byzantine periods (Galili, Rosen and Sharvit 2010), and the millstones type (see Fig. 27 in the discussion below), the ship can be dated to the 1st–5th centuries CE or later.

A Cargo of Basalt Water Millstones from a Mamluk Shipwreck off Megadim (Survey Map 7, Assemblage No. 15)

In 1964 one of the authors (E. Galili) discovered a concentration of bronze artifacts off the Megadim coast. The initial finds included a few scores of coins and a basalt millstone. The site was covered by sand soon after exposure. Almost twenty years later, in 1983 the site was re-exposed following a strong storm. Salvage excavations by the IAA recovered and documented two shipwreck assemblages, dating to the Hellenistic and the Mamluk periods. During the following years, the site was exposed several times and vast numbers of artifacts were recovered from these two wrecks.

The site is located c. 2 km north of Atlit (coordinates 195160/737170) (Fig. 1). The coastline in the wreckage area is sandy and straight with no shelter for seagoing vessels. The Mamluk shipwreck assemblage was scattered over an area measuring c. 75 × 50 m, some 50–125 m offshore. The artifacts rested on top of the clay seabed at water depths

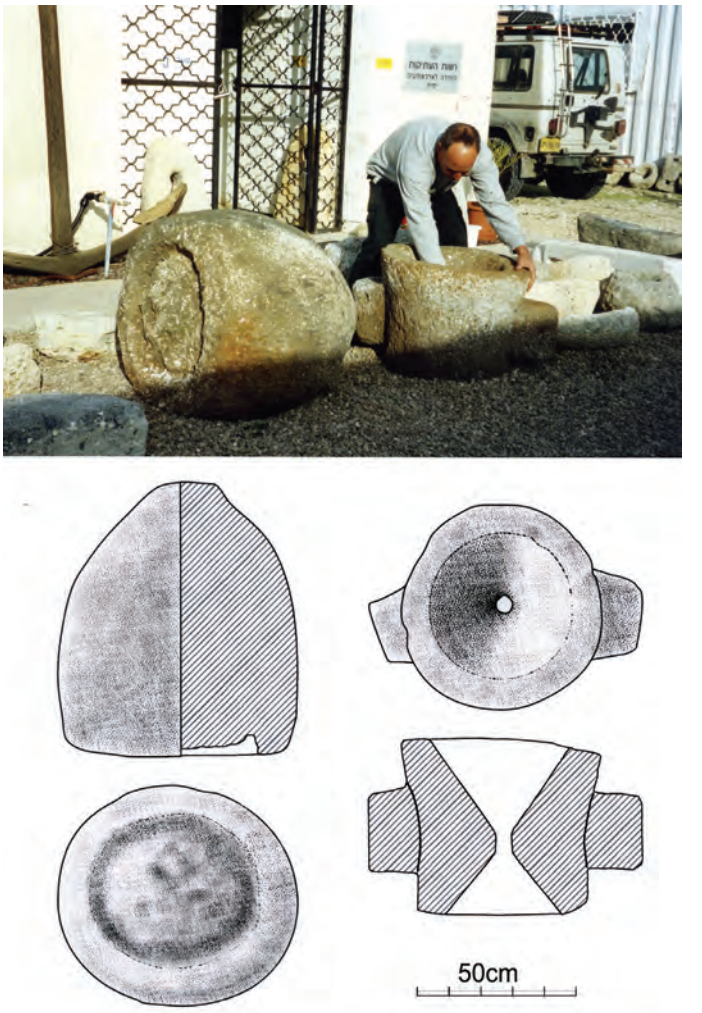

Figure 12. Herzliya: A pair of upper (number 10 in Figure 11) and lower (number 2) millstones retrieved from the site: top – photo (E. Galili), bottom – drawing (IAA).

of 2.5–4.0 m. Although the finds were scattered throughout the site, one major artifact concentration was found in the south sector of the concentration of artifacts.

The finds: Most of the heavy cargo, including two basalt millstones was concentrated in a relatively small area (c. 15 x 25 m) designating the location of the wreckage (Misch-Brandl, Galili and Wachsmann 1985; Raban and Galili 1985; Galili 2021). Ten masses of iron objects weighing several hundred kg each contained various items, mainly nails, hinges, tools, and hardware. Dozens of bronze items bearing incised inscriptions and decorations, including mortars and pestles, fittings for doors and wooden boxes, candle holders, candlesticks, and lamps, presumably originating from a mosque, were also found. Hundreds of thousands of bronze coins, with a total weight of few hundred kg, were found concreted together in lumps that were contained in woven baskets made from palm leaflets.

The basalt millstones: Two upper water millstones (Fig. 13), each weighing ca. 300 kg were recovered from the southwest corner of the main concentration. They showed no signs of being used. The stones were retrieved and transferred to IAA facilities.

Discussion: Such large stones are not intended to be used onboard. Given their massive size and weight, and lack of use signs, they were most probably carried onboard as trading goods or paying ballast. The size of the ship may be estimated by the discovered cargo (c. 10 tons), suggesting that it was a medium-sized vessel. However, it could have also carried perishable cargo (i.e., fruits, grains, cotton or livestock) which vanished, as well as additional cargo that was salvaged soon after the wreckage. Most probably the metal findings were intended primarily for recycling.

The coins were all minted along the Syrian coast, most of them in the Tripoli mint. The latest coin was minted in 1404/1405, during the reign of Sultan al-Nasir Faraj ibn Barquq (Ariel Berman, personal communication). Consequently, the

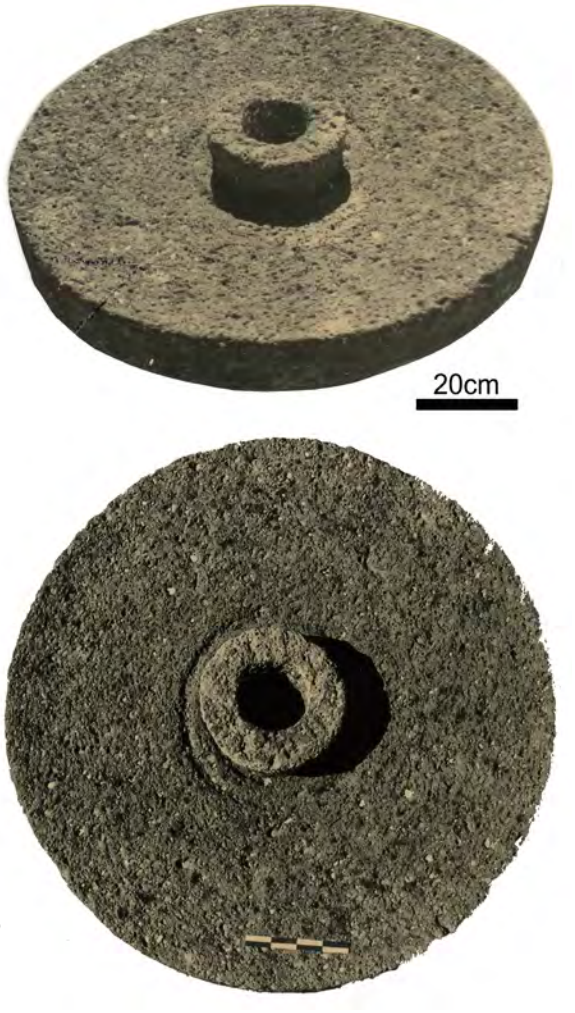

Figure 13: Megadim: A water millstone retrieved from a Mamluk shipwreck (IAA).

ship was wrecked shortly after this date, at the beginning of the 15th century CE. The assemblage originated in north Syria and was probably shipped from Tripoli southwards off the Levantine coast. Possibly the ship was on its way to Alexandria, Egypt when the wreckage occurred.

A Pair of Basalt Donkey Millstones from Shikmona (Tel es-Samak/Porphyreon) (Survey Map 7, Assemblage No. 182)

In 1967 an underwater survey headed by J. Galili on behalf of the UESI was carried out off Shikmona, before the construction of the Oceanographic Institute (Fig. 1).[4] A basalt millstone was documented on the sea bottom (Figs. 14, 15a, hence millstone a). A few years later, another broken similar millstone was recovered closer to the coast at a depth of 1 m (Fig. 15b, hence millstone b). The site (coordinates 196350/748074) is an open, shallow rocky bay located a few hundred meters north of Tel Shikmona, called Saba'at by the local fishermen. The Upper Carmel Nose off Tel Shikmona is a shallow stone plateau. The sea conditions in the area are unfavorable for navigation and there is no natural shelter for ships (Galili and Sharvit 1999a; Galili and Sivan in press).

The finds: The upper bi-conical basalt part of the Pompeian millstone (0.53 m high and 0.50 m in diameter) was at 3.5 m water depth, some 120 m from the coast northwest of the tell. During 1975 the two millstones were retrieved from the sea

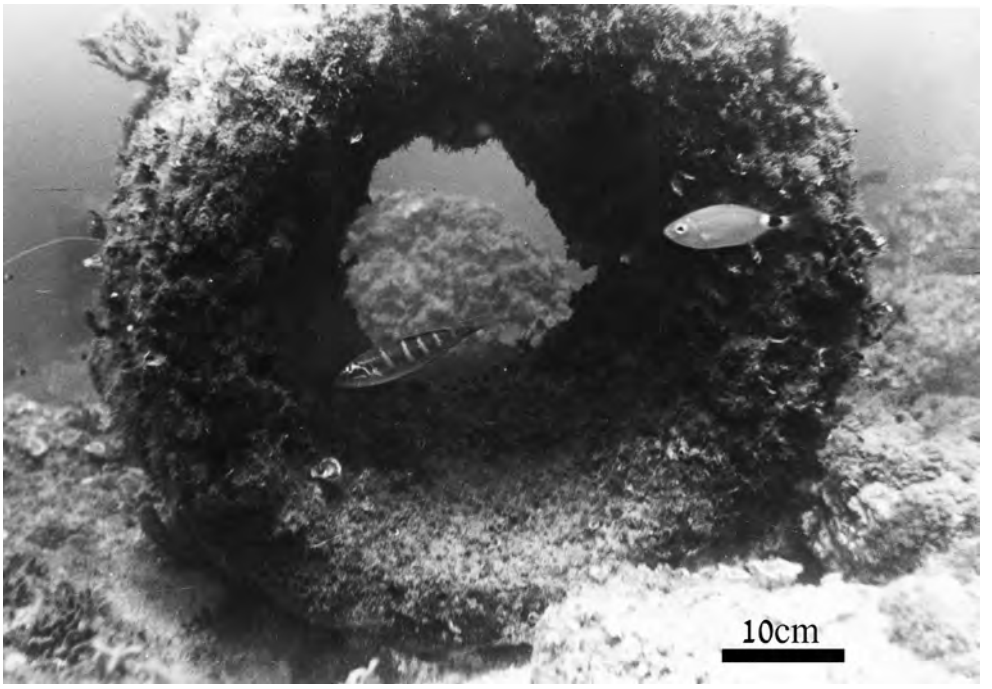

Figure 14: Shikmona: A Pompeian (donkey) millstone as found on the sea bottom (J. Galili).

4 It is agreeable today among scholars that the site is not to be identified with Jewish Shikmona but rather with the Byzantine Christian town of Porphyreon (south) during the Classical periods (Eisenberg 2023).

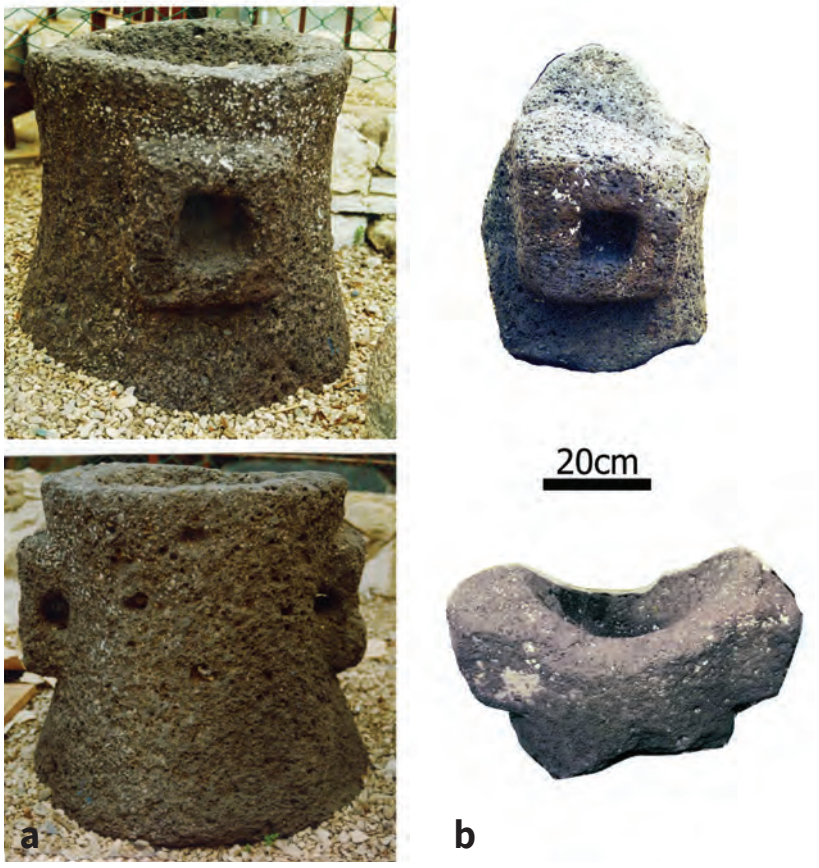

Figure 15: Shikmona: The two upper donkey millstones (E. Galili).

and transferred to the municipal archaeological Museum of Haifa. The broken basalt millstone b, originally of identical dimensions (Galili and Sivan in press) was recovered east of the location of millstone a.

Discussion: These two millstones probably originated from a Roman/Byzantine ship that drifted ashore and wrecked. They were probably carried on board as cargo. Given that the sea bottom in the site is rocky, the cargo and the heavy objects on board were not covered by sand during the wreckage and post-deposition. It thus seems that the rest of the cargo was salvaged in antiquity. Another possibility is that the millstones were jettisoned from a grounded ship, or were used as improvised stone anchors by a distressed ship.

Two Basalt Grinding Basins from Neve Yam (Survey Map 7, Assemblage No. 39)

The Neve Yam anchorage is located some 12 km south of Haifa (Fig. 1). The natural anchorage is a basin open to the southwest and protected from the north by a rocky headland and from the west by a small island and a submerged *kurkar* ridge. Underwater surveys at the site have been conducted by the University of Haifa and the IAA since the early 1980s. Shipwreck assemblages dating from the Early Bronze Age onwards have been retrieved (Galili and Sharvit 1999b; Galili, Gale and Rosen

2011:68–69). Among them are Late Bronze Age concentrations of copper ingots, bronze artifacts, and hematite weights (Galili et al. 2024).

The finds: In 1983 a concentration of 15 one-holed triangular stone anchors was recovered some 150 m offshore, at 3–4 m depth (coordinates 193469/731086) (Galili 1985; Galili, Sharvit and Artzy 1994; Galili and Sharvit 1999b). The anchors are made of limestone and were identified as being of the Byblos type, which is considered a cultural marker of the Middle Bronze Age. In addition, an unfinished flat bowl (preform) (0.30 m in diameter, 5 cm high) and a square-sectioned pestle (0.25 m long, 5 x 5 cm in section), both made of granite stone were recovered, as well as two flat, rectangular grinding basins made of basalt (0.53 x 0.42 m x 8 cm, and 0.50 x 0.34 m x 8 cm) (Fig. 16). Similar basins made of black material (possibly basalt) were found in the cabins of models of Egyptian kitchen tender boats recovered from the tomb of Meket-re, dated to the Middle Kingdom, and are displayed in the Metropolitan Museum (Winlock 1955 Fig. 65, depicting equipment of the Brewery and Bakery G, item no. 4; Fig. 77, center right, figure depicting food supply storage and cooks at work on tender boats R and S).

Discussion: The distribution of the stone anchors, the two basins and the granite artifacts on the sea bottom suggests that they originated from the same ship, which was caught by a storm and wrecked in the surf zone. Judging by the Byblos-type anchors and the parallels from the tomb of Meket-re, the assemblage can be dated to the Middle Bronze Age II (19th–18th centuries BCE). The basins may have been used for grinding cereal and preparing food onboard, or as cargo.

Figure 16: Neve Yam: Two basalt grinding basins – a: tops; b: bottoms (E. Galili).

An Olynthus Basalt Millstone from Yavneh-Yam Anchorage (Survey Map 2, Assemblage No. 4)

During an underwater survey carried out by the IAA in Yavneh-Yam anchorage, a rectangular upper millstone of the Olynthus type was recovered (Galili and Sharvit 2005). The stone was retrieved from area A of the anchorage, at a depth of 5 m, 150 m offshore (Fig. 1). The Yavneh-Yam anchorage (coordinates 171220/648130) is the only natural partly sheltered site on the southern coast of Israel, between Jaffa and Tel Ridan, in the southern Gaza strip. The western part of the anchorage is bound by a row of *kurkar* islets stretching between two rocky capes parallel to the shoreline. On the lee side of the *kurkar* islets is a relatively protected area (1 to 7 m deep) of about 60 dunams.

The Olynthus millstone: The stone is box-shaped (0.34 x 0.47 m; weight 43 kg), with a trapezoid depression on the top and an elongated hole along the middle of the depression (Fig. 17). Two depressions appear on the narrow sides of the object, containing remains of iron nails, used to attach a wooden handle to move the upper stone over a lower one (Frankel 2003b Fig. 6). The object was in an excellent state of preservation. On the bottom (the working side of the stone) were a number of straight, parallel grooves showing no signs of wear. Similar upper stones were discovered in a shipwrecked Hellenistic period merchant vessel from Kyrenia in Cyprus, dated to the 3rd century BCE (Katzev 1969), and in a Hellenistic shipwreck discovered in southern Turkey (Pulak 1987). Upper stones of this type have been found in various areas of the eastern Mediterranean (Frankel 2003b; cf. also Peacock 2013 Fig. 3.4). The millstone from Yavneh Yam probably belongs to a Hellenistic assemblage of artifacts recovered from the anchorage (assemblage 4) which originated from a shipwreck (Galili and Sharvit 2005).

Concentrations of Donkey Millstones (Pompeian Type) from the Coast of Ashkelon (Survey Map 1, Assemblages Number 7, 8)

Underwater surveys conducted by the IAA off Tel Ashkelon (Fig. 1) in 1999, revealed dozens of millstones, perforated stone weights of olive oil presses and a round stone wheel for crushing olives or grapes (Galili and Rosen 2012). The 800 m long seafront of Tel Ashkelon was supported by a seawall reinforced by reused granite columns. Most of the wall, which was built during the Early Islamic period and renovated during the Crusader period, has been eroded by the sea and parts of it are currently in the shallow waters opposite the tell. During the 20th century the construction of marine structures south and north of Tel Ashkelon resulted in a shortage of sand and consequently, changes in the coast configuration. The sandy beach generally loses tens of meters of its width, the waves reach the edges of the tell, especially during winter storms, and outcrops of beachrock and *kurkar* are exposed on the seabed and on the coast. Ancient remains, including the millstones and olive press weights, were intermittently discovered on the exposed bedrock. *The finds*: The underwater archaeological remains in Ashkelon can be divided into three main types: A) Architectural elements, granite columns, and remains originating from the seawall and archaeological deposits of the tell that collapsed due to marine

erosion. These were discovered at a depth of 0.5–1.5 m, 1–40 m offshore; B) Remains of ships and cargos were recovered at a depth of 3–5 m, about 50–150 m offshore; C) Concentrations of various types of anchors were found on or adjacent to underwater rock protrusions, at a depth of 6–12 m, 200–300 m offshore. These anchors were lost by ships that anchored at a safe distance from the shore, using the submerged rocks as anchor holds, in the absence of a protected harbor. The millstones recovered on the shallow seabed opposite Tel Ashkelon belong to category A.

The millstones and olive press stone weights were found in three concentrations stretching over 350 m opposite the tell, in shallow water close to the coast. Because of the similarity in their pattern and nature of distribution, these finds are described as a single group. The northern concentration (coordinates 156789/619195): West of the beach restaurant and south of it, eight upper, basalt donkey millstones (Pompeian type) were recovered. Additional finds included granite columns that fell from the city wall as well as various architectural elements and a headless anthropomorphic granite statue of natural size made in an archaic style. Of interest is a round, whole, crudely worked

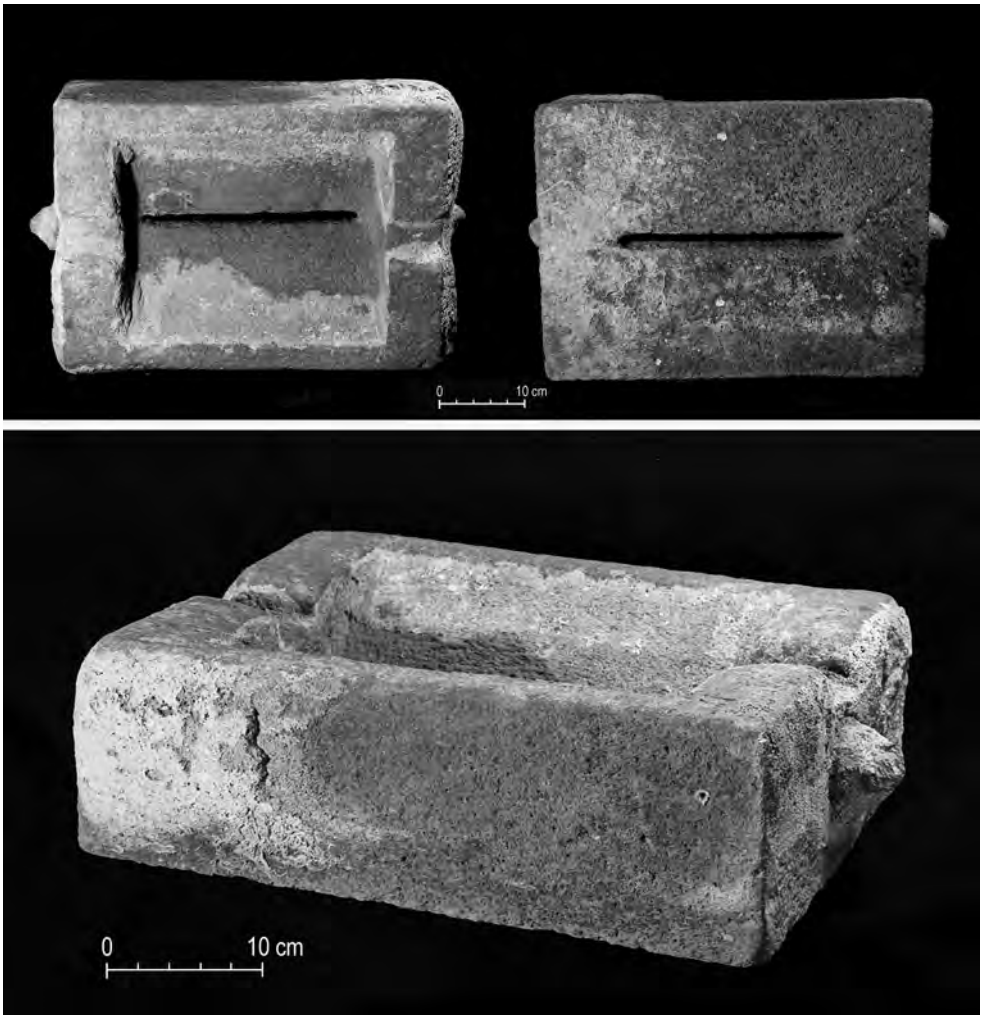

Figure 17: Yavneh Yam: The Olynthus millstone (IAA).

stone (possibly an unfinished crushing wheel) (1.20 m in diameter, 0.30 m thick) made of sandstone, with a round hole in its center (diameter 0.12 m) (Fig. 18). The central concentration (located between the two others): Six upper, basalt donkey millstones were recovered, as well as four limestone weights for olive oil presses (weighing about 300 kg each), decorated marble capitals, and parts of marble statues and granite columns. The southern concentration (coordinates 156646/618993): Ten upper, basalt donkey millstones, granite columns and architectural elements, decorated marble capitals, and fragments of marble statues, were discovered at the southern part of the tell, opposite the surviving relicts of the seawall (known as the Column Wall). Altogether 24 upper donkey millstones made of basalt were documented in the three concentrations (Figs. 19, 20). Five millstones were retrieved from the central concentration (numbers 11, 12, 13) and two from the northern concentration (numbers 1, 4).

In all the donkey millstones the upper and lower inside working cone surfaces were worn and occasionally broken. All of them had square holes in both sockets for attaching the wooden shaft used to rotate the stone (cf. Frankel 2003a:47). It seems that after one inside cone of the upper stone was worn, the stone was turned over and the other cone was used until it was worn and could no longer be used. A similar practice was identified in a millstone recovered in Ḥorbat Migdal, Tsur Natan (Etan Ayalon, personal communication). This indicates that they were in use for a long time and presumably went out of use due to wear. The diameter of the millstones ranges

Figure 18: Ashkelon: Whole crushing wheel made of *kurkar* stone (E. Galili).

from 0.65 to 0.90 m, their height is 0.55–0.70 m, and their original weight is estimated at about 300 kg each. In two of the millstones, the bottom part of the internal cavity was sealed with grey mortar containing remnants of charcoal and fragments of shells (e.g., Fig. 20 no. 13) (For details see Galili and Rosen 2012, table 1). It seems that the cavity was intentionally filled to increase the weight of the millstones that had fallen out of use. These stones were intended to be used as weights (see discussion below).

Discussion: The maritime nature of Ashkelon is attested by the city's location on the coastline. The imported artifacts found during excavations in the tell and the historical sources suggest that extensive maritime activity took place there and may indicate the existence of a harbor. However, underwater and coastal surveys conducted so far revealed no remains of a built harbor in Ashkelon. The historical sources do not definitively indicate its presence, and some even ruled out its existence (For details see Galili and Sharvit 1994; Sharvit and Galili 1998; Galili, Sharvit and Dahari 2001; Galili and Rosen 2012; Galili et al. 2021a and references therein). The morphology of the shallow continental shelf, the physical conditions of the coast, and the underwater archaeological findings discovered in Ashkelon suggest that the city did not have a real constructed harbor in ancient times. It appears that ships arriving there anchored hundreds of meters offshore, utilizing underwater *kurkar* outcross as anchor holds. The transportation of passengers and goods between the ships and the shore must have been carried out by lighters. A thorough examination of the millstones has raised several finds: 1) All were worn and broken due to extensive use, and must have been out of service; 2) Not a single conical base that could be attributed to the upper millstones was found; 3) The millstones, olive press weights and crushing wheel were discovered in shallow water (1 to 1.5 m depth), close to the coast. Observations on shipwrecks along the Israeli coast in general, and in Ashkelon in particular, indicate that heavy objects are typically found

Figure 19: Ashkelon: Pompeian millstones and oil press weights while being retrieved from the sea (IAA).

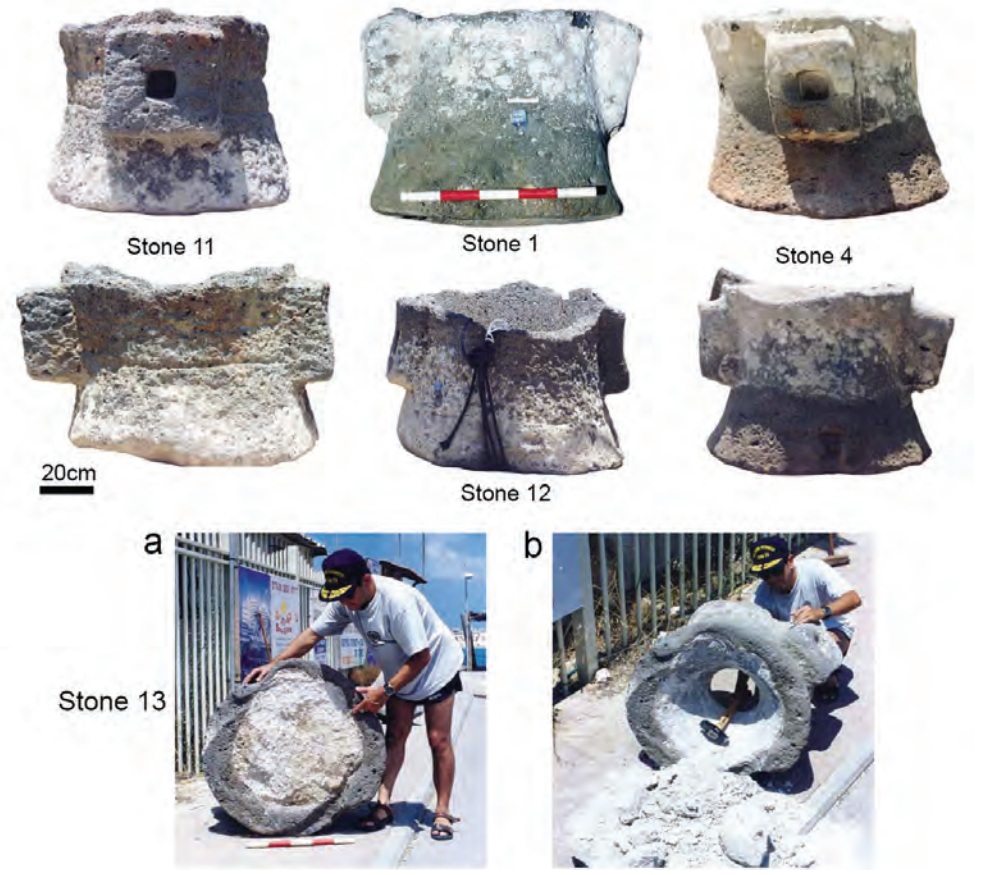

Figure 20: Ashkelon: Some upper Pompeian millstones (IAA).

at depths of 2.5 to 4 m (Galili, Weinstein-Evron and Ronen 1988:36–42). The shallow area where the stones were discovered rules out the possibility of their origin from an ancient ship's cargo; 4) It is unlikely that such heavy millstones, which are out of service, would be loaded onto a ship for transport due to their low economic value; 5) One should not assume that these stones were used as ballast stones on vessels. They are too heavy, and significant effort would have been needed to load them onto a ship. Studies involving ancient shipwrecks have shown that ballast typically consists of stones that are easy to transport by hand, usually weighing up to 30 kg (e.g., Shimron and Avigad 2003:154); 6) The distribution of the stones in shallow waters, in a narrow and long strip of c. 350 m is atypical for the cargo of a shipwrecked vessel near the shore; 7) Two of the millstones were filled with mortar, suggesting that they were no longer usable as such.

