In Centro

Collected Papers
Volume III

Time

Editors:
Guy D. Stiebel
Ido Koch
Avner Ecker
Amir Gorzalczany
Yotam Tepper
Amit Shadman
Salome Dan-Goor

רשות העתיקות
ISRAEL ANTIQUITIES AUTHORITY
TEL AVIV UNIVERSITY
Bar-Ilan University
אוניברסיטת בר-אילן

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Volume III

רשות העתיקות
ISRAEL ANTIQUITIES AUTHORITY
Central Region

TEL AVIV UNIVERSITY
The Sonia and Marco Nadler Institute of Archaeology
The Jacob M. Alkow Department of Archaeology and Ancient Near Eastern Cultures
The Chaim Rosenberg School of Jewish Studies and Archaeology
The Lester and Sally Entin Faculty of Humanities

המכון לארכיאולוגיה
The Institute of Archaeology
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Preface

> “A man doesn’t have time in his life to have time for everything.”
>
> (Yehuda Amihai)
>
> “It’s not that we have little time,
> but more that we waste a good deal of it.”
>
> (Seneca)
>
> “Time flies like an arrow. Fruit flies like a banana.”
>
> (Groucho Marx)

In 1806 Prof. Rasmus Nyerup, of Copenhagen University, complained: “Everything which has come down to us from heathendom is wrapped in a thick fog; it belongs to a space of time we cannot measure. We know that it is older than Christendom, but whether by a couple of years or a couple of centuries, or even by more than a millennium, we can do no more than guess”. Archaeology is linked by its umbilical cord to its effort and ability to date material culture, as well as archaeological layers. Over the past 150 years, the field has undergone several methodological and technological revolutions that have enabled a shift from relative dating techniques to absolute dating. The development of comparative knowledge in typological content fields, on the one hand, and on the other hand, breakthroughs such as the development of radiocarbon dating in the late 1940s by Nobel Prize laureate Prof. Willard Frank Libby and the use of Optically Stimulated Luminescence (OSL) dating for absolute dating, or paleomagnetism for archaeomagnetic dating, are currently opening up new and exciting possibilities. These methods are already being applied, ranging from the dating of artifacts to the exploration of the site, and ending with the perspective of landscape archaeology.

The third “In Centro” (במרכז) conference focused on the very core of archaeological work: the theme of time. It was hosted on June 9, 2022 by Bar-Ilan University, which joined the organizing bodies, the Central Region of the Israel Antiquities Authority and the Institute and Department of Archaeology and Cultures of the Ancient Near East at Tel Aviv University, and was conducted in a hybrid format, with an option for online participation via Zoom. The conference included five sessions, three of a thematic nature and two presenting a variety of research innovations from the excavations of the Central Region of the Israel Antiquities Authority.

In the two morning sessions, dedicated to the topic “Is Everything Relative? Chronology and Methodologies of Time,” both dating methods and case studies were discussed. Lectures included the use of ^{14}C dating, archaeomagnetic dating and Optically Stimulated Luminescence (OSL), alongside the application of portable luminescence methods for the dating of shafts from the Chalcolithic period or a tomb from the Hellenistic period, as well as the exploration of the fields of Yavne. The third session, “Real-time: Innovations in Spatial Excavation,” featured presentations of several excavations spanning a broad timeframe: from the Neolithic to the Islamic period. Afternoon sessions opened with the fourth session, titled “בין הזמנים (Between Time Periods): Perspectives on Time in the Past,” which presented a spectrum of cultural artifacts, beginning with Iron Age Judean calendar tablets and a burial inscription from Beth Sheʿarim relating to the destruction of the Temple and ending with sundials from Judean Desert monasteries in the Byzantine period. The conference concluded with a session that presented the results of several excavations in the Coastal Plain, including finds related to the glass industry at Umm al-Zinat and excavations in Caesarea Maritima and its nearby Sebastos harbor.

The book consists of thirteen papers—ten in Hebrew and three in English. The opening paper, by Regev *et al.*, focuses on the presentation of the first radiometric dates achieved for the Early Bronze Age from the eastern slope of the City of David, Jerusalem, and their comparison to ceramic data from previously published contexts. Nitsan Ben-Melech presents in her article the advantages and limitations of the OSL dating method, as expressed in research in the Southern Levant. The third article, by Eythan Levy, introduces an innovative use of a computer model (ChronoLog software) for the construction of absolute chronologies in archaeology, with a discussion of chronological networks. In the fourth paper of these proceedings, Ackermann *et al.* present the results of their use of the portable OSL technique for interpreting the secrets of shafts from the Chalcolithic period, recently excavated in Tel Aviv. This technique is further employed by Roskin *et al.* in the fifth paper, which analyzes the history and usage of a Hellenistic tomb recently uncovered in Jaffa.

In the sixth paper of this volume, Haddad *et al.*, who directed the excavations in the mega-project near Tel Yavne, present a fascinating portrait of the cultivation and agricultural activity in the fields of Yavne, emphasizing the vineyards and wine industry and its changes over generations. In the seventh paper of the volume, Tendler *et al.* detail the findings from the excavation of the Kafr Bara cave, ranging from the Neolithic period to the Early Bronze Age. The following paper presents the unique findings of a salvage excavation conducted by Dor Golan and Durar Masarwa at Tel Yaḥam, where remains of a fortified settlement from the Middle Bronze Age, Late Bronze Age and Iron Age were recently exposed. In the ninth paper of the volume, Alla Nagorsky and Itamar Taxel present a preliminary overview of the findings from the salvage excavations in Tel Qatra, located at the northern sector of Gedera.

Jonathan Ben-Dov offers in his paper a new interpretation of a group of Iron Age perforated bone plaques from Judah as portable calendars and discusses them in the context of the administrative year of 360 days in the Bible. In the eleventh paper of the volume, Gorin-Rosen *et al.* present the glass industry that was uncovered in the Late Roman site of Umm al-Zinat in the southeastern

Mount Carmel. In the twelfth paper of the proceedings, Peter Gendelman and Uzi ʿAd analyze the image and nature of the city of Caesarea following the Islamic conquest of 640/1 CE, providing new insights into a period in the city's history that was little known to research. The closing paper of the volume, by Sharvit *et al.*, presents the new findings and a new interpretation associated with the wave-breaker in the ancient harbor of Caesarea.

It is our pleasant duty to extend our gratitude to all those who assisted and contributed to the conference and the production of the book. Thanks go to Mr. Eli Eskosido, General Director of the Israel Antiquities Authority; to Prof. Gideon Avni, Chief Scientist of the Israel Antiquities Authority; to Prof. Oded Lipschits, Director of the Institute of Archaeology of Tel Aviv University at the time of the conference; to his successor, Prof. Yuval Gadot, the outgoing Director of the Department of Archaeology and Ancient Near Eastern Cultures; and to Prof. Aren Maeir, Head of the Institute of Archaeology at Bar-Ilan University. It was their support and assistance that made the conference and the publication of its proceedings possible. Special thanks are extended to Ms. Tamar Magen-Elbaz and her team for all the work ahead of and during the day of the conference. We are grateful to Mr. Yoni Amrani and Ms. Efrat Nidam of the Israel Antiquities Authority and to Ms. Nirit Kedem of the Institute of Archaeology at Tel Aviv University for their assistance, as well as to Ms. Ayelet Gazit of the Institute of Archaeology for designing the conference poster and invitation. Heartfelt thanks are extended to Ms. Tsipi Kuper-Blau, Publications Director at the Institute of Archaeology of Tel Aviv University, who led the production of the volume with a high level of professionalism. Last but not least, we owe a debt of gratitude to the publication team of the Institute of Archaeology, who were behind the technical production of the book—especially to graphic designer Ms. Ayelet Gazit and editorial assistant Mr. Daniel Kleiman.

There is seemingly no better way to conclude the introduction to a volume that deals with material culture and archaeology of time than the words of the author of Ecclesiastes: "To every thing there is a season, and a time to every purpose under the heaven" (Ecclesiastes 3:1).

The Editors

Insights into the Contribution of Radiocarbon Dating in Reconstructing Jerusalem's Past: The Early Bronze Age Settlement of Jerusalem

Johanna Regev, Joe Uziel, Yuval Gadot, Helena Roth, Eugenia Mintz, Lior Regev and Elisabetta Boaretto

Less than a decade ago, the dearth of radiocarbon dates from Jerusalem stood in stark contrast to the plethora of excavations that had been conducted in the city's ancient core. Although earlier excavations were not familiar with the application of absolute dating, later excavations still relied solely on relative dating, primarily based on pottery typology. The extensive use of radiocarbon dating in excavations throughout Israel, beginning in the 1990s (e.g., Sharon, Gilboa and Boaretto 2007) and increasing in the new millennium (see, e.g., Mazar and Carmi 2001; Boaretto *et al*. 2005; Boaretto 2009; Finkelstein and Piazetsky 2006; 2015), seemed to have passed over Jerusalem. This situation has been largely corrected due to the project initiated by the authors,[1] which aimed at providing a complete radiocarbon framework for the reconstruction of the history of settlement at the site, including dating all layers of human activity, as well as important structures and elements that reflect on the city's character in various periods. The project approached

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* **Johanna Regev, Eugenia Mintz, Lior Regev** and **Elisabetta Boaretto**: The Weizmann Institute of Science, Rehovot; **Joe Uziel**: Israel Antiquities Authority; **Yuval Gadot** and **Helena Roth**: Tel Aviv University

[1] The absolute dating of Jerusalem's archaeological layers was funded by the Israel Science Foundation (Grant No. 1873/17).

the dating of the archaeological elements as a collaboration between field archaeologists and radiocarbon specialists, working together in real time, at the excavation site in order to properly define the sampling methods and the related stratigraphic sequence. The samples taken were coupled with microarchaeological analysis, in order to help the characterization of the context. The radiocarbon analysis was undertaken together with standard archaeological methodology (pottery analysis, numismatics, etc.), in order to use all relevant data when dating a layer. The samples were analyzed in the Dangoor Research Accelerator Mass Spectrometer D-REAMS Laboratory at the Weizmann Institute of Science, after being collected in the various areas of excavation.[2] By applying stratigraphic analysis, as well as pottery, coin and glass dating, models were constructed that enabled a much higher resolution in the dates attributed to various features.

To date, 196 radiocarbon dates from Jerusalem have been published (Regev *et al*. 2017c; 2020; 2021; 2023). Although we continue to publish more of the samples collected, the published data have brought Jerusalem to the forefront of radiocarbon research in Israel, greatly impacting the methodology applied to excavations in Jerusalem as a whole, with radiocarbon field specialists more actively integrated into the various excavations. The current paper presents more of this data, particularly results dating to the Early Bronze Age. These dates further the discussion on the EB I–II transition. While past research suggested a more direct correlation between the transition of sub-divisions of the Early Bronze Age and the transitions between these period (e.g., Braun 2011), the radiocarbon dating of numerous sites in the southern Levant has shown that these transitions, and in particular the EB I–II transition are much more gradual, occurring over a longer period of time

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[2] The radiocarbon research was supported by the Exilarch Foundation for the Dangoor Research Accelerator Mass Spectrometer (D-REAMS) Laboratory. We wish to thank the Kimmel Center for Archaeological Science and George Schwartzman Fund for the laboratory and funding support for the material analysis. E. Boaretto is the incumbent of the Dangoor Professorial Chair of Archaeological Sciences at the Weizmann Institute of Science, Rehovot.

at different sites and in different parts of the region (Regev *et al*. 2012). The current paper provides additional data to the understanding of the variations of this transitional period, particularly for the hill country.

The Early Bronze Age in Jerusalem

The earliest human activity in the ancient site of Jerusalem, located on the Southeastern Hill, goes back to the Epipaleolithic period, some 15,000 years BP, as evidenced by stray finds found in the vicinity of the spring (Marder and Khalaly 2004). Such activity—with no associated architecture—continued at the site until the Early Bronze Age, to which the first structures and secure burial contexts can be attributed. Of most significance are two particular

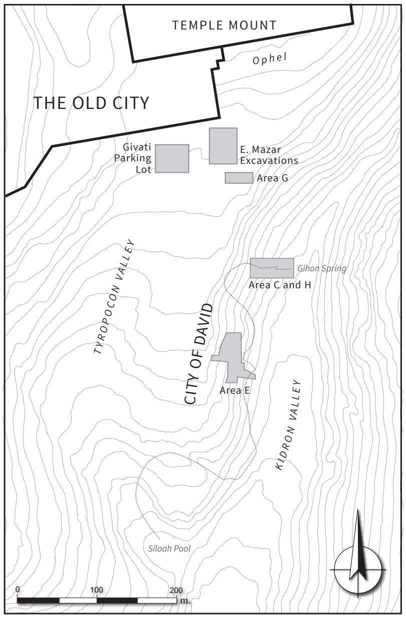

Fig. 1: Map of the City of David, showing the location of areas yielding Early Bronze Age remains (by Joe Uziel)

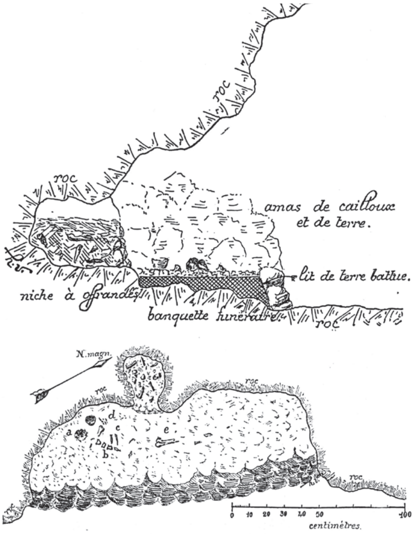

Fig. 2: Plan and section of Early Bronze Age burials exposed by M. Parker (Vincent 1911)

locales (Fig. 1). The first are two Early Bronze I burials, excavated in the early 20th century by M. Parker and published by L.H. Vincent (1911) (Fig. 2). While the excavation as a whole was not very scientific, a significant assemblage of vessels was uncovered and published, providing a secure chronocultural horizon for the burials in the EB I (see Maeir, Yellin and Goren 1992), which can be radiocarbon dated in the Southern Levant between 3700–3200/3100 BCE (Regev *et al*. 2012; 2020).