Cargoes of similar millstones, originating from a shipwreck near the coast, were discovered at the Herzliya beaches (Galili and Rosen 2007; see above). However, the characteristics of the cargo from the Herzliya shipwreck are entirely different from those of the findings in Ashkelon: in Herzliya, upper and lower millstones were found; they were completely new and had not been used; they were concentrated in one location over a limited area, marking the site of the ship's sinking; they were found at a depth of 3 to 4 m, which corresponds to the depth at which heavy cargoes of shipwrecked vessels are

generally found along the Israeli shores. All this indicates that the origin of the discussed millstones and the stone weights in Ashkelon is not from a shipwreck. The possibility that they originated from Roman structures in the tell which collapsed seems unlikely, since lower conical millstones were not found, and all those that were found were unusable. It appears therefore that the millstones and the stone weights were brought for secondary use on the ancient beach after they had fallen out of service. It should be noted that the stone weights showed no signs of wear, thus it is not clear why they went out of use.

A description in the Jerusalem Talmud (Shabbat 4: 2, 7, 1) which refers to the term "Nadiraia of Ashkelon," may hint at the use of the millstones and olive press weights. According to Sperber (1986:77–80; 1993:163–168), these were boats that were grounded ashore to facilitate loading and unloading. Sperber suggested that the port of Ashkelon must have had boathouses, equipped with stone slips onto which sea-going ships were dragged halfway out of the water. According to Casson (1971:363–364), such slipways were usually partially cut in the rock and partially constructed. However, no such rock-cut facilities have been discovered in Ashkelon.

It is possible that in Ashkelon mobile slipways were used to haul watercraft. The various millstones and the heavy stone weights were brought to the shore for anchoring such mobile slipways. The term "Nadiraia of Ashkelon" may refer to the boats that were hauled ashore, as suggested by Sperber, or to these mobile slipways and dragging devices (capstans) that were used to haul ships out of the sea. However, it appears that these devices were not cut into bedrock. Since the coastline in Ashkelon is sandy and subjected to seasonal changes, it would have been impractical to build permanent slipways and lifting facilities. Rather, the physical conditions necessitated the use of portable wooden winches and sliding surfaces. These devices were anchored using perforated stones that were buried in the coastal sands (known as "dead anchors" in nautical terms) (Fig. 21). Similar wooden devices were in use in the region until the British Mandate period (Hornell 1935:103, Fig. 12), and they are still being used in various Mediterranean locations today, e.g., Anfushy bay, Alexandria (Galili and Rosen 2012). It seems that the area where the millstones and olive press weights were discovered was once a sandy beach. Over the years, a layer of sand 2–3 m thick has eroded, and the shoreline has retreated tens of meters inland, lowering the beach profile. The erosion led to the exposure and discovery of millstones and weights on the shallow seabed. They were most probably brought to the shoreline to anchor mobile wooden winches and slipways. These installations could have been used in favorable sea conditions for hauling boats and small ships ashore for repairs, possibly during the Roman or Byzantine periods, when a vibrant economic activity took place in Ashkelon.

A Pair of Millstones from Ashkelon North (Coordinates 158936/622600; Survey Map 1, Assemblage No. 549)

Two flat, round millstones made of basalt were recovered (Fig. 22). They are whole (0.6 m in diameter, 5 cm thick), both having a round hole ("eye"; 5 cm in diameter) at their center. One of the stones (the upper of the pair) has a cylindrical protrusion (0.10 m in diameter, 5 cm high, having 9 cm funnel at the top) on its upper surface, while the other (the lower

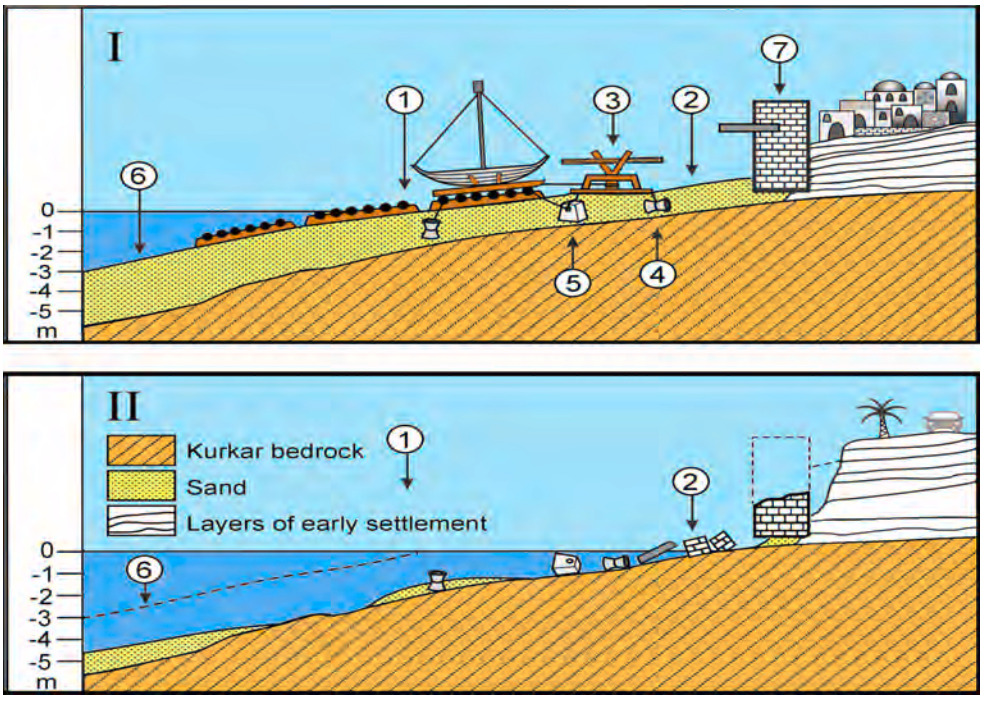

Figure 21: Schematic cross section of the coast opposite Tel Ashkelon: I – in ancient times, when the coast was sandy and wide; II – today, the narrow, rocky coast after erosion. The sections demonstrate the proposed reconstruction of a movable slipway, anchored with secondary-used millstones and stone weights: 1. Location of the coastline in ancient times, before the coastal erosion; 2. Recent location of the coastline and remains of the city wall which has collapsed due to coastal erosion, with stone weights and millstones used for anchoring hauling devices exposed in the shallow water; 3. Capstan for hauling the boats; 4, 5. Perforated stones (secondary-used millstones and olive press weights) buried in the coastal sand to anchor the capstan and the wooden movable slipway sections; 6. The level of the sand before the coastal erosion; 7. The seaside city wall, before the coastal erosion (E. Galili).

one) is flat. Other finds recovered in this area include two lead braziers for cooking and heating water onboard and a lead assembly piece of a wooden anchor, which are associated with a Roman-period shipwreck assemblage. The millstones may have also originated from this wreck. It should be noted that these stones are much smaller than usual water millstones (though probably too large to be operated by hand) and perhaps were planned to serve in a small water mill (see Avitsur 1960:8, Figs. 84–85 [depicting small ancient watermill stones, diameter 0.55–0.60 m]; 1976:80–81, Fig. 222:1–2).

An Upper Donkey Millstone from Tel Koness (Kfar Galim) (Coordinates 195680/741199) (Survey Map 7, Assemblage No. 10)

A small, broken upper donkey millstone (0.50 m long) was documented c. 80 m northwest of Tel Koness, at 3 m water depth (Fig. 1). The millstone may have originated from a Byzantine shipwreck located there. Additional finds associated with this shipwreck include a two-armed iron anchor and a round concaved lid made of bronze (0.50 m in diameter), with some wheat grains attached to it.

Figure 22: Ashkelon North: A pair of round (water?) millstones (E. Galili).

A lower Rectangular Grinding Stone from Naḥal Bet HaEmek Outlet (Shavei Zion) (Coordinates 207598/765602) (Survey Map 9, Assemblage No. 42)

An underwater survey conducted by the IAA off Shavei Zion yielded a rectangular, whole lower grinding stone of the Olynthus type (0.50 x 0.70 x 0.10 m) made of basalt at 5 m depth. The flat top of the stone is covered by parallel groves. The site is a small anchorage protected from the north winds, located at the outlet of Naḥal Bet HaEmek. Additional finds recovered there include pottery figurines of the goddess Tanit and broken pottery vessels dated to the Persian period. The context of the grinding stone is unclear.

MILLSTONE FINDS REPORTED BY CITIZEN DIVERS

A cargo of Water Millstones from Michmoret (Coordinates 184100/686000) (Survey Map 4, Assemblage No. 1)

During May 2005 a cargo of 22 millstones was reported by the diver Yosi Eilon, a few hundred meters north of Michmoret (Fig. 1). The millstones site is some 60 m offshore, at a water depth of 2.5–3 m. Most of the stones were concentrated in one pile, and others were dispersed around it over an area of c. 10 x 10 m. They were lying on a rock which is covered by sand most of the year and are rarely exposed for short periods. The stones were made of basalt and similar in size and shape. Their diameter was 1.20 m, and they all have a cylindrical protrusion on their upper side (c. 0.25 m in diameter, 0.17 m high) and a central hole. They were all identified as upper millstones of a water mill. No other finds associated with the ship that carried them were identified in the site, so they cannot be dated.

A Cargo of Water Millstones off Akko (Coordinates 184100/686000) (Survey Map 9, Assemblage No. 15)

During 1993 a cargo of 15–20 millstones was reported by the diver Nimrod Almog. They were observed on a rocky sea bottom at 10 m depth, some 400 m west of Akko lighthouse (Fig. 1). They are usually covered by sand and only rarely exposed. The millstones are round (c. 1.10 m in diameter, which means that they were probably intended for use in a water mill) and are probably made of basalt. They cannot be dated.

Two Water Millstones Offshore Caesarea Maritima (Coordinates 187024/714408) (Survey Map 6, Assemblage No. 70)

Tow round millstones (diameter 0.60–0.70 m, thickness 0.20 m) were located by the fisherman diver Adam Kotzer at 24 m depth northwest of the Roman harbor, adjacent to the western fringes of a submerged *kurkar* rock (Fig. 1). The millstones were attached, suggesting that they were originally tied together with a rope which vanished. They were most probably used as emergency weight anchors when the ship was dragged landwards during a storm, in an attempt to avoid the dangerous coast. The stones were dragged on the sandy seabed until they reached the rock, where they were stopped, holding the boat, but later the rope tore and they were lost at sea. It should be noted that these stones are also much smaller than usual (see Ashkelon North above).

A Lower Donkey Millstone from Tel Nami Anchorage (Coordinates 193378/729418) (Survey Map 7, Assemblage No. 215)

A small (0.40 m in diameter) lower donkey millstone was identified and documented by the diver Shlomi Katzin in 2 m depth and was left at sea (Fig. 23). The site is a small

Figure 23: Tel Nami: A lower basalt donkey millstone (S. Katzin).

shallow bay located southeast of Tel Nami. A few small (30–50 kg) one holed stone anchors were documented there, as well as broken pottery vessels, *kurkar* ashlar stones, and un-local ballast stones.

A Lower Donkey Millstone from Atlit North Bay Anchorage (Coordinates 194538/734815) (Survey Map 7, Assemblage No. 175)

A whole lower conical donkey millstone (0.35 m in diameter) was found at a water depth of 3 m (for small Pompeian mills see Peacock 2013:92–93; for smaller upper parts from Tel Dover see Frankel 2019: 261, Fig. 19) (Fig. 1). The stone was retrieved by the diver Dubi Dvir and handed to the IAA marine branch. The north bay of Atlit is rich with assemblages of shipwrecks. The basalt millstone may belong to a Hellenistic concentration of artifacts recovered in an area of c. 30 x 50 m, including a bronze battering ram, a hoard of bronze Ptolemaic coins, and a basalt bowl. The coins suggest that the shipwreck could be dated to the end of the 2nd century BCE.

MILLSTONES QUARRIES

Millstone Quarries on the Northern Akko Coast (Survey Map 9, Assemblages Number 26, 27)

During the 1995 coastal survey of the IAA, two quarries of round stones were identified and documented on the rocky intertidal zone of the northern coast of Akko (Galili and Sharvit 2001 and Table 1 therein) (Fig. 1). Circular channels (0.2 m deep, 0.13 m wide) were cut in the rock to enable the extraction of the stones. The round depressions left behind and some stones which broke during the extraction and were left in the quarry indicate that the quarried stones' diameter was c. 0.8–1.0 m and they were c. 0.20–0.25 m thick.

The finds: Two separate quarries were documented: 1) The northern one (coordinates 207042/759996) is 70 m long and 20 m wide and extends on a north-south line, parallel to the coastline at 0.3 m above Israel Mean Sea Level (hence MSL) to 0.27 m below Israel MSL (Figs. 24–26). It is divided by an east-west-oriented modern sewage pipe. Circular depressions cut in the beachrock—negatives of millstones detached from the rock—and some "positive" stones broken and left *in situ*, were documented. Thirty-six circular incisions (1.2–1.4 m in diameter, 0.2 m deep) were observed. These included 23 "imprints", among them 13 millstones left *in situ*. Some are whole while others were probably broken during the extraction. 2) In the southern quarry (coordinates 207032/759877) eight round depressions were documented at an elevation of 0.3 to 1 m above sea level. Fragments of pottery shards dated to the Persian period (N. Getzov, personal communication 2015; Antonioli et al. 2017) were embedded in the beachrock. The pottery may suggest that the beachrock was consolidated after ca. 400 BCE, suggesting that the stones were quarried at a later period, which fits the appearance date of these millstones in or after the Roman period (Frankel 2019:263; Alonso and Frankel 2017:475–476).

Discussion: The extracting of the stones was carried out by cutting a channel around the stone, then hammering iron splits into the channel, to build lateral pressure which detached the stone from the bedrock (Safrai and Sasson 2001; Galili and Sharvit 2001 and references therein; see also Peacock 2013 Fig. 8.9 for

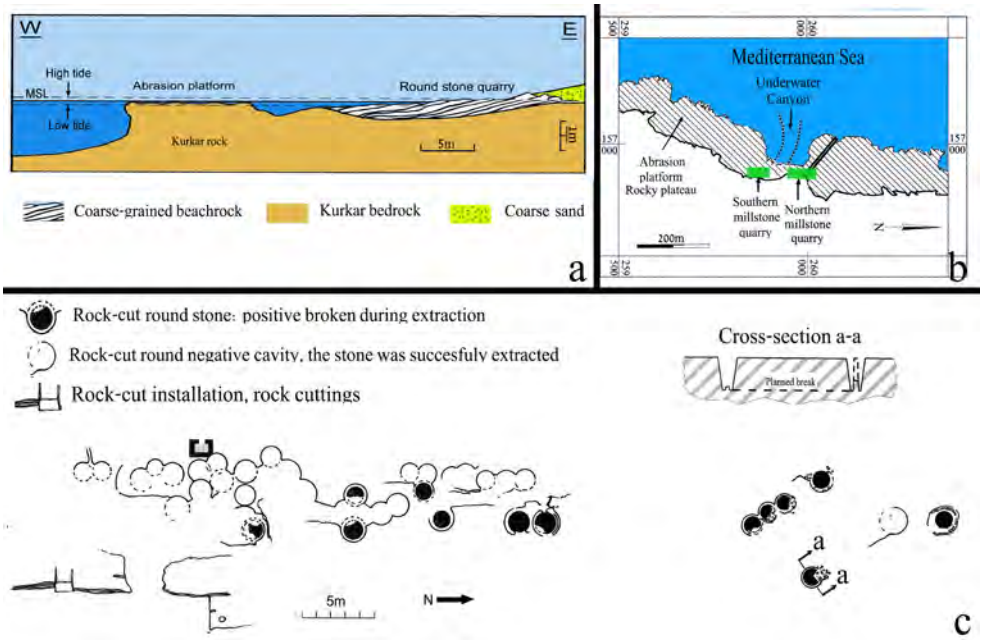

Figure 24: Akko: Two coastal quarries of round stones: a) Schematic cross-section of the northern quarry; b) Location of the two quarries (E. Galili); c) Plan depicting the distribution of the cut depressions in the northern quarry and the broken stones left in situ (IAA).

Figure 25: Akko: The northern coastal quarry of round stones, view to the north (E. Galili).

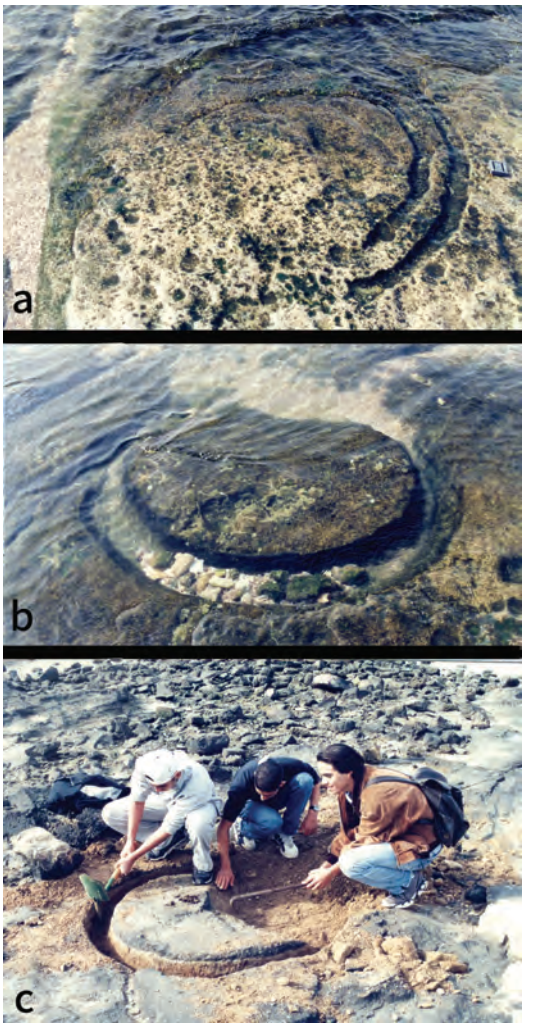

Figure 26: Close-up look on round depressions in the northern quarry: a, b – cut channels used for detaching the stones from the bedrock; c – a stone that has been broken during the quarrying and thus left *in situ* (E. Galili).

such practice in inland quarry in Switzerland). The practice of using wooden splits and water in ancient quarries suggested by scholars (e.g., Durkin and Lister 1983) has never been proved (Dworakowska 1987). Choosing the type of stone and the sites of the quarries is of interest. The beachrock in the two quarries is hard and composed of course sand (mainly broken shells) and some fine quartz grains, cemented by carbonate. The stones were probably used as millstones intended for grinding. The coarse and relatively hard stone could have been chosen as a local substitute for the preferred basalt stone, which was commonly used for grinding cereal grains. Beachrock was used in ancient Israel for various purposes, including grinding and building (e.g., Avitsur 1957; Neri 1994; Nol 2021). The reason for this was probably because the basalt sources were distant from the coastal communities and the beachrock was available and accessible and easier to get. However, the possibility that the round stones were used for other purposes (e.g., for closing burial cave openings) cannot be ruled out. The two quarries are located adjacent to a relatively deep underwater canyon, in a place where the abrasion platform is very narrow (Fig. 24 above). Thus, the access of ships/boats to the quarries was good. This suggests that the quarrying sites were chosen so that the stones could be transported by sea to coastal destinations or by camels or oxcarts to local mills.

DISCUSSION

Site Formation and Post-Deposition Processes

The coast of Israel is generally un-indented and lacks natural shelters; it is mostly sandy and slightly graded. Over the millennia storms drove ships ashore, where

they were wrecked in the breakers zone. Ancient Shipwrecks and cargoes are usually scattered on the shallow sea bottom at depths of 2–4 m (Galili, Oron and Cvikel 2018). A collection of objects from a specific period, concentrated in a limited area on the seabed, is usually an indication of a shipwreck site. Few wooden hulls of ships have survived in some naturally protected anchorages such as the northern Caesarea Maritima anchorage, Maagan Michael, Dor southern bay and Akko Bay.

Analysis of the composition of scores of wrecks along the Israeli coast has demonstrated that the products of a shipwreck in the surf zone were generally separated into three main classes by the sea acting on the wreck: 1) People and livestock drifted away from the wreck or were washed ashore. Light cargoes, as well as wooden parts and objects firmly attached to them, were also washed ashore; 2) Heavy metallic or stone objects sank into the sediment during the storm or soon thereafter, accumulating on the clay (or stone) substratum under the sand; 3) Pottery vessels either drifted ashore or rolled on the shallow sea bottom away from the wreck site. In most cases, they were eroded or broken by the surf. Therefore, in open sandy beaches, only heavy objects remained at wreck sites in the surf zone.

Ships carrying millstones were probably wrecked under similar circumstances while sailing along the coast or anchoring. Much of the cargo has probably been salvaged in antiquity post wreckage, some cargo may have been dispersed away from the wreck by currents and waves and some of it may have been made of perishable, organic materials that did not survive. In addition, post-depositional processes (e.g., fishing) and sand quarrying may have caused damage and added some intruding artifacts to the sites.

Sea-Level Considerations

Archaeological and geological investigations suggest that the coastal area of western Galilee is tectonically stable (Galili and Sharvit 1998; Sivan and Galili 1999; Galili et al. 2007). The elevation of the two millstone quarries in Akko suggests that the stones could have been quarried under the current sea level most of the time, often taking advantage of low tide events. The coastal quarries along the Galilee coast, including the millstone quarries, and other archaeological and geomorphological sea-level markers studied along the Israeli coast suggest that the relative sea level along it has not considerably changed in the last 2000 years (within the limits of the local micro tidal regime) (Galili and Sharvit 1998; Sivan and Galili 1999; Galili et al. 2021b).

The Use of the Millstones Onboard

Small millstones and grinding stones (weighing up to c. 30 kg) (e.g., Atlit North Bay, Tel Nami) may have been used onboard for grinding cereals for feeding the crew. The cargoes containing very heavy, unused water millstones (e.g., those from the Megadim and Atlit assemblages) and the very heavy unfinished donkey (Pompeian) millstones (from Herzliya shipwreck) were transported as cargo, most possibly as paying ballast.

Secondary Use of Millstones as Weight Anchors

Perforated stones weighing tens of kgs or more were considered valuable assets in a maritime context. Thus millstones that went out of use (such as the small upper donkey millstones from Kfar Galim, described above), could have been secondarily used as stone weight anchors or end weights of fishing nets. Two such broken donkey millstones made of basalt (weighing 20–30 kg) were recovered in the Sea of Galilee (near Kibbutz Maagan). The pair of large water millstones recovered attached off Caesarea harbor may have been onboard as cargo and were probably used during an emergency as a weight anchor, to keep the ship away from the coast. A specific use of exhausted millstones as weights on the coast of Ashkelon (see above) is another example of reusing.

Coastal Quarries of Round Stones Along the Mediterranean Coasts

Coastal quarries of millstones/round stones, using coarse beachrock or sandstone, are common on the Mediterranean coasts. Fifteen coastal quarries were identified and published, among them four in Greece, three in Italy, two in France, four in Spain and two in Israel (Antonioli et al. 2017). The elevations of these quarries range between c. minus 0.3 m to plus 3.0 m relative to present sea level. The round stones were cut from calcarenite, beachrock and sandstone. The diameter and thickness of the quarried stones suggest that they were used for grinding flour in water-powered mills. Most of these stone quarries were active from the Byzantine period to the 18th century CE. Using coastal quarries as sea-level markers must be done with caution since some stones were extracted above sea level, while others were cut at sea level or in the intertidal zone (during low tides) (Antonioli et al. 2017).

The Use of Millstones in Israel and Their Chronology

The oldest written reference concerning water mills is that of Strabo (*Geographica* XII, 556) who mentions such a mill built by Mithridates, king of Pontus. Thus, it may be dated to before 65 BCE (Frankel 2007). Based on Rabbinic sources (Tos. Shabat 1, 28), Frankel suggested that water-powered mills (probably using Pompeian millstones) began to appear in Israel during the Roman period as early as the 1st century BCE (Frankel 2003a; 2007). However, the earliest proofed evidence of their usage in a mill is from Naḥal Tanninim dam, in the Byzantine period (Porath, ʿAd and Saʿid 2023:123–156). The large, flat, round water millstones were common in Israel during the Mamluk and Ottoman periods (Ayalon 2023), and probably around the Mediterranean coasts as well, as can be learned from the millstone quarries published by Antonioli et al. (2017). The millstone quarries in Akko and the basalt water millstone cargoes recovered off the Israeli coast may thus be post-5th century CE (late Byzantine to Ottoman periods), and it is not a coincidence that the water millstones that could be dated (Atlit and Megadim) are probably from the 14th–17th and the 15th centuries respectively (Fig. 27).

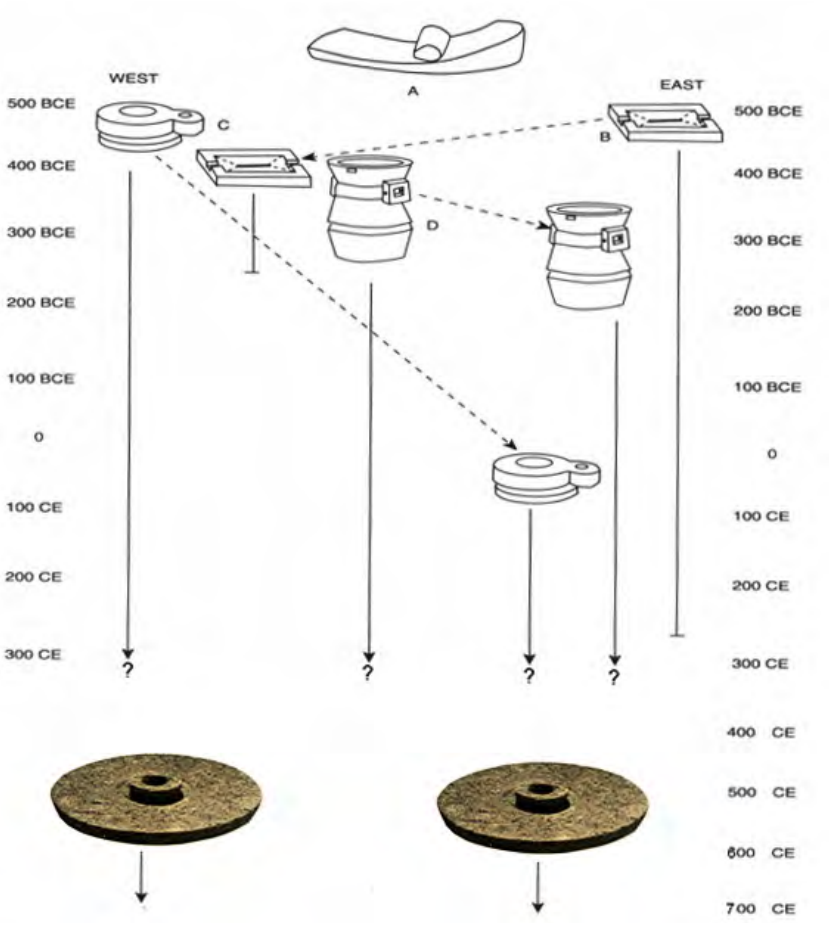

Figure 27: Typology and chronology of millstones based on Frankel (2007) and Ayalon (2023), modified by E. Galili.

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Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

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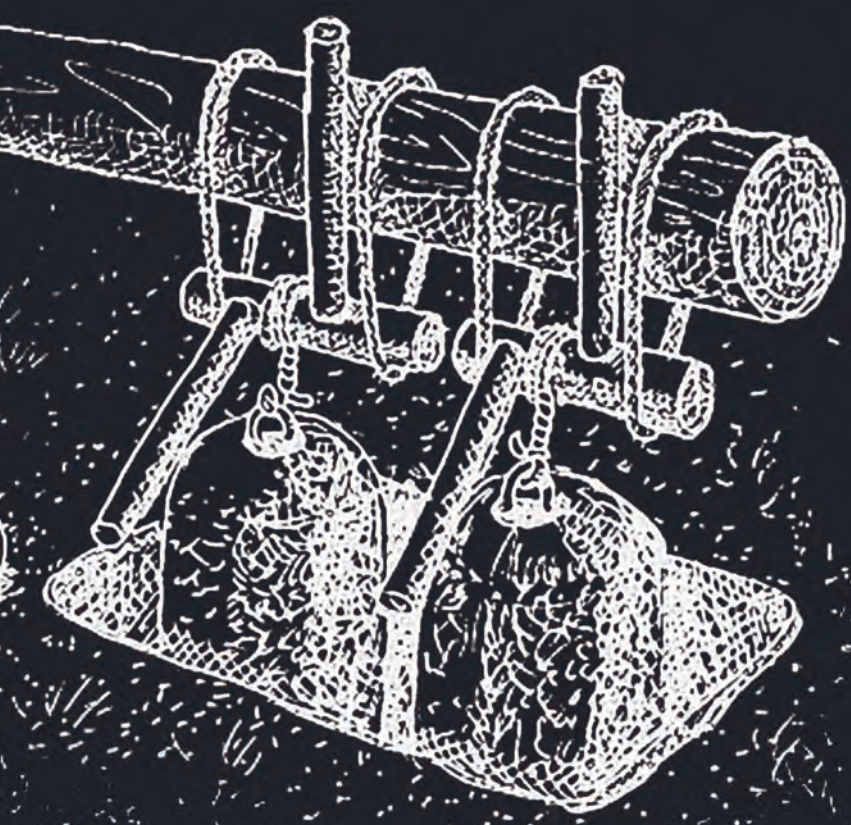

Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

Editors:
Michael Eisenberg, Uzi ʻAd and Etan Ayalon

To Dr. Rafael (Rafi) Frankel (1929–2023)

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

The Birth of a Trope: Women Grinding Grain with Rotary Hand Mills in Early Bible Dictionaries

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ABSTRACT

The image of women grinding grain with a rotary hand mill was reproduced in Bible dictionaries and customs books that were extremely popular with western Christian audiences throughout the 19th and early 20th centuries. Drawings and, later, photographs depicting two women grinding vividly illustrated well-known Bible verses such as Matthew 24:41 and reinforced the Orientalist idea that the 19th-century inhabitants of the Holy Land were trapped in a world virtually unchanged since biblical times. The origins of this trope can be traced to a woodcut depicting two women grinding grain with a rotary hand mill in Scotland that was reproduced in an early English edition of the most successful Bible dictionary in the 19th century: *Calmet's Dictionary of the Holy Bible*. The "father of biblical geography," Edward Robinson, retained this image in the edition of *Calmet's* that he edited prior to his first visit to the Holy Land in 1837–1838, and interpreted his own ethnographic observations of women grinding grain in Palestine through the Scottish image. It was only at the turn of the 21st century that archaeologists, beginning with Rafael Frankel, started giving serious attention to rotary hand mills, a ubiquitous and conservative food technology that is strongly associated with women.