The second location includes buildings on the lower eastern slopes, uncovered in Y. Shiloh's excavations of Area E (Fig. 3). Area E was extensively excavated in the 1970s and 1980s by Shiloh. These excavations exposed two Early Bronze Age strata: 20 and 19. The main structure was composed of three

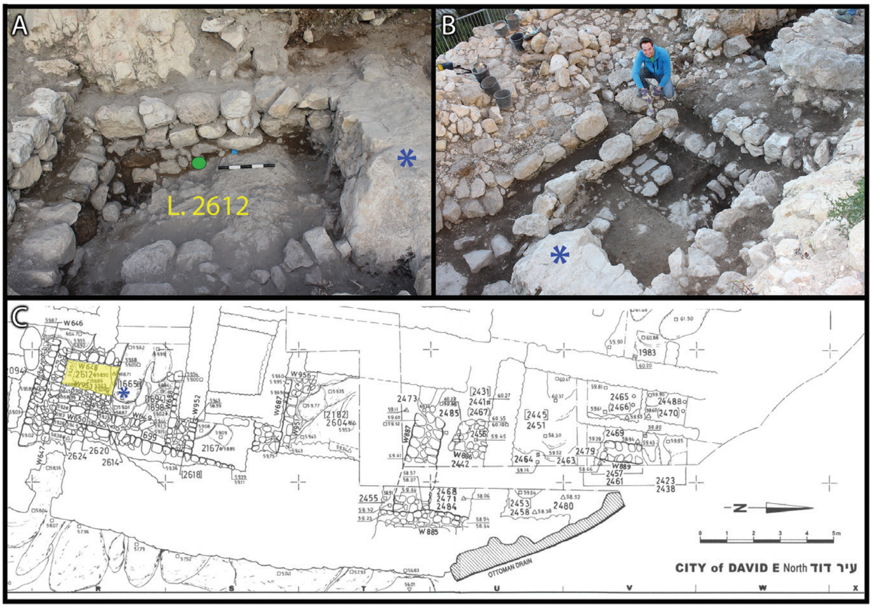

Fig. 3: Area E, EB broadroom house (Shiloh's L.2612); A) after cleaning during the 2016 excavations, view to the west; the green circle marks the location of the ^{14}C samples below W648; the blue asterisk marks a large bedrock slab inside the room, appearing in all three images; B) view to the east of the same room; the MB city wall is seen in the upper left (photos by Johanna Regev); C) Shiloh's drawing of Strata 19–20 (after De Groot 2012, Plan 52b); the yellow area marks the area seen in A

rooms (De Groot and Bernick-Greenberg 2012: 123–127). While Shiloh (1984: 25) originally dated the construction date to the EB IB, linking them with the burials, the final report suggests that the original date was erroneous as no pottery that could be exclusively dated to the EB I was found in direct relation to the structures. As such, Greenberg suggested that the assemblage from beneath the structures should be dated to the EB II, placing the establishment of the building in this period. Furthermore, the finds from within the structures indicate use of the buildings in the EB II and the early stages of the EB III (De Groot 2012: 144; Greenberg 2012: 308). It is important to note that the date ranges provided by Shiloh, De Groot and Greenberg all conform to the low chronology that was widely accepted, prior to the recent radiometric study of many Early Bronze Age sites throughout the country, which has shown that in fact, the dating of the Early Bronze Age, including its internal division, is much earlier than previously thought (see Regev *et al*. 2012; Table 1).

Recent excavations in Area E (Regev *et al*. 2021) provided the opportunity to more accurately date the structures in Area E,[3] particularly in light of the new chronological scheme of the Early Bronze Age as a whole (see Regev *et al*. 2012). In the current study, the authors initiated a renewed excavation aimed at recovering material for a radiocarbon-dated absolute chronology from all the key contexts that could be correlated with the Shiloh's stratigraphy. The excavation locations chosen for this purpose were mainly located within baulks which remained from the previous excavations and, as in the case presented in this article, re-cleaning of a previously excavated building, in the hope of locating remains that are still *in situ*.

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[3] The excavations of the baulks in Area E were directed by Yuval Gadot with the help of Helena Roth (license Nos. G-62/2015, G-24/2016 and G-11/2017). The project was conducted within the confines of the City of David National Park. The excavations were conducted in cooperation with Macquarie University (Sydney, Australia, 2015), University of Bonn, University of Heidelberg, the Christian Theological Academy in Warsaw (2016), Charles University, Prague, and Zurich University (2017). The work was made possible thanks to the generous contribution of Dr. Holger Aulepp. The authors wish to extend their thanks to Prof. Manfred Oeming, the late Prof. Axel Graupner, Prof. Gill Davis, Prof. Martin Prudký, Prof. Filip Čapek, Prof. Jakub Slawik and Dr. Florian Oepping. We wish to thank all the support provided by the Israel Antiquities Authority and Ir David Foundation (ELAD).

Table 1: Early Bronze Age radiocarbon samples from Jerusalem

Area	RT No.	Libby age	Archaeological context	Locus, basket, type	Cal 1s [BCE]	Cal 2s [BCE]	δ13C [‰]
Area E	RTD 10219	4468 ±21	0–10 cm above bedrock, and below a layer of small stones and pottery. This layer is 10 cm under the wall of room L.2612 (Shiloh locus).	L.3070, B.130646, olive pit/fruit	3326(49.8%)3230 3182(11.0%)3156 3109(7.5%)3092	3334(55.3%)3212 3192(32.2%)3082 3060(8.0%)3028	-21.53
	RTD 10220	4513 ±28		L.3070, B.130646, cereal	3346(11.8%)3320 3237(29.5%)3176 3160(27.0%)3106	3356(30.7%)3262 3249(64.8%)3100	-23.67
	RTD 8776	4473 ±33	10 cm above bedrock, from within the layer of small stones and pottery. 10 cm under the wall of room L.2612 (Shiloh locus).	L.3070, B.130646/7, olive pit	3331(44.4%)3216 3188(12.9%)3152 3126(11.0%)3092	3342(86.9%)3076 3064(8.5%)3026	-21.25
	R_ combine L.3070	4482 ±14	Under wall of room L.2612.	–	3328(35.8%)3262 3250(13.3%)3222 3182(14.3%)3155 3110(5.0%)3100	3336(58.8%)3212 3193(36.7%)3094	
Area U	RTD 9607	4426 ±19	Room 17130 Gray layer directly above bedrock, under a layer of crushed pottery	L.17130, B.172128.4, cf. olive pit	3097(68.3%)3018	3315(2.0%)3296 3286(8.7%)3240 3105(73.5%)3005 2990(11.2%)2928	-20.37
Spring Tower	RTD 7901	4025 ±26	Under a stone in northern part of the spring tower, 2nd layer from top with charcoal flecks	L.14700, B.147000 and B.147005, cereal, olive pit	2574(16.4%)2556 2543(51.8%)2488	2621(4.6%)2600 2584(90.8%)2469	-18.37

Fig. 4: Area E, ^{14}C sample locations; A) W648 in L2612; the red asterisk marks the same stone in all four images under which the samples were collected; B) the layer of pottery and small stones, extending roughly 10 cm below the lowest course of W648 stones, is above the dotted line; C) detailed location of the three dated samples prior to removal of B130647; RTD 8776 is from the pottery layer marked in B, and RTDs 10219,20 are below this layer; D) the same location, after the removal of B130647, revealed a gray compacted sediment with a cluster of charred seeds (photos by Johanna Regev)

Methods

All samples were collected in the field by the authors, aimed specifically for chronology building by radiocarbon dating, in order to link the contexts securely to the feature dated. The screening for preservation and quality of the material for radiocarbon dating, as well as the pre-treatment process toward dating, was tailored according to the type of material and sample size, as presented in previous studies (Boaretto 2009; 2015; Regev *et al*. 2014; 2020). After careful separation of the contaminants from the original material, the samples were graphitized and measured at the D-REAMS laboratory at the Weizmann Institute of Science (Regev *et al*. 2017). Radiocarbon ages (Libby Age) are reported in conventional radiocarbon years (before present = 1950) in accordance with international convention (Stuiver and Polach 1977). All calculated ^{14}C ages have been corrected for fractionation so the results are equivalent to the standard δ^{13}C value of -25‰ (wood). Calibrated ages in calendar years have been obtained from the calibration tables of IntCal20 (Reimer *et al.* 2020) by means of OxCal v. 4.4.4 (Bronk Ramsey 2009). The charred botanical remains were identified using binocular microscope SMZ-800N (Nikon). The context sediments were characterized using FTIR (Fourier Transform Infrared Analysis) analysis with Nicolet iS5 (Thermo) FTIR instrument at 4 cm^{-1} resolution. The spectra could be used to identify the presence of anthropogenic substances, such as burnt clay (Berna *et al*. 2007), phosphate (Weiner 2010) and disordered calcite (Regev *et al*. 2010).

Results

During a small-scale excavation in the spring of 2016, we cleaned room L2612, one of the two broad rooms excavated by Shiloh. The bedrock in the room was not level, and in some parts the walls were built directly on bedrock, while in other parts, a sediment layer of up to 30 cm lay between the bedrock and the lowest course of stones of the walls. In that sediment layer, 5–10 cm beneath the stones of the wall, a horizontal line of pottery sherds and small stones could be traced in the well-cleaned section (Figs. 3–4). Based on the FTIR spectra (Weiner 2010), the mineral composition of the sediment above and below the pottery horizon is very similar, where both have a dominant presence of clay rather than calcite. The calcite crystalline order is that of limestone, based on the grinding curves method (Regev *et al*. 2010). The horizon beneath the pottery was grayish in color, compacted, and had a slightly higher presence of phosphate, and the clay is slightly heat altered. We found a cluster of seven seeds in the small amount of sediment that could be collected from this sediment and dated samples RTD 10220 (cereal) and RTD 10219 (olive or fruit pit). Sample RTD-8776 (olive pit) originated from the sediment within the layer of pottery and small stones. The

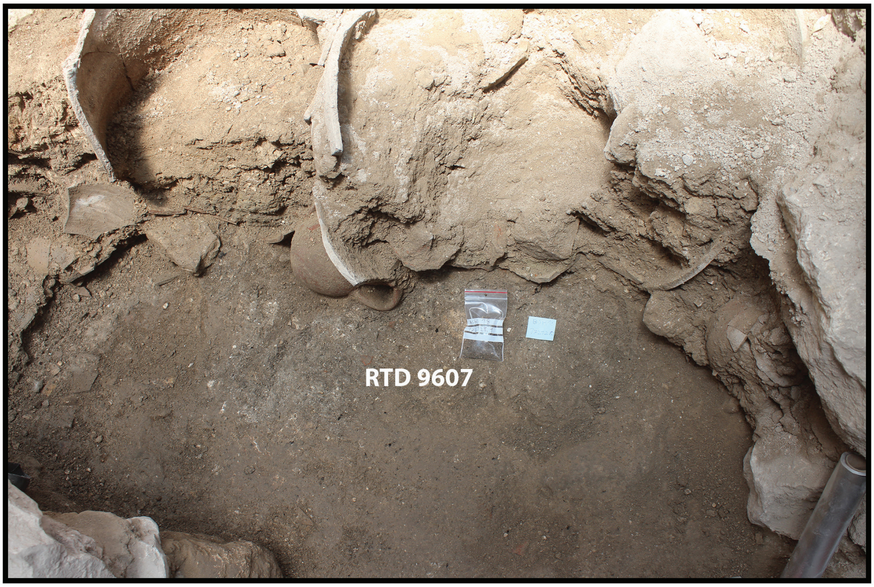

Fig. 5: Area U, location of sample RTD 9607; several seeds from a thin gray layer directly above bedrock and under a layer of Iron Age vessels (photo by Johanna Regev)

three measurements are similar and give a R-combined result of 4482±15 ^{14}C year BP, calibrating within 68.3% probability between 3330–3100 BCE. This broad calibrated range of dates is due to the calibration plateau occurring at this time. This range correlates with the late EB IB horizon in Beth Yeraḥ, which includes "Grain-wash" decorated pottery, but also with the early horizon of EB II, where the repertoire already includes as hallmarks the "South Levantine Metallic Ware" and Golan cooking pots (Greenberg and Porat 1996; 2014). These chrono-cultural horizons have identical calibrated ranges. In Tel Beth Yeraḥ, due to many dates in stratigraphy, it was possible to model the transition date from the late EB IB to the early EB II between 3220–3100 cal BCE (Regev *et al*. 2020). In Jerusalem, no stratigraphy could be obtained in the previously excavated room without remaining baulks, thus leaving the calibrated range long. Similarly, in Tel Yarmuth the final EB IB and early EB II have some overlap in the calibrated ranges. There the transition between the EB IB and EB II was modeled a century later than in Tel Beth Yeraḥ, between 3100–3000 BCE (Regev *et al*. 2012). As noted before (De Groot 2012), the architecture in Area E is similar to the broad room houses widely excavated in Tel Arad (Amiran and Ilan 1996) in Stratum III and II. The end of the early EB II, Stratum III houses in Arad is dated between 2910–2900 BCE. Since our dates originate underneath the room walls, from two layers with identical dates, and they are most likely to present the time immediately preceding the construction of the rooms, they fit very well the overall scenario of building time at the late EB IB or early EB II. As the pottery inside the room consist of slightly later pottery, from the EB II and EB IIIA (including some Khirbet Kerak sherds), the data reasonably suggests a lengthy Early Bronze Age occupation in the southeastern slopes of the City of David of roughly 300 years.

Another radiocarbon date, pointing to a prolonged Early Bronze Age occupation, came from Area U, Room 17130, an olive pit sampled directly above bedrock as RTD-9607, underneath rubble of the 8th-century BCE earthquake (Fig. 5; Uziel and Chalaf 2021; Regev *et al*. 2021; 2023). This date is slightly later than those from Area E, within a clear EB II cultural setting, having a calibrated range between 3100–3020 cal BCE, correlating with Arad Str III and the early part of the EB II at Beth Yeraḥ (Regev *et al*. 2017; 2020).

It is important to note a third context, where another, most likely Early Bronze Age, date was retrieved. The samples taken from underneath the Spring Tower (Regev *et al*. 2017c) yielded a date from roughly 2500 cal BCE. However, the date obtained (RTD-7901) consisted of two fragments, combined together from a cereal and an olive pit. Therefore, it may indicate a late EB III date, or alternatively mixed material from the Early and Middle Bronze Ages. As such, it is clear that there was activity in the vicinity of the spring either from 2500 BCE or earlier. Despite the limitations in using this date in the current research, the retrieval of the dates beneath the spring tower helped determine the methodology of the entire project, which strictly dated single samples from that point onward.

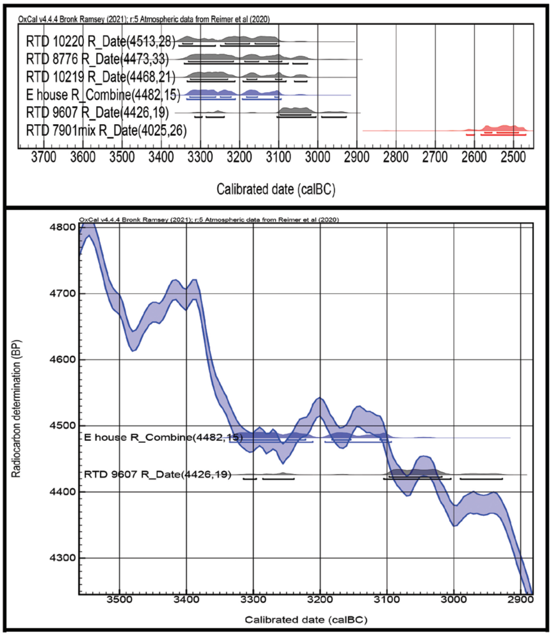

Fig. 6: ^{14}C dating results; top: calibrated probability distributions of the five EB dates; the combined result of the three samples from Area E is in blue, and the result of the mixed sample from the Spring Tower is in red; bottom: the probability distributions of the combined result and the date from Area U on the calibration curve, showing the fluctuating nature of the curve in this region

Discussion

Although less extensive than the results from other periods, the Early Bronze Age ^{14}C results provide another indication of the settlement of Jerusalem in this period. Although earlier artifacts were collected in the area of the eastern slopes of the City of David, spanning the period between the Epipaleolithic period and the Chalcolithic period, the earliest architectural remains and burials found at the site are securely attributed to the Early Bronze Age. It is likely that the familiarity with the natural spring, i.e., the Gihon Spring, which emanates from a cave at the base on the Southeastern Hill, led to the eventual settlement along the hill's slopes in the late fourth millennium BCE. The settlement seems to have been limited to the eastern slopes, only growing towards the upper parts of the mound in later periods. Interestingly, the settlement was established in the late EB I or early EB II, as attested to by the ceramic evidence as well as the radiocarbon dating (Fig. 6). The ceramic analysis led Greenberg (2012) to conclude that although Shiloh (1984) had suggested dating the construction to the EB I, the latest pottery beneath the building dated to the EB II, setting the date of construction in this period. Although it is difficult to determine the more precise dating of the settlement, due to the lack of a dense stratigraphic sequence, it is possible that the dates retrieved signify that the date of construction may reflect a period of transition between the EB IB and EB II. The additional dates from Area U indicate that the human activity extended further to the north from Area E, towards the area of the spring, although these dates were not retrieved from architectural contexts. It appears that the settlement continued to utilize the spring well into the EB II. To date, no clear radiocarbon evidence for EB III occupation has been discovered, although this may be due to chance and the meager contexts available for sampling during our study. If the settlement did continue into this portion of the Early Bronze Age, it is not clear what the nature and character of the site was, although it is difficult to imagine that it would have evolved much. If the site was abandoned and did not continue into the EB III, the reasons for the abandonment cannot be determined with any sense of certainty, although it is possible that the residents of the village relocated to one of the fortified towns in the hill country that flourished in the EB II–III (e.g., Hebron, ʿAi, Jericho). Regardless, it would be centuries before the site of Jerusalem would be occupied once again, in the Middle Bronze Age.

Conclusions

The current paper presents a small venue into another new, previously undated, period by radiocarbon in Jerusalem. The use of absolute dating has changed the way in which we approach fieldwork in the vicinity of the ancient core of Jerusalem. Whereas in the past, layers, strata and architectural elements were dated according to artifact typology of material culture—particularly pottery—recent excavations have integrated ^{14}C dating, alongside existing methods, in order to better date each feature using all available evidence. By integrating stratigraphy and pottery, the modeled ^{14}C dates may be greatly narrowed down and provide precise dates that can be linked to specific moments in the city's history. At a minimum, the radiocarbon dates corroborate other dating methods, providing additional evidence for the dating of strata. At times, as in relation to the Early Bronze Age in Jerusalem, the radiocarbon dates can pinpoint times of site occupation and allow correlation with sites that have more precisely modeled ^{14}C chronologies based on multiple stratigraphic contexts. The occupation dated in Jerusalem is contemporaneous to EB IB late and early EB II as dated in Tel Beth Yeraḥ, Tel Yarmuth and Tel Arad. Once widely and carefully applied, radiocarbon dating can revolutionize the understanding of timing of events, cultural changes and regional processes. In all these cases, there is no doubt that the application of ^{14}C in the field has begun to revolutionize the archaeology of Jerusalem.

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A Computational Model for Absolute Chronology in Archaeology

Eythan Levy

Introduction

This paper summarizes our recent approach to chronological modelling in archaeology. This approach is based on the ChronoLog software (chrono.ulb.be), developed by the author in collaboration with Prof. Gilles Geeraerts (Université libre de Bruxelles) and Dr. Frédéric Pluquet (Haute École Louvain en Hainaut). We first review our model, based on the notion of chronological networks, and then present our software tool, ChronoLog. We end with a few concluding remarks and directions for future research.

The "Chronological Networks" Model

This research started from the observation that chronological data induce a network. Kings, strata, ceramic types and other archaeological *realia* are all connected to each other via a network of synchronisms. Hence, any chronological change to one entity in this network (for example, changing the dates of a given king) might potentially affect the dating of other units along the network. How can such networks be formalized? Can a practical software tool be built to study these networks? Our survey of the literature showed

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that no such tool was available for archaeological researchers. Hence, we developed both a theoretical formalization of chronological networks and an accompanying software. In this paper, we review the main tenets of our model (for full details on chronological networks, see Levy *et al*. 2021).

A chronological network comprises three types of entities: time-periods, sequences and synchronisms.

Time-periods

The time-period is the basic unit of chronological networks. It can represent a stratum, a reign, a ceramic type, a historical period, a cultural phase, or any other chronological unit containing no gap. A time-period contains three variables: its start, end and duration (expressed in years). The start or end of a period can be known (e.g., 1200 BCE), lower bounded (e.g., after 1200 BCE), upper bounded (e.g., before 1300 BCE), in a range (e.g., 1200–1300 BCE), or unknown. The same holds for durations (five years, at least five years, at most five years, between five and ten years, or unknown). For examples, see Fig. 1.

Sequences

Time-periods can be grouped into sequences—i.e., they follow each other directly. More formally, in each sequence, the end of a period equals the start of the next period. Sequences are drawn as time-periods stacked on top of each other, with the earliest period on top and the latest at the bottom. A sequence

Fig. 1: Examples of ChronoLog time-periods: Period A lasts exactly six years, from 1984 to 1990; Period B lasts exactly six years, at an unknown absolute time; Period C starts no earlier than 1300 CE, ends no later than 1400 CE, and lasts 20–40 years (the start date appears in the lower left corner, the end date in the lower right corner and the duration in the center)

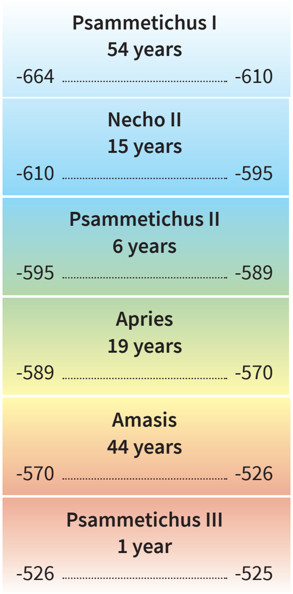


Fig. 2: Example of a sequence: the Twenty-sixth Egyptian Dynasty, with known dates and durations

can represent, for example, a dynasty, a stratigraphic sequence, or a sequence of cultural phases. Fig. 2 provides an example of a sequence.

Synchronisms

Synchronisms express the connections between time-periods and are what makes our models connected into a network-like structure. Clearly, there can be many types of synchronisms between two time-periods, and the chronological networks model features a precise typology of such synchronisms. We represent a synchronism as a simple line connecting two time-periods, with the type of synchronism written above the line (Fig. 3). Table 1 provides a list of the main synchronisms occurring in chronological networks, with precise definitions. For a more detailed list of synchronisms, and a detailed discussion of their chronological significance, see Levy, Piasetzky and Fantalkin 2021.

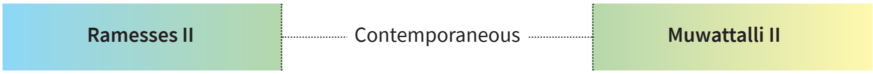
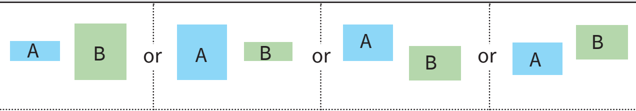
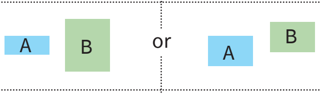
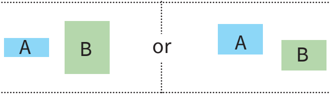
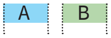
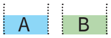


Fig. 3: Example of a synchronism between Egyptian pharaoh Ramesses II and Hittite king Muwattali II; these kings wrote letters to each other, implying that their reigns intersect at some point; the contemporaneity synchronism used here is one of the simplest types of synchronisms, expressing merely that the two time-periods intersect at some point, but that we have no further knowledge of the relation between the two time-periods

Table 1: Examples of the main types of synchronisms used in the "chronological networks" model (in the figures, time flows from above to below)

Name	Image
Contemporaneity (A contemporary with B)	
Inclusion (A included in B)	
Overlap (A overlaps with next period B)	
Starts during (A starts during B)	
Ends during (A ends during B)	
Synchronized start	
Synchronized end	
Equality	
Ordered boundaries	$A \left\{ \begin{matrix} \text{starts} \\ \text{ends} \end{matrix} \right. \left\{ \begin{matrix} \text{before} \\ \text{after} \end{matrix} \right. \left\{ \begin{matrix} \text{start of} \\ \text{end of} \end{matrix} \right. B$
Delay synchronism	$A \left\{ \begin{matrix} \text{starts} \\ \text{ends} \end{matrix} \right. \left\{ \begin{matrix} \text{exactly} \\ \text{at least} \\ \text{at most} \end{matrix} \right. \left\{ \text{X years} \right. \left\{ \begin{matrix} \text{before} \\ \text{after} \end{matrix} \right. \left\{ \begin{matrix} \text{start of} \\ \text{end of} \end{matrix} \right. B$

Example

Fig. 4 provides an example of a simple chronological network (dubbed "ChronoLand"), featuring two strata, two kings and two synchronisms. The strata have unknown dates but a supposed duration of between 20 and 100 years. The first king, Albert, has a reign of at least ten years, starting no earlier than 1200 CE. The second king, Baldwin, has a reign of at least 35 years, ending no later than 1300 CE. It is known from historical and archaeological sources that Stratum 2 starts during the reign of Albert and Stratum 1 ends during the reign of Baldwin. Why does this model constitute a network? First, because the periods are connected to each other via synchronisms, and second, because this connection implies that any change to the dates or duration of one time-period has the potential to affect the dating (or duration) of other time-periods.

Computing Chronologies

Clearly, the model outlined above enables us to represent a wide variety of chronological data, including relative and absolute chronological knowledge. Yet as such, it only dealt with the representation of data, not with computational issues. We now illustrate the need of chronological software to not only encode

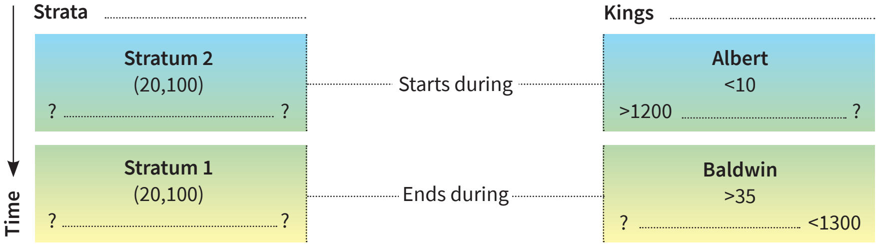


Fig. 4: Example of a small chronological network, featuring two sequences, the first representing a stratigraphic sequence (an earlier stratum [Stratum 2] followed by a later stratum [Stratum 1]) and the second one a dynastic sequence (King Albert followed by King Baldwin); this example illustrates the representation of partial chronological knowledge in the time-periods and shows the use of two different types of synchonisms to represent the relation between Stratum 2 and Albert and between Stratum 1 and Baldwin

and visualize the data, but also to automate chronology building based on these data. Indeed, when looking at the example of Fig. 4 above, we are still in want of a chronology. How can all the displayed data be combined into a chronology? In other words, what are the tightest possible ranges one can obtain for the start and end date (and duration) of each time-period? Clearly, the presence of synchronisms must help us deduce at least some information regarding the absolute dates of the strata and kings. Hence, we need a tool to compute such a chronology, and to ensure that the computed chronology is the tightest (i.e., most precise) one that can be deduced from the available data.