Keywords: Ancient food technology, rotary hand mills, ground stone tools, biblical lifeways, biblical Orientalism, Edward Robinson, Bible dictionaries

INTRODUCTION[1]

The image of women grinding grain is a well-known Orientalist trope that held great appeal for western Christian audiences in the 19th and early 20th centuries,

1 It is my honor to contribute this essay in memory of Rafael Frankel, the first Israeli archaeologist I encountered during my first trip to Israel in 1992. I spent part of that summer as well as the fall semester as an overseas student at the University of Haifa and the experience included two months at Kibbutz Beit HaEmek, Rafi's home and the location of a small museum and archaeological park that he introduced to the students in my group. Years later, he advised me in my analysis of the Olynthus mills from Sepphoris. His important contributions to the study of ancient food technology have had a great impact on my own work and I am indebted to him for his many insights into the development of grain grinding technology specifically.

and illustrations of two women operating a rotary hand mill can be found in early Bible dictionaries, encyclopedias, and customs books published in English. At that time, rotary hand mills were believed to have been the common domestic grinding apparatus in "biblical times;" now we know that this technology was introduced into the eastern Mediterranean world only in the early Roman period (Frankel 2003). The image was also popular among commercial photographers working in the Middle East and North Africa in the late 19th and early 20th centuries, and photographs of women and girls operating the rotary hand mills that were in common use in the region were disseminated widely among western consumers (Fig. 1). The image of two women grinding was particularly popular in photographs of Palestine because of the many allusions to this process in the Bible (Graham-Brown 1988:151, Photo 9), especially Matthew 24:41: "Two women will be grinding meal together; one will be taken and one will be left."[2] Even some of the early western archaeologists working in Palestine posed local women with grinding stones from archaeological contexts in imitation of this well-known image and included these photographs in their site reports (Ebeling 2018). This oft-reproduced trope perpetuated the Orientalist concept that the observable inhabitants of the Holy Land were trapped in a "primitive" world largely unchanged since biblical times while also conveying inaccurate information about an ancient food technology that is strongly associated with women.

This image was not created from the first-hand observations of early western travelers to the Holy Land, however. Instead, it originated in a woodcut of two women operating a rotary hand mill in 18th-century Scotland by the Welsh artist Moses Griffith published by Thomas Pennant (1774: 328) (Fig. 2). A detail of this woodcut appears in an

Figure 1: Native women grinding wheat, Palestine, ca. 1900. Keystone View Company, Publisher. Photograph. https://www.loc.gov/item/2004671710/

2 All Bible verses are from the NRSV unless otherwise noted.

Figure 2: Women at the Quern and Luaghad with a view of Talyskir. Moses Griffith, Public domain, via Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Girl_with_ponytail-Women_at_the_Quern.jpg

early 19th-century English edition of *Calmet's* edited by Charles Taylor (Calmet 1812–16) to illustrate grain grinding in biblical times, and a nearly identical redrawn image was used to illustrate the entry "Corn" in the edition of *Calmet's* edited by Edward Robinson (Calmet 1832), the "father of biblical geography" and the first systematic western explorer of Palestine. The impact of *Calmet's* cannot be overstated: according to Charles Fritsch, in his review of Bible dictionaries and encyclopedias published in 1947, "[n]o other Bible dictionary has had such a long life – about a century and a half – and no other has been the parent of so many progeny" (Fritsch 1947:365). Tracing the history of the use of Moses Griffith's woodcut in the earliest Bible dictionaries in English allows us to better understand the methodology that was used to create such lasting and problematic images of everyday life in biblical times.

ROTARY HAND MILLS AND BREAD IN THE LOCAL DIET

One of the longest-lived grain-grinding technologies in the eastern Mediterranean world, the rotary hand mill was the predominant domestic grain grinding implement in use during the last two millennia throughout parts of Europe, the Mediterranean, and the Middle East. It consists of two round stones—an upper, mobile stone and a lower, stationary stone—of varying diameters, thicknesses, weights, and raw materials, although vesicular basalt seems to be the most desirable material for grinding grain cross-culturally. Grain is poured through a hole in the center of the upper stone and this stone is turned in a rotary motion using a vertical stick inserted into a second, smaller hole on its top. The cracked grain or flour comes out of the sides of the hand mill and is collected from the mat or piece of fabric on which it

sits or in an emplacement built to contain it (Ebeling 2018:1019). According to Rafael Frankel (2003; 2007), this technology developed in the western Mediterranean in the 5th century BCE and was brought to Palestine by the Roman legions in the 1st century CE. The Pompeian or donkey mill (*mola asinaria*) developed from the rotary hand mill in the west and was brought to Palestine during the Roman period as well. These rotary grinding implements mostly replaced the handstone and grinding slab/quern technology in use from at least the Upper Paleolithic in the Near East and the Olynthus mill that was introduced into the region in the Persian period (Frankel 2003; Alonso and Frankel 2017). Rotary hand mills were documented in periodic use in Jordan as late as 2012 (personal observation) and remain an understudied area in ground stone artifact research in the region (Ebeling 2019).

Bread and other grain-based foods have been dietary staples in the region for millennia. While it could be prepared and baked in a number of ways (Avitsur 1976; 'Arraf 2006), the wheat and barley from which it was most often made had to be reduced to a finer texture using stone tools before it was mixed with water and other ingredients. While roasted and/or minimally processed cereal grains (*freekeh*, semolina, bulgur/burghul, etc.) were also consumed, bread was the central carbohydrate of nearly every meal and the means by which other foods were eaten by dipping from a communal bowl. Domestic grinding and baking technologies were critical in 19th and early 20th century Palestine since water mills were not available in all areas (Avitsur 1960; Frankel 2007) and public bakeries only existed in larger towns ('Arraf 2006). Rotary hand mills, considered essential tools of daily life, were ubiquitous in nomadic, rural, and urban domestic contexts. According to the accounts of western travelers to the region in the 18th and 19th centuries and the work of local and foreign ethnographers and other researchers in the early 20th century, women were closely associated with grinding grain (Ebeling 2019:82) and baking bread (Ebeling and Rogel 2015:338–339) during this period.

EARLY BIBLE DICTIONARIES AND CUSTOMS BOOKS

Long before the developments that made it possible for large numbers of pilgrims and other westerners to travel to the Holy Land in the mid 19th century, aspects of traditional life in the region were described and illustrated in widely read Bible dictionaries and customs books. A fundamental motivation of the authors of these books was to animate and supplement understandings of life in biblical times for primarily Christian audiences in Europe and the United States. Publications in this genre include quasi-ethnographic, often fanciful accounts that conflate the habits and traditions of observable "primitive" peoples in the Middle East and elsewhere with those of the peoples described in the Old and New Testaments. Although the authors and illustrators of the first Bible dictionaries did not travel to the Holy Land themselves, they depicted the land and its people—who were then understood as "the living people of the Bible" (Grafton 2019:137)—as frozen in biblical times and virtually unchanged for 2,000–3,000 years. The guiding principle of these publications, according to Daniel Varisco (2013:190), was that "the observable customs of people living in Bible lands would serve to both validate and illuminate Scripture."

In the second half of the 19th century, as Holy Land tourism grew, the number of published travelers' accounts swelled to some five thousand books and articles; American missionary William McClure Thomson's *The Land and the Book*, first published in 1859, was by some estimates the most widely-read book in the US in the 19th century (Cunningham and McGeough 2018:163; Grafton 2019:173). By the time Thomson traveled to Palestine, he and other westerners were steeped in biblical imagery obtained not only through the Bible, which was the primary text available to those learning to read and write, but also through secondary literature like Bible dictionaries that included maps and other drawn images. Although the popular art used to illustrate Bible customs has not yet been the subject of much scholarly research (Varisco 2013:191, note 10), these best-selling *illustrated* texts shaped the imagination of readers on the inhabitants of the region. During the second half of the 19th century and into the early 20th century, Thomson and his many contemporaries illustrated their publications with increasing numbers of drawings and, later, photographs depicting the lifeways of the Arab and Bedouin inhabitants of the Holy Land and their biblical ancestors as viewed through a biblical Orientalist lens. As will be shown below, the image of women grinding grain commonly reproduced in these customs books have their origins in the earliest illustrated Bible dictionaries.

Augustin Calmet's *Dictionary of the Holy Bible* and its First English Translation (1732)

One of the earliest and most influential Bible dictionaries was written by Antoine Augustin Calmet (1672–1757), a French Benedictine monk who achieved scholarly respect (and some criticism) for his focus on the literal meaning of the text in his Bible exegesis. He was also the author of sacred and profane history and an extremely popular and influential work on vampires (Yoder 2017). The first edition of his *Dictionnaire historique, critique, chronologique, géographique et littéral de la Bible* was published in 1720. Edward Robinson, who authored the edition published in 1832 (see further below), summarized Calmet's achievements thus:

> "His general character, as a scholar and writer, is that of a diligent and judicious collector and compiler, with more of tolerance than was usual among the Catholics of that day, but without any profound skill in original investigation, or any distinguished tact or taste in the plan and arrangement of his works. His Dictionary is justly regarded as affording a popular exhibition of the learning then extant upon the subjects of which it treats; without making in itself any important additions to the common stock" (Calmet 1832:iii).

The earliest English edition of Calmet's work, by Samuel D'Oyly and John Colson, was published in 1732 in three volumes and illustrated with 160 copper plates. In the preface, the authors describe the nature of these images:

> "The Prints are of two Sorts; some represent the Antiquities of the *Hebrews*, their Dresses, Ceremonies, Temples, Synagogues, Tombs, and Musical Instruments; the Plans and Elevations of the Cities and principal Places in the Holy Land. Others

> set before us the Marches of Armies, the Sieges, Camps, and Orders of Battle, whereof there are Descriptions in many Places of the Scripture, circumstantial enough to enable one to argue from them with solidity" (Calmet 1732:iii).

As in other early works of this kind, it is unclear from where these images derive. While there are no accompanying illustrations for the entries "Bread" and "Mill," these entries offer a glimpse into the authors' approach to using the (limited) observations of western travelers to inform and interpret the biblical text.

While most of the information in these two entries derives from biblical passages, some references to contemporary bread-baking practices in the Middle East are included in the "Bread" entry specifically. The authors state that there are several ways bread is baked among "the Hebrews, and other eastern People" (Calmet 1732:325) according to the observations of Laurent d'Arvieux, who traveled to Palestine and the Arabian Peninsula in the mid-17th century. These include baking in a *tannur* and what seems to be a *tabun* ("a great Pitcher half full of certain little Flints that are white and glittering, on which they cast the Paste spread in the form of flat Cakes" (Calmet 1732:325). Interestingly, the latter method is described as "the most common way in Palestine" at the time and it remained so for more than two centuries after D'Oyly and Colson's writing (Ebeling and Rogel 2015).

More relevant to this discussion is the entry "Mill" (Calmet 1732:203), which contains a description that seems to confuse large Roman grinding implements and rotary hand mills. In explaining Matthew 18:6 ("If any of you cause one of these little ones who believe in me to sin, it would be better for you if a great millstone were fastened around your neck and you were drowned in the depth of the sea"), the authors write: "This Asses Millstone, according to some, was a large Stone turned round by an Ass, to distinguish it from the smaller Stones which were turned by the Arm. Others believe that the Mola asinaria was the lower Millstone, which was sluggish and immovable" (Calmet 1732:203). D'Oyly and Colson almost certainly have a rotary hand mill in mind when they contextualize Exodus 11:5 ("Every firstborn in the land of Egypt shall die, from the firstborn of Pharaoh who sits on his throne to the firstborn of the female slave who is behind the handmill and all the firstborn of the livestock), although no ethnographic references to women grinding grain are provided: "…before the Invention of Wind-mills and Water-mills, they commonly made Use of Hand-mills to grind their corn" (Calmet 1732:203). The authors are apparently confused about the meaning of the Hebrew word *reḥayim* in Deuteronomy 24:6 ("No one shall take a mill or upper millstone in pledge" which the authors translate as "Thou shalt not take the two Stones of a Mill, and the Carriage") (Calmet 1732:203). It is unclear what kind of implement is pictured here in the apparent absence of any knowledge of the handstone and lower grinding slab/quern sets that were used to grind grain in the Iron Age.

Charles Taylor's New English Edition of *Calmet's* (1798)

A new English edition of *Calmet's* was published in London in 1798 under the direction of the engraver Charles Taylor (1756–1823) "with considerable

retrenchments and additions" in the words of Edward Robinson (Calmet 1832:iii). The additions included a separate volume called *Fragments, Illustrative of the Manners, Incidents, and Phraseology, of the Holy Scriptures*, which "consisted of discussions and illustrations of oriental life, character, and manners, drawn chiefly from travellers in the East" (Calmet 1832:iii). Four more editions (1800–1803, 1812–1816, 1823, and 1830) were published in London; the American edition of 1812–1816 was copied from the third London edition. As will be discussed further below, Edward Robinson was brought on after Taylor's death to edit the American edition published in 1832.

It is important to keep in mind how influential the early English editions of *Calmet's* were at that time. According to Andrew White (2015), many Bible dictionaries produced by the mid 19th century were based at least somewhat on the writings of Calmet. Charles Taylor's popular English editions, which include hundreds of images drawn from a variety of sources, were probably the most accessible to American audiences. As Robinson noted (Calmet 1832:iii), Taylor incorporated descriptions as well as illustrations of daily life in the East based on the accounts of western travelers, and this is perhaps the first Bible dictionary in English that includes illustrations of grinding stones to illuminate biblical passages. A plate called "Bread" includes four line-drawings of grinding stones (Calmet 1798 Pl. CIX:1–4) and these images are explained in the entry called "Bread, and its Preparation" (15–17) (Fig. 3). Importantly, Taylor does not include images of people operating this equipment.

The first three line-drawings (Calmet 1798 Pl. CIX:1–3) depict rotary hand mills. They are interpreted in the text using travelers' accounts: "Nos. 1, 2, 3, Is a Hand-Mill, as used constantly in the private houses in the East: as the form, as well as office, of this mill is alike throughout the greater part of Asia, Travellers describe it in nearly the same terms" (Calmet 1798:15). In the discussion of references to grinding in the biblical text that follows, Taylor clearly has the rotary hand mill in mind as the implement used to grind grain in biblical times. He also mentions that women are most often observed using rotary hand mills: "[i]t is in the East, the constant office of the women to grinding the corn; which they do every morning at day break: the grinder usually sits down on the floor, &c. and placing the mill on her lap, by means of a handle, works the upper stone with her right hand" (Calmet

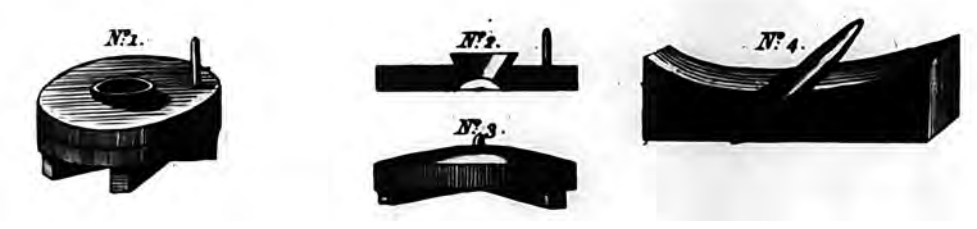

Figure 3: Four line-drawings of rotary hand mills and a handstone with grinding slab/quern. Detail from Calmet 1798: CIX:1–4. Public domain, courtesy of Internet Archive. https://archive.org/details/bim_eighteenth-century_fragments-illustrative-_calmet-augustin_1798/page/n841/mode/2up

1798:15). It is unclear where the detail about the mill being placed on a woman's lap is coming from, as earlier in the entry he cited a traveler who described seeing a wooden board used to catch the flour ground using a rotary hand mill, and it is very uncomfortable to operate the heavy stones on one's leg.

The most interesting drawing in the context of this essay is the fourth line-drawing (Calmet 1798 Pl. CIX:4), for it depicts a handstone and grinding slab/quern set similar to those found in excavations of Bronze and Iron Age (and earlier) contexts in the Levant. Taylor explains:

> "We can hardly call No. 4 a mill; but it is an instrument used for the same purpose, though it rather bruises than grinds. It consists of two parts; a hollow stone, and a roller, which being rolled upon the corn to be ground, reduces it to a coarse meal. Niebuhr tells us, that this instrument was used on board the ship in which he voyaged; and that, after being used to it, coffee, thus bruised, was esteemed by him superior in flavour to that which was ground: as the Arabs maintained that corn also was." (Calmet 1798:16–17)

A look at Niebuhr (1792) reveals that he was talking about a mortar and pestle set, not a handstone and grinding slab/quern set like that depicted in Taylor's plate: "…instead of grinding their coffee-beans, [they] pound them in a mortar. We carried a coffee-mill with us into Arabia, but soon found the taste of the pounded coffee much superior to that of the ground, and left off using our mill. The pounding seems better to express the oily parts of the bean, which give the coffee its peculiar relish" (Niebuhr 1792:229). Why did Taylor understand Niebuhr's mortar as something other than a mortar? Where did Taylor find this illustration of a handstone and grinding slab/quern set and why did he include it alongside three drawings of rotary hand mills? He does not connect these specific grinding stones to anything biblical in his description. Instead, he seems fairly sure in his identification of the rotary hand mill as the grain grinding implement of biblical times.

Charles Taylor's 1812–1816 Edition of *Calmet's*

Taylor's 1812–1816 American edition of *Calmet's*, copied from his 1812–1816 London edition, incorporates some of the illustrations previously published in the separate *Fragments* volume in the text. The entry called "Mill, or Quern, for Grinding Corn. Matthew XXIV. 41" is illustrated with the same three line-drawings of rotary hand mills published in the 1798 edition (see above) along with something new: an image of two women operating a rotary hand mill (Calmet 1812–1816:344) (Fig. 4). While no credit for the illustration is provided, the image is a detail from Moses Griffith's woodcut "Women at the Quern, and at the Luaghad, with a View of Talyskir" published by the Welsh naturalist, traveler, and antiquarian Thomas Pennant (1774 Pl. XXXIV).[3] The handstone and grinding slab/quern set that appeared in the 1798 edition of *Calmet's* (Pl. CIX:4) is not included and there is no hint as to why Taylor chose to leave it out of this edition.

3 I thank Alexandra Leich for identifying this image as Griffith's woodcut.

Figure 4: Three line-drawings of rotary hand mills and detail from Moses Griffith's woodcut. From Calmet 1812–1816:344. Public domain, courtesy of HathiTrust. https://babel.hathitrust.org/cgi/pt?id=uc1.b3514479&seq=424&q1=

Griffith's woodcut depicts a young woman (left) and an older woman (right) grinding grain with a rotary hand mill, or quern. The mill sits on the skirts of the older woman, probably to catch the ground flour. The upper stone has a raised pattern on the visible outer surface and an unusually long stick presumably used to turn the upper stone is set in a hole on its surface. Each woman wears a tartan shawl and their hairstyles are specific to their age and marriage status in the context of 18th-century Scotland: the young woman on the left wears a ribbon around her head and her hair in a ponytail while the woman on the right wears a bonnet. According to Laurie Stanley-Blackwell (2015:172), the rotary hand mill was noted for its late survival in the Highlands and Islands of Scotland and the persistence of this antiquated technology elicited the curiosity and comment of outsiders like Pennant.

Taylor quotes Pennant's observations in Scotland at great length in the discussion that follows and it is clear that he is convinced that the rotary hand mill like those recently observed in Scotland was the grinding implement used in biblical times. The fact that the image shows a rotary hand mill being operated by two women is important. This can be seen in the "Index of the Principal Subjects Illustrated" in the back of this edition: the illustrated entry that begins on p. 344 is listed as "Mill for grinding corn, extant in Scotland, worked by two women, who sing meanwhile; laws respecting; explaining several Scriptures, Matth. ii 18" (Calmet 1812–1816:xii). Taylor connects the rotary hand mill seen in Scotland with rotary hand mills noted by travelers in the East, citing the observations of Edward Daniel Clarke (1817:69), who describes two women in Nazareth operating a rotary hand mill in a manner similar to that which he witnessed in Cyprus and the accounts of visitors to Lapland (northern Finland) and Scotland with which he was familiar. Clarke connects his knowledge of women grinding grain to "the observation of our Saviour, alluding to this custom in his prediction concerning the day of judgement, Matt. xxiv, 41" (1817:242). It appears that Taylor was not the only one in the early decades of the 19th century to conflate biblical descriptions, the observations of visitors to northern Europe, and the observations of visitors to the eastern Mediterranean.

Edward Robinson's Edition of *Calmet's* (1832)

The eminent American biblical scholar Edward Robinson (1794–1863) was brought on to publish a new version of *Calmet's* for the American public sometime after Taylor's death in 1823 (Calmet 1832). In addition to omitting "crude and fanciful speculations as could only tend to divert the mind of the Biblical student from the right way" (Calmet 1832:iv), Robinson added insights from biblical scholars writing in German as well as the writings of western travelers to the East. Like Taylor before him, Robinson had not yet visited the Holy Land himself. At the time of his writing, he may not have yet known that he would travel extensively through Palestine just a few years later.

In the entry "Corn," Robinson omits Taylor's three line-drawings of rotary hand mills first published in the 1798 edition and retained in the 1812–1816 edition, and includes a redrawn version of Griffith's woodcut (Fig. 5). The two figures are similar—the older woman's face seems slightly younger in this version, and the younger woman's tartan is not as distinct as in the original—and the tree in the background is removed. It is clear that Robinson's understanding of the connection between the rotary hand mill observed in Scotland and the grinding implement used in biblical times is essentially the same as Taylor's when he writes "[t]hese mills are still in use in the East, and in some parts of Scotland" (Calmet 1832:314). He continues by describing both Clarke's observations in Cyprus and parts of Palestine and Pennant's account of his tour of Scotland. The redrawn image of Griffith's woodcut is positioned within the text wrap close to his assertion that "[t]he employment of grinding with these mills is confined solely to females" (Calmet 1832:314) and yet another reference to Matthew 24:41. Interestingly, he does not mention Clarke's account of women using a rotary hand mill in Nazareth.

I must stress how unusual this image is in the context of this edition of *Calmet's*: it is one of only a handful of quasi-ethnographic illustrations of women in the entire book. The only other images of women are a drawing of a woman on a bed that illustrates the entry "Bed," a drawing of a woman pouring from a skin in the entry "Bottle," and three drawings of women in bridal costume under "Canticles: Bride's Dress" (Calmet 1832). The redrawn image of two women operating a rotary hand mill based on Griffith's woodcut is the only one of these drawings that depicts contemporary European women rather than women in the "East." Robinson seems convinced that this particular image accurately illustrated grain grinding in biblical times, although he chose to omit most of Taylor's other illustrations for being too speculative.

Figure 5: Moses Griffith's woodcut redrawn. From Calmet 1832:314. Public domain, courtesy of Internet Archive. https://archive.org/details/calmetsdictionar00calm/page/314/mode/2up

Robinson published *A Dictionary of the Bible, for the Use of Schools and Young Persons* the following year and included the same redrawn image and a nearly identical description in the entry "Corn" (1833:67–68). He was thus responsible for introducing the image of two women grinding grain to a broad audience in America in the first half of the 19th century. Bible lands writings like the dictionaries authored by Robinson were regularly used in sermons and Sunday school lessons in American Protestant churches through the 19th century (Cunningham and McGeough 2018:175; Varisco 2013:189) and many children and adults would have been familiar with these early mass-produced and illustrated publications.

Edward Robinson and Eli Smith in Palestine 1837–1838 and Robinson's Legacy

In 1837–1838, Robinson made his famous trip through Palestine with Eli Smith documented in their three-volume *Biblical Researches in Palestine, Mount Sinai and Arabia Petraea* (1841). He and Smith observed and recorded local customs while also identifying biblical sites. Smith, an American missionary based in Beirut who was fluent in Levantine Arabic, was already familiar with the lifeways of the local people and likely helped Robinson interpret and understand his ethnographic observations (Thomas Davis, personal communication). The description of a rotary hand mill in *Biblical Researches* appears to be Robinson's own, however:

> "In another tent a woman was kneeling and grinding at the hand-mill. These mills are doubtless those of scriptural times; and are similar to the Scottish *quern*. They consist of two stones about eighteen inches or two feet in diameter, lying one upon the other, with a slight convexity between them and a hole through the upper to receive the grain. The lower stone is fixed, sometimes in a sort of cement, which rises around it like a bowl and receives the meal as it falls from the stones. The upper stone is turned upon the lower, by means of an upright stick fixed in it as a handle. We afterwards saw many of these mills; and saw only women grinding, sometimes one alone and sometimes two together" (Robinson and Smith 1841:180–181).

It is clear from this passage that Robinson also interpreted his ethnographic encounters in Palestine through the images and descriptions in *Calmet's*. His visit to Palestine apparently confirmed the suitability of using the Scottish image of two women operating a rotary hand mill to illustrate both contemporary practices in Palestine and life in biblical times. In fact, Robinson did not rewrite later editions of the Bible dictionaries he authored before his trip to Palestine to incorporate his own ethnographic observations of grain grinding. Both the 1848 edition of *A Dictionary of the Bible, for the Use of Schools and Young Persons* (Robinson 1848) and the ninth edition of *Calmet's* (1852) preserve the same text and redrawn image of Griffith's woodcut published in the earlier editions.

Robinson's authority is clear in the Bible customs books published in the second half of the 19th century that acknowledge and make use of his and Smith's

important work in Palestine. William McClure Thomson's best-selling *The Land and the Book* (1859) is instructive, as it is an early publication in the genre that cites Robinson and Smith's influential work regularly. It also includes an exceptionally large number of new illustrations.[4] In a passage in which Thomson describes his visit to Lydd, he cites Robinson's observations and even offers corrections to Robinson and Smith's map! ("The map of Dr. Robinson has some mistakes in this region which deserve to be corrected" [Thomson 1859:290]). He also includes a drawing of two women grinding grain using a rotary hand mill based on his own observations of such a scene in Lydd. In this image, two women are sitting on opposite sides of a large hand mill set in a grinding emplacement, one turning the upper stone and the other poised to throw some of the grain in her basket into the central hole in the upper stone. Thomson explicitly connects his observation to not only the biblical text, but also to what he heard in church sermons:

> "This little circuit [traveling through Lydd] has afforded me a beautiful illustration of Scripture. Two women are sitting before the door of their house, upon a large piece of sackcloth, grinding on a hand-mill. I heard the ring of this apparatus some time before I saw it, and I now understand what is meant by the preacher when he says, The sound of the grinding is low, because the grinders are few" (1859:294–295).

After listing other Bible verses that mention grinding, Thomson relates that he enjoys the sound of grinding that he had become accustomed to hearing every morning and evening in every village and Arab camp, and it is clear that he is familiar with this ubiquitous food processing activity. Thomson identified the rotary hand mill as the grinding implement used in biblical times on the basis of biblical references, his own first-hand observations, and almost certainly information provided in *Calmet's* and similar publications that was reinforced through church sermons.

While a review of the several thousand other Bible dictionaries and customs books published in the 19th century is beyond the scope of this study, it is important to note that early western ethnographers and archaeologists working in Palestine at the turn of the 20th century were steeped in this biblical Orientalist imagery. For example, the German theologian Gustaf Dalman, who would later make major contributions to the understanding of traditional Palestinian lifeways in his seven-volume *Arbeit und Sitte in Palästina* (1964), believed that rotary hand mills had been used in Old Testament times. In his 1902 article "Grinding in Ancient and Modern Palestine," he asserts that the Hebrews did not know of handstones and grinding slabs/querns like those depicted in Egyptian tomb models for "[t]hey were already in a higher stage of civilization, their system being the rotating of one round flat stone on another stone of the same kind by the power of the human hand – that is to say, the hand-mill"

4 In her analysis of *The Land and the Book*, Heleen Murre-van den Burg (2006:48) emphasizes the lasting significance of the illustrations Thomson had created—most of them apparently by his son—for his book: "It seems likely that these numerous drawings contributed not only to the popularity of the book, but also to the creation of strong images of the Holy Land, in which the boundaries between the present state of Palestine and the land as it was in biblical times are consistently blurred—in a close parallel with the historical continuity that is assumed in the written text."

(Dalman 1902:9). Early western archaeologists were also responsible for perpetuating the trope of two women grinding grain by publishing photographs of local women posed with handstone and grinding slab/quern sets in their site reports. As I have argued elsewhere (Ebeling 2018:1018), "[t]his timeless image sunk into the collective archaeological consciousness as an illustration of how life really was and impeded serious archaeological study of an essential daily life activity" as a result.

CONCLUSION

While a number of researchers have examined Orientalist photographs produced by foreign and local photographers in Palestine during the late 19th and early 20th centuries (see Zananiri 2021, note 16 for an extensive list), few (Cunningham and McGeough 2018; Varisco 2013) have considered the impact of earlier drawn images reproduced in Bible dictionaries and customs books. These early images were inculcated into children and adults both at home and in church and later reproduced *ad infinitum* in travelers' accounts, illustrated Bibles, and photographs that remained popular for more than a century. In my opinion, the success of the trope of two women grinding grain with a rotary hand mill was largely due to Edward Robinson, a highly-respected scholar who was responsible for both a popular English edition of the most successful Bible dictionary published in the 19th century and the foundational text for 19th century western travelers to Palestine. While Robinson does not deserve blame for how he interpreted his own first-hand observations during his first trip to the Holy Land, he was responsible for validating and perpetuating Taylor's use of an ethnographic image from 18th-century Scotland to illustrate biblical lifeways.

While this may seem like a fairly trivial point to some, consider how long it took for the history of the rotary hand mill in the Levant to be clarified by archaeologists. It was the late Rafael Frankel, to whom this volume is dedicated, who recognized its earliest appearance in Palestine in a 1st century CE context at Masada and suggested that this technology was introduced to Palestine by the Roman army (Frankel 2003:18). Given their ubiquity in archaeological contexts since the Byzantine period and the conservatism of this essential domestic food technology, it is incredible that rotary hand mills have only been the subject of serious study by archaeologists starting with Rafael Frankel at the turn of the 21st century.