Tightening

The tightest possible chronology one can deduce from the network of Fig. 4 is shown in Fig. 5: the strata are now assigned a duration of at most 80 years, Albert starts reigning no later than 1260, dies between 1200 and 1265, and Baldwin dies no earlier than 1240. In the same way, earliest and latest start/end dates have been computed for each stratum. These new dates derive from a phenomenon we have called "chronological propagation": dates of a given time-period propagate to neighboring time-periods following the available synchronisms, and affect their neighbors in different ways, depending on the precise types of synchronisms involved (for a precise characterization of the propagation behaviour of each type of synchronism, see Levy, Piasetzky and Fantalkin 2021). In this case, the 1300 CE latest end of Baldwin propagates to

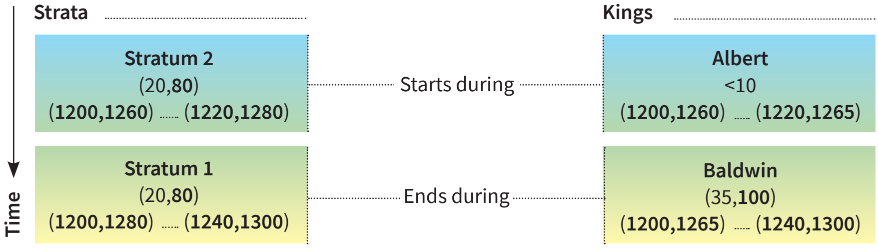


Fig. 5: The tight chronology deduced from the network of Fig. 4; updated results have been computed for the start, end and durations of each time-period (tightened results are shown in bold)

the latest end of Stratum 1 via the “ends during” synchronism. It then combines with the 20-year minimum stratum duration to provide Stratum 1’s earliest start of 1280 CE. This date then propagates to the end of Stratum 2, where it combines again with the minimum duration to provide Stratum 2’s earliest start of 1260 CE, which in turn propagates to King Albert via the “starts during” synchronism, providing Albert’s earliest start of 1260 CE. In short, a date coming from Baldwin (1300 CE) propagated all the way to Albert, via Strata 1 and 2, incorporating minimum durations along the way. Clearly, spotting such propagation paths with the naked eye is a challenging task. A computational approach is therefore required. Furthermore, each period is affected by many different propagation paths, thus necessitating a clever approach to find the path yielding the most precise chronological results. We call the search of such precise chronological bounds (i.e., the tightest possible results for the start dates, end dates and durations) the “tightening operation” (see Levy *et al*. 2021: 6–7 for a full discussion).

Consistency Check

Clearly, chronological data can at times be inconsistent. Hence, even before computing the tight chronology of a chronological network, we must check its consistency. The chronological network of Fig. 6 shows a modified version of the previous network, in which Baldwin is awarded at most 25 years of reign (instead of at least 35). Such a model is not consistent—i.e., its data are contradictory. Detecting the inconsistency with the naked eye is a challenging task. The problem is the following: with the new data, the whole dynasty lasts at most 35 years (10+25), but the stratigraphic sequence lasts at least 40 years (20+20). Yet the two synchronisms imply that the stratigraphic sequence starts and end within the lifetime of the dynasty. In other words, we must make (at least) 40 years fit within (at most) 35 years, which is impossible.

The two examples given here are meant to convey the message that checking and computing chronologies is a difficult task to perform with the naked eye, even on a small model with only four time-periods, let alone on real-life case

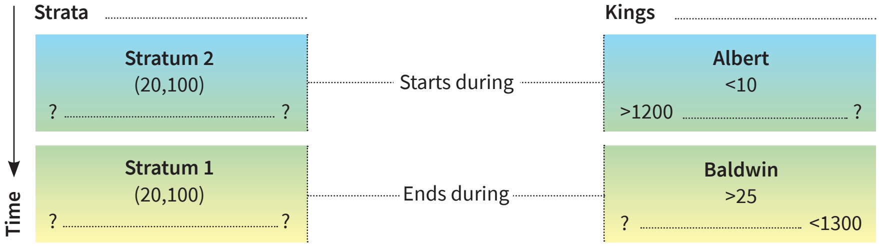


Fig. 6: Example of an inconsistent model; Baldwin is now awarded at most 25 years of reign (instead of at least 35); the model is inconsistent because the minimum 40 years of the two strata cannot be made to fit within the timespan of the dynasty, restricted to at most 35 years

studies involving dozens (or hundreds) of time-periods. We conclude that one cannot achieve this task without recourse to specialized software. The next section presents the ChronoLog software, which we have developed precisely for such purposes.

ChronoLog

ChronoLog is a software tool designed for archaeologists and historians to encode their chronological data in the shape of a chronological network, to check the consistency of the data, and to automate the building of chronologies (tightening). The main idea of the software is to offer a user-friendly tool which requires no mathematical knowledge on the part of the users, and which enables them to test several different chronological scenarios, and immediately see the outcome of different chronological hypotheses. The software is fast, enabling users to work with very large networks, and it also provides a detailed report (called a "trace") of each computed result. ChronoLog is available for free at chrono.ulb.be, and consists of a Java executable file (JAR file). ChronoLog runs on any operating system (Windows, MacOS, Linux, a.o.) with a recent Java installation (note that JAVA can be downloaded free of charge at java.com/en/download/).

Encoding the Network

ChronoLog enables users to encode their chronological network by point-and-click (see the online user manual for more details, though the software's interface is quite self-explanatory). Fig. 7 illustrates the model presented above (Fig. 4), as encoded in ChronoLog. The graphical syntax is similar to that used in the theoretical chronological networks exposed above: duration at the center of the time-period, start date at the bottom left, end date at the bottom right. Clicking on a time-period enables the changing of its start date, end date or duration, and clicking on a synchronism enables the changing of the type of synchronism. New synchronisms are created simply by joining two periods with the mouse. New sequences and periods can be created directly by the user by clicking the "Add period" button, or by inserting a predefined sequence from ChronoLog's library of standard sequences, including Egyptian, Mesopotamian, Greek and Hittite sequences (among others).

Testing Hypotheses

ChronoLog automatically launches a consistency check whenever new data is added to the model and, if the model is consistent, it launches the tightening procedure to update the chronology. Any updated value (start date, end date, or duration) is shown in red, in order to ease visualization of the impact of the new data.

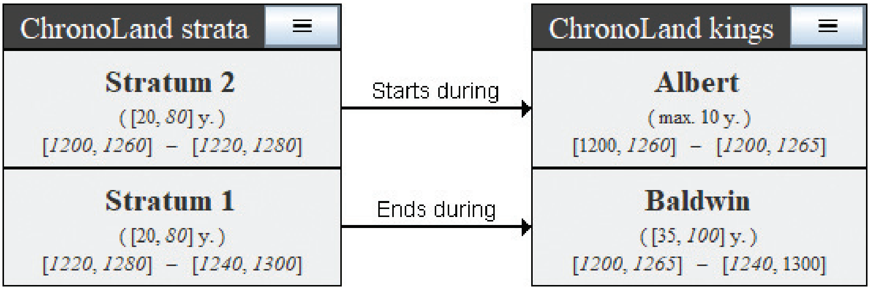


Fig. 7: The model of Fig. 4, encoded in ChronoLog; the straight numbers represent the inputs, while the italicized ones represent the updated dates and durations obtained via the tightening procedure

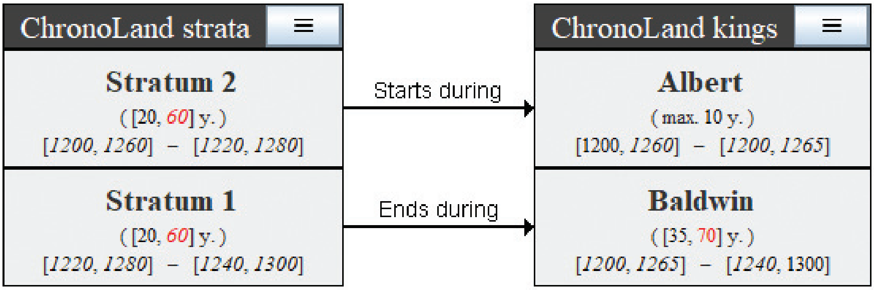
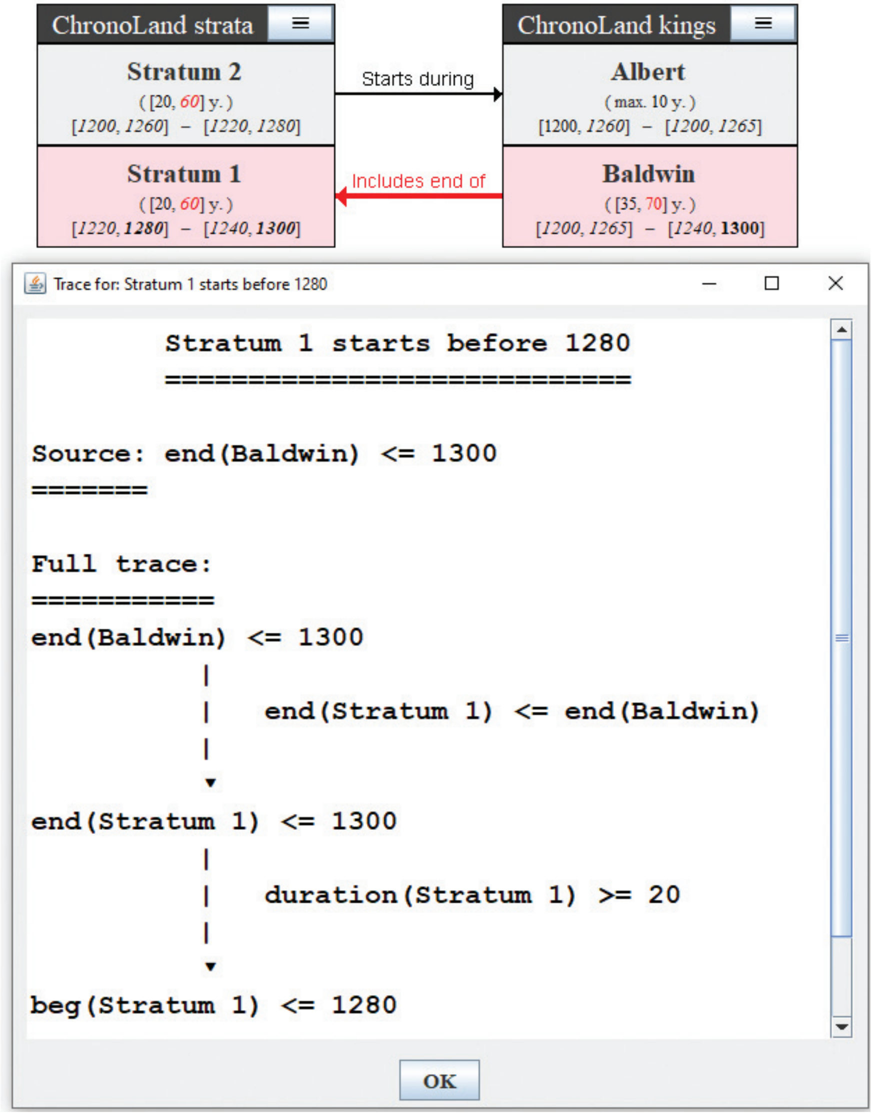


Fig. 8: Updating the network: setting a 70-year maximum duration for Baldwin yields a 60-year maximum duration for each stratum (changes shown in red)

Fig. 8 provides an example in which the user changes the maximum duration of Baldwin to 70 years (recall from Fig. 4 that Baldwin was not awarded any maximum duration before) and wishes to see if that change will impact the chronology. One sees in red that this change modified the maximum duration of both strata from 80 to 60 years. Performing such trials lies at the core of the ChronoLog philosophy: we see chronology as something fluid, where different hypotheses should be envisioned and their outcomes assessed, rather than as a monolithic field where dates are considered “frozen” and not subject to alternative interpretations.