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Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

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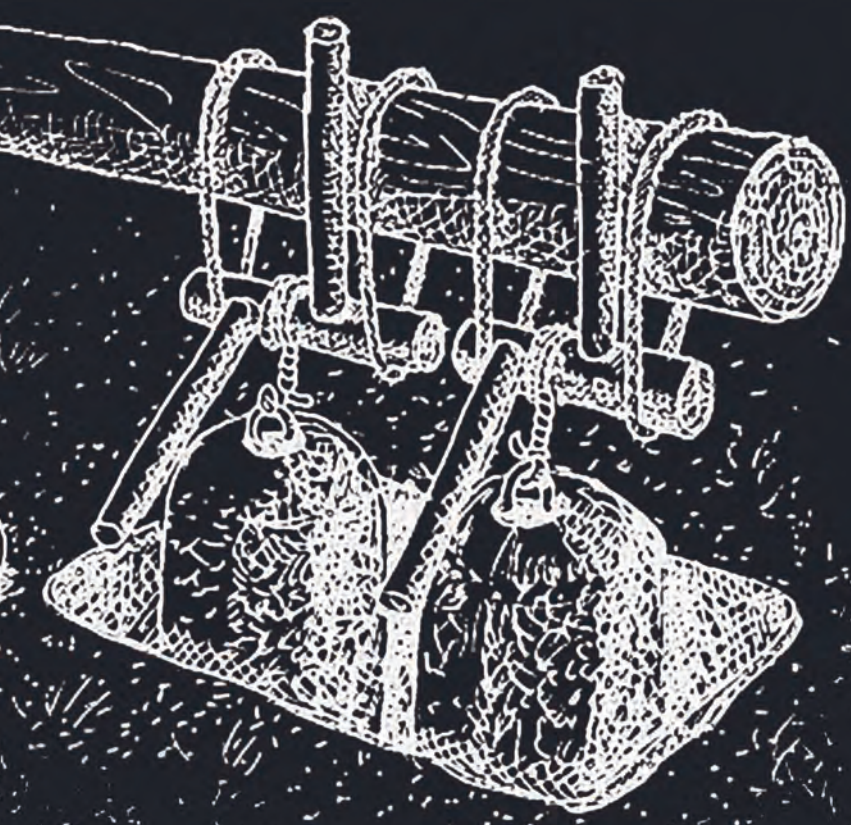

Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Opus Sectile Stones Production in Late Antique Caesarea Maritima

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ABSTRACT

The 1992–2021 IAA excavations at Caesarea Maritima yielded ample *opus sectile* stones—geometric, floral, figural, and background fillers—that originally composed wall and floor mosaics. This study focuses on *sectile* pieces uncovered in four complexes dating between the 5th and 7th centuries CE: two private mansions, a semi–public complex and the Octagonal Church.

The multiplicity of shapes, stone variety (of hardness and color), thickness of defined and amorphous shapes, dyes, rust remnants, cutting and sawing leftovers, and finishing degree, all enabled the tracing of the production process of the late antique Caesarea *sectile* pieces.

The study made clear that the shapes were cut out of slabs which were sawed on the spot, either by water–powered multi blade saw machines which sawed several slabs at a time or by manual sawing. The craftsmen made use of obtainable stones, including recycled architectural members and furniture; for availability and cost reasons yellowish limestone was often used instead of *giallo antico* and red siliceous sandstone instead of porphyry.

Tool-marks indicate that the tools and techniques employed for cutting, shaping and embellishing the *sectile* pieces depended on the stone hardness, fragility and workability, on the mosaicists' personal preferences and training, and on the desired effect of the final product, whether intended for decorating walls or for decorating floors. From the material studied it also became clear that no matter how the pieces were cut, by sawing or by hammering and chiseling, rough shaping often required refinements and adjustments before putting the pieces together to create a pattern. It seems that rough smoothing was done before cutting; high-level smoothing/polishing was done after the mosaics were affixed to their place. As for wall facing, differences in finishing depended not only on the stone's receptivity to tools or the mosaicists' expertise, but also on the intended place of each *sectile* piece in the composition, whether in the viewer's eye level or higher. High location did not require perfection in cutting and smoothing, and in accurate fitting of the pieces together; as a result, time and money could have been saved.

Keywords: Bitumen, Caesarea Maritima, colored stones, *crustae*, late antique technologies, limestone, marble stones, *opus sectile*, sandstone, sawing, slate

INTRODUCTION

The study encompasses evidence from excavations conducted by Israel Antiquities Authority teams between 1992 and 2021 in 5th to 7th centuries CE private, semi-public and public complexes (Fig. 1).[1] The mansions in Insulae W2S4 (Gendelman and Porath 2022) and E1S6,[2] the semi-public complex in Insula W2S3,[3] and the octagonal church complex built in the 5th century CE on top of Augustus and Dea Roma temple remains,[4] were all luxuriously ornamented with colorful *opus sectile* wall panels and floor carpets (*sectilia pavimenta*). Of the four, the semi-public complex in Insula W2S3 is the only complex which was fully excavated. The prodigious amount of *crustae* it yielded provides significant information—in addition to the information gleaned from the *opus sectile* workshop uncovered in Insula W2S4 (Dray 2011)—as regards to the production of *opus sectile* stones in late antique Caesarea. Hopefully, other complexes which are still buried—fully or partly—and wait for exposure, will yield more *crustae* and more information. Unfortunately, not even a single wall panel was preserved in its original form, and from many of the floors only imprints remained. Nonetheless, the quantities and variety of identifiable shapes and amorphous background fillers uncovered at Caesarea thus far, point to a large-scale production of *sectile* pieces for wall facing and flooring during a period of no less than two hundred years.

Studies dealing with *opus sectile* usually focus on the repertory of the shapes (*crustae*), on the patterns and compositions, on the technique of putting together the pieces, and on installing *sectile* wall panels and paving *sectile* carpets. Less attention is paid to the cutting techniques of the pieces. This paper focuses on the latter; and although the archaeological remains of wall and floor mosaics in the *opus sectile* technique constitute only a fraction of what late antique Caesarea originally had, they provide ample of evidence of the availability and variety of stones used for producing the *sectile* decoration, of the techniques employed for cutting and shaping the pieces, and of the aesthetic and economic preferences of the Caesareans.

STONE SUPPLY AND AVAILABILITY

The range of types of stones and the variety of colors needed for decorating a complex of hundreds, or more often thousands, square meters of walls and floors with *opus sectile* required an accurate estimation of the amount of stones necessary. To acquire the stones the mosaicists could turn to one or more of the marble-yards that late antique Caesarea undoubtedly had, wherein row blocks and architectural members in different degrees of finishing, were available. If unsatisfied with what the stocks

1 Map is by A. Iamim and P. Gendelman. All photographs, reconstructions and charts are by the authors.

2 Gendelman and ʻAd 2020; the mosaics final report by Rivka Gersht was delivered for publication.

3 Gersht and Gendelman 2021; Gendelman and Porath forthcoming. The study of the *sectile* pieces from Insula W2S3 was made possible through the support of the Israel Science Foundation, Grant No. 31/10 awarded to Rivka Gersht and Peter Gendelman.

4 Excavated between 2015 and 2021 by Peter Gendelman, Uzi ʻAd and Muhamad Hater.

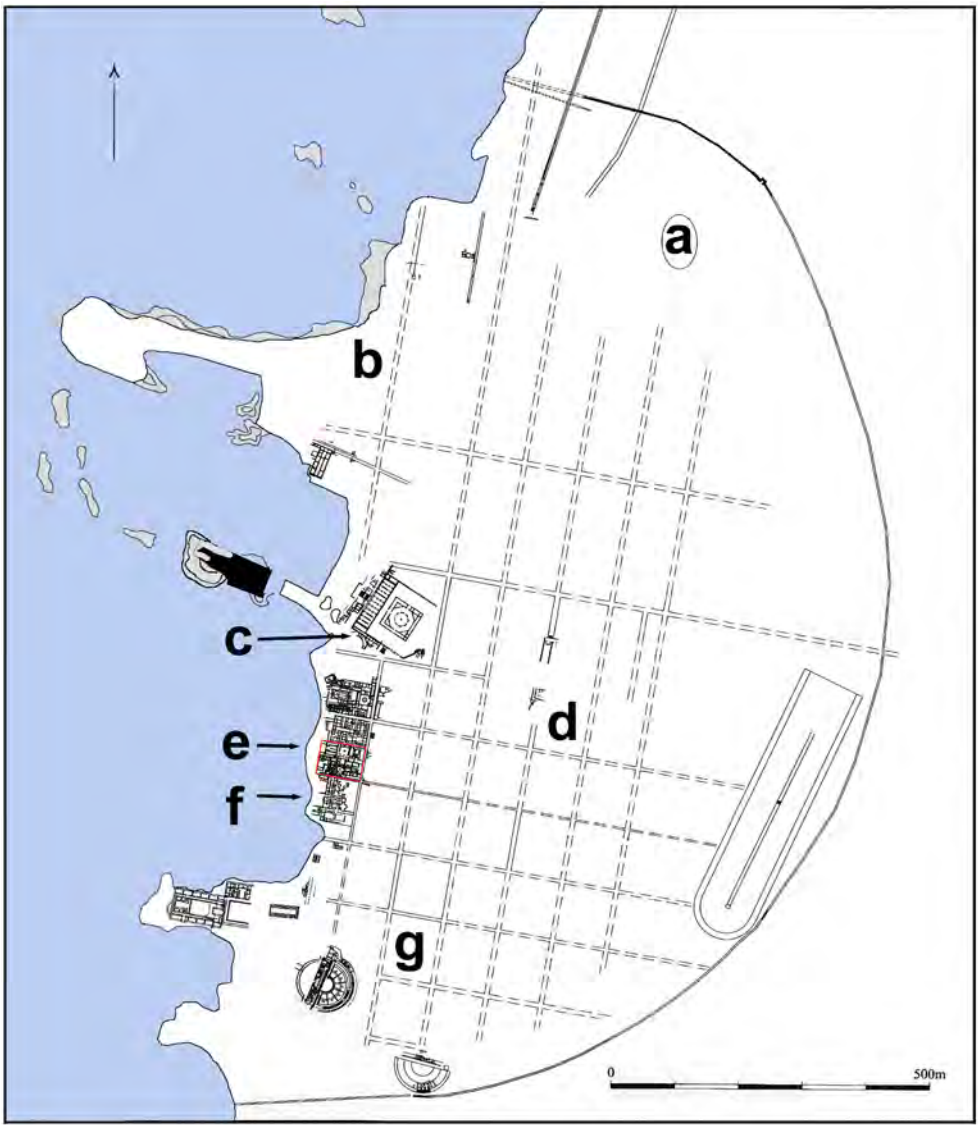

Figure 1: City map of Caesarea with locations mentioned in text: (a) Hadrianic amphitheater. (b) Complex identified as Antoninus Pius Thermae. (c) Octagonal church complex. (d) Insula E3S2. (e) Insula W2S3. (f) Insula W2S4. (g) Insula E1S6.

of the new and second-hand materials, stored in the marble-yards, could offer they could import the stones directly or through import agencies. Another possible source of stones was *spolia* taken directly from buildings wherein renovations took place or from Roman period buildings that went out of use.

As no written testimony to these procedures at Caesarea is available, we had to rely mostly on what can be deduced from the finds themselves and on written sources from elsewhere. One is a 4th century CE fragmentary document written on the verso of papyrus found in Oxyrhynchus, Egypt (Papaconstantinou 2012). The document was written by someone whose job was to prepare an inventory list of architectural members from demolished or abandoned buildings that can still be used. The list

includes a brief record on the location of the items within each surveyed complex, their state of preservation, dimensions, condition (still standing or laying on the ground), type of stone (local or foreign), and which item can be easily removed or for which more effort is required.

Whether such inventory lists were made by experts of demolition-guilds, like the *collegium subrutorum* which functioned in 1st century CE Rome (*CIL* 6.940), is unclear; however in light of the legislation in late antiquity, concerning renovating, dismantling and recycling materials from private and public buildings, it becomes obvious that the authorities were well aware of the need of supervising and restricting inappropriate conducts.[5] We have no reason to doubt that the same occurred at Caesarea.

There is clear evidence for availability of raw material and second-hand stones in late antique Caesarea, which mosaicists could use for producing *sectile* shapes. Large scale sawing took place in at least three locations: Hadrian's amphitheater (after it ceased to function in the 4th century CE) (Fig. 1:a),[6] near the complex identified as Antoninus Pius Thermae (Fig. 1:b),[7] and in the area of the Octagonal Church complex (Fig. 1:c), built in the 5th century CE on top of the demolished temple of Augustus and Dea Roma. Leftovers of sawed stones—white, grayish and colored marble stones, limestone and alabaster—with parallel slits were found in these locations (Figs 2:1–3, 5, 7–8; 3:1; for additional examples from the Octagonal Church complex, see Gersht and Gendelman 2023: Fig. 8). These leftovers indicate that water–powered multi blade saw machines—like the one depicted in the Hierapolis relief; and the real ones, whose remains were found in Ephesos and Gerasa (Seigne 2002; Ritti, Grewe, and Kessener 2007; Kessener 2010:284–290; 2012)—functioned in the city. Also found in each location is a large quantity of yellow clay rich in quartz, the result of using abrasive material for sawing.[8] Most if not all of the sawing in the amphitheater, as the remnants evince, was of white and grayish architectural members taken from the dismantled facility (Fig. 3). The evidence of sawing *spoila* from the two other locations is sporadic.

Fragmentary leftovers with parallel slits show variation in the thickness of the sawn slabs, not only between the fragments, but also within each one of them. In one of the marble fragments uncovered near the complex identified as Antoninus Pius Thermae (Fig. 2:7), for example, the thickness of the thinner slab was 0.8 cm, the thicker was 1.9 cm and the medial 1.7 cm. In one of the alabaster fragments from the same location (Fig. 2:8), the slabs' thickness varied from 1.4 to 1.65 cm. Thin slabs were likely intended for producing *sectile* shapes for wall decoration; *sectile* shapes for flooring required thicker slabs.

As no trace of cutting *sectile* pieces was found in the amphitheater, the slabs must have been shifted from the amphitheater to spots within the city, where *opus*

5 For examples concerning private buildings, see *Codex Iustinianus* 8.10; concerning public property, see *Codex Iustinianus* 8.12; *Codex Theodosianus* 15.1; Alchermes J. 1994.

6 Excavated by Peter Gendelman in 2009–2010.

7 Partly excavated in 2017–2019 by Uzi 'Ad. The thermae might be the one mentioned in Malalas' *Chronography* 11.367–368: "Ἔκτισε δὲ καὶ ἐν Καισαρείᾳ τῆς Παλαιστίνης λουτρόν, καὶ ἐν Νικομηδείᾳ τῆς Βιθυνίας καὶ ἐν Ἐφέσῳ τῆς Ἀσίας· ἅπερ δημόσια λουτρὰ εἰς τὸ ἴδιον ἐπεκάλεσεν ὄνομα".

8 Yellowish ochre abrasive substance was found in the Forum of Aregenua, France, where large scale sawing took place (Tendron, Germain-Vallée and Jardel 2012:115 and Figs 2, 3).

Figure 2: Sawing leftovers: 1–6, 9 from the area of the Octagonal Church complex; 7–8 from near the complex identified as Antoninus Pius Thermae. 1, 2, 6, 7, 9 white and grayish marbles; 3 bitumen; 4 conglomerate; 5 limestone; 8 calcite-alabaster.

sectile panels had been produced at the time. In contrast to the amphitheater the area of the Octagonal Church complex yielded a large number of *sectile* shapes cut out of white, grayish and colored stones, of which many—as the remnants of thin slabs indicate—were produced on the spot (Fig. 2:1–6).

Clear evidence of producing *sectile* shapes out of recycled sculpted members is provided by a number of pieces found in different locations, whose underside retained the carving of the items they were cut out of (Fig. 4). The shield (Fig. 4:6), for example, and two additional *sectile* pieces (Fig. 4:3–4) were likely cut out of fluted or spiral shaped columns. The parallelogram (Fig. 4:1) and the trapezoid (Fig. 4:2) were probably cut out of pedestal bases. Yet not all recycled pieces derived from architectural members; useless stone furnishing was also considered appropriate material. A *sectile* shape uncovered, like the aforementioned ones, in the semi-public complex which occupied Insula W2S3, was cut out of an *orbis* tabletop (Fig. 4:7), another from the same complex

Figure 3: Sawed *spolia* from Hadrian's amphitheater: 1 marble seat with remnants of parallel slits; 2 slab sawed from entablature; 3 sawed pilaster base.

was likely cut out of a champlevé relief (Fig. 4:5). The large hexagon uncovered in the Octagonal Church complex was likely cut out of screen panel to be embedded in a *sectile* floor (Fig. 4:8).

Obviously, not all slabs were sawed by means of water powered machines; manual operated frame-saws, like the one shown on a late Flavian relief from Ostia (Kessener 2010:284, Fig. 1), must have had also employed at Caesarea. Manual sawing by means of frame-saw and a combination of abrasive and water was widely used in antiquity; toothed blades were usually operated for sawing soft stones, toothless metal blades or cords were employed for sawing hard stones (Rockwell 1993:45–46; Kessener 2010:283–284; Wootton, Russell and Rockwell 2013:6–7). The fact that manual frame-saws were used at Caesarea for cutting thin panels, narrow strips and other *sectile* shapes, is evidenced by fragmentary slabs which the *marmorari* used as working tables for sawing. Remnants of yellow clay within the slits of the fragment found in the Octagonal Church complex, indicate the use of abrasive material (Fig. 2:9). Two additional fragments from the same complex are leftovers of manual sawing of

Figure 4: *Sectile* shapes produced of recycled architectural members and furniture: 1–4 giallo antico; 5–8 white and grayish marbles.

second-hand objects; one, a small fragment of dark gray marble colonnette (Fig. 2:6), was definitely too small to be sawed by water–powered multi blade saw machine. In the other, an unidentified object of dark red conglomerate with whitish and grayish inclusions, the unparalleled slits indicate manual sawing (Fig. 2:4).

STONE VARIETY

All of tens of thousands of *sectile* pieces uncovered at Caesarea were made of imported stones that reached the city from 2nd to 6th century CE by land and sea. By

and large they can be sorted, according to their geological features, into metamorphic rocks (marble, slate), sedimentary rocks (sandstone, limestone, travertine, breccia), igneous rocks (granite, porphyry), and carbonaceous sedimentary rocks (bitumen[9]). The variety of white, gray and colored stones which were available in late antique Caesarea is beyond imagination. We have already presented a share of the inventory in former publications (Gersht and Gendelman 2021; 2023) and will refer to some of them in the discussion bellow. As significant number of *sectile* shapes was cut out of colored stones whose provenance is still under study, we decided not to discuss their source in this context.

In each one of the complexes, where massive *opus sectile* work was carried out, stone variety was dependent on the needs (patterns and usage), availability and costs. As a rule, white, grayish, gray and red rectangular strips were mainly used for borders. Other white and colored shapes—circle, spindle, triangle, square, rectangle, parallelogram, rhombus, kite, trapezoid, pentagon, hexagon, arc, crescent, shield—were used for geometric designs (Figs. 5–6, 13); however some, as circles, spindles (= pointed petals) and crescents were also used for floral patterns (Figs. 7–8). *Sectile* pieces shaped for figural emblems—heads, torsos and limbs of human figures, marine creatures, and land animals—were mainly cut out of limestone and white marble (Fig. 9). Likewise cut out of limestone and white marble were many of the floral shapes: stems, petals, leaves (ivy, cordate, compound), nodes, and palmette and lily motifs (Figs. 7–8).

CUTTING AND SHAPING TECHNIQUES

At Caesarea most, if not all, *sectile* shapes were cut on the site, where the wall and floor mosaics intended to be incorporated. In each location functioned a temporary workshop, like the one that operated in the late antique mansion which occupied Insula W2S4 (Dray 2011; Gersht and Gendelman 2019:57; 2021:134; Gendelman and Porath 2022:181, 190).

Shapes were cut manually out of sawn slabs or otherwise unusable second-hand stones in a variety of techniques. Tool-marks clearly indicate that the tools and techniques employed for cutting and shaping the *sectile* pieces depended (a) on the stones' geological formation which affected their hardness, fragility and workability, (b) on the mosaicists' personal preferences and training, and (c) on the desired effect of the final product whether intended for decorating walls or for decorating floors.

Where sawed slabs were available, the most pragmatic—fast, frugal and accurate—method to produce straight sided geometric shapes, was to mark an orthogonal grid by using impermanent material like paint or charcoal, or by any channeling tool; then to saw the shapes by following the lines. Grid of the kind, marked on a fragmentary Greco scritto slab, was found in 1st–4th century villa dei Nonii Arrii in Toscolano Maderno, at the province of Breccia (Sacchi 2015:138,

9 Early Roman period black bitumen *opus sectile* tiles were found in the Givati excavations, Jerusalem (Tchekhanovets 2020:826, note 1).

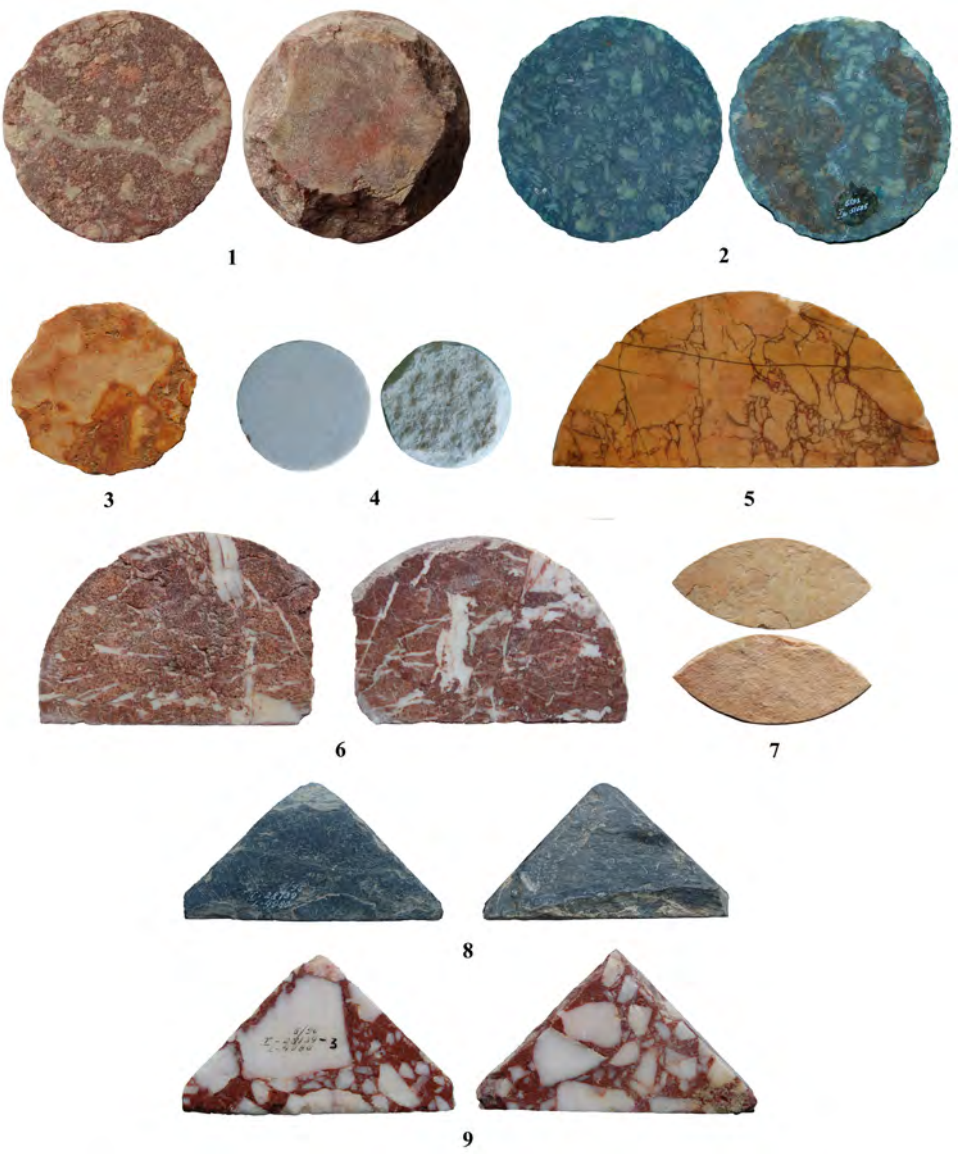

Figure 5: Geometric shapes: 1–4 circles (1. marmor Carium brecciated; 2. porfido verde antico, serpentino antico; 3. Travertine; 4. grayish marble). 5–6 semi–circles (5. giallo antico / marmor Numidicum brecciated; 6. fior di pesco / marmor Chalcidicum). 7 spindle (foliated/ multilayered limestone). 8–9 triangles (8. Slate; 9. Breccia coralline).

Fig. 15); another one, marked on a Proconnesian marble, was found in the Villa of Maxentius on the Via Appia, Rome (Conlin et al. 2006/2007: Fig. 8).[10] The grid system could have been also useful for producing shapes with curved outlines like circles, spindles, arcs, crescents and shields; but for these more time and further expertise in using tools were required.

10 Fragments marked with what seems to be grid were also found in Aregenua, France (Tendron, Germain-Vallée and Jardel 2012: Fig. 6).

In almost all Caesarea *sectile* shapes the sides are sloping inward in order to achieve a more stable adhesion to the wall or floor (Figs. 4:3–4, 6–7; 5:1, 4, 6, 8–9; 6:8; 7:2, 22); this is especially conspicuous in the thicker shapes. Imprints of robbed *opus sectile* floors have their outlines raised in a mirror image of the sloping sides of the *sectile* shapes (Fig. 13:1). The thickness of most shapes intended for walls varied from 1 to 2 cm. The thickness of those prepared for floors reached up to 3.5 cm and more. The lateral sides and underside are perhaps the most reliable markers for the technique employed for cutting and shaping each *sectile* piece. For demonstrating the diversity of techniques, we selected a collection of *sectile* pieces whose hardness, fragility and receptivity to tools can stand for most if not all thousands of *sectile* pieces that the Caesarea excavations yielded.

Among the hardest stones are the green porphyry (*porfido verde antico, serpentino antico*), red porphyry (*porfido rosso*), *giallo antico* (*marmor Numidicum* and *marmor*

Figure 6: Geometric shapes: 1–4 squares (1. red siliceous sandstone; 2. foliated/ multilayered limestone; 3. cipollino verde; 4. brecciated dolomite of unknown origin). 5 parallelogram (slate). 6–7 trapezoid (6. brecciated dolomite of unknown origin; 7. giallo antico). 8 shield (grayish marble with gray veins). 9 rhombus (white marble). 10 arch (giallo antico). 11–13 strips (11. white marble; 12–13. porfido verde antico, serpentino antico).

Numidicum brecciated), brecciated dolomite and *Africano* (*marmor luculleum*). The quantities of green porphyry and *giallo antico sectile* pieces uncovered at Caesarea are incomparably larger than that of the red porphyry; the *Africano* examples are few. The *sectile* pieces produced of the hardest stones were cut out of sawn slabs. Many of the pieces retained parallel sawing marks on their underside, often with rust stains as a result of side-to-side movement of toothless metal blade or cord (Figs. 5:2; 6:11; 7:20). In a few examples sawing marks are also visible on the upper face (Fig. 6:13). It seems that for shaping curvilinear pieces the mosaicists used right angled shapes that had been sawed in advance; they removed the redundant parts by hammering the piece onto a chisel-like blade set in a block of wood, in a technique similar to the cutting of tesserae (Fig. 5:2). The same technique was also employed for shaping rectilinear shapes when needed (Fig. 6:12).

To a second level of hardness, with receptiveness to most tools and techniques, belong the whitish and grayish marbles, colored stones (e.g., *fior di pesco / marmor Chalcidicum; cipollino rosso/ marmor Iassense/ marmor Carium brecciated*; *cipollino verde/ marmor Carystium/ marmor Styrium* and *Breccia corallina*) and travertine. Amongst the rectangular shapes cut out of whitish and grayish marbles there are pieces with six sawn faces (Fig. 6:1–4, 6–7, 9), while in other pieces the underside is coarse, bearing point or flat chisel marks. The divergence between the two suggests that different methods of production were used for producing these shapes. In one, thin sawn slabs, which were likely marked with grid, were sawed into shapes; some of these shapes still have parallel sawing marks with rust stains on their underside (Fig. 6:11). In the second method, much thicker slabs were sawed into long strips, probably by water–powered multi blade saw machine. The process of detaching the strips from the slab, by using chisels, left the strips with coarse underside and the leftovers with parallel slits like those in Fig. 2. The same technique was employed for producing some of the *giallo antico* strips. Needless to say that the rectangular strips produced in both methods could also be used for cutting other shapes such as squares, circles, triangles and trapezoids, either through manual sawing or by using chisels.

Not only contours of pieces made of stones of highest level of hardness were cut by hammering onto a chisel-like blade. Same technique was employed for cutting *Fior di pesco / marmor Chalcidicum* pieces out of sawn slabs (Fig. 5:6), and for cutting circles out of other second level of hardness stones (Fig. 5:1, 3). In contrast, most *Cipollino rosso*, *cipollino verde* and *Breccia corallina* rectangles and triangles have sawn sides, slightly chipped by chisel to form slanting (Fig. 5:9).

Among the stones of different levels of hardness, worth mentioning is the red siliceous sandstone. Whatever the reason, be it cost considerations or availability, the stone was widely used by mosaicists working at Caesarea as substitute for red porphyry (Fig. 13:2, 4). It was cut into amorphous pieces which were used as background fillers in wall patterns (Fig. 8:1), and into basic geometric shapes, mainly rectangles, squares, triangles and circles, used in wall facing and flooring alike. No sawing marks are observable on *sectile* shapes and fillers made of red siliceous sandstone. Tool marks at their sides indicate that the cutting procedure was the same as that of porphyry and foliated/ multilayered limestone shapes.

The latter is one of four kinds of limestone, differ in density and color, which the mosaicists working in late antique Caesarea used to produce *opus sectile* shapes. The yellowish–pinkish foliated/ multilayered limestone is the hardest, more fragile than the others, and is unsuitable for sawing. The quarrying method of this rock in itself produced slabs. The slabs, 0.5 to 2.5 cm thick, were separated along the natural crevices of the layers and dislodged by using crowbars. After reaching their

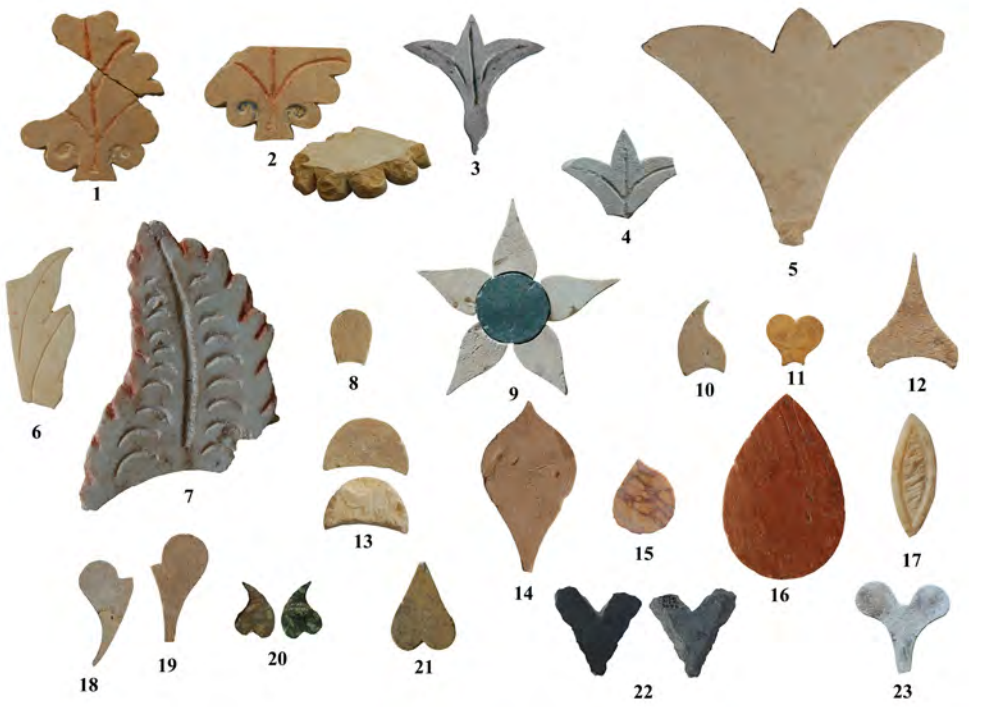

Figure 7: Floral shapes: 1–2 palmettes. 3–5 Lilies. 6–7 serrated leaves. 8–13 petals. 14–17 leaves. 18–19 nodes. 20–23 cordate leaves. Materials: 1, 2, 11, 21 yellowish limestone. 3–4, 8–10, 12–14, 18–19, 23 white limestone. 5–7, 17 white marble. 15 giallo antico brecciated. 16 red siliceous sandstone. 20 porfido verde antico, serpentino antico. 22 slate.

Figure 8: Floral shapes: 1 cordate leaf (ivy) and stems of white limestone; fillers of red siliceous sandstone. 2 laurel wreath in champlevé technique, grayish marble.

destination at Caesarea, the slabs were cut into shapes. The cutting procedure of small shapes by hammering onto a chisel-like blade was akin to that of the above-mentioned *porphyry*, *giallo antico* and *Africano* stones. Large rectilinear shapes were likely cut by hammering onto a block of stone, much as is done today. The other three kinds of limestones were workable with any tool. The yellowish limestone, because of its color and easiness to work with, substituted the *giallo antico* marble in carving complicated shapes like nodes and compound leaves (e.g., Fig. 7:1–2, 11, 21). Of the two kinds of white limestones, the softer, although rather dense, was easy to work even with a knife; it could be sawed with all types of saws including those appropriate for wood (e.g., Fig. 7:3–4, 9, 23).

Like the foliated/ multilayered limestone, the cleavable slate stone was quarried as slabs; if too thick it could easily be split to the required thickness. The slate *sectile* pieces were either sawed or shaped by hammering (Figs. 5:8; 6:5; 7:22). Also dark gray but less bluish are the bitumen shapes cut with chisels; like the slate they were used for both wall facing and flooring. Noteworthy is the fragmentary bitumen slab uncovered during the 2014 salvage excavation conducted by Peter Gendelman in Insula E3S2 (Fig. 11). Although only one corner of the slab was preserved (2.7–3.4 cm thick), enough remained to realize that it was inlaid with *opus sectile* geometric shapes (0.9 cm thick), most likely cut out of colored stones. The salvage excavation exposed a few square meters of a large insula; it is therefore expected that when more of the same insula and perhaps the adjacent one will be excavated, more slabs of the kind will be found.

SECTILE SHAPES WITH INCISED UPPER FACE

Upper face of most *sectile* shapes is plain. In a number of figural, floral and geometric shapes the upper face bears incisions; occasionally the incisions were filled with dye.

A. Figural Shapes

The incisions engraved into the upper face of body *crustae* meant to accentuate details and endow three-dimensional illusion—like in painting—to depictions of human figures and other creatures. Facial details of human beings and animal (Fig. 9:1–2, 13–15, 17, 19), hair (Fig. 9:13), fingers and toes (Fig. 9:3–5), caudal fins (Fig. 9:18) and bird tails or wings (Fig. 9:16), all bear incisions fashioned by means of point and flat chisels, and drills when needed (e.g., Fig. 9:7, 9). When the details were incised into foliated/ multilayered limestone the underneath layer—either pinkish or yellowish—endowed the incisions with the impression as if being painted.

Identifying obscure fragments as body *crustae* was made possible by comparing incised details to examples from other sites. V shaped incision as in Fig. 9:6, for example, defined the area between the collarbones of Venus fastening her sandal from Pompeii (Dohrn 1965: Pl. 56:2), but also the frontal knee of at least one *sectile* figure from Nero's Domus Transitoria nymphaeum on the Palatine (Dohrn 1965: Pl. 50:5). Curved incisions and small circles, as in Fig. 9:7–9, marked breasts and nipples

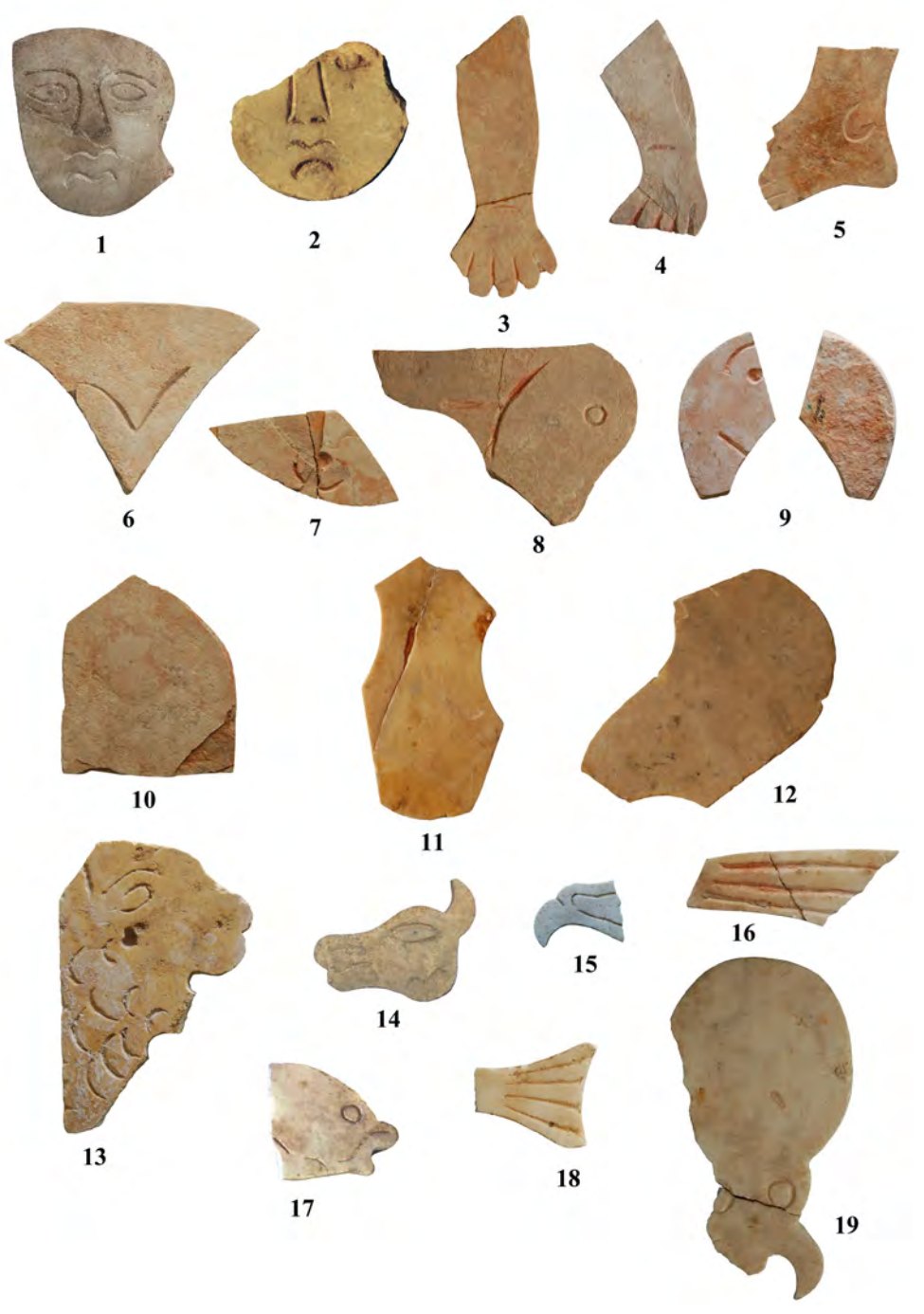

Figure 9: Figural: human and animal body parts. Materials: 1, 14–19 white marble. 2–10 foliated/multilayered limestone. 11–12 giallo antico. 13 yellowish limestone.

of several other figures from the same Domus (Dohrn 1965: Pls. 50:4, 51:3–4; Tomei 1997:66, 72; Dunbabin 1999:263, Fig. 279, with references). Curved incisions and circles also accentuate breasts of *sectile* figures that decorated the Claudian nymphaeum-triclinium at Baiae (Alagia, Cuccurullo and Nieberle 2016:418, Fig. 4; Cuccurullo 2018: Fig. 6) as well as the navel of the above-mentioned Pompeian Venus (Dohrn 1965: Pl. 56:2). All these 1st century CE examples, like the contemporary Pompeiian Dionysiac panels in *opus sectile* (Elia 1929:265–270, Figs. 1–3; Dohrn 1965: Pl. 57; Dunbabin 1999:263–264, Fig. 280) were made in the incrustation technique (*opus interrasile*, *interraso marmore*), in which the *crustae* were embedded in a background slab.

Incised and plain human and animal body parts are also familiar from later date, e.g., feline paws and fish from the Roman villa in Toscolano Maderno (Sacchi 2015: Fig. 18), 3rd–4th century animal heads from the Sardis Synagogue (Ασημακοπούλου–Ατζακά 1980: Figs 10β, IIε), 4th century animal protomas from the Imperial Mausoleum in Milan (Neri, Verità and Bugini 2015: Fig. 5), 5th century dolphins from the Octagonal Church at Philippi (Ασημακοπούλου–Ατζακά 1980: Fig. 21α), 5th–6th century figures from Palatium Sessorianum, Rome (Borgia, Colli and Palladino 2008: Figs 52–54), and a 6th century figure from the Baptistery Basilica at Peyia (Πέγεια), Cyprus (Ασημακοπούλου–Ατζακά 1980: Fig. 53γ).

Given Dunbabin's note that in the late Empire the regular form of *mural opus sectile* substituted the incrustation technique (Dunbabin 1999:263–264), and since only fragment of a single geometric background slab have been found at Caesarea thus far (Fig. 11), we assume that the figural *crustae*—like those in the mid 4th century panel of Hylas and the Nymphs from Junius Basus' Basilica, Rome (Becatti 1969: Pl. 83; Dunbabin 1999: Pl. 38), and the late 4th to early 5th century mosaics from the so-called "edificio fuori Porta Marina", Ostia (Becatti 1969: Pls. 55–56; Dunbabin 1999: Pl. 40)—were treated in the regular technique.

Obviously, not all body parts bore incisions; a number of them were plain. If not found together with those bearing incisions—as in the case of the plain fragment from L377 in Insula W2S3 (Fig. 9:10)—their identification is difficult, sometimes even impossible. Additional plain *sectile* piece from Insula W2S3, found in L344 (Fig. 9:11), was not accompanied with incised body parts; yet its dimensions, the curved outline forming its shape, and the fact that apart from a crack it was found intact, are in favor of figural identification. By comparing the undefinable *giallo antico crustae* (Fig. 9:12) with *crustae* embedded in the *sectile* mosaics from the 4th century CE Basilica of Junius Bassus (Becatti 1969: Pls. 81–83), it becomes clear that they could have belonged to images of human and/or animal figures.[11]

B. Floral Shapes

Only a few floral shapes with incised upper face were found at Caesarea; they include palmettes, lilies and serrated leaves. The incisions vary from strait and curved lines that mark the midribs, veins, and serrated margins of leaves (Fig. 7:1–4, 6–7) to wider recessed areas on or between the leaves (Figs. 7:1–2, 17; 8:2). A large number

11 For earlier examples, see the reconstructions offered for *crustae* from Villa Adriana, Tivoli (Cinque and Lazzeri 2012: Figs. 25–27).

of incised *sectile* leaves is included in the *opus sectile* friezes which decorated the building outside Porta Marina, Ostia (Becatti 1969:81–86, Pls. 57, 58:1, 67, 68, 69:1). Incised *sectile* leaves were also found in other sites, for example in Nero's Domus Transitoria, Rome (Dohrn 1965: Pl. 53; Fusco 2014: Fig. 36), in the Roman villa in Toscolano Maderno (Sacchi 2015: Fig. 21a), in Trier (Krencker et al. 1929:318, Fig. 509 on p. 315; Ασημακοπούλου–Ατζακά 1980: Fig. 24β), and in the Imperial Mausoleum in Milan (Neri, Verità and Bugini 2015: Fig. 4).

In some of the Caesarea shapes the incisions were filled with dyes whose traces are still visible. Incisions of the kind, filled with colored mixtures, are included under the term champlevé technique (see Gersht 2022:194–195). No trace of color was preserved on the lance–shaped leaf (Fig. 7:17), but the uneven point chisel strokes in its recessed inner part suggest that it was, or at least intended to be, filled with color. Red color, however, remained within the incised margin of a serrated leaf (Fig. 7:7); red and blue on a number of palmettes (Fig. 7:1–2).[12] Remnants of red ochre were also preserved in the recessed areas between the leaves of a couple of *opus sectile* laurel wreaths, which ornamented a small bath caldarium in Insula W2S3 (Fig. 8:2; Gersht 2022:195, Fig. 2).

C. Geometric Shapes

Unless the lance–shaped leaf (Fig. 7:17) was used as spindle in a geometric pattern, only two examples with incised upper face were identified among the geometric shapes, both in the champlevé technique. One, a small rhombus was found in Insula W2S3 (Fig. 6:9); the other, of which less than half was preserved, was found in the adjacent Insula W2S4 (Fig. 10:1). The latter, when intact, showed a circle of *peltae*; the areas between the *peltae* were filled with red dye (Fig. 10:2).

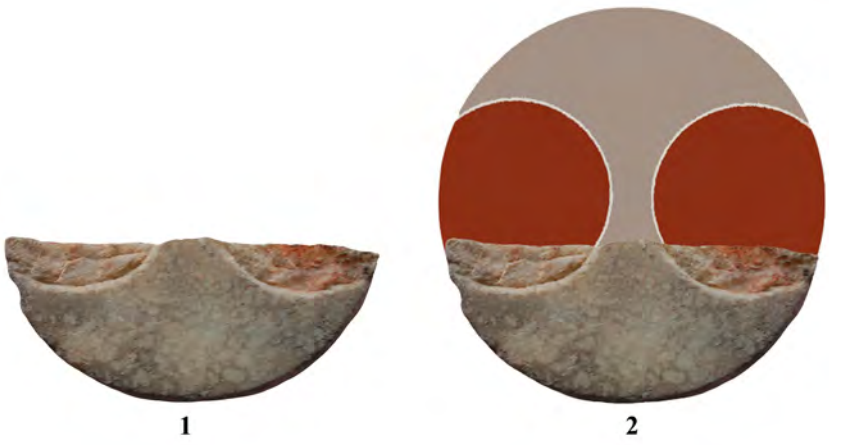

Figure 10: 1 Circle of peltae in the champlevé technique, Insula W2S4. 2 reconstruction.

12 Pieces of *opus sectile* from the Synagogue at Sardis were likely also filled with color (Rautman 2020: Fig. 14).

FINISHING AND ADJUSTMENTS

No matter how the *crustae* were cut, by sawing or by hammering and chiseling, rough shaping often required refinements and adjustments before putting the pieces together to create a pattern. As mentioned above, almost all *sectile* shapes have their sides sloping inward. This was done by chiseling, using flat and roundel chisels. The chisels had to be held at a sloping angle to avoid micro-fractures beneath the surface, but also to achieve an applicable angle for a better fitting of the stone into the pattern and for a more stable adhesion to the wall or floor. When needed, the sides' upper edges were smoothed by scrapers and/ or rasps; by scraping back and forth the tools left multidirectional marks on the surface.

Figure 11: Bitumen slab, originally inlaid with *opus sectile* geometric shapes.

Upper faces, especially those bearing noticeable sawing marks, were similarly smoothed by scrapers and/or rasps. The question is in what stage of production the *sectile* shapes were smoothed, before or after the cutting, or after the panels were attached to the wall; or in case of floors, after the *sectile* mosaics were laid. Same question is relevant regarding the process of polishing. It seems more reasonable that rough smoothing, unless required otherwise, was done before cutting; high level smoothing/polishing was done after the mosaics were affixed to their place.

There was twofold reason for utilizing abrading stones upon installed mosaics—technical and aesthetic. Technically, polishing wide areas is simpler than polishing small surfaces; aesthetically, the abraders leveled the surface and granted the mosaic shiny look. In Caesarea the mosaicists used pumice and sandstone abraders for achieving highly smooth finish. A number of such stones were identified in Insulae W2S3 and E3S2, the Octagonal Church complex and the Hadrianic amphitheater (Fig. 12:1–4).[13] Obviously the highest level of smoothing by stone abraders could only be achieved on hard types of stone, such as marble, porphyry, and foliated/ multilayered limestone.

Opus sectile wall panels, as the range of thickness of the shapes suggest, were prefabricated in the reverse method. The panels found scattered broken over the floor of the workshop in Insula W2S4 are substantial evidence that this method was actually

13 For the various kinds of abrasive materials, see Rockwell 1993:48; Wootton et al. 2013:9, Fig. 25.

employed in late antique Caesarea. In the reverse method the shapes were laid next to each other with their upper face down (Dray 2011). In this method uniform thickness of shapes was not required, nevertheless in case of extremely thick shape the underside was cut off, up to the required thickness. *Opus sectile* floor was laid directly, thus more uniformity of thickness was needed. It is apparent, based on scattered pieces and imprints of robbed floors that in most cases the shapes had their underside sawed or otherwise leveled by chisels (Fig. 13).

Many elaborate shapes bear remnants of red pigment along their sides; this must be the result of negative templates which the mosaicists used to achieve maximum accuracy and uniformity in size and profile (Fig. 12:5). Negative templates were likely

Figure 12: Abrasive stones and proposed reconstruction of template: 1, 4 pumice abrasives. 2–3 sandstone abrasives. 5 template.

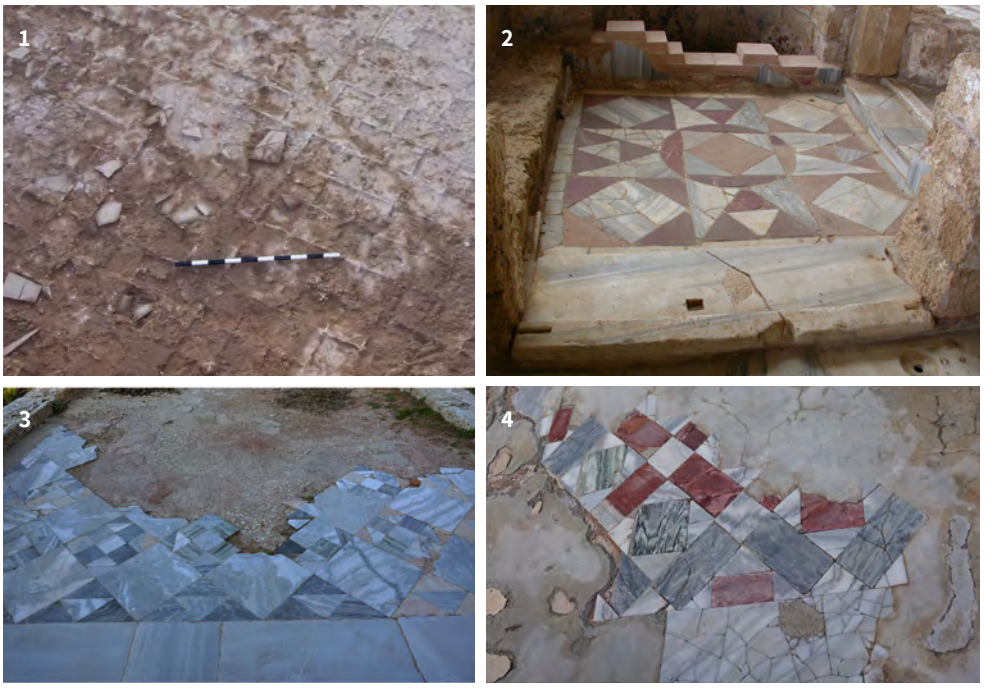

Figure 13: *Opus sectile* floors: 1 imprints, Insula E1S6. 2 Insula W2S3. 3–4 Insula W2S4.

made of wood. After the template was brushed with red pigment it was held up against the *sectile* piece to test it for accuracy. The process could have been repeated several times; after each time the piece was scraped until the whole area was equally levelled to receive the dye (Gersht and Gendelman 2019:59–60, Fig. 6c).

EDXRF AND SEM-EDS ANALYSES

As noted above, the underside of many *crustae* bear sawing marks with rust stains (Figs. 5:2, 6:11, 7:20), the sides of certain *sectile* shapes bear red pigment (Fig. 12:5), and the upper face of a number of shapes is ornamented with red and blue dyes (Fig. 7:1–2, 7). To identify the chemical composition of the pigments and to confirm the hypothesis regarding the rust remains, samples were taken from a small number of pieces and were analyzed by using EDXRF (ARL – QUANT'X, Rhodium detector and Beryllium window),[14] and SEM-EDS (Quanta 200 FEG environmental scanning electron microscope and energy-dispersive X-ray spectroscopy).[15]

Three *sectile* pieces were analyzed by SEM-EDS and three *sectile* pieces by EDXRF, of which one was analyzed by both techniques. In SEM-EDS the *sectile* pieces were introduced into the vacuum chamber where the stone, dye and rust had been analyzed separately. In EDXRF powder of stone and dye, taken by scalpel, were analyzed. As

14 The EDXRF analyses were done by Dr. Ahuva Be'eri in 2012, then a PhD student at the Tel Aviv University.

15 The SEM-EDS analyses were done by Dr. Zahava Barkay at *The Wolfson Applied Materials Research Center*, Tel Aviv University.

it was impossible to reach absolute isolation of dye from stone the results of each element in both techniques are qualitative.

The results of the red dye have shown high percentage of iron, indicating the presence of ferric oxide: hematite (Fe2O3) or red ochre (Fe2O3·nH2O). Each could have been used in the negative template process (Fig. 12:5), as well as in filling recessed areas in floral motives and human and animal body parts (Fig. 9:16, 18). The analysis of the blue dye by SEM-EDS only (Fig. 7:2) showed high percentage of silicon (Si) and copper (Cu) which accords with the composition of Egyptian blue ($CaCuSi_4O_{10}$ or $CaOCuO(SiO_2)_4$). Red ochre, hematite and Egyptian blue were identified in Herodian, Roman and Late Roman Caesarea wall paintings (Linn 2017).

As for the rust, the relatively high concentration of iron, detected on the *sectile* pieces underside, is unquestionably the result of sawing by using iron blade or cord. The iron's residues were oxidized resulting rust ($Fe_2O_3·nH_2O$).

IN CONCLUSION

Even if taking into account only the bulk of 6,347 *sectile* shapes and fillers—intact and fragmented—uncovered in the semi–public complex which occupied Insula W2S3 (Fig. 14), the distribution of the variety of stones provides a clear picture of the availability of materials, aesthetic preferences and financial considerations of the Caesareans. Whitish and grayish marbles comprise 19% of the whole bulk; these stones were easily attainable, for the *spolia* used by the mosaicists was mainly of white and grayish marbles. Colored stones — marble, breccia, travertine, granite and porphyry — constitute 4%, red siliceous sandstone 13%, *giallo antico* 24%. Limestone constitutes 32%, of which 15% is foliated/ multilayered limestone; green porphyry

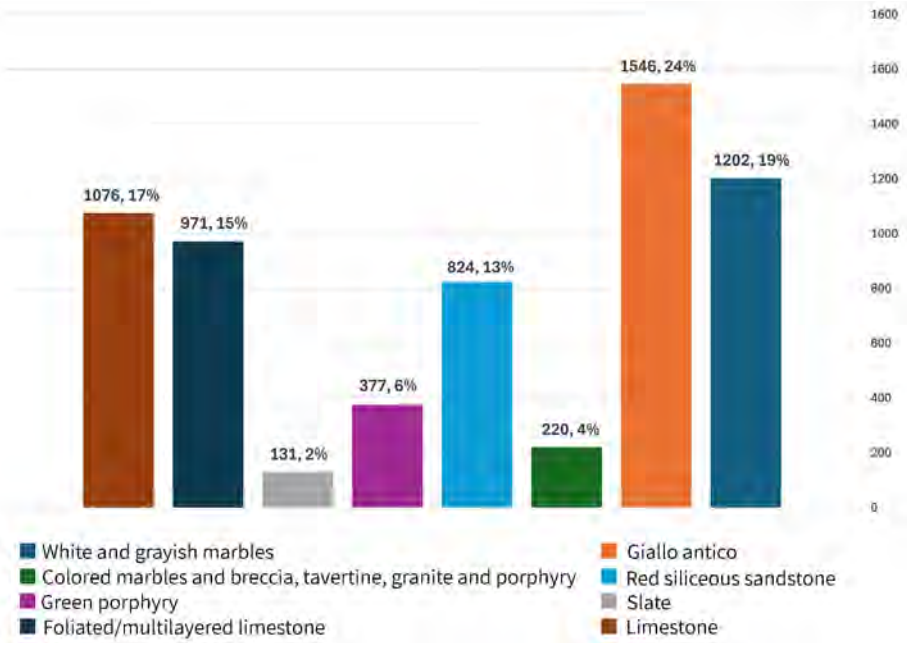

Figure 14: Chart of quantities and percentage of *opus sectile* shapes from Insula W2S3.

6%, and slate 2%. If taking into account also the 2,709 fragments—unidentifiable, wall revetment and floor tiles—which were found together with the *sectile* shapes and fillers, the numbers of pieces and related percentage change in favor of the white and grayish marbles, as shown in Fig. 15. If considering also the complex's *sectile* floors still *in situ*, the picture changes in favor of the white and grayish marbles even more, but also in favor of the red siliceous sandstone and the foliated/ multilayered limestone (Fig. 13:2; Gersht and Gendelman 2021: Figs. 18, 19, 21, 24).

The study of wall and floor *crustae* showed that at Caesarea availability, aesthetic preferences, and financial considerations were all interwoven. Likewise were the cutting and finishing techniques. As red porphyry was available in limited amounts, the red siliceous sandstone was used instead. Often the two stones were laid side by side, like in the border of the panel that decorated the west wall of Caldarium L698 of the Large Bath in Insula W2S3 (Gersht and Gendelman 2021:120–121, Fig. 22).

The same holds true for slate and bitumen. Given the small number of bitumen shapes uncovered thus far in late antique Caesarea contexts, we assume that when a piece of dark gray was needed and all corresponding slate shapes had been used up, a Roman bitumen piece could have been a suitable substitute. A significant number of Roman bitumen shapes was found recently in two locations next to the Temple Platform of Augustus and Dea Roma. A few hundreds of shapes cut out of white and grayish marble and hard white limestone were found together with the bitumen pieces. Preliminary study of the Roman shapes showed that the cutting techniques were very much like those employed in late antique Caesarea, yet the repertory includes a few unfamiliar shapes, and the finishing is more refined. A few pieces with similar finish were found in Insula W2S3; we therefore cannot rule out the possibility that shapes taken apart off walls of Roman period structures were embedded into Byzantine *opus*

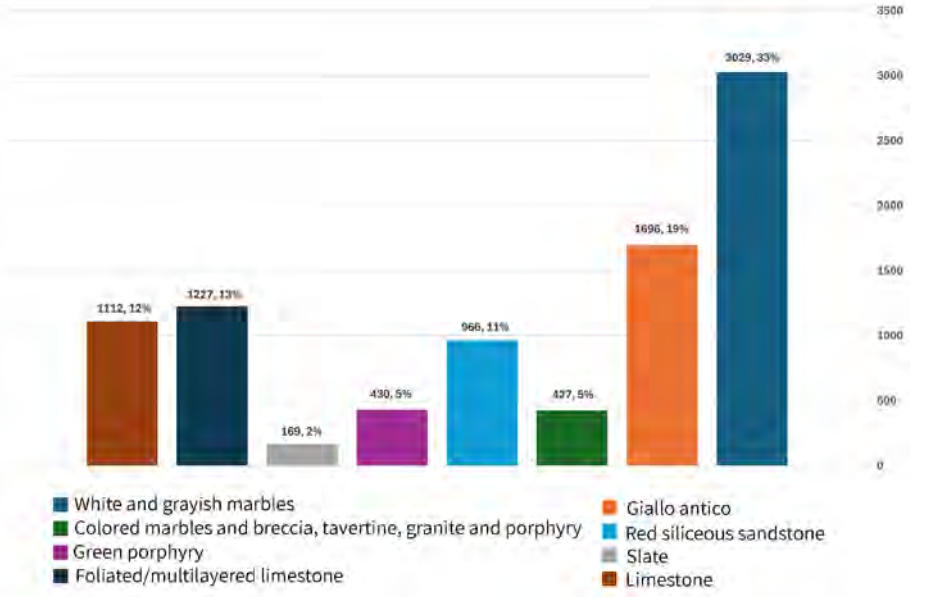

Figure 15: Chart of quantities and percentage of identified and unidentifiable *opus sectile* shapes and detached fragments of flooring and veneer slabs from Insula W2S3.

sectile wall panels. Whether the Roman shapes were cut at Caesarea or brought to the city already cut, perhaps even as prefabricated small emblems, is not yet clear.

Back to the aesthetic and economic preferences in late antique Caesarea. We assume that the differences in finishing were not only dependent on the stone's receptivity to tools or the mosaicists' expertise, but also on the intended place of each *sectile* piece in the composition, whether in the viewer's eye level or higher. High location did not require perfection in cutting and smoothing and in accurate fitting of the pieces together;[16] as a result, time and money could have been saved. Likewise, the sides of many amorphous *crustae* intended as background fillers were shaped roughly (Fig. 8:1) for financial reasons. Saving money by saving time and efforts was perhaps also behind the use of yellowish limestone, instead of the *giallo antico* marble, in carving complicated shapes like nodes and compound leaves (Fig. 7:1–2, 11, 21).

Although the *sectile* shapes in Figs. 4–10 cover only part of a richer variety of forms, they offer a clear picture of the repertory of shapes, enabling to place Caesarea in line with other sites where rich repertory of *sectile* shapes was found, such as Ostia (Becatti 1969) and Apamea (Balty 2004). In both sites, geometric *sectile* shapes such as circles, spindles and arcs, function as floral elements next to petals and serrated leaves familiar from the Caesarea repertoire. The Ostia, Apamea and other sites *crustae* (e.g., see Wielgosz 2013; Neri, Verità and Bugini 2015; Sacchi 2015) indicate that not only forms, probably also production techniques were similar all over the ancient world. The grid examples and the trend of reusing materials as source for *sectile* shapes—as was for example also in late antique Sagalassos (Corremans et al. 2012:46–47, Fig. 3)—are additional evidence of the mosaicists working methods and their competence in saving efforts, time and costs.