Trace Reporting

When ChronoLog detects an inconsistency in a model, it provides a detailed report explaining why the model is inconsistent. Such reports are called traces. In the same way, for each computed date (or duration), the user can ask for a trace explaining the full propagation path that led to that result. Fig. 9 provides an example showing the trace for the 1280 latest start of Stratum 1. ChronoLog produces both a trace in textual form (featuring mathematical inequalities and the chain of involved time-periods) and a visual trace by coloring in pink all the time-periods and synchronisms involved in the propagation path. In this example, one sees that the 1280 CE result for Stratum 1 derives from the 1300 CE latest end of Baldwin, which propagates to the end of Stratum 1 via the “ends



```
       Stratum 1 starts before 1280
       ============================

Source: end(Baldwin) <= 1300
=======

Full trace:
===========
end(Baldwin) <= 1300
          |
          |    end(Stratum 1) <= end(Baldwin)
          |
          ▾
end(Stratum 1) <= 1300
          |
          |    duration(Stratum 1) >= 20
          |
          ▾
beg(Stratum 1) <= 1280
```

Fig. 9: Example of trace reporting; the trace, shown graphically in pink and also textually, shows that the 1280 CE latest start of Stratum 1 derives from the 1300 CE latest end of Baldwin, then propagates to the end of Stratum 1 via the “ends during” synchronism, then propagates to the start of Stratum 1 via that stratum’s 20-year minimum duration

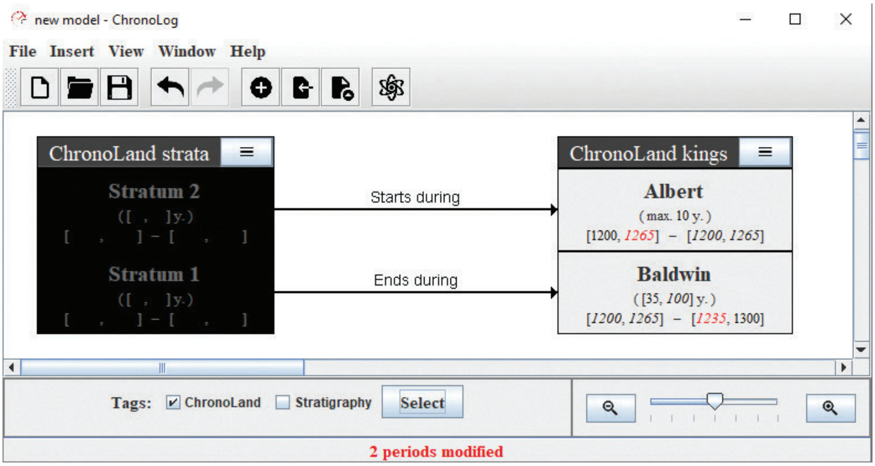
during” synchronism, then propagates to the start of Stratum 1 via the 20-year minimum duration. For large models, identifying long propagation paths with the naked eye is a complex task; hence the need for a computational tool to find the traces. Furthermore, trace reporting (coupled with an explicit encoding of all the ground hypotheses of a given chronological discourse) is indispensable for chronological results to be falsifiable, that is, for enabling researchers to check the accuracy of a claimed chronology. In other words, each chronological result claimed by ChronoLog is purely deductive, based on the encoded data, and verifiable by the user through the reported trace.

Tagging

An additional feature of ChronoLog is that it allows users to tag their sequences with (free-text) keywords such as “stratigraphic,” “epigraphic,” or “radiocarbon” (among others), in order to identify the type of information involved in a given sequence. This enables users to obtain selective chronologies with just a click of the mouse. For example, one might wish to check how the removal of all stratigraphic data would affect the chronology of a region. This allows the production of not only one given chronology for a given chronological network, but several different chronologies, depending on the type of information taken as ground data. As an example, Fig. 10 shows our same basic model, with the list of tags displayed under the main panel. We have unchecked the “Stratigraphy” checkbox, which automatically excludes the two strata from the model and recomputes the chronology. We can see (in red) how the latest start and earliest end of Baldwin have been affected by the removal of the strata.

Radiocarbon

Radiocarbon dates, expressed as ranges (e.g., 900–800 BCE), can be directly included into ChronoLog. Yet ChronoLog does not use probabilities; hence, the probabilistic confidence level (e.g., 68% or 95%) associated to the radiocarbon result is not taken into account by ChronoLog. The inclusion of a radiocarbon result into ChronoLog is treated just like any other piece of data: it is considered



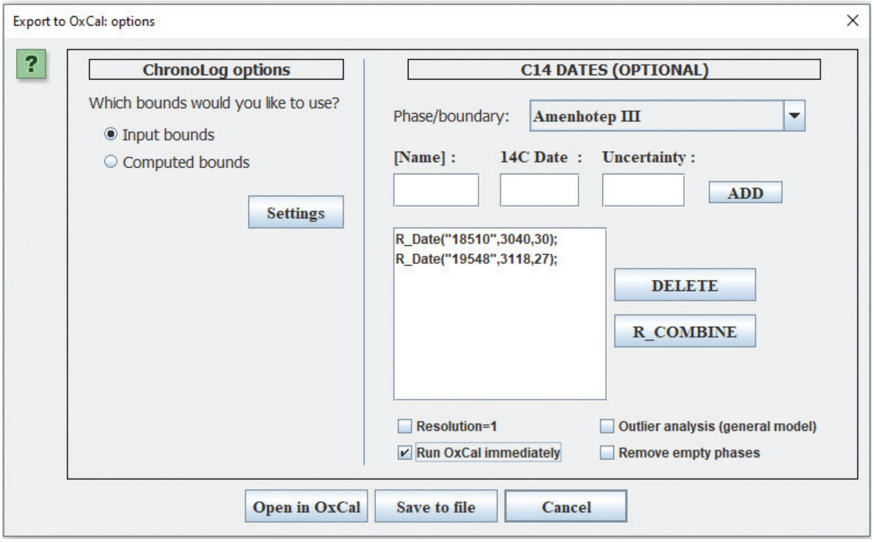
Tags: ☑ ChronoLand ☐ Stratigraphy

2 periods modified

Fig. 10: Example of tagging; the strata have been removed from the model by unchecking the “Stratigraphic” tag at the bottom of the window; as a result, Albert now has a latest start of 1265 CE instead of 1260 CE and Baldwin an earliest end of 1235 CE instead of 1240 CE (the image also displays the full ChronoLog window, including its menu, toolbar and status bar)

true (unless an inconsistency is detected) and used for constructing the chronology. An example of a large ChronoLog model including radiocarbon dates has been presented in Levy *et al.* 2022a. This model evaluates the date of appearance of Philistine pottery at Megiddo under a variety of hypotheses regarding strata durations, Egyptian synchronisms, and inclusion/exclusion of radiocarbon results. Using the mechanism of tags decribed above, it allowed us to propose several computer-generated chronologies for the event under discussion and to better assess the respective contribution of historical data vs. radiocarbon results in the obtaining of the final chronology.

A totally different approach is possible, consisting of using ChronoLog as a graphical user interface for building Bayesian radiocarbon models for the OxCal software (c14.arch.ox.ac.uk/oxcal/OxCal.html). OxCal is the most widely used tool for building Bayesian radiocarbon models. The goals of such models is to incorporate prior chronological knowledge (dates, durations, synchronisms) into the radiocarbon calibration process in order to obtain more precise radiocarbon dating results. However, building an OxCal model is a technical task, for which many archaeologists have to rely on the help of a radiocarbon specialist. ChronoLog enables archaeologists to build complex OxCal models by themselves, with just a few clicks of the mouse. They first build a regular chronological model using ChronoLog, representing the prior chronological data, then encode all their radiocarbon (uncalibrated) determinations directly into ChronoLog, and finally click on a button which automatically generates the OxCal model. This approach was described in detail in Levy *et al.* 2022b. Fig. 11 shows the ChronoLog interface for encoding radiocarbon determinations. Once encoded, the user chooses between either saving the generated OxCal script directly on his own computer, or having ChronoLog directly connect to the OxCal website and open the model there.



Which bounds would you like to use?

● Input bounds

○ Computed bounds

Phase/boundary: Amenhotep III

```
R_Date("18510",3040,30);
R_Date("19548",3118,27);
```

☐ Resolution=1

☑ Run OxCal immediately

☐ Outlier analysis (general model)

☐ Remove empty phases

Fig. 11: The ChronoLog radiocarbon encoding dialogue

Conclusion

This paper briefly summarizes our approach to chronological modelling in archaeology. We presented our concept of chronological networks—formalizing the concept of interconnected chronological data (see Levy *et al.* 2021)—and our concept of chronological propagation—formalizing the classical notion of archaeological cross-dating (see Levy, Piasetzky and Fantalkin 2021). We then presented the ChronoLog software (chrono.ulb.be), which implements these two notions, allowing users to build chronological networks by themselves, to check their consistency, to obtain a computer-generated chronology based on their data, to test chronological hypotheses, and also to automatically generate radiocarbon Bayesian models for OxCal. To the best of our knowledge, no other tool currently provides an equivalent range of chronological features. ChronoLog is still under active development, with new versions being posted online every six months, approximately.

The advantages of the ChronoLog for engaging chronological debates in archaeology are manifold: 1) all the chronological ground hypotheses of the debate are clearly laid on the table, in the ChronoLog model, with no hidden assumptions or “rules of thumb”; 2) every claimed result (computed date or duration) is fully traceable, hence verifiable by human users; 3) any inconsistency in the data is automatically detected and reported by the software; and 4) users can generate several different chronologies for a given case study, depending on the type of data one wishes to include in the model. Case studies published so far have applied this methodology to the Twenty-sixth Egyptian Dynasty (Levy *et al.* 2021: 20–26), to Aegean Late Bronze Age chronology (Levy, Piasetzky and Fantalkin 2021: 16-29), to Philistine chronology (Levy *et al.* 2022a) and to several case studies related to Bayesian modelling (Levy *et al.* 2022b).

This brief summary does not permit us to touch on the technical details behind ChronoLog. The chronological computations performed by ChronoLog require complex algorithmic techniques which have been described in full mathematical detail in Geeraerts, Levy and Pluquet 2017, and in a more succinct way in Levy *et al.* 2021. In a nutshell, the set of chronological constraints encoded in a chronological network is translated into a directed graph (a mathematical model representing a network), on which shortest-path algorithms are applied in order to compute the chronology. In a way, finding the tightest possible chronology is similar to finding the shortest path from one point to the other using a car navigation system, but with chronological events instead of geographical locations and time delays instead of geographical distances. To the best of our knowledge, such algorithmic techniques have not been previously applied to archaeological chronology. For future versions of ChronoLog, we plan to continue exploiting a wide array of algorithmic techniques in order to automatically detect new synchronisms, to provide a quantitative assessment of the strength of given chronological results, expressed in terms of the number of different propagation paths supporting these results (see Levy, Piasetzky and Finkelstein 2020 for preliminary steps in that direction), and to automatically detect chronological data that do not contribute to the final computed chronology.

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Between Caesarea Maritima and Qaysariya: The City between 640/641 and 750 CE

Peter Gendelman and Uzi ʿAd

This article deals with a somewhat short episode in the history of Caesarea Maritima—a period of a little over a century from 640/641, when Caesarea was conquered by Muslims, to 750 CE, when Marwan II, the last Umayyad caliph, was defeated in battle and later killed. Several papers based on both written sources and available archaeological data already addressed this period, most noticeably those written by Kenneth G. Holum (2011a; 2011b), Gideon Avni (2011), Donald Whitcomb (2011) and Joseph Patrich (2006; 2011). Since 2014, however, several excavations conducted by the Israel Antiquities Authority at Caesarea (Fig. 1) have contributed additional data regarding occupation of the site during the Umayyad period. We present this data here, in addition to previously unpublished and highly relevant materials from Yosef Porath's excavations in the 1990s on behalf of the Israel Antiquities Authority in the South-West Zone (SWZ) of the city in Insula W2S3 (Area I).

Archaeological Evidence

Harbor Horrea (Area LL)

This large complex, which includes two elongated side-by-side warehouses, is located on the northern quay roughly on the point of connection between the median and western basins of the Caesarea's harbor (Fig. 1:1). The *horreum* was

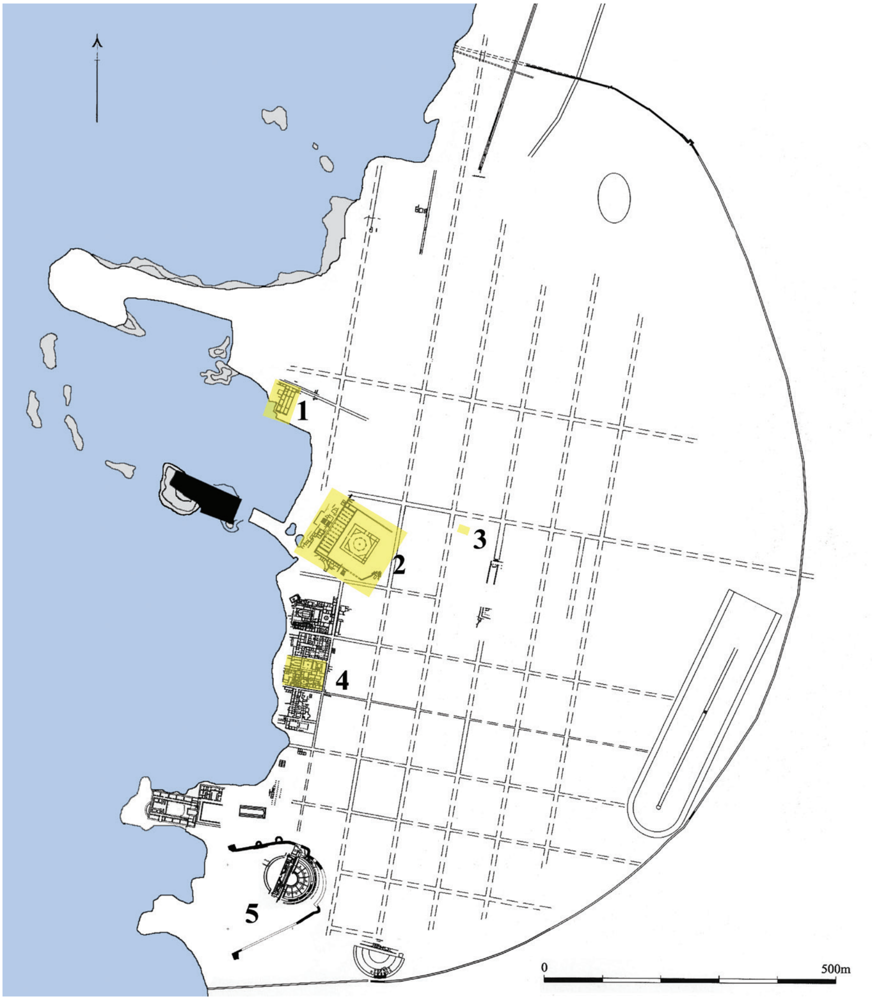

Fig. 1: Map of Late Antiquity Caesarea Maritima showing areas under discussion: 1) Harbor *Horrea* (Area LL); 2) temple platform; 3) salvage excavations in eastern neighborhoods of the city; 4) semi-public complex on Insula W2S3; 5) fortezza (Anna Iamin and Peter Gendelman)

built during the second half of the 4th or the beginning of the 5th century CE upon remains of earlier constructions, and it remained in use with minor changes until the end of the Umayyad period. Some parts of the complex were previously exposed by the expeditions of the Hebrew University of Jerusalem, under the direction of L.I. Levine and E. Netzer (1986) and later by the Combined Caesarea Expedition under the direction of K.G. Holum and A. Raban (Stabler and Holum 2008). The southern and western parts of the complex were severely damaged by the sea and by the construction of harbor fortifications during the Crusader period. During the 2013–2017 excavations conducted on behalf of the Israel Antiquities Authority, the entire complex was exposed (ʿAd, Arbel and Gendelman 2018).

The Byzantine Period/Late Antiquity

During Late Antiquity the large storage complex (over 30 × 47 m) included two *horrea* (eastern and western) (Fig. 2) located on the south of a southeast–northwest street flanked by shops that led into the inner part of the city. The *horrea* share a common wall, which is a remnant of an earlier, Roman period, building. There is no passage between the two *horrea*.

The eastern *horreum* includes an antechamber (R4) entered from the street and flanked by two administrative rooms (R5 and R6). The antechamber terminates with a wide gate leading to the central corridor (R2), which was paved with a mosaic floor (Fig. 3a). This corridor passes between two wings of sizeable storerooms, four on each side (R1, 15–17 in the eastern wing, and R3, R12/13, R14 and R18 in the western wing). The storerooms were built upon series of east–west oriented subterranean vaults (Fig. 3b), and its plaster floors were placed on top of an isolated layer of terracotta tiles (Fig. 3c). This flooring arrangement of the *horreum* indicates that it was used as a granary. The remains of supporting columns made of local sandstone (*kurkar*), set in the center of at least four storerooms (Fig. 3d), indicate that the western *horreum* was at least two storeys high. This conclusion is also supported by its massive ashlar walls.

The western *horreum* (Fig. 2a), less well preserved than the eastern one, includes an antechamber (R20) entered from the street and two rows of storerooms probably accompanied by a corridor on the west. Of the western row only two relatively small rooms, paved with plaster floors, survive (R21 and R22). The eastern row includes four storerooms, paved with plaster and mosaic floors and separated from each other by a relatively narrow wall. Four massive piers stand in the corners of the larger, northern, room, indicating that it had been roofed by arches.

Fig. 2: Harbor *Horrea* (Area LL): a) plan (by Rivka Mishaev); b) aerial photo (Griffin Aerial Imaging)

The Umayyad Period

In the period following the Islamic conquest, possibly a short time gap following 640/641CE, both *horrea* continued in use at least partially as a storage facility. However, several alternations were carried out during the second half of the 7th century CE. The large storerooms of the eastern *horreum* were subdivided by partitions into two or more smaller compartments, similarly to R1, R3, R12/13, R15 and R16 (Figs. 2a, 4a–c). The western administrative room R6 was connected to its adjacent room (R3) by breaching their common wall. The newly created compartments were interconnected and paved with simple plaster, flagstones, or earthen floors. The new floor level was raised by an average of 0.5 m in the western wing and even up to 1 m in eastern wing. Consequently, the height of entrances was shortened and the level of thresholds raised. Some of the new rooms preserved remains of fine white plaster on their walls. Accordingly, a new plaster floor in the central corridor was laid 0.15–0.2 m above the earlier mosaic (Fig. 3a). Rooms R12 and R13 had no changes and probably continued to use floors from the Byzantine period. In room R12 a concentration of dozens of imported and local amphorae was exposed above the floor, some discovered almost intact and the rest broken but reparable (Fig. 4d–e). The imported amphorae originated from the Aegean region and from Egypt and are dated to the second half of the 7th century. Many of the amphorae bear Greek graffiti and dipinti, including monograms and crosses, and at least one vessel was incised with an Arabic inscription.

The western *horreum* was also altered (Fig. 2a): the eastern row was mostly repaved with a new plaster floor that rose up to 0.6 m above the previous pavement; the main changes, however, were in the large northeastern room of the complex (R8). The arch-bearing piers were reinforced, and an additional arch was installed roughly equidistant between them (Fig. 5a). An additional pier constructed of a core of reused *kurkar* column drums and faced by ashlars was set against the northern wall (Fig. 5b). One of two openings in the western wall of the storeroom was blocked, and a new floor of high-quality gray plaster was installed, sloping toward the center of the room. The room’s walls of the room

Fig. 3: Eastern *horreum*: a) mosaic pavement on central corridor; b) subterranean vault; c) pavement of terracotta tiles on storeroom R3; d) supported column on storeroom R15

and the arches were coated with a thick layer of grayish-white plaster, which was preserved to a height of up to 1.5 m above the floor. All the piers preserve a tie hole on one of the corners, 1–1.2 m above floor level, probably for the tying of a beast of burden.

The alterations made to the badly-preserved western row of storerooms were more significant. The previous storerooms were replaced by two new

Fig. 4: Eastern *horreum*: a–b) smaller compartments on R15; c) smaller compartments on R1: d) storeroom R12 with amphorae deposit; e) one of the amphorae from R12

compartments (R21 and R22), separated by a newly constructed wall with an opening. The rooms were paved with plaster floors, 0.2–0.4 m higher than those of the previous period. The walls in both rooms were coated with gray plaster. Near the northeastern corner of the northern room (R21), a *tabun* was incorporated within the new floor and a new opening was breached to connect it with the antechamber (R20) of the previous period's *horreum* (see Fig. 5c).

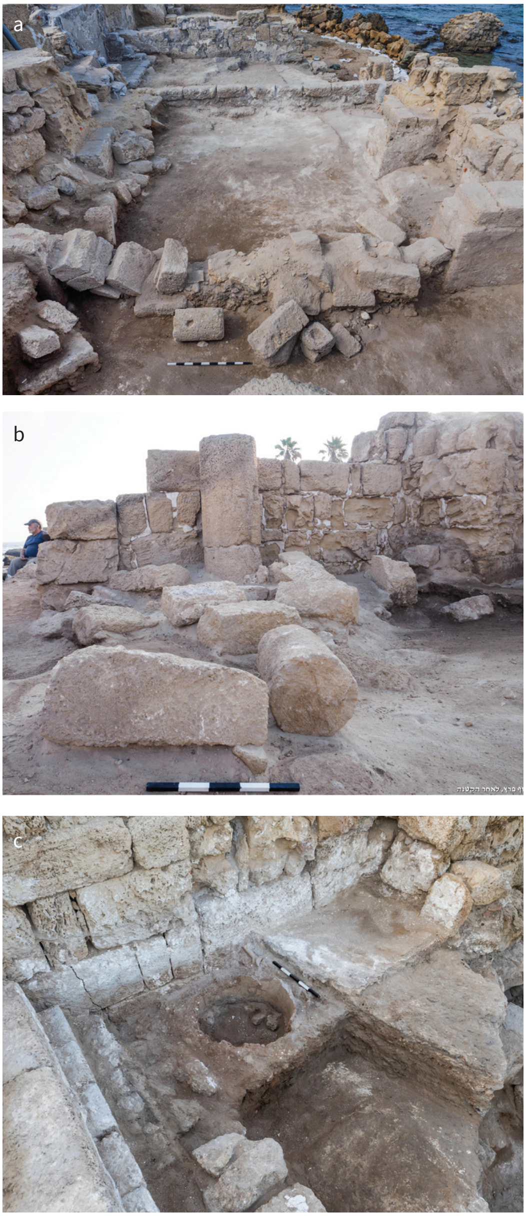

Fig. 5: Western *horreum*: a) fallen arch on R8; b) pier made of reused *kurkar* column drums on R8; c) *tabun* and blocked door on R21

The End of the Complex

The complex was abandoned for unknown reasons toward the end of the 7th or in the beginning of the 8th century CE. Except for empty amphorae in room R12 of the eastern building (as deduced by the absence of stoppers), there were no intact or reparable pottery vessels or personal or household items left on the floors of either the eastern or the western buildings. This suggests that the buildings were vacated by their inhabitants voluntarily, rather than due to any disastrous event.

A layer of ash and chunks of coal, including remains of charred wooden beams, was discovered above the floor of the central corridor of the eastern building. This indicates that this wing of the building was burned soon after its abandonment. The ashlar walls of the corridor and some of the rooms from the eastern (R1, R15) and western (R3, R12 and R13) wings bear marks of exposure to a fierce conflagration (Fig. 6a).

A 0.1–0.4 m thick layer of brown soil accumulated above the burnt layer and the floors, and a thick layer of clean sand (1.2–2.6 m high), mixed with stones from the collapsed walls and arches, covered the entire complex (Fig. 6b–c).

The Vaults of the Temple Platform and Adjoining Areas

The Temple of Augustus and the Goddess Rome was constructed as part of Herod the Great's founding project of Caesarea Maritima and its port Sebastos. The temenos occupied an artificial platform with a curvilinear eastern back-wall, covering a total area of roughly 13 dunams (Figs. 1:2, 7). The platform is surrounded by retaining walls, each almost 3 m wide, containing an inner fill composed of layers of hard-packed sand and crushed sandstone. The western façade consists of a set of six vaults flanked by two large halls (25 × 25 m each) open to the harbor, the roofs of which were supported by arcades. During the last decade of the 5th or the first decade of the 6th century CE, a magnificent octagonal church was built over the site of the demolished Herodian temple and a new staircase connected the temenos with the eastern quay of the inner harbor. The new staircase was smaller than the previous one. In the early 6th century CE, the vaults on both sides of the new propylaea were converted

Fig. 6: Western *horreum*: a) marks of fire on R2; b) deposit of sand on R2; c) deposit of sand on R8

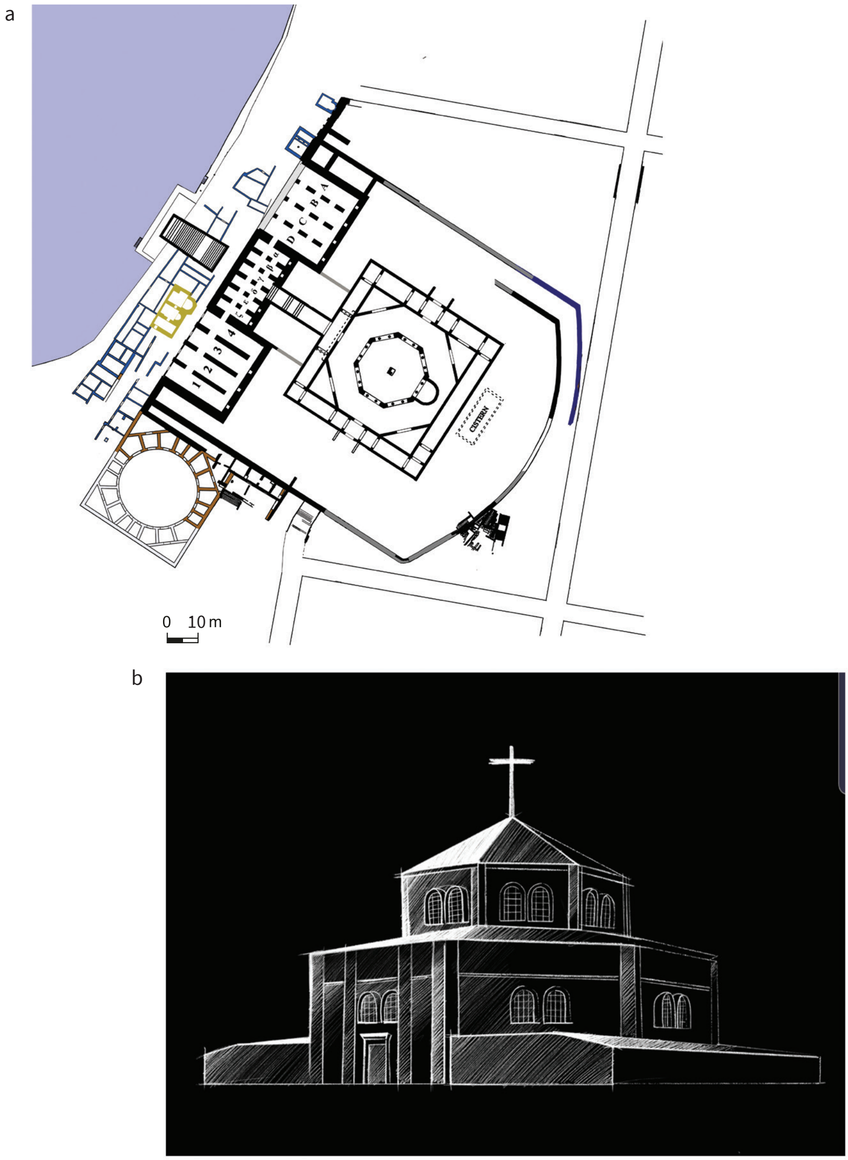

Fig. 7: Temple platform: a) ground plan of the temple platform area in the Byzantine period; b) proposed reconstruction of octagonal church (Breeze Creative Ltd and Peter Gendelman)

into a warehouse with a storage space of ca. 1,300 m^2. The vaults were paved with plaster (Vaults 1–4 and A, D) and/or plain tessellate mosaic floors, some equipped with underfloor dolia jars, a practice familiar from other late antique *horrea* in Caesarea (Patrich 1996: 163). By the middle of the century the *horreum* had been enlarged to cover the entire western mole of the inner harbor.