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Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

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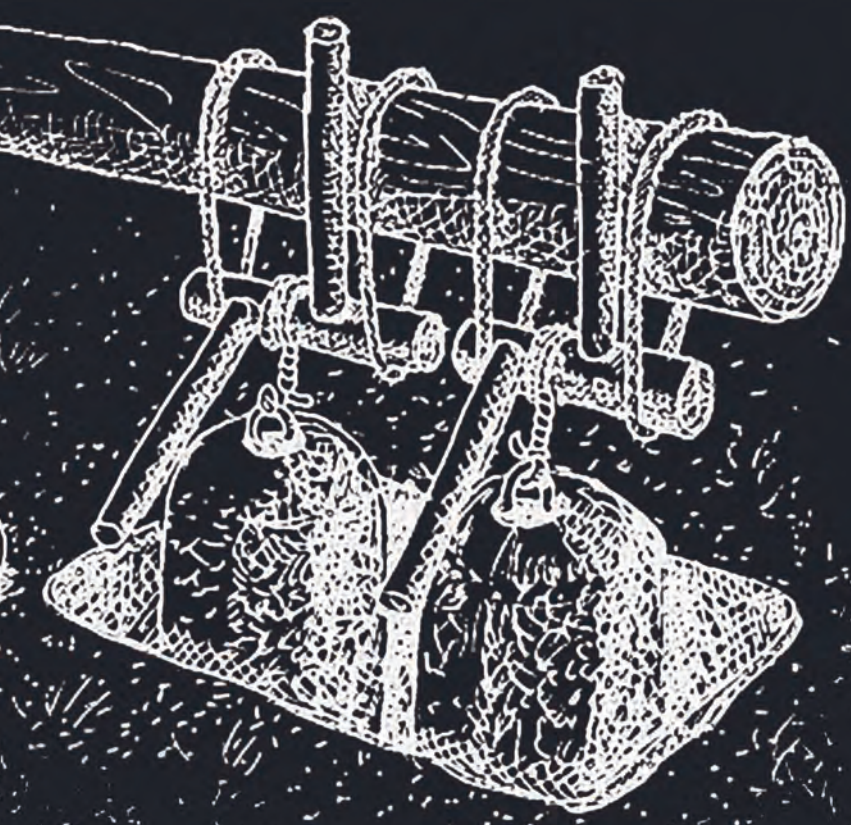

Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Industry and Commerce in Umayyad Baysān

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ABSTRACT

During the Umayyad period, Baysān underwent significant urban and economic transformation, with its civic center repurposed for industrial activities. Pottery workshops thrived in repurposed Roman-Byzantine structures such as the forum, theater and amphitheater, producing a wide range of domestic wares. The blending of local traditions with Umayyad innovations is evident in the craftsmanship and distribution networks of these products.

The city's textile dyeing industry also prospered, highlighted by the discovery of an advanced dyeing installation within the former eastern thermae. This installation demonstrates the sophistication of the dyeing techniques and the demand for high-quality fabrics in the region. Together, these industries underscore Baysān's role as a vibrant hub, blending Byzantine heritage with Islamic economic and cultural advancements.

Keywords: urban transformation, Roman-Byzantine heritage, Baysān, pottery workshops, textile dying facilities, bazaar, portico-shops

HISTORICAL BACKGROUND

During the Roman and Byzantine periods, Nysa-Scythopolis—later known as Baysān in the Islamic era—was strategically located at a central regional crossroads (*Capita Viarum*). These routes connected the Umayyad districts of *Jund al-Urdunn* and *Jund Filastin* (Isaac and Roll 1982; Roll 2005).

The early 7th century[1] witnessed pivotal events in Syria-Palaestina, including the Persian/Sassanian invasion (614), the Islamic conquest (634–636), and the subsequent collapse of imperial and municipal authority in the *poleis* of the eastern provinces, leading to the Byzantine Empire retreat (Baras 1982:300–349; Tsafrir and Foerster 1994:109–110; Bar-Nathan and Atrash 2011:1–15; Walmsley 2007:31–34).

In 635, the Islamic army captured Nysa-Scythopolis. While al-Tabari mentions a battle near the city and its surrounding lands (*xwra*), archaeological evidence suggests the city was not taken by force. Instead, historical sources indicate that its surrender followed the terms of the *sulḥ Dimashq* agreement (Al-Tabarī I:2158; Gil 1992:43; Sharon 1999:200). The city was now renamed Baysān—restoring its ancient Semitic name

1 All dates in this paper are CE unless expressed otherwise.

(Abel 1952, II:393–406; Avi-Yonah 1962; Raynor 1982:212–222; Fuks 1983:159; Tsafrir and Foerster 1997; Elʿad 1998; Sharon 1999:198–214)—and retained much of its urban structure as it became part of *Jund al-Urdunn*, with Tabariyya (Tiberias) as its capital.

The administrative organization of *Bilād al-Shām* (Syria-Palaestina) during the early Umayyad period closely corresponded with the Byzantine administrative structure and the related monetary system, with *Palaestina Secunda* becoming *Jund al-Urdunn*. However, a degree of incongruity emerged, as Baysān's urban landscape, dominated by Roman-Byzantine monuments, began to lose its cultural relevance. The city transitioned gradually from a *polis* to a *medina* (Tsafrir and Foerster 1994:95–117; Kennedy 2006; Avni 2011:290–301).

Following the Arab conquest, Tel el-Husn, a prominent mound in the city center, became the focal point of the Umayyad administration (FitzGerald 1931:15–17), featuring large courtyard buildings and an administrative complex (Figs. 1, 2).

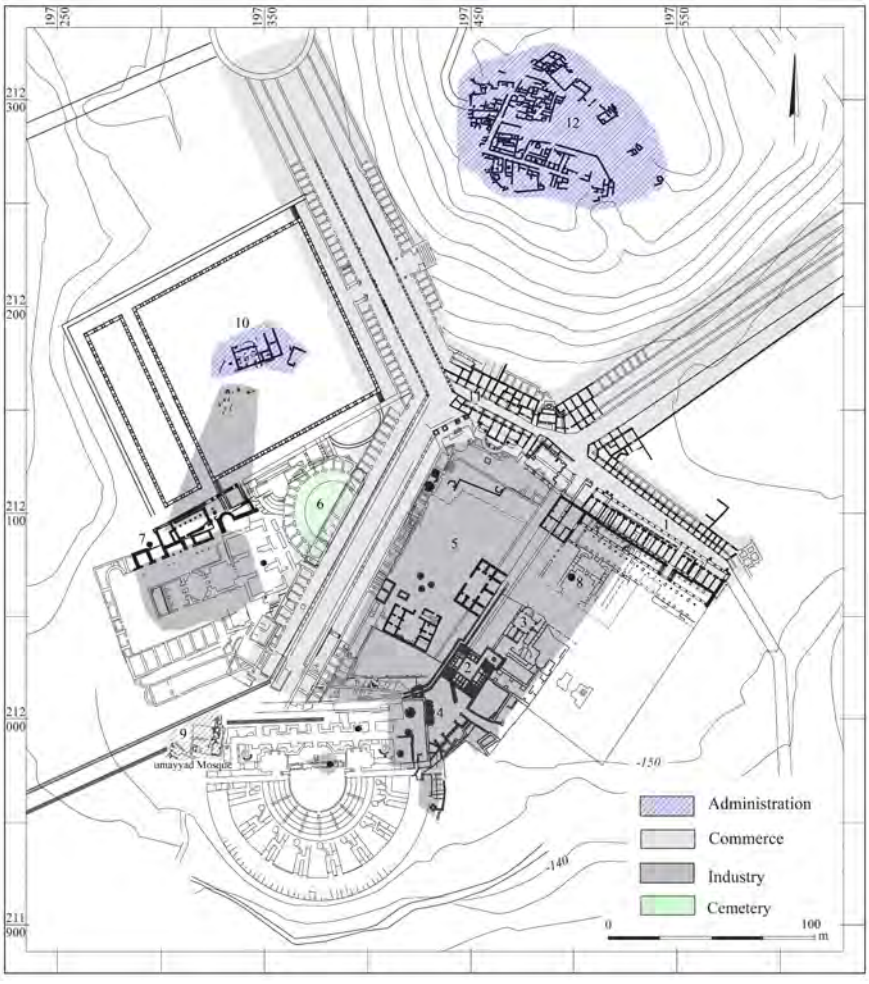

Figure 1: Plan showing the subdivision of the Roman-Byzantine civic center during the Umayyad period: 1. Hishām's sūq; 2. Umayyad textile industry; 3. Dwelling; 4. Theater pottery workshop; 5. Forum pottery workshop; 6. Umayyad cemetery; 7. Umayyad kilns in the western thermae; 8. Lime kilns; 9. Mosque; 10. Umayyad industrial building; 11. Street of Monuments; 12. Umayyad quarter (drwan by T. Meltsen).

Figure 2: Aerial view of the civic center, looking northeast (photo G. Laron).

Meanwhile, the deteriorating Roman-Byzantine civic center at the foot of the mound was transformed into a commercial and industrial zone by the late 7th century (Mazor and Najjar 2007:xiv).

Under the patronage of the Umayyad caliph Abd al-Malik (685–705) and his son Hishām (724–743), Baysān flourished. Abd al-Malik's reforms introduced Islam governance to the region, fostering growth, while Hishām advanced the city's economic infrastructure.

Baysān maintained its economic, commercial, and administrative significance within the region. Ecclesiastical authority, particularly from monastic institutions, retained partial jurisdiction during this period (Schick 1995). The city enjoyed relative peace from 634/635 to 697, preserving its architectural framework and cultural heritage despite a gradual, continuous decline.[2]

INDUSTRIAL FACILITIES

The industrial landscape of Umayyad Baysān was characterized by large-scale facilities primarily focused on pottery production and textile dyeing, with additional evidence

2 Archaeological evidence of the 659/660 earthquake, as well as the subsequent restorations, has been documented, indicating that the city underwent a rapid recovery.

of metal production installations. These industrial activities were housed within repurposed Byzantine complexes, including the former civic center and amphitheater.

Pottery Production

At least three pottery workshops were identified in Baysān: one in the theater, another in the forum, and a third in the amphitheater.

The theater pottery workshop occupied an extensive area of 1640 m^2. Its layout was adapted to the theater's eastern section, extending into its eastern piazza and staircase (Bar-Nathan and Atrash 2011; Atrash 2022:84–117; Figs. 3, 4). The workshop was divided into two main sections: the courtyards, which contained pools, kilns, raw material storage areas, and waste zones; and the enclosed halls, which housed potters' workrooms and drying spaces. These extended into the former eastern orchestra entrance *(aditus maximus)*, preserved from the Roman/Byzantine period with its original basalt vault ceiling.

Two adjoining pools were constructed on two levels, utilizing the slope of the theater's eastern staircase. The open raw material storage area was situated next to

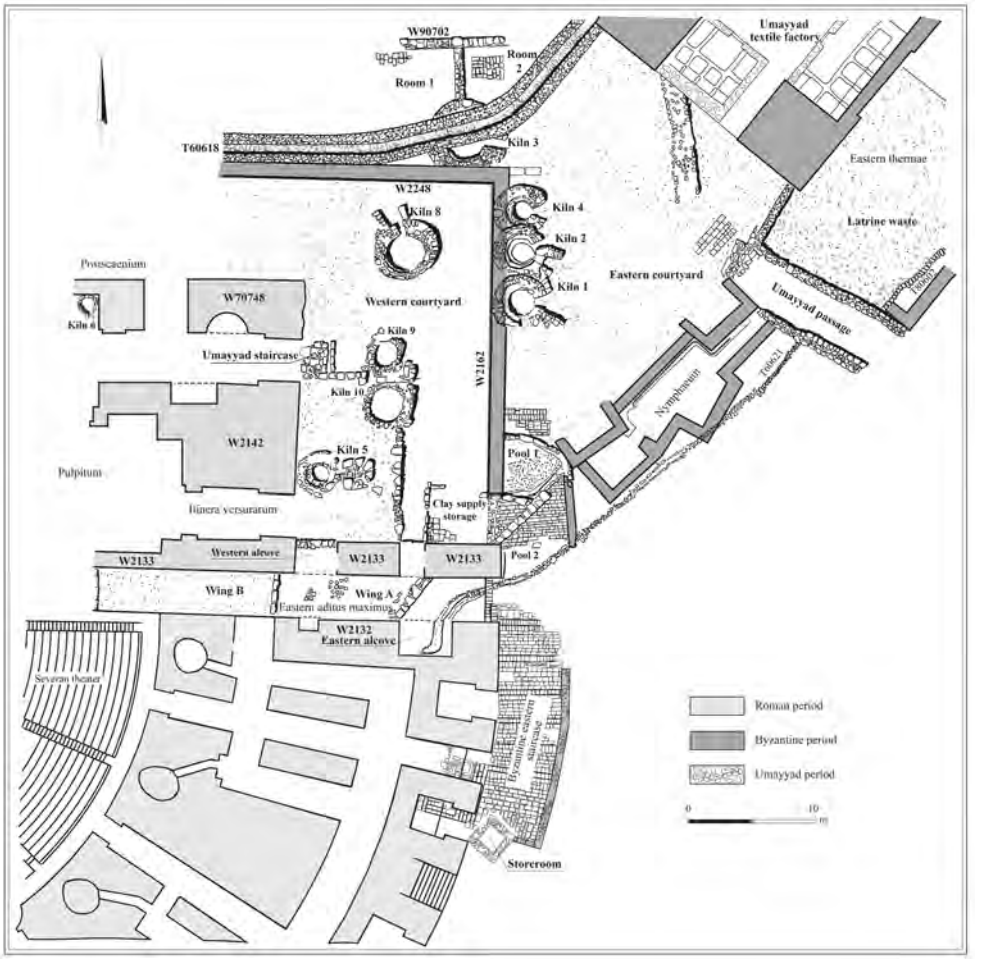

Figure 3: General plan of the theater pottery workshops (drawn by T. Meltsen).

the workrooms, while the roofed workspaces in the eastern *aditus maximus* were accessible from several directions. In the eastern alcove, a wheel room held a bench along its northern wall where the potter sat with a wheel in a shallow pit in front of him (Fig. 5).

Figure 4: View of the theater pottery workshop, looking south; the eastern staircase is in the background (photo G. Laron).

Figure 5: Artist's reconstruction of the potter's wheel-room in the eastern alcove (drawn by T. Meltsen).

Ten cylindrical updraft kilns were uncovered in this workshop, most with a diameter of 3.4–4.1 m, and one larger kiln measuring 5.3 m in diameter. The pottery-firing chamber is believed to have been a solid, domed structure with a central chimney that could be closed (Bar-Nathan and Atrash 2011:192–193; Fig. 6).

The forum pottery workshop, located north of the theater, covered a vast area of 8060 m^2 and was established in the southern part of the forum (Bar-Nathan and Najjar 2011:163–178). It was composed of two identical large courtyard buildings constructed of basalt stone and two settling pools inside the western portico, while a storage area for raw materials was located to the south. Seven kilns, also of the cylindrical updraft type, were constructed in the northwestern part of the forum (Tsafrir and Foerster 1992a:7; Figs. 7, 8).

One of the two courtyard buildings (22 × 12 m, 264 m^2), located at the center of the former forum, is a two-storied rectangular structure with a large central courtyard. The courtyard is flanked by two wings, each containing three rooms that likely served as potters' workrooms and storerooms for the tools and the finished vessels. Hundreds of these vessels were discovered in the ruins of the building following its collapse during the earthquake of 749. The central courtyard was accessed via its main entrance and was roofed with wooden beams supported by two large basalt stone arches. The potters' workroom had an additional entranceway leading to the back of the building, from which the pools could be accessed. Remains of a staircase next to the main entrance indicate the existence of a second floor that served as the potters' dwelling (Fig. 9).

Noteworthy finds from this building include a fragment of the top of the upper part of a potter's wheel; a complete stone potter's wheel—a variety of the pivot-and-socket type (Fig. 10); numerous buff-ware storage jars and flasks; and a lamp mold accompanied by lamps produced using this mold.

The second courtyard building of the forum workshop (310 m^2; Fig. 7 above), situated to the northeast of the first, featured a central courtyard surrounded by rooms on three sides. Two wings, flanking the courtyard to the north and south, each contained three

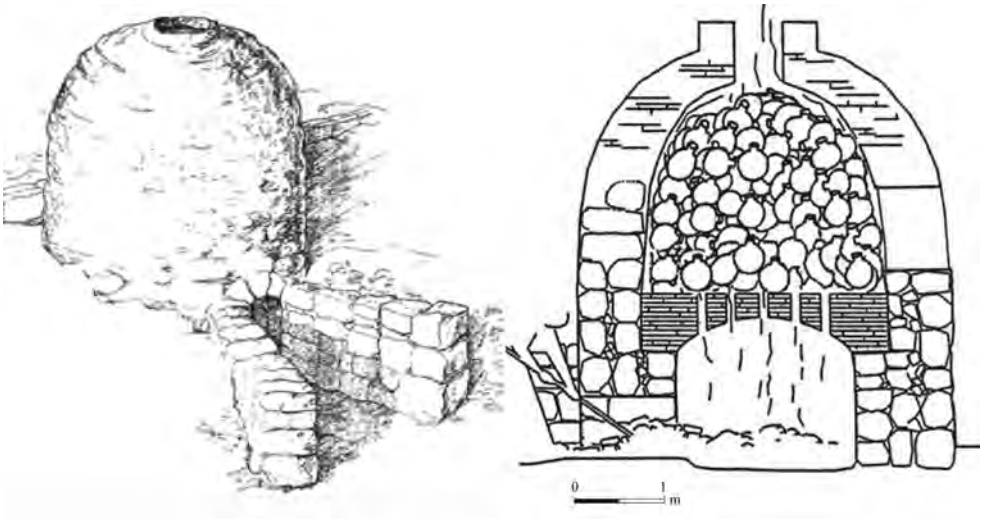

Figure 6: Isometric reconstruction and schematic section of a kiln (drawn by T. Meltsen).

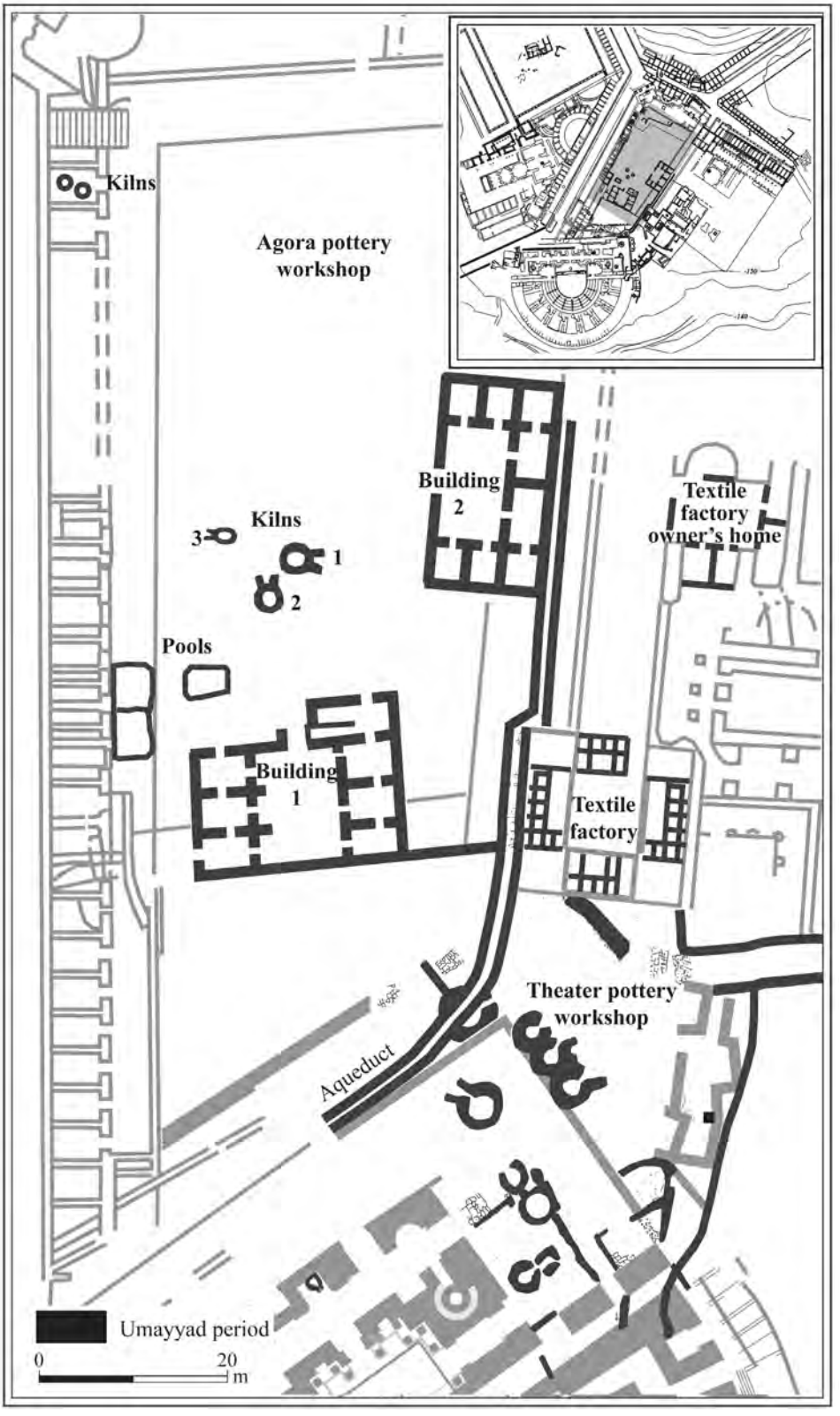

Figure 7: Plan of the Umayyad industrial zone: the forum, the theater pottery workshops, and the textile facility (drawn by T. Meltsen).

Figure 8: View of the forum pottery workshop, looking east (photo G. Laron).

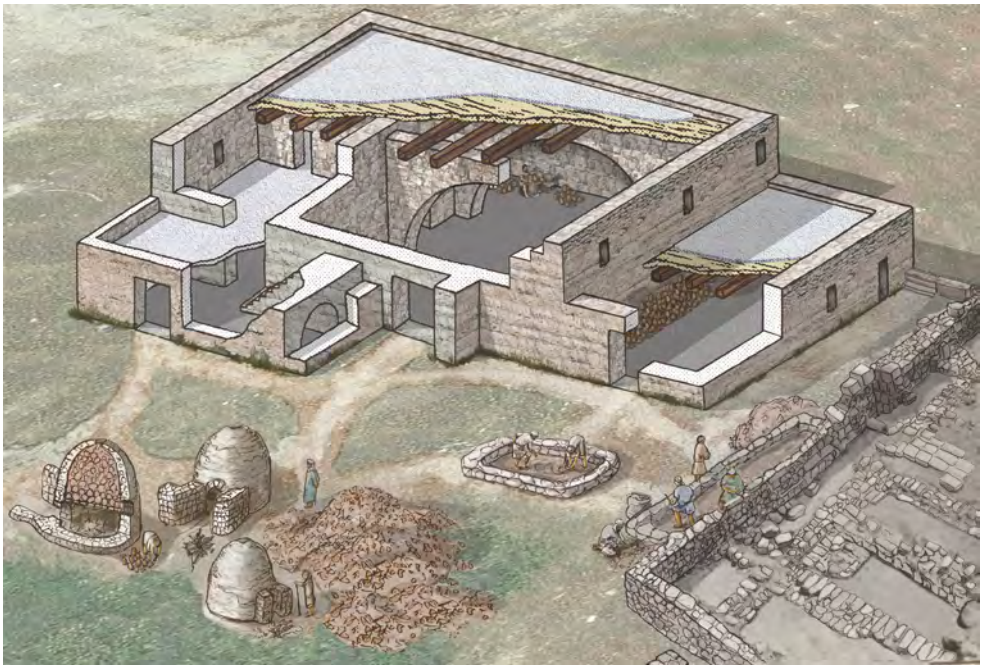

Figure 9: Suggested reconstruction of Building 1 in the forum pottery workshop (prepared by T. Meltsen).

Figure 10: Potter's wheel from the forum pottery workshop (photo G. Laron).

rooms, while the eastern wing, at the back of the courtyard, housed two rooms. These rooms probably were storerooms and workrooms, and it is possible that at least part of the building served as a dwelling for the workers. On the western side of the forum, shops from the Byzantine period were restored, likely used for selling the ceramic merchandise produced at the workshop.

The third pottery workshop, of which the excavation has not been published, was established outside the civic center, in the former amphitheater. It contained several kilns and pools for preparing clay.

The range of pottery types produced by the Baysān pottery workshops during the Umayyad period encompasses almost the entire repertoire of quotidian domestic vessels of that time. Some of these are types that were rooted in the late Byzantine tradition and were further developed in the Umayyad period, including bag-shaped storage jars, cooking ware, gray basins, and kraters. Among the new vessel types of the Umayyad period were spherical storage jars, small storage jars, pots, spouted jugs, flasks, and necked cooking pots, as well as a variety of different types of bowls, kraters, censers, oil lamps, and toys (Fig. 11). The Umayyad-period types are usually made of a different raw material than their late Byzantine predecessors which tended to fire to a light red, pink, or buff color; this raw material remained the predominant source in pottery production throughout the 8th century. We may surmise that the three pottery workshops of Umayyad-period Baysān played a major role in supplying pottery vessels to the city and its environs.

Textile Dyeing Industry

Nysa-Scythopolis, during the Roman-Byzantine period, is well known from historical Latin sources for its flourishing linen industry. A Diocletian edict (*Edictum De Pretiin Rerum Venalium*) from the early 4th century (301) and another 4th-century Latin source (*Descriptio Tutius Orbis*) relate to the quality and prices of linen products from Nysa-Scythopolis, which were described as among the finest and most expensive products in the entire empire.[3] It seems that Umayyad

3 Schürer 1973–1987, I:77, n. 205; it is also known from the historical sources that ripe flax stalks were harvested and gathered into sheaves once the crops turned green to yellow. They were left to partially dry, and subsequently, the seeds and woody straw were separated from the stocks. Then the materials were submerged in water with fungi and bacteria, initiating a micro-biological process that broke the pectic, cambium, phloem, and parenchyma in the

Figure 11: Selected theater pottery workshop products (photo G. Laron).

Baysān and its hinterland rural villages continued to be important centers for growing, processing, dyeing, spinning, and weaving textile products. Previously in the hands of Christian guilds, the industry was now presumably managed by Islamic merchants and might have constituted an important industrial and commercial component in the *medina* economy.

The western section of the eastern *thermae* retained its original domes. The square *frigidarium* (20.4 × 19.5 m) contained four large pilasters: two in the southwest (6.1 × 6.1 m) and two in the northeast (6.1 × 4.4 m), each decorated with semi-round niches housing statues and equipped with pendentives supporting a large stone *copula*. Between the pilasters were three rectangular, marble-plated pools (each 8 × 6 m, 1.5 m deep; Fig. 12).

A sophisticated industrial installation for textile dyeing by indigo was established in the *frigidarium* of the Roman/Byzantine eastern *thermae*. The large pools in the *frigidarium* hall were divided into smaller vats for dyeing textiles, and equipped with paved working surfaces, well-constructed water systems, and drainage channels (Figs. 13, 14).

The textile dyeing complex comprised two main sections. One section occupied the central hall and wide entrance of the *frigidarium* (Fig. 13:7), accessible from the northeast and southwest, with the latter connected to the

fibers. Dried, they were ready for further processing (Plini, *NH* 196:19.2.7, 19.3.16; Forbes 1956:27–42). Laws in the Theodosian Code (374) refer to flax production, linen dying and weaving (Pharr and Davidson 1952:145–147). Guilds of the textile industry at Nysa-Scythopolis (*linteones orlinyfus publico*) referred to textile production stages conducted in villages in the city's *xwra*. Nysa-Scythopolis guilds producing complete garments are mentioned in the Code and in Talmudic sources (Safrai 1994:192–202).

vast theater pottery workshop. The facility had a plastered floor with various small installations of unknown function (Figs. 13:5; 15). It also had identical small rooms, each with deep square vats surrounding a stone-paved central area (Fig. 16). Each room (5.70 × 4.35 m and 8.65 × 4.40 m, respectively) contained six symmetrical П- or Г-shaped vats surrounding a stone-paved central space (2.6 × 2.3 m), paved with limestone, basalt, and marble pavers; all of the 24 large and small vats were well-preserved (1.3 × 1.3 m and 1.05 × 1.05 m, respectively, 1.20 m deep). The walls and floors of the vats were thickly plastered. Each vat had a working surface (0.7–0.8 m wide), separated from the vat by banisters. The vats received water from channels set on top of their walls (Fig. 17). At their bottom was a clay pipe outlet connecting to a drainage system in the central hall. Water was supplied by various channels reaching the complex from the south. In the other flank of the complex was a grinding installation—a 1.25 m in diameter millstone, presumably producing the color ingredients (indigo) for dyeing the textiles, set within a rectangular basilica hall (10.2 × 5.8 m; Figs. 13:8; 18). A narrow corridor led from the millstone installation into the main textile processing facility.

A luxurious courtyard-type house located within the eastern *frigidarium* was presumably inhabited by the owner of the textile processing complex. The house (200 m^2) featured a central hall surrounded by five rooms, all roofed by a stone *copula* (Figs. 19, 20).

Another possible textile industry facility of this period was located within the abandoned amphitheater (not excavated). Various small, deep basins with paved working surfaces, supplied by water channels, were noted there.

A multi-roomed industrial complex, which may have already functioned for textile dyeing processing in the Late Byzantine period (6th century), was uncovered in the city's piazza near the northwestern gate (Caesarea Gate),

Figure 12: Eastern thermae's frigidarium, looking south (photo G. Laron).

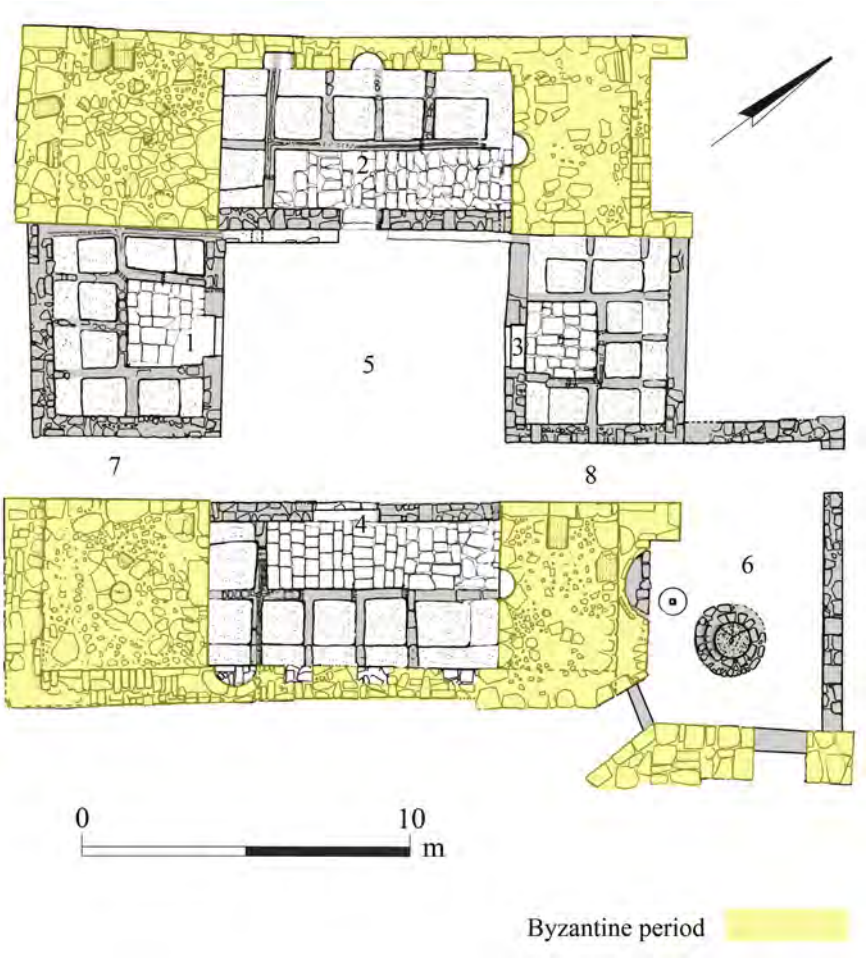

Figure 13: Plan of the Umayyad textile dyeing facility: 1–4. Textile (indigo?) dyeing installation; 5. Central hall; 6. Millstone; 7–8. Entrance (drawn by T. Meltsen).

connected to the Northern Colonnaded Street. The complex had a stone-paved area and water channels, and its rooms were paved with mosaic floors. One of the rooms was divided by thin plastered partition walls into a rectangular central area and an area with three deep square rectangular vats with plastered walls and floors, supplied with water via a clay pipe.

Textile production at Nysa-Scythopolis is recorded as early as the Hellenistic period (170–108/107 BCE) at the site's Tel Iẓṭabba, where a residential quarter with courtyard houses was uncovered. Here, wooden warp-weighted looms (1.80 m high, 0.70–0.85 m wide) were revealed together with hundreds of clay pyramid-type loom weights in various rooms (Mazor, Atrash and Sandhaus 2025).

THE CITY'S COMMERCIAL AREAS

The tradition of conducting commercial activities along colonnaded streets continued at Baysān in the Umayyad period, although in a different fashion. The urban and regional traffic on which these activities depended, and which connected the city with

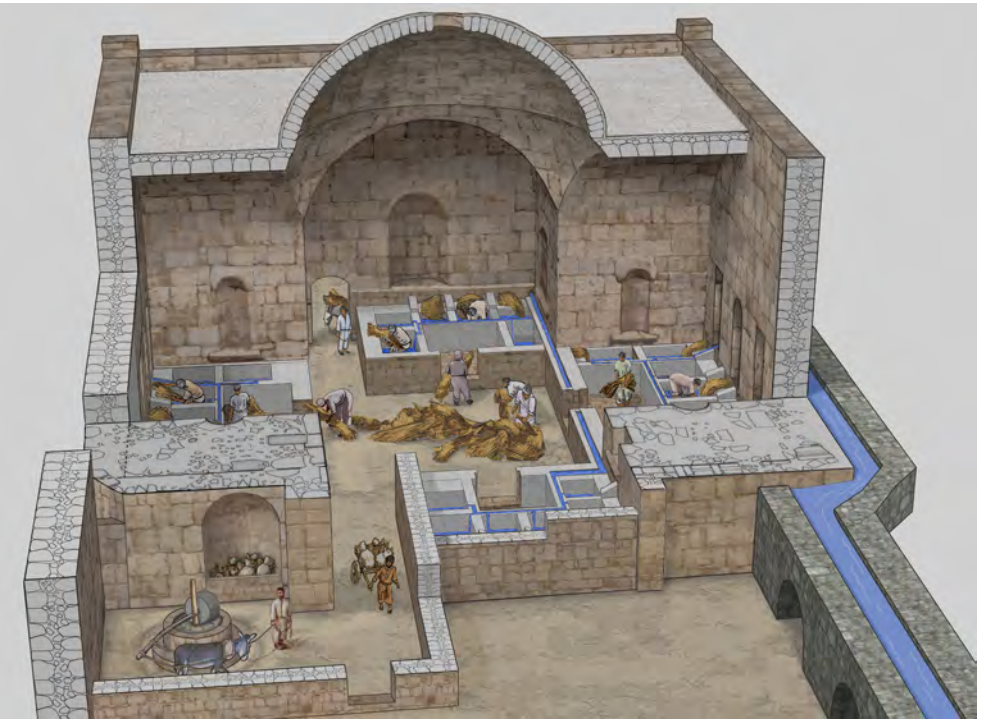

Figure 14: Suggested reconstruction of the textile dyeing facility in the frigidarium (prepared by T. Meltsen).

Figure 15: Eastern thermae's frigidarium and textile dyeing facility, looking southwest (photo G. Laron).

Figure 16: Room 4 of the textile dyeing facility, looking northeast (photo G. Laron)

Figure 17: Room 1 of the textile dyeing facility, looking southwest (photo G. Laron).

Figure 18: Grinding installation (possibly for indigo) in the textile dyeing facility, looking southwest (photo G. Laron).

Figure 19: Owner's house related to the textile dyeing facility, looking southeast (photo G. Laron).

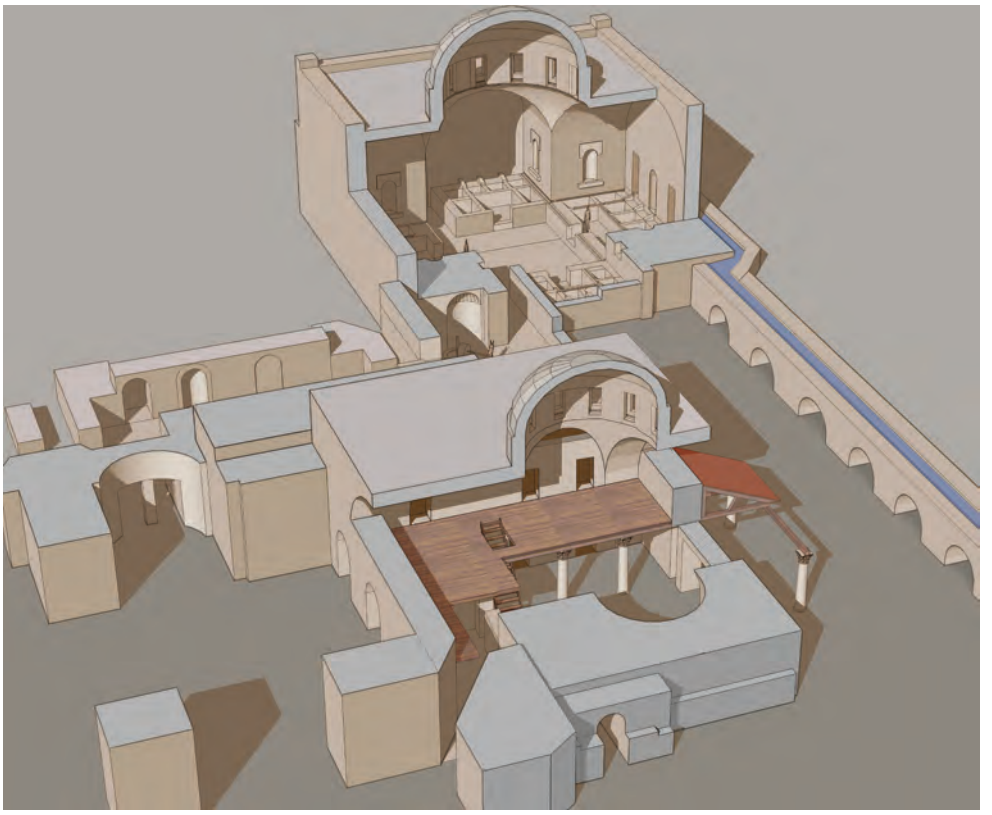

Figure 20: Suggested reconstruction of the textile dyeing facility and owner's house, looking west (prepared by T. Meltsen).

the other important markets of *Jund al-Urdunn* was sustained through the city's main arteries connecting the civic center with the city gates and regional road junctions, as well as the bridges across Ḥarod Stream, which were still functioning. The colonnaded streets became dominated by crowded bazaars (*sūq*), divided according to the types of commodities (Foerster and Tsafrir 1987–1988:34–35; 1988–1989:22, 126–128; Tsafrir and Foerster 1992b:18–19, 22–25, 27–32; 1994:108–112; Arubas 2005:2). The preceding Byzantine splendor and monumentality of these streets gave way to narrow earth-beaten lanes, while the shops intruded onto porticoes and streets. A new market was constructed by caliph Hishām in AH 120 (738) along the southern side of Silvanus Street, over a ruined Byzantine-period basilica that had formerly glorified the entrance into the eastern thermae (Fig. 21; Tsafrir and Foerster 1992b:25–30; 1994:108–112; 1997:123, 138–139; Khamis 2001:159–176; Arubas 2005:2).[4] The grand market comprised 38 shops in two stories, the floors opening to opposite sides. An arched arcade was constructed in front of the market complex, and a monumental gate, adorned with two gilded glass inscriptions attributing the project to Hishām, was set at the center of the *sūq* (Fig. 22). The archaeological assemblage of finds from the market shops indicated the specialization of various of them. It seems that those were affluent shops, trading in

4 For information on markets located along colonnaded streets in Aleppo and Jerusalem, see Wirth 1975:203–260.

Figure 21: Grand market of the eastern thermae, looking northwest (photo G. Laron).

commodities such as gold and imported glass that served the elite. Among the finds, a set of scales incised with gradations numbered in Greek and Arabic seems to attest to a bilingual population (Tsafrir and Foerster 1989–1990:127–128).

CONCLUSIONS

During the Umayyad period, as Nysa-Scythopolis-Baysān turned from *polis* to *medina*, the city's civic center was gradually altered, first by letting go of the former ideology of maintaining the public spaces as such, and then by changing the functions of these spaces. The monumental complexes were abandoned, left as empty reminders of a glorious past, becoming unused by the city inhabitants. Although the colonnaded main streets still functioned, they were turned into a series of narrow lanes, while porticoes were inhabited by rooms for various purposes, some of them becoming shops. The commercial activity in the shops set up along the streets appears to have been especially vibrant, and a monumental new bazaar was eventually erected along Silvanus Street. Industrial complexes that in the past were never part of the civic centers of Roman-Byzantine *poleis* were newly constructed. Two vast pottery workshops inhabited the former theater and the forum, and an impressive and sophisticated industrial complex, composed of numerous vats and

Figure 22: Monumental gate of the eastern thermae adorned with two gilded glass inscriptions and suggested reconstruction (prepared by B. Arubas).

working surfaces presumably serving as a textile dyeing facility, was installed in the former eastern *thermae* and *frigidarium*. These large-scale transformations unravel the drastic changes brought about by the Islamic *medina* urban concepts.

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Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

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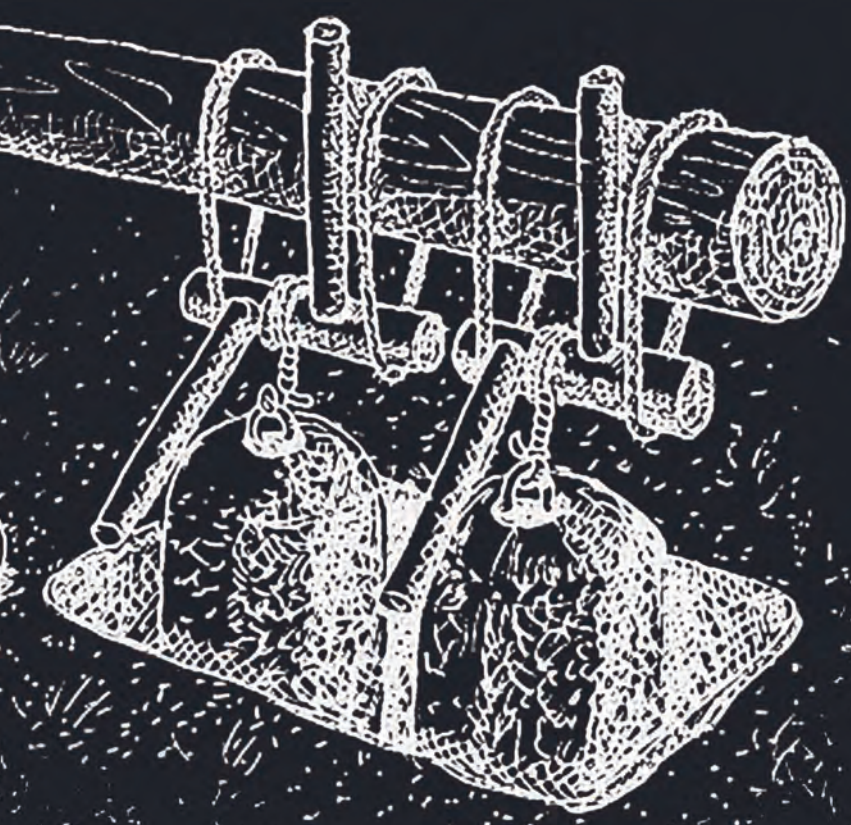

Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

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To Dr. Rafael (Rafi) Frankel (1929–2023)

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

A Drive Center (Mandrel) from the 7th Century CE Yassi Ada Shipwreck, and Turning Hollow Wood Items in Antiquity

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ABSTRACT

The turning of wooden objects in antiquity has been discussed in several studies. A detailed answer is now provided to the question of how to turn hollow items, in which easy access to the design of the interior space is essential. This suggestion is based on a new identification of an item discovered in the Yassi Ada (Türkiye) shipwreck from the 7th century CE. It was also verified by comparing the work methods and accessories used by traditional craftsmen to this day, and experimenting with turning a bowl on a replica ancient lathe.

Keywords: woodturning, mandrel, drive center, Roman woodworking technology

INTRODUCTION

At the beginning of the 8th century BCE, the wood industry was ready to adopt new inventions (Sitry 2022:58–60). The lathe, which was the first woodworking machine, opened a new era in the history of carpentry. The ancient lathe, although primitive and slow, was revolutionary in many aspects.[1] The process of production was shortened and became more efficient, and the cost of the product decreased. The significant change was in the design. The concept of round symmetrical items was an innovation which influenced the style of domestic ware, and symmetrical wooden bowls, boxes, etc. appeared on the tables of wealthy families.

As technology advanced, the products were better worked, and presented a handsome appearance, as a result of traces of working the surface being erased. At this point, the scholar's task of deciphering the working methods and the order of operations became difficult. Despite this, a closer inspection of the objects and the turning waste as well as ethnographic testimony may hint at the techniques used by the ancient craftsman.

1 For the first time it was the workpiece that moved, and the working tool was static. For the operation of the ancient lathe see Rieth 1941:101–104; Sitry 2006, I:259–272; Fellmann 2009:62.

THE ARCHAEOLOGICAL EVIDENCE

A close look at turned hollow objects shows few indicative signs of the methods used to hold the work piece on the lathe. Most common is the dent in the center of a symmetrical object left by the pivot of the lathe (Fig. 1).[2] Occasionally a scar is seen in the place we expect to find the pivot mark.[3] A scar usually appears at the base or bottom of the receptacle or on both. It is usually a result of core method turning. In this case, the item is placed between pivots (Fig. 2). During turning, the turner clears the bowl cavity, but leaves a central core supported by the lathe pivots. At the end of the operation, the core is removed manually, leaving a prominent mark on the surface of the item. In other cases, efforts to erase pivot marks may also leave scars.

A unique mark that is the subject of our discussion is a series of holes arranged around a central hole on the base of an item. The use of this method has been identified in various Roman sites.[4] These marks identify an efficient method that allows easy access to turning the bottom of the objects. In turning items in which the shape or size of the raw material does not allow the drive string to be wrapped around it, the turner uses a drive center (mandrel) which is a cylindrical accessory made of wood and fixed to the workpiece by means of a group of metal pins—three to five in number—arranged at one end around the central pin, with the other end supported against the pivot of the lathe. In some cases, the workpiece is supported at its other side directly against the opposite pivot (Fig. 5a–c). In the case of small items or in the finishing stages of the object, it is possible to attach the workpiece to the mandrel without the assistance of a counter pivot (Fig. 5d–e). In the latter position, the mandrel is supported horizontally on an annular collar, thereby eliminating the need for a counter pivot. The turner is now able to work the inner space of the item without interruption. The idea of operating such an apparatus has been discussed by several scholars in the past (Rieth 1941:101–104; Pugsley 2003:123–135; Fellmann 2009:60–63; Christensen 2005:64, Fig. 29a-b).

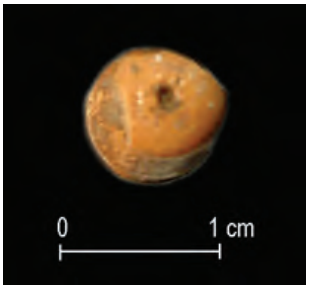


Figure 1: Cover for a cylindrical box, ʿEin Rachel. IAA No. 96-9011. Photograph: Yigal Sitry.

2 These marks are common, and usually denote the turning of elongated cylindrical items (Fellmann 2009:63; See marks on a handle, item IAA No. 1276-2263/1 from Masada [Sitry 2006, II:111, Fig. 346, Photo 89]; Button—item IAA No. 96-9010 from ʿEin Rachel [Sitry 2006, II:147, Fig. 432, mistakenly numbered 96-9002]). However, this mark is also observed on the base of vessels and cylindrical boxes (Sitry 2006, II:69–70, Fig. 161, item No. 464673 from Wadi Murabbaʿat caves).

3 Sitry 2006, II:68 (item No. IAA 81-1737 from Moah, Fig. 163, Photo 27; Pugsley 2003:73–74).

4 Pugsley observed four tiny holes which are traces of the mandrel's metal pins (Pugsley 2003:73, Fig. 4.15). The author has found at least 15 items from sites in the Land of Israel bearing such traces (Sitry 2006). The clearest examples are bowl No. 61-1359 from the Cave of the Letters (Fig. 3), bowl No. 468310 from the Wadi Murabbaʿat caves, as well as two spindle whorls: No. 461093 from the Wadi Murabbaʿat caves (Sitry 2006 II:136, No. 22, Fig. 64) and 36-1353 from Nessana (Fig. 4).

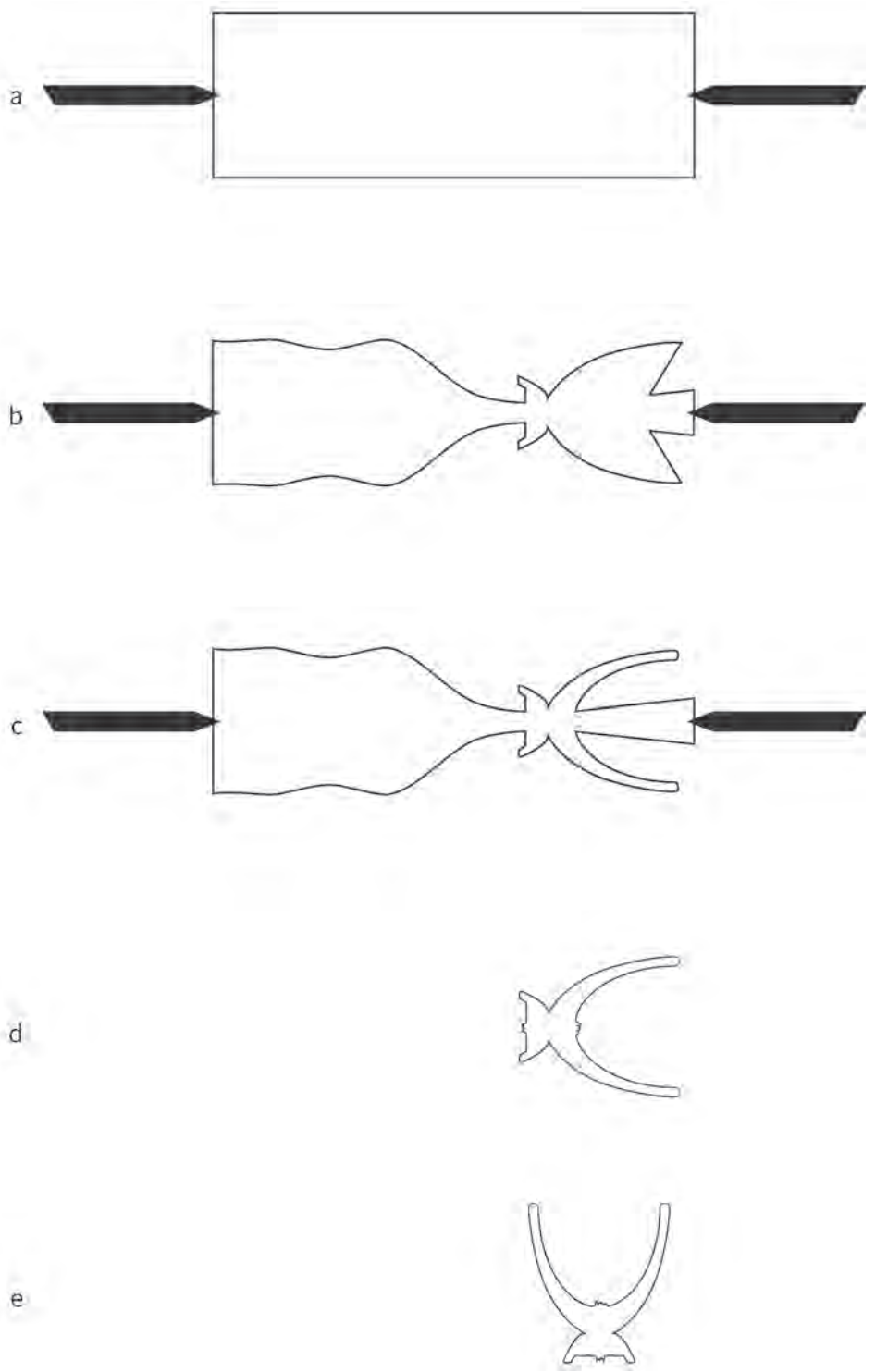


Figure 2: Diagram of turning a bowl by the core method. Drawing: Dana Sitry.

Figure 3: Bowl from the Cave of the Letters, base. IAA No. 61-1359. Photograph: Yigal Sitry.

Figure 4: Spindle whorl, Nessana. IAA No. 36-1353. Photograph: Yigal Sitry.

THE DISCOVERY IN THE YASSI ADA SHIPWRECK

In the 7th century CE Yassi Ada shipwreck, a wooden cylinder was discovered with a central hole[5] in one end and four holes around a central hole in the opposite end (Katzev S.W. 1982:288–289, Item No. MF52; Fig. 6). Remains of iron oxide were

5 The drawing appears to show a square hole, but it might be that the hole changes inside to a cone to accept the pivot. It is also possible that a square metal plug with a conical recess to house the pivot fits in the square hole to prevent wear of the mandrel. Such a fitting was also used in soft stone turning (Amit, Seligman and Zilberbod 2016 Fig. 20.9).

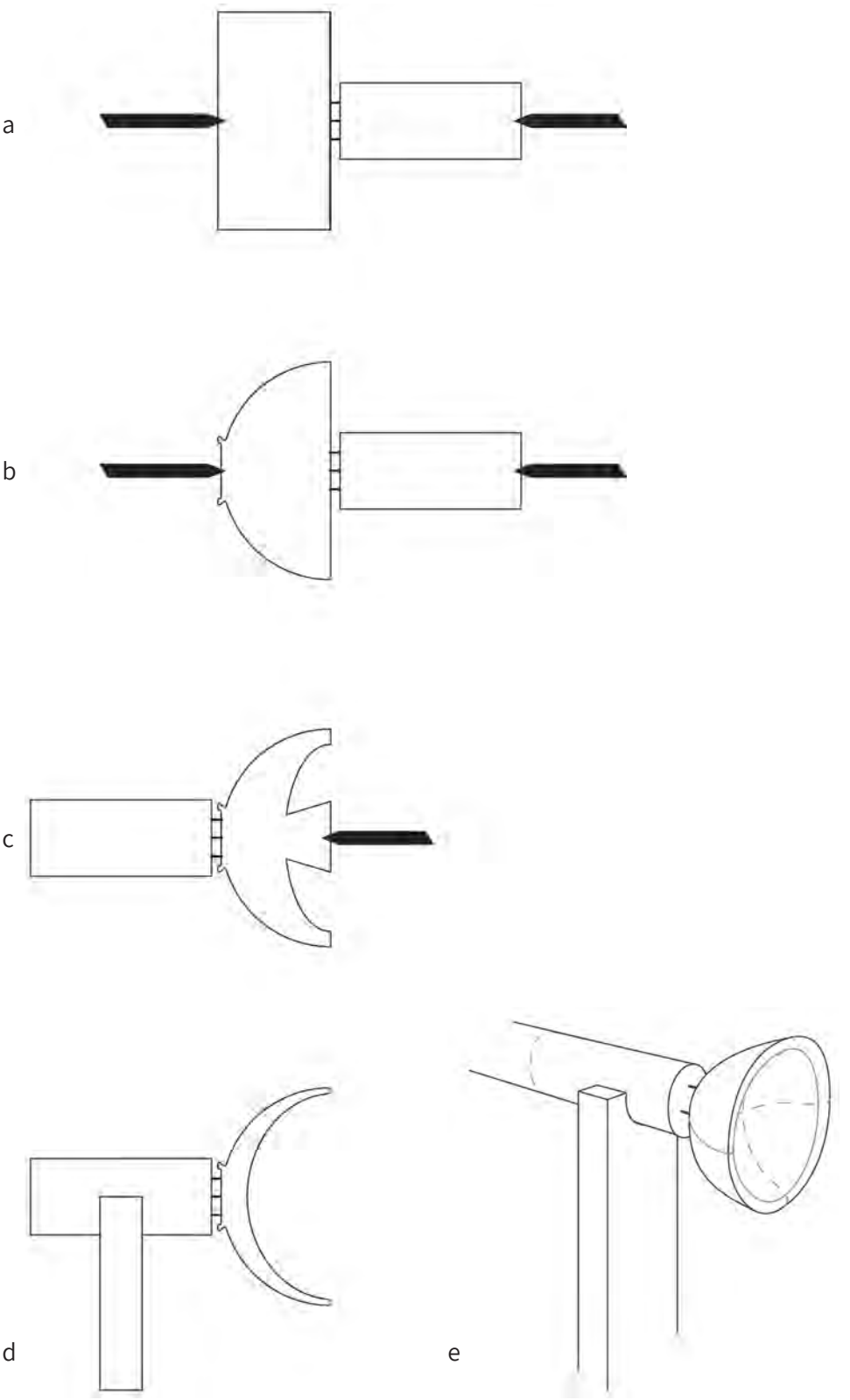


Figure 5: Diagram of turning a bowl using a drive center. Drawing: Dana Sitry.

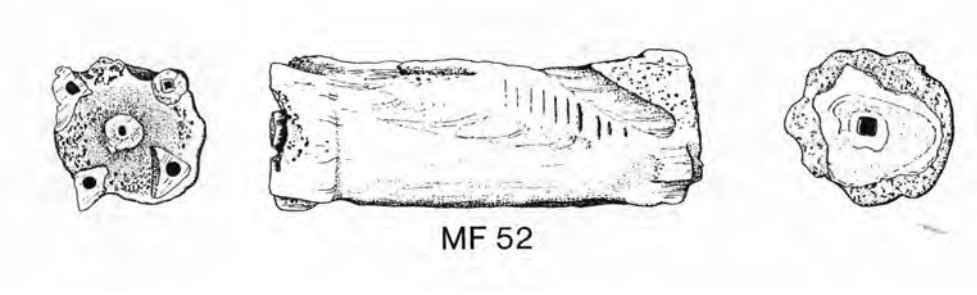


Figure 6: Drive center (mandrel) from Yassi Ada Shipwreck. After Katzev S.W. 1982 Fig. 12:16.

discovered in the holes. The ends of the cylinder were slightly larger in diameter than its central part. The excavators mistakenly identified this item as a carrying handle or a reel (Katzev S.W. 1982:289). However, the set of carpenter's tools found in the wreck,[6] plus the existence of a pivot of a lathe in this set,[7] the dimensions of the item, the remains of iron oxide in the holes—evidence of wear of metal pins—and the match between the position of the pins and the marks on wooden turned objects, all support the identification of this item as a mandrel.

CIRCUMSTANTIAL EVIDENCE

A. Ethno-archaeological Comparison[8]

Traditional turners observed in several ethnographic studies used a simple device very similar to the Yassi Ada mandrel to achieve the same results. A traditional turner was documented by Lorimer in the Hunza valley (today in Pakistan) using a primitive slow lathe to which a mandrel was hooked while turning the interior of a small bowl (Lorimer 1938 Pl. IV; Fig. 7). This technique was used also through the 20th century in the British Isles,[9] and green-working amateurs who use traditional techniques today are still using mandrels of various types (Abbott 1989:174–182).

6 Among the finds in the wreck were: five axes of two major types, five adzes, four hammers, three chisels, two gouges, a caulking iron, three punches, an awl, a pair of compasses, four files and a pivot of a lathe. Altogether there were 30 tools as well as 14 iron nails (Katzev M.L. 1982). Missing, but no doubt were on board but lost or did not survive the shock of being removed from sea water: a mallet, a drill with drill bits, saws of two or three types, and a plane.

7 Item No. Fe87, identified by the excavators of the wreck as bi-dogleg file, is actually a pivot of a lathe (Sitry 2022:58 and note 14). This item, plus the three gouges, leave no doubt about the existence of a lathe on board.

8 Two anthropological assumptions underlie this argument and allow ethno-archaeological comparison. First, the number of possible solutions to a technological challenge is smaller than the number of places where a solution to this challenge appeared. Therefore, when a technological challenge occurs, the same solution is found in several places—even remote places that have no mutual connection. Second, traditional societies living in natural and technological environments similar to those of ancient societies usually arrive at the same technological solutions. Consequently, under these circumstances it is reasonable to extrapolate from existing traditional techniques to ancient ones, as indeed has been demonstrated by many anthropological studies.