At the same time the Roman octagonal *macellum* located next to the southern revetment wall of the temple platform was rebuilt. The vaulted radial cells and the central court were paved with plain tessellated mosaics. The reconstructed cells were given a second storey of shops and stores, and a sizeable complex of shops, called the Upper Market, was built on a high ground area to the east of the octagonal *macellum*.

The Umayyad Period

During the second half of the 7th century CE most of the area was abandoned, with only a few indications of human activity. The only clear marks of occupation from the Umayyad period were uncovered within three remaining vaults (B–D) of the northern cluster (Fig. 8a). All three were repaved with a floor of yellowish crushed chalk, and a circular lime kiln was constructed within the southernmost vault (D). The cone-shaped lime kiln, up to 2.7 m in diameter, was constructed of reused ashlars and had a stokehole opening located on the west. It was operated from a small *praefornium* defined by the walls and used a mosaic floor from a previous period as a working surface (Fig. 8b–c). Several marble architectural elements found in the vicinity clearly indicate that the lime-kiln operation was based on abundant marble elements taken from previous constructions and especially from the Octagonal Church.

This lime-kiln operation ceased during the late 7th or early 8th century CE as a result of the collapse of the remaining vaults of the northern group (Vaults B–D). It is not clear whether they collapsed due to some structural failure during their construction almost 800 years earlier or because of natural disasters, such

Fig. 8: Temple platform: a) Vaults A–D, general view; b) Vaults C–D, view to the east; c) lime kiln on Vault D

as one of the earthquakes of 710, 749m or 756 CE (Amiran, Arieh and Turcotte 1994: 266–267).

The Eastern Neighborhoods of the City

Remains from the Umayyad period were uncovered in a small salvage excavation conducted by the authors in the area located to the east of the eastern gate of the Crusader-period fortification (Fig. 1:3). On the whole, this area yielded diverse finds from the Roman to the Fatimid periods (Gendelman and ʿAd 2023). During the Byzantine period this area was occupied by a large (and probably public) building, which was partially exposed. Among its several rooms it also contained a large hall paved with a polychrome mosaic floor (8.37 × more than 7 m) (Fig. 9a).

During the Umayyad period the building underwent significant alterations. The hall was subdivided into at least four smaller rooms (ca. 2–4 × 2 m) (Fig. 9b). Similarly, additional rooms to the west of the hall were subdivided. The newly constructed walls were made of reused ashlars and spolia laid directly upon the mosaic floors of the previous period. With the exception of one of the constructed rooms, which was paved with a plaster floor, the rooms retained the previous mosaics as their floors. The building was abandoned most probably during the first half of 8th century CE; later, in the 9th century CE, industrial installations were constructed over it. Pottery dating between the mid- or late 7th century to the mid-8th century (Gendelman, forthcoming) and post-reform *fals* of 90 H (707 CE) (Bijovsky, forthcoming) were discovered on the floors of the Umayyad building.

The Southwestern Zone Insula W2S3

Between 1992 and1998 the Israel Antiquities Authority Expedition to Caesarea Maritima, directed by Yosef Porath, excavated an enigmatic complex found within Insula W2S3 (Figs. 1:4, 10a). The complex was first built in the 5th century CE and continued to function until the Persian invasion (614 CE) or the Arab conquest (640/641 CE) (Porath 1998: 42–43; 2008: 1660; Gersht and Gendelman 2021: 97; Gendelman and Porath, forthcoming). The complex is divided by

Fig. 9: 2014 excavation in eastern neighborhoods of the city; a) general view; b) Umayyad-period rooms upon mosaic floor from the Byzantine period

entrances and a passageway into two almost equal parts, and it includes two adjoining baths accompanied by administrative and service units on the southern half (Fig. 10b). The northern part consisted of a two-storey basilica facing the peristyle courtyard and several small rooms adjoining it from the east (Fig. 10c–d). Most of the complex was luxuriously decorated with a variety of floor and wall mosaics (tesserae and opus sectile), wall revetments, wall paintings and sculptures, and so on. The insula W2S3 complex seems to have functioned as a semi-public facility and could have been the property of one of the corpora of Late Antique Caesarea (Gersht and Gendelman 2021: 142).

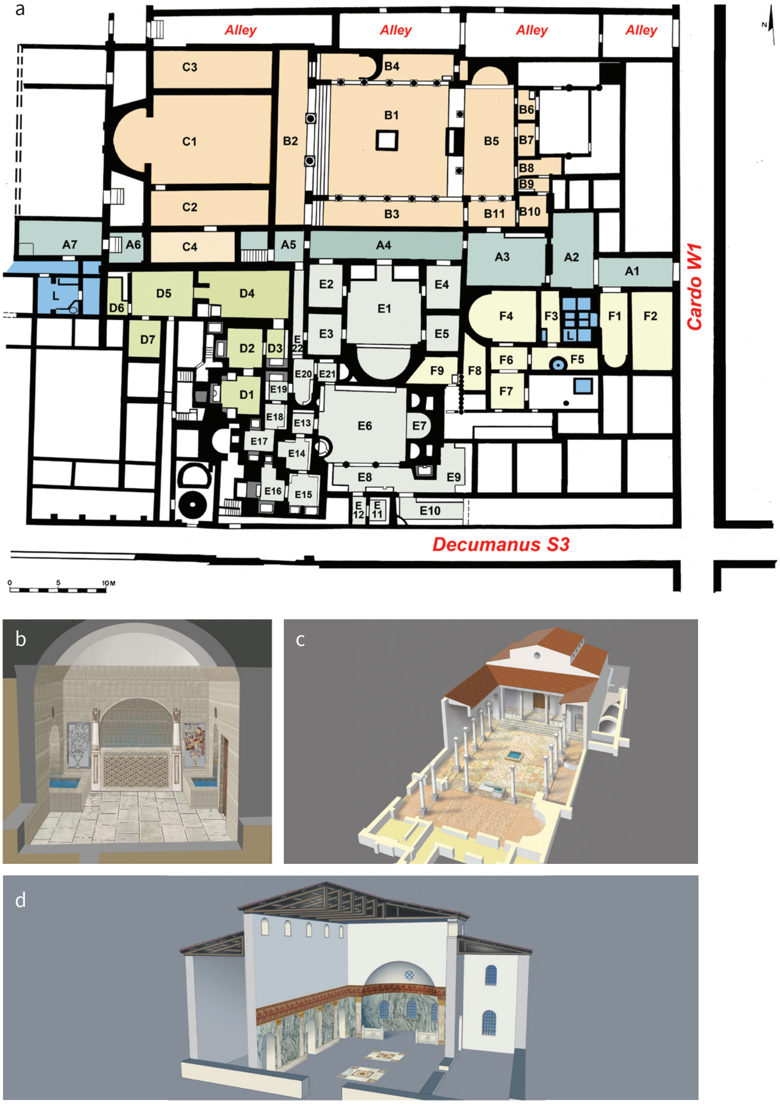

Fig. 10: Semi-public complex on Insula W2S3; a) ground plan from Byzantine period; b) reconstruction of one of large bath *caldaria*; c) reconstruction of peristyle court; d) reconstruction of basilica

The Post-Byzantine Occupation

The semi-public complex of insula W2S3 was abandoned in the mid-7th century CE. Since then its materials were plundered for recycling and reuse. Its disintegration can be divided into two stages:

- Primary recycling of precious materials and covering by irrigation channels and agricultural plots (Stratum 4)
- Stone robbery for construction and for the lime industry (Stratum 3)

The first stage began with the dismantling of timber roofs that mainly covered the northern part of the complex and the dismantling of the upper floor of the two-storey basilica. Timber, rooftiles and probably of some of the metal implements were recycled, whereas ashlars, marbles and stone slabs of veneer or flooring were piled up in the complex's expanses. The cleared areas within the basilica's ground floor and the open court to its west were converted into agricultural plots (Fig. 11a). The plots occupied the rooms and courtyards of the semi-public complex while their walls still stood up to 3–6 m high. These walls were intentionally left erect to protect the plots from the western winds and salt spray from the sea (Porath 2008: 1663).

Three such plots have been recorded: The largest, Plot I, covered the area of the former courtyard west of the two-storey basilica (ca. 8 × 17 m; ca. 136 m^2); Plot II covered the ground floor of the basilica's main hall (ca. 8.7 × 13 m; ca. 100 m^2); and Plot III, the smallest, covered the ground floor of the basilica's northern aisle (3–5 × 15.5 m; ca. 58 m^2). As preparation for the construction of the plots, a thick layer of soil, mixed with city garbage rich in organic material, was spread within each one. In addition, a water well and a system of superficial channels were installed. The channels, 0.1 m wide and approximately 0.1 m deep, were curved and made of reused ashlars that were laid in line. Openings intersected the channels every 0.5–1 m. Each channel started from a basin located next to the well's mouth. Plot II was irrigated with a rather elaborate system of four main channels and two secondary channels that distributed water from a circular well, located roughly

Fig. 11: Semi-public complex on Insula W2S3: a) ground plan of irrigated agricultural plots; b) Plot II; c) Plot I; d) unfinished well on peristyle court of previous period

in the middle, to each part of the plot (as shown in Fig. 11b). The narrow Plot III was irrigated by a single channel from a square well, while on Plot I, only a circular well and a segment of a secondary channel remain (as shown in Fig. 11c). Similarly irrigated plots were excavated by the Caesarea Combined Expedition team on the northern part of insula W2S3 and on the Late Antique *praetorium* on insula W2S2 (Patrich 1999: 81–82, 94, Fig. 12; Lehman 1999: 138–139, 148).

An attempt to create an additional irrigated plot on the higher elevated peristyle court east of the basilica was unsuccessful. During the effort, a significant amount of marble architectural elements was partially moved aside to the northwestern and southeastern corners of the previous peristyle court. As a result, the portico columns fell from their bases. Later, a layer of soil mixed with city garbage, ranging in thickness from 0.5 to 0.9 m, was spread over the area. The workers dug a water well within the previous stratum apsis, but abandoned its shaft before reaching the water table, and the project was never completed (Fig. 11d).

The exact type of plants cultivated in these plots is still unknown. The small size of the plots and the nature of the irrigation system point towards a crop that requires frequent irrigation and quite small areas, such as vegetables or herbs. We are informed, however, by 10th- and 11th-century CE sources, that the inhabitants of Early Islamic Caesarea had cultivated date palms, oranges and citron trees, wheat and black pepper (Nāṣer-e Khusraw 1986: 19; al-Muqaddasī 1886: 55).

The finds indicate that the area of the semi-public complex was used for agriculture only during a short period within the second half of the 7th century CE (Gendelman and Porath, forthcoming). The second stage, pertaining to the lime industry, began already in the first half of the 8th century CE (Gendelman and Porath, forthcoming). The agricultural plots were replaced by lime-production kilns and the remains of the building were further dismantled for their stones. During this stage the semi-public complex lost much of its marble architectural members and decoration, except for those that were covered beneath the agriculture plots. Some of these were burned to lime, but other were taken for reuse. Evidence of this activity is a deposit of marble slabs found in one of the rooms next to Decumanus S3. The slabs were prepared for transportation but for some reason were left in place (Fig. 12a).

Two lime kilns were constructed one next to the other in the area. The larger kiln, which was more than 2 m in diameter at its bottom but less well preserved, occupied one of the service rooms of the large bath's frigidarium. The smaller kiln, 1.5 m in diameter, was constructed within the apse of the large bath's apodyterium (Fig. 12b). The kilns were constructed using reused *kurkar* ashlars and were lined inside with fragments of basalt mortars. Not far east from the larger kiln, a large oval pit (ca. 6 × 6 m and over 1 m in depth) was discovered. The bottom of the pit was covered with ten consecutive layers of white lime, each layer approximately 3 cm thick. The pit most probably functioned as a slaking pit for the production of quicklime from lime kilns. The water required for lime slaking came from a nearby well that originated in the Byzantine period but continued to be used later, as indicated by the pottery found in a fill that sealed it up, dated from the mid–late 8th to the beginning of the 9th century CE.

Evidence of prolonged lime production in the area is shown by the large deposit of lime kiln waste that was deposited over the agricultural lots from the previous stage. The accumulation of lime waste ranges from approximately 3.2 m deep above Plots II and III to approximately 1 m above Plot I (Fig. 12c–d). It is unlikely that such a large amount of lime waste (more than 200 m^3) came only from the two lime kilns mentioned above. It is very possible that the waste from two additional contemporary lime kilns located in the neighborhood of insula W2S4 (Gendelman and Porath 2022: 190) and probably one or more additional lime kilns located in adjacent, not yet excavated, areas, contributed to this waste deposit.

The remains of the lime industry and stone robbery were covered with a sand dune that reached a height of 5–6 m on the southern half of the complex, and with a layer of sandy soil containing numerous marine faunal remains and potshards eroded by the sea. Similar layers were found on the northern half of the insula, as described by Patrich (1999; 2011: 51–52). Within these layers, simple pit or cist burials were discovered, with the skeletons laid on their sides and their skulls facing southeast in a characteristic position for Muslim

Fig. 12: Semi-public complex on Insula W2S3: a) deposit of marble slabs; b) lime kiln on the large bath's apodyterium; c–d) lime waste accumulation above agricultural plots

populations. The few finds associated with these burials, including Arabic epitaphs, permit dating from the 9th century CE onwards (Sharon 1996: 409–411, Nos. 1–2; *CIAP* II: 264–270, Figs. 72–74).