9 Wales, around 1920 (John 1976:18), Ireland around 1930 (MacManus 1983:43, Pls. 5, 6a).

Figure 7: Traditional bowl turning in Hunza valley. After Lorimer 1938 Pl. IV.

B. Experimental Archaeology

In 2003 the author carried out an experimental production of a small wooden bowl through all its stages from raw material to a finished object, using a replica traditional lathe (Sitry 2006 I:283).[10] In this experiment I used wood of an olive tree (*Olea europaea*) with a relatively high moisture content.[11] The bowl was turned from both sides using a replica accessory identical in dimensions to the mandrel from the Yassi Ada wreck, even though we could turn the exterior between the pivots (Figs. 8, 9). The results of the experiment were quite good, the free access to the inner space was convenient and made it possible to turn the bottom of the bowl without interruption and without leaving a mark or scar, as happened frequently with the previous core method. Sometimes, as the balance between the forces acting on the workpiece was disturbed, the object stopped or even slid over the metal pins of the mandrel. These slip traces are sometimes visible in the form of tangential grooves a few millimeters long at the base of turned bowls (as seen in Fig. 3).

Various types of accessories have been used since the invention of the lathe to improve the grip on the workpiece and thereby optimize turning. Each one leaves characteristic marks on the surface of the piece.

Pugsley suggested that the symmetrical circular decorations on the bottom of bowls are actually marks made specifically by the turner whose purpose was to

10 I would like to thank David Harrison, a skilled traditional carpenter, who helped me arrange and carry out this experiment.

11 The turning of moist wood was common in antiquity and was necessary because of the limited rotational speed of the primitive lathe (Sitry 2006, I:167, 266).

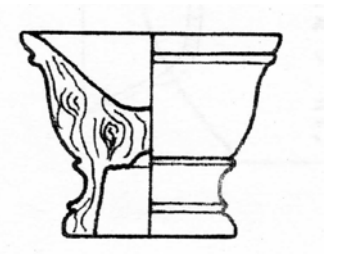
Figure 8: The author turning a bowl on a pole lathe, 2003. Photograph: David Harrison.

Figure 9: Turning the interior of the bowl, 2003. Photograph: David Harrison.

center a pressure mandrel on the bowl (Pugsley 2003:110–111). The use of this type of mandrel is based on the frictional connection between the straight and flat surface at the end of the mandrel and the straight and flat surface at the bottom of the bowl, and it does not leave marks on the base of the object.[12]

An improved variant of a pressure mandrel, which is a friction-based accessory, is a mandrel with a projecting round end that fits into a matching round recess in the bottom of the bowl. Marks of this type were found on the base of a make-up bowl from Shaʿar Ramon (Fig. 10) as well as on a tiny goblet from ʿEin Rachel.[13]

A 'finger' type mandrel designed for holding small cylindrical items was discovered in Egypt.[14] It has several 'fingers' sawn at one end (Fig. 11). A workpiece held between the 'fingers' supports the new identification of this item. The principle of this mandrel's work is simple: the 'fingers' are flexible enough to hold cylindrical items slightly larger than the space between them with a strong enough grip to allow turning. An experiment performed by the author with a replica of such a device was successful. Amit, Seligman and Zilberbod (2016:329–330, Fig. 20.11) believe that in turning small soft stone items, a similar accessory with the addition of a metal ring to ensure the mandrel's grip on the item was used.



CONCLUSIONS

The new identification of the mandrel from the Yassi Ada wreck verifies our hypotheses regarding the turning methods of small objects, bowls, and other receptacles. For the first time we pointed at the device responsible for the process and found a match to the traces it left on the items. We describe two methods for turning the internal spaces. We believe both were in use at the same time, and the turner chose which to use according to the needs of the work. Items with a deep and narrow cavity, such as cylindrical containers, were usually turned using the core system. For turning relatively shallow bowls the mandrel was preferred. It could be used either with the addition of a counter pivot, or by using an additional device for support.

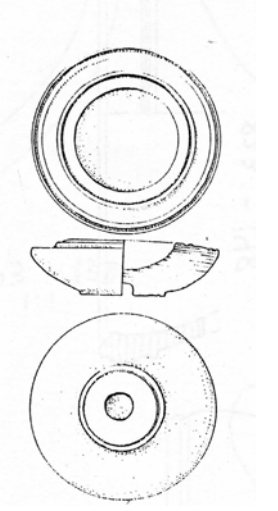


Figure 10: Cosmetic bowl from Shaʿar Ramon. IAA No. 81-498. Drawing: Carmen Hirsch.

12 Such circles, that according to Pugsley helped centralize the pressure mandrel, were discovered on the bottom of several bowls in the Land of Israel: IAA No. 463270 from Qumran (Sitry 2006, II:62, Fig. 154); Nos. 96-9110, 9111, 9112 from the Cave of the Letters (Sitry 2006, II: 49–50, Figs. 88, 54, 55 respectively).

13 Items Nos. D125, D127 (Sitry 2006, II:65, Pl. 34, Figs. 157, 158).

14 The cylinder—Museum No. LDUCE-UC 71499—was part of Petrie's Roman period collection from Egypt (its specific location is unclear).

Figure 11: Finger mandrel. Petrie Museum, London. Museum No. LDUCE-UC 71499. Courtesy: Petrie Museum, London.

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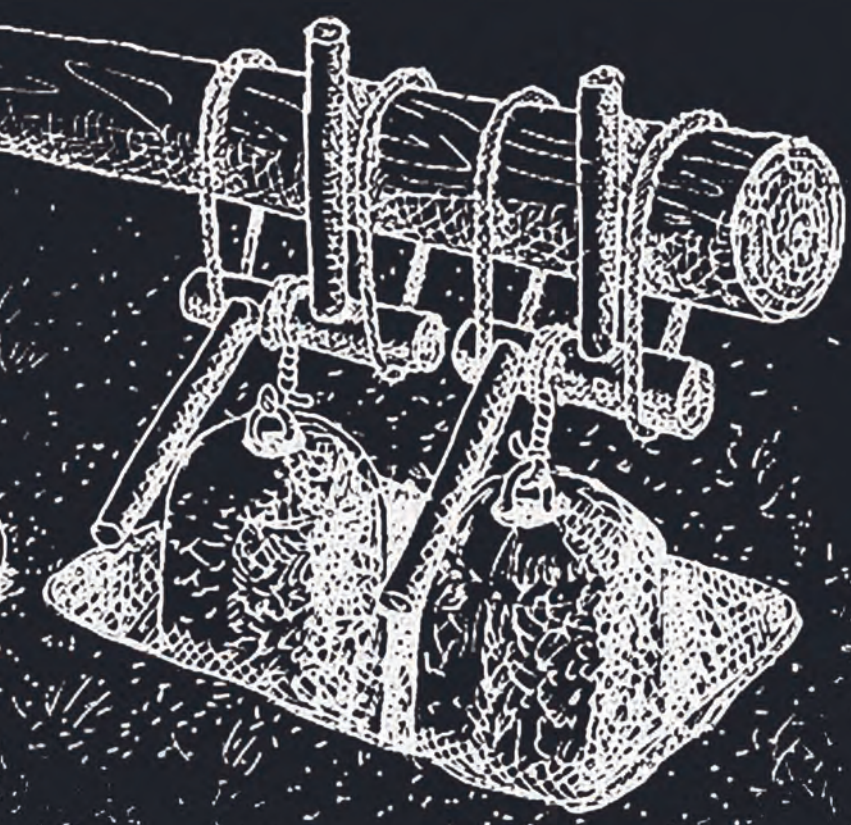
Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel

Edited By

Michael Eisenberg, ʻUzi Ad and Etan Ayalon



Ancient Technologies, Methods of Production and Installations in Israel— Essays in Honor of Rafael Frankel

Editors:
Michael Eisenberg, Uzi ʻAd and Etan Ayalon

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אוניברסיטת חיפה UNIVERSITY OF HAIFA

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תוכן העניינים

Editors' Foreword

This volume, which includes 21 articles and is bound as the book *Ancient Technologies, Methods of Production and Installations in Israel—Essays in Honor of Rafael Frankel,* seeks to shed light on a field of knowledge that our esteemed colleague and friend, the late Dr. Rafael (Rafi) Frankel, dedicated his entire scholarly life to. His profound impact on this field is immeasurable, and his legacy continues to inspire us.

The articles compile the most up-to-date information from across Israel, drawing on archaeology, ancient sources, and ethnographic comparisons. They explore research into the industries of wine and olive oil production, flour milling, spinning and weaving, lime production and stone inlays (*opus sectile*), various rural industrial installations, the crafting of stone pipes, the use of drills in woodworking, and anvils for sharpening sickles.

We wish to express our gratitude to the diverse group of contributors, the anonymous external reviewers for their insightful comments—which significantly enriched the quality of the articles—and the Zinman Institute of Archaeology for its financial support in producing this book.

The Editors

Haifa, August 2025

Michael Eisenberg, Uzi 'Ad and Etan Ayalon

Secondary Use of Ancient Marble Posts as Anvils for Serrating Sickles in Modern Times

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ABSTRACT

In the collection of the "Man and his Work Center" at MUZA, Eretz Israel Museum, Tel Aviv, there are three rare examples of Roman-Byzantine marble chancel screen posts reused in modern times as anvils. Two are from the Golan, while the third is from Nazareth. Each of them has 6–16 flat surfaces of irregular width, covered in rows of tiny triangular depressions.

Recently, their use has become clear through ethnographic testimonies:

A photo, taken in Nazareth between 1900–1920 (Matson Collection), shows such a marble anvil surrounded by sickles. This image was discussed by the ethnographer Gustaf Dalman alongside a description of sickle serration on a "white stone."

A photo from the 1960s, found in Shmuel Avitsur's archive, depicts two Nazareth blacksmiths serrating a sickle atop a marble anvil, using a hammer and a small chisel.

The marble post was chosen for two reasons: a. Its small diameter allows for comfortable holding of the round sickle on it; b. The marble's relative softness and flexibility reduced the risk for hand injuries and damage to tools during the process, unlike hard stone or iron anvils.

While similar marble anvils are not known to us in Israel, hundreds of bone parallels have been discovered across Eastern Europe and the Western Mediterranean, dating from the Hellenistic period to the 20th century. Ethnographic evidence also confirms the practice of serrating sickles there on large leg bones to this day.

Keywords: Marble anvils, bone anvils, serrating sickles, ethnography

INTRODUCTION

The collection of the Man and his Work Center at MUZA, Eretz Israel Museum, Tel Aviv, contains three marble chancel posts along whose length flat faces of irregular width were chiseled for secondary use. The faces are covered across their width with rows of tiny triangular depressions and diagonal grooves. Research into the question of the secondary use of these rare items included a renewed survey of ethnographic work in the early twentieth-century Land of Israel and a study of parallels made of different raw material from the Mediterranean basin. The answer

to this question reveals an interesting aspect in the production process of serrated sickles in the region.[1]

COLLECTION AND HISTORY OF RESEARCH

In 1967, shortly after the Six-Day War, Yehuda Roth of Kibbutz Sha'ar Hagolan set out with friends to conduct an ethnographic survey of a number of abandoned villages on the southern part of the Golan Heights. Particular emphasis was placed on the agricultural activities and lifestyles of the inhabitants (Roth 1985). He noted two main reasons to conduct the survey specifically in this remote area: "The first – we found here in the abandoned villages evidence of a traditional lifestyle the likes of which was not preserved in Judea and Samaria and the Gaza Strip; and the second reason – the Golan villages faced ongoing destruction, and the need was urgent to survey and learn, photograph and document all aspects of this life before abandonment and destruction took over" (Roth 1985:7).

Given that the primary goal of the survey was to learn about the traditional lifestyle, Roth decided to focus on relatively small and isolated villages where it was best preserved. In addition, according to Roth, when they were abandoned, the inhabitants left all their belongings behind, sometimes in actual mid-use, as Roth told one of the authors (E. Ayalon): "Like in Pompey." Thus, he chose to conduct the survey mainly in five villages (Fig. 1): Jubbayn, Rujm al-Yaqousa, Yaqousa, Dabbousiya, Khirbet Al-ʿUyun, and apparently also Kafr Hareb (Roth 1985:6–7, 41). For comparison, the team also visited more developed villages: Sqoufiye, El-ʿAl and Al-Hamma. When the work began, the survey group established a connection with the Avshalom Institute for the Land of Israel Studies headed by Prof. Shmuel Avitsur, who assisted in an advisory capacity and in funding the work. Avitsur provided scientific sponsorship for the survey, and the documentation of the retrieved objects was managed by the card file system and registration methods of the Avshalom Institute. Some of the artifacts—including the tools of a blacksmith's workshop in the town of Fiq (see below)—were then donated to the ethnographic collection, initially called Beit Svivatenu, that Avitsur established alongside the Avshalom Institute (Avitsur 1998:49–51, 58–59). Years later, after this collection had been enhanced and expanded, it was transferred to Ha'aretz Museum (today MUZA, Eretz Israel Museum, Tel Aviv) where in late 1982 the Man and his Work Center was established (Avitsur 1998:76–77). Between 1983 and 1984, after Roth's health declined and he could no longer care for the ethnographic collection, he donated almost all of it to the Eretz Israel Museum, including many documentary photographs taken during the survey. In cooperation with Roth and his kibbutz, the museum published two booklets he wrote: One described the southern Golan survey in general, and the other focused on the blacksmiths who worked there, in the district capital of Fiq (Roth 1984; 1985; Ayalon 1986:316–317).

1 This subject was first presented in a lecture at the conference "Archaeology and Material Culture in the Modern Period 2" at Bar-Ilan University, May 30, 2024. The paper was translated by Miriam Feinberg Vamosh.

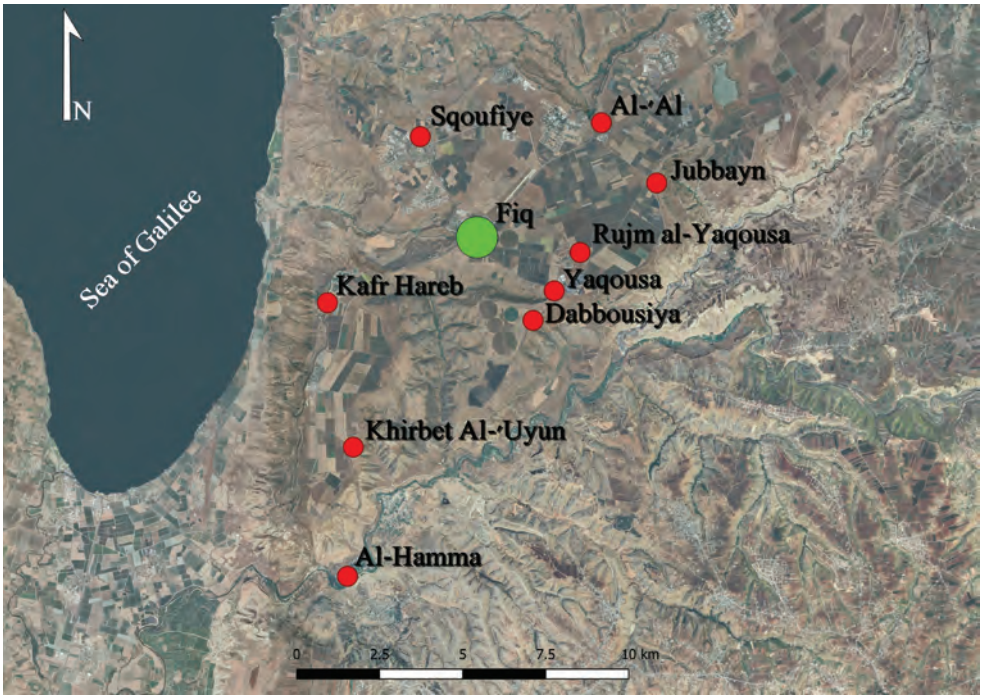

Figure 1: Map of sites in the Golan Heights surveyed by Yehuda Roth (Prepared by Eli Cohen Sasson)

In each of the villages that Roth surveyed he collected and documented rich and unique material findings, which included a wide variety of iron tools. Many are stamped with the name of the manufacturer and thus, three main blacksmiths could be identified: Halil, Yusuf and Sami (Roth 1984:15).[2] Roth concluded that these objects were made in the region by Golan blacksmiths, but that their workshops were not located in the five small villages. On the assumption that they operated in a larger and more central settlement to ensure their livelihood (see Roll and Ayalon 1989:234–237 and references therein), and "on the basis of hints from other manufacturing sectors," Roth expanded the survey to the town of Fiq (Fig. 1 above), which served as the district capital of the southern province of Quneitra (Roth 1984:15), where indeed, he found three different smithies. In one he also found the hammer with which the blacksmith Halil stamped his name on the tools he produced; the hammer led to the definitive identification of Halil's workshop and the tools he produced that were discovered in the various villages in the region. Sickles still in the production process, before serration, were also found in the workshop (Roth 1984:15–23, Figs. 8d–8g, 9). Roth associated the other workshops to the blacksmiths Yusuf and Sami arbitrarily due to the lack of secure evidence, an approach obviously taken for the sake of convenience in collecting and documenting the finds (Roth 1984:24). He associated the workshop where "we enjoyed looking at a special type of sickle… outstanding in the delicate and precise

2 In addition to these three large groups, individual tools bore other names, such as Talil, Sa'ad and Mohammad (Roth 1984:10, 13 and Fig. 8b). The owner's name was also incised on a few of the tools after production.

serration of their cutting edges" (Roth 1984:26) with Yusuf, and the workshop where evidence of more modern work methods was found he associated with Sami (Roth 1984:27–31).

THE MARBLE ANVILS (FIG. 2)

Among the items Roth retrieved in two of the smithies in Fiq were polygonal marble posts bearing rows of numerous tiny triangular depressions or grooves, documenting these objects in the card catalogue as "sharpening stones" (nos. 2–3 in Fig. 2 and Table 1). Both were donated to the Man and his Work Center in the Eretz Israel Museum in 1984. The third post, which Avistur had retrieved, was part of the original Man and his Work Center collection. Unfortunately, no details about it were preserved (however, see below). In the early 1980s, when the post was registered in the museum collection, it was also mistakenly identified as a "sharpening stone," as per Roth's identification.

The three marble posts can apparently be dated to the Roman–Byzantine period. They were used either as table or altar legs (Hirschfeld 1993:252), or to support a church chancel screen (Habas 2020:129–130) or a synagogue chancel screen (Ilan 1991:312, 317). Their ends are broken and in two of the posts a depression—one round and the other square—had been drilled into one end, apparently to stabilize them vertically with some sort of peg during their original use. In each of the posts, in their phase of secondary use, apparently in modern times, 7–16 flat faces of irregular widths were

Figure 2: The three marble posts from the Man and his Work Center collection (Photos: Leonid Padrul Kwitkowski and Eli Cohen Sasson).

Table 1: Details of the Posts

No.	MHW collection no.	Origin	Max. length (cm)	Max. diam. (cm)	Number of faces and their width (cm)	Smoothing and re-serrating	Source of the marble*	Remarks
1	1389	Nazareth	33	10	7 faces 0.6–6	Yes	Paros Island, Greece(?)	Avitsur collection. Quadrilinear depression at one end
2	176.84	Golan Heights, Fiq	22	12	12 faces 2–3.5	Yes		In the permanent exhibition
3	177.84	Golan Heights, Fiq	85	11.5	16 faces 1.5–3.4	Yes	Proconnesus Sea of Marmara, Asia Minor	Round depression at one end. Soot stains and remnants of rust

* The source of the marble was identified by the late Prof. Moshe Fischer.*

Figure 3: Marble post from the Man and his Work Center collection, close-up of the depressions and grooves (Photo: Eli Cohen Sasson).

chiseled or sawed and then filed and smoothed.[3] Parts of the faces are covered with non-linear rows of tiny triangular depressions or diagonal grooves across them (Fig. 3). A close inspection of the long anvil revealed rust in the tiny depressions, apparently a remnant of contact with iron—obviously from sickles that were serrated on it (below). Some of the faces in all three anvils reveal that at some point they had been smoothed to efface the depressions and prepare them for reuse.[4]

THE ETHNOGRAPHIC EVIDENCE

The mystery of the secondary use of the posts, and the rejection of the theory that they were used for sharpening (which actually leaves a smooth face, or at most tiny parallel grooves), has been solved thanks to ethnographic evidence in the Land of Israel and beyond.

1. The G. Eric and Edith Matson collection contains more than 22,000 historical photographs from the Middle East, taken between 1898 and 1946 by members of the American Colony Photo Department. Eventually, this became the Matson Photo Service. This huge collection, now in the U.S. Library of Congress, is a rich source of prime importance for ethnographic research of the southern Levant in the pre-modern era, and includes documentation of sites in the Land of Israel, lifestyles, craftspeople and holy places as well as countless distinctive figures (Ayalon 2012). One of the photos in the collection (Fig. 4), taken between 1900 and 1920, documents two blacksmiths seated in front of a shop or workshop in Nazareth with nearly 20 sickles at their feet in various stages of production (it can be seen that wooden handles had not yet been attached to most of them). Near the foot of one of the blacksmiths is a polygonal stone (marble?) post, identical to the three objects under discussion. On it is a sickle with a wooden handle and nearby are a hammer and chisel. The other man holds a file-like tool. The caption of this photo in the Matson collection is: "Sharpening sickles" (Matson 1980, II, No 567; LC-DIG-matpc-01263).
2. Gustaf Dalman (1855–1941), born in Germany, was active in the early 20th-century Land of Israel, among other fields, in nature (geography, zoology, and botany), archaeology, and ethnography—daily life of the inhabitants (Männchen 1993;

3 The faces may have been prepared with a saw or a metal cable, as shown in the sawing of a large marble column in Jaffa in the early 20th century (Scholten 1929, II, Fig. 93). Schumacher provides additional evidence from late 19th-century Ashkelon (Schumacher 1886:172).

4 The remnants of rust and the resmoothing of the faces were identified by Yehoshua (Yeshu) Dray, and we thank him for his comments.

Serr, Fischer and Rautenberg 2016). His greatest contribution to ethnographic research is his monumental work *Arbeit und Sitte in Palästina* (Dalman 1928–1942), which describes in detail the daily life of the local population, mainly Arabs and Bedouin, who largely maintained their traditional (pre-modern) lifestyle, which Dalman diligently sought to experience firsthand (Serr, Fischer and Rautenberg 2016:27). The third volume of this work, which deals with breadmaking from the harvest to the grinding of the flour (*Von der Ernte zum Mehl* in the original language), represents the photograph from the Matson collection which depicts the blacksmiths in Nazareth, as described above (Dalman 1928–1942, III, Abb. 4). The text accompanying the photograph reads (freely translated from the German): "cutting the teeth with a handleless chisel and a small hammer, with the iron set on a white stone" (Dalman 1928–1942, III:22). In other words, according to Dalman's important testimony, the stone post served as an anvil as the sickle was serrated using a hammer and chisel, as shown in the photograph.[5]

Figure 4: Blacksmiths in Nazareth serrating sickles (Matson collection).

3. In recent years the authors, assisted by Nili Cohen, launched an extensive project to reidentify and re-catalogue the photographs left by Shmuel Avitsur. They include thousands of images, among them documentation of various craftspeople. One photograph, taken circa 1960, shows a blacksmith in Nazareth using a hammer and chisel to serrate a large sickle held by another blacksmith sitting opposite him, on a stone anvil of the type discussed here (Fig. 5). The photograph is inscribed on the back in Arabic with the words "blacksmiths of the Zoabi family, *karuta* sickle, *sultani* stone."[6] The *karuta* sickle appearing in the photograph is of medium size, short, with tiny, dense serration, a tool common in the Galilee and used mainly for harvesting tall wheat (in Nazareth it was called *kalusha* [Avistur 1966:23, 30–31, Pl. B:2; Roth 1985:56]). A comparison of the stone anvil shown in the archive photograph with the marble item from the Man and

5 Interestingly, Dalman, who was fluent in Arabic, called the marble anvil *ḥagar rgabe* (*ḥagar* in Arabic means stone), a term whose meaning is unclear to us.

6 We thank Fauzi Ibrahim for his translation of the inscription.

his Work collection (Fig. 2 and Table 1 above, anvil no. 1) reveals it to be the exact same item and thanks to the photograph we learned its origin. It seems that Avitsur purchased the anvil on this visit to Nazareth right after documenting the work of the blacksmiths, as he had done in many of his other travels. Nazareth was a well-known center for blacksmiths (*ḥadad* in Arabic) in the Galilee until the mid-20th century, with expertise, among other fields, in sickle production (Avitsur 1966:23; 1982:100–101).[7]

Close perusal of the two abovementioned photographs alongside Dalman's and Avitsur's testimonies reveal that for decades, Nazareth blacksmiths re-used marble posts as anvils on which to serrate sickles. This was apparently also the case in Fiq in the Golan Heights, the origin of the two other anvils in the collection. In Halil's forge, Roth, as noted, found sickles under production (Roth 1984:18, Fig. 9:b–d), and the blacksmith to which the stamp "Yusuf" was ascribed specialized in the production of sickles with precise and delicate serration (Roth 1984:26, Fig. 16:d–f). In addition, we compared the pattern of the grooves on the anvils and one of the serrated sickles from Fiq in the museum's collection, in terms of the size of the groove in the stone relative to the sickle's serrated tooth, the space between the grooves compared to the distance between the serrated teeth and the curvature of the lines of grooves in the stone compared to the shape of the sickle (Fig. 6, and cf. Fig. 3 above). According to all the criteria examined, the comparison confirms that the sickle was serrated on one of these anvils (or a similar one) using a hammer and chisel, with the corner of the chisel and the serrations of the sickle creating the grooves in the stone, one tiny groove for each serration in the sickle under production; or to renew the serration after it became dull due to use. The marble anvil was apparently chosen for two main reasons: One—because the cylindrical form and diameter of the post enabled the curved sickle to be held comfortably across it at a convenient angle for serration using a chisel (as can be seen in Fig. 5 above). The second reason stemmed from the characteristics of the stone itself: The marble anvil was well suited for this purpose due to its relative softness (comparable to that of bone; see below), which helped prevent the chisel from breaking and reduced injury to the blacksmith's hand from the hammer striking a metal anvil. At the same time, the marble anvil is not overly soft, and therefore it provides adequate resistance to the chisel during the serration process.[8]

The secondary use of ancient marble objects was very common in various periods, including Late Antiquity and the pre-modern era. For example, an impressive 13th-century hoard of marble objects intended for secondary use, including posts, was discovered in Akko (Stern 2013). Fischer (1998:287–291) presents numerous examples of secondary use of ancient marble objects as architectural components in later structures, for example, marble posts used as gutters, a column base as a capstone on a cistern, pieces of a capital as a gameboard and another capital as a

7 In a personal communication with one of the authors (E. Ayalon) the crafts researcher Yonit Kristal noted that a former blacksmith of the Zoabi family in Nazareth told her that he clearly recalled his father—also a blacksmith—serrating sickles on a stone anvil.

8 Our thanks to the blacksmith Giora Biran for the information, and to Saar Nudel for his assistance in this matter.

Figure 5: Blacksmiths of the Zoabi family in Nazareth serrating a sickle (Avitsur archive).

Figure 6: Closeup of a *karuta* sickle on a grooved marble anvil from the Man and his Work Center collection (Photo: Eli Cohen Sasson).

bodeda, a portable pressing installation for domestic production of olive oil. The variety of secondary uses of ancient marble objects can now be expanded to include posts that became anvils for the serration of sickles. It will be interesting to explore whether saws were also serrated by the same method using the same equipment.

BONE PARALLELS TO ANVILS FOR SERRATING SICKLES

Other than the three marble anvils in the collection of the Man and his Work Center, no similar objects are known to us from the Land of Israel, neither in the collections of various museums nor in findings from the many archaeological excavations undertaken in this country. To the best of our knowledge, no chisel marks in a pattern similar to those appearing on the anvils have been discovered on objects made of other raw materials. On the other hand, in many Eastern and Western European countries, as well as in North Africa, marks similar to those on the marble anvils under discussion were discovered on numerous large leg bones of cattle dating from the Hellenistic period to the present day (Briois, Poplin and Rodet-Belarbi 1997; Davis and Moreno-García 2007; Moreno-García et al. 2007; Beldiman et al. 2011; Oliver and Moreno-García 2019; Fig. 7). As with the mistaken preliminary identification of the use of the marble anvils in the Land of Israel, many and varied suggestions have been put forward for the chisel marks on cattle bones (Briois, Poplin and Rodet-Belarbi 1997:197). The use of the bones became evident when an ethnographic parallel was documented from the Balearic Islands (Majorca) of a woman serrating sickles on an anvil made from a large cattle bone (Aguirre, Etxeberria

Figure 7: Tiny depressions created by serrating sickles on a cattle leg bone (Moreno García et al. 2007 Fig. 1).

and Herrasti 2004; Esteban and Carbonell 2004). The earliest evidence of this use appears in a book containing photos and ethnographic evidence from the Balearic Islands, including a photograph of a woman serrating a sickle on a bone anvil using a hammer and chisel (Llompart, Mulet and Ramis 1990, Fig. 6). Two interesting facts may be distinguished in the photo: First, sickle serration was apparently women's work there, in contrast to the complete male monopoly on blacksmithing in the southern Levant (as seen in Matson's and Avitsur's photos and numerous other ethnographic examples; see Avitsur 1976:143–152). Secondly, in the Balearic Islands the ends of the sickle were tied to the feet of the artisan so that it could be leaned against the anvil at the correct angle to serrate the tool without the assistance of another person. Bone anvils for the serration of sickles have been in use across many countries for more than 2,000 years: Ukraine, Romania, Moldova, Hungary and Austria in Eastern Europe; north Italy, Spain, Portugal, southern France, Sardinia and the Balearic Islands in Western Europe; as well as Morocco and Tunisia in North Africa.

SUMMARY

The three marble anvils described above reflect a certain sophistication on the part of traditional blacksmiths in the northern part of the country, both in the secondary use made of ancient objects and in their ability to distinguish the characteristics of the posts as suitable for their purpose—in this case the serration of harvesting sickles. Evidence of this secondary use appeared beginning in the early 20th century from two regional centers—Nazareth in the Galilee and Fiq in the southern Golan Heights. However, it remains unclear whether there were reciprocal ties and exchanges of knowledge between the two places, or if the artisans in each locale independently arrived at this solution. No less interesting is the fact that for over 2,000 years, in many countries in Europe and the western Mediterranean identical use was made of large, thick animal leg bones, a custom that persists to this day in the Iberian Peninsula. In the Land of Israel, we do not know of a similar use, although these solid bones were raw material for the production of a wide variety of objects such as handles, beads, gaming pieces and decorated pieces (Ayalon 2005).

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