Discussion

Short Summary of Written and Epigraphic Sources

Caesarea Maritima, the capital of the Late Antique province Palaestina Prima, was captured by the Muslim army under Muʿawiyah's command in 640/641 after a siege that lasted either seven months or years (*CIAP* II: 252–253; Avni 2011: 317, n.77). The sources not only dispute the length of the siege but also the way in which Caesarea was captured. In the 8th century CE chronicle by John, Bishop of Nikiu, he mentions: "… the horrors committed in the city of Caesarea in Palestine…" by Muʿawiyah's troops during the conquest (John of Nikiu 1916: CXVIII.10). The 13th-century CE Syriac chronist Bar Hebraeus describes in his *Tarikh Mukhtasar Ad-Duwal*, written in Arabic, that the city capitulated by agreement (*CIAP* II: 253), and in his *Chronography*, written in Syriac, that Muʿawiyah "captured the riches that were in it, and he laid the inhabitants thereof under tribute" (Bar Hebraeus 1932: 104). The Arabic sources, which date from the 9th–11th centuries CE, state that the city was stormed and some 4,000 captives were taken (for a list of sources, see *CIAP* II: 253; Patrich 2011: 52–58).

The information from written sources about the city of Caesarea during the second half of the 7th century and the beginning of the 8th century CE is meager. According to al-Balādhurī, during the revolt of ʿAbdallah b. az-Zubayr (683–693), the city was recaptured or "damaged" by the Byzantines. According to al-Ṭabarī's chronicle, in 690 CE, ʿAbd al-Malik took the city back from the hands of the Byzantines, then rebuilt and fortified it (*CIAP* II: 253; Elad 1996: 150–151, n. 29; Whitcomb 2011: 73).

Recently, rather unexpected and very interesting evidence of Caesarea's status during the early stages of the Early Islamic period was published. The lead bulla found at Apollonia/Arsuf bears the following Arabic inscription (Amitai-Preiss and Tal 2015: 194–195):

Obverse: *khātim kūrat Qaysārīyah*
Reverse: *madīnah Arsūf*

Obverse: Sealing [bulla] of the urban center of Qaysārīyah
Reverse: Town [of] Arsūf)

The authors dated the bulla no later than the 9th century CE most “possibly during (or after) the reign of Muʿāwiyah I as either governor of Syria (640–661 CE) or caliph (661–680 CE), or otherwise shortly after that” (Amitai-Preiss and Tal 2015: 196). The authors state that the bulla signifies a time in which Caesarea still held its previous administrative functions to some degree under Umayyad rule until Ramleh, the new capital of *Jund Filasṭīn*, was established around 714 CE.

Archaeological Data

The archaeological data concerning the character and expansion of the Umayyad-period occupation at Caesarea, from both newly excavated and already published areas, coheres quite well.

The Temple Platform and Adjoining Areas

The data from the areas located near and around the temple platform, located at the core of the Roman and Late Antique city, is quite uniform. It seems that the octagonal church, on top of the platform, survived, but gradually lost its marble furniture and decoration (Holum 2004: 196). The northern parts of the *horreum* on the western front of the temple platform were mainly abandoned and partially reused for lime production and probably for other purposes, such as storage for recycling materials taken from the abandoned buildings in the area and from elsewhere in Caesarea. The location of the area on the harbor’s quay is suitable for uploading these materials onto boats and ships and transporting them to any destination, near or far, more easily and less costly than by land. In contrast, the southern parts of the *horreum*, the Octagonal Macellum and the Upper Market do not show any signs of occupation of any sort.

Harbor Horrea (Area LL)

The remains of the Umayyad-period occupation on the LL *horrea* undoubtedly show that the facilities were transformed from public warehouses to what looks more like a dwelling. The division of larger storerooms into smaller rooms suitable for habitat, some incorporating cooking devices, indicates this process. The nature of this occupation, however, is not entirely clear. It is unlikely that the deposit of Aegean and Egyptian amphorae alongside locally produced transport containers from R12 was for private consumption. We would like to propose that the *horrea* were turned into barracks for a garrison or for guards that were protecting the harbor. This assumption well explains the amphorae stored on the R12 as part of centralized supply for the guards staying there. There were several episodes during the events of the second half of the 7th century CE at Caesarea when a garrison may have been stationed:

- The first is ʿUmar's order to Muʿawiya, which governed Syria and Palestine, to repair the coastal fortification and set watch guards along the coast to prevent Byzantine attacks by sea (Elad 1996: 146–147). Although Caesarea is not mentioned in al-Muqaddasī's list of established *ribāṭat* (Khalilieh 1999: 213–214), a watchtower with permanent guard may have been stationed there (cf. Elad 1996: 147).
- The second is the recapture of Caesarea by Byzantines sometime between 683 and 690 CE (see above).
- The third episode is the reconquest of Caesarea by ʿAbd al-Malik, who rebuilt and fortified it (see above).

The evidence from the graffiti and dipinti inscriptions on amphorae from the deposit on R12 seems to be in keeping with the first option, as most of it was written in Greek and bore crosses and Christograms. The appearance of the amphorae from Egypt with graffiti in Arabic, if that is the case, may be a part of trophies or evidence of ongoing marine trade with Egypt, although it still was in the hands of Muslims. This proposition, however, requires further confirmation and will be discussed in the final report (currently in preparation).

The Eastern Neighborhoods of the City

Over the course of 80 years or more, archaeological fieldwork and research have only explored limited parts of the city, mainly in the vicinity of the port and along the Mediterranean coast. As a result, information about the eastern parts of the city is scattered in various publications, and large unexplored areas of the city remain unknown. However, the data from the small excavated area eastward of the temple platform has shown that during the Umayyad period there was a break from the type of settlement known in Late Antiquity in Caesarea. In this particular case, a large, probably public, complex was entirely or partially converted to a private dwelling. Unfortunately, we lack information regarding the ethnic or religious identity of the new inhabitants. The building may have been inhabited by newcomers resettled by Muslim authorities within deserted public or private properties, or by local people who improved their living conditions at the expense of deserted properties.

Southwestern Zone Insula W2S3

The post-640/641 CE activity on Insula W2S3, as well as neighboring areas, is agricultural and industrial in nature. There is no evidence of permanent habitation. The irrigated plots on the formerly public and semi-public buildings are undoubtedly part of the process de-urbanization and depopulation of previous metropolitan city. Yet the agricultural usage was quite a short episode that was followed by the establishment of an extensive lime industry.

Patrich (2011: 48) suggested that the lime-kiln industry related to the construction of the fortification of the Early Islamic town during the Abbasid period. In fact, the date and stratum of this fortification does not concur with those of the of the lime industry on Insula W2S3.

It is, however, more likely that it was established during construction of the so-called Fortezza on the southwest corner of the Roman and Byzantine city of Caesarea. This fortified area in the southwestern part of Roman–Late Antique Caesarea included an extensive area surrounded by a curtain wall with semi-circular towers, as shown in Fig. 13. The Fortezza fortification incorporated the

Roman theater, and, according to the excavators, no significant contemporary buildings were found within the large area it encompassed (Frova 1965: 159–164). The date of the Fortezza is still in dispute, but a small probe conducted by Y. Porath in 1999 showed with a high degree of possibility that it was established during the late 7th century CE (Porath 2008: 1663). Porath also proposed that the Fortezza was established by ʿAbd al-Malik as part of his efforts to fortify the city after it was recaptured from the Byzantines in 690 CE (see above).

Conclusion

We do not know precisely what population changes occurred at Caesarea Maritima, the largest and most populated city of the province Palaestina Prima, since it was captured by Muʿawiyah. The chronicles, such as those of Pseudo-Dionysios of Tel Maḥre (after 775 CE), give a wide range of death tolls during the 640/641 conquest, from the entire population to about 7,000 in Theophanis' *Cronographia* (ca. 810–815) and some 4,000 captives who were exiled by Muʿawiyah (see account of literature sources in Patrich 2011: 55–56). Some scholars assume that the city of Caesarea, along with other coastal cities and towns, was left virtually empty of its original inhabitants and later repopulated by emigrants (e.g., Levy-Rubin 2011: 157). It is likely that some significant parts of Caesarea's population immigrated to the territories held by the Byzantines, as evidenced by the 14th-century CE Samaritan chronicle of Abuʾl-Fath, who states that some Samaritans of Caesarea left the country (Levy-Rubin 2011: 164). However, since in this testimony the people of Caesarea appear in the same line with their counterparts from other cities of the Palaestina Prima, including the city of Gaza, which was already captured in 637 CE, it most probably refers to the early wave of immigration, most likely prior to or shortly after the Battle of Yarmuk (August 16–20, 636 CE).

The available data from archaeological excavations, although fragmentary, reveal that most of the public buildings and wealthy mansions in Caesarea were abandoned following the 640/641 event, as indicated by Porath,

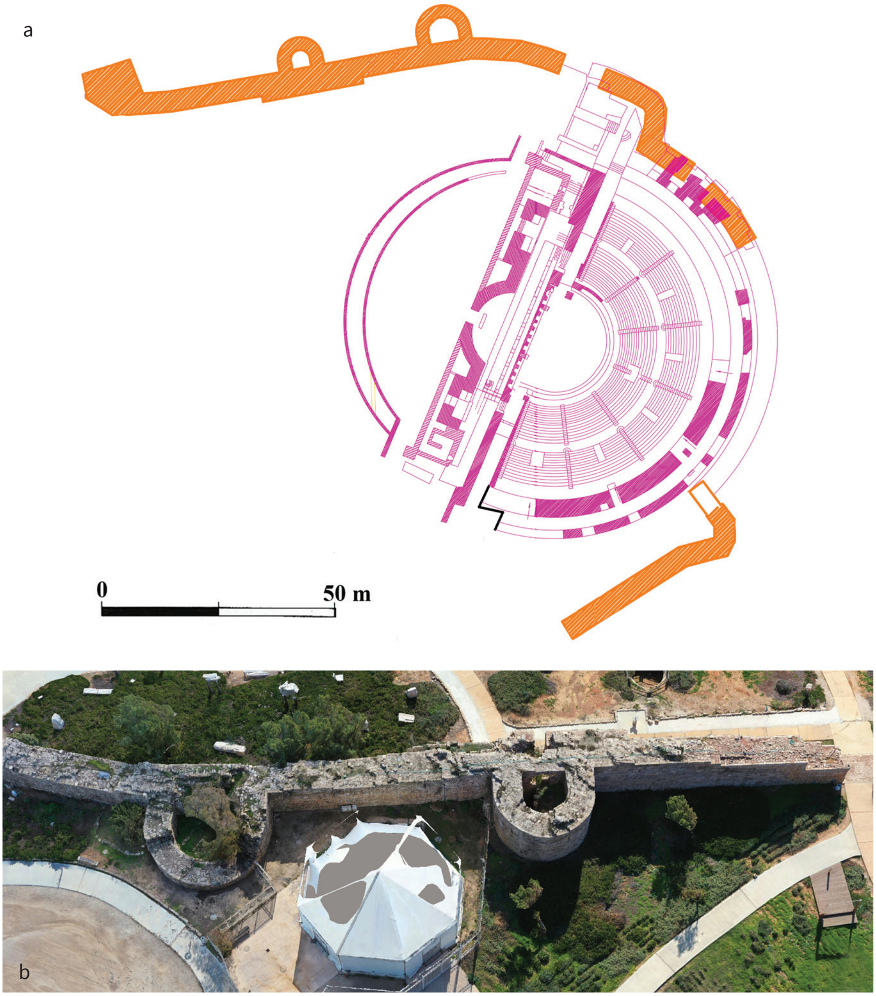

Fig. 13: Fortezza: a) ground plan (Anna Iamin and Peter Gendelman); b) aerial view of northern curtain wall with towers

Gendelman and Gorin-Rosen (2006) and Gendelman and Porath (2022: 190). These areas were either resettled by new inhabitants or used for agriculture, stone and material recycling and lime production during the Umayyad period. Archaeological and written sources indicate a process of extensive de-urbanization and depopulation of Caesarea following the 640/641 event. The city became a mere shadow of its former self during the Umayyad period. Although the date of Apollonia’s bulla is controversial, the information it provides suggests that Caesarea maintained its role as an administrative center and was still considered a provincial or district capital city during the second half of the 7th century CE. However, the establishment of Ramle in 714 CE as the new capital of *Jund Filasṭīn* brought this to an end. The Early Islamic town of Qaysariyya, established most probably during the early 9th century CE, bears little resemblance to the previous metropolis of Palaestina.

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Abstracts

1 | Insights into the Contribution of Radiocarbon Dating in Reconstructing Jerusalem's Past: The Early Bronze Age Settlement of Jerusalem

Johanna Regev, Joe Uziel, Yuval Gadot, Helena Roth, Eugenia Mintz, Lior Regev and Elisabetta Boaretto

pp. 1*–16*

Recent archaeological research in the ancient core of Jerusalem has witnessed a drastic change in methodology, headlined by the use of advanced analytical techniques, with radiocarbon dating at the forefront. Whereas prior to the onset of the current absolute dating project, ^{14}C dating was sparsely used in the excavations in Jerusalem (despite its extensive application in other sites in the country), almost 200 dates have been published to date or are soon to be published. The current paper presents the importance of the project, stressing the cooperation between field archaeologists and radiocarbon experts in the field, integrating the use of micromorphological analysis and micro-stratigraphy, in a collective effort to properly identify and characterize the archaeological contexts being sampled. In this manner, the dates provided can greatly contribute to the fine-tune dating of the various features and occupation layers in Jerusalem. The current paper presents for the first time Early Bronze Age radiocarbon dates retrieved from the eastern slopes of the City of David, comparing them with the previously published ceramic data of the same contexts.

2 | The Sands of Time: OSL Dating of Archaeological Sediments

Nitsan Ben-Melech

pp. 1–20

Dating through material culture is an archaeologist's bread and butter. However, in sites with little or no material finds or where such finds are not found in clear stratigraphic contexts, the dating strategy could rely on one of the most common finds—the sediment.

The Optically Stimulated Luminescence (OSL) dating method dates the last exposure event of soils to light or high temperatures, brought about by the different deposition and sedimentation processes in the site. By establishing the connection between the sedimentation processes and the site's history, we can offer an absolute date for different activities at the site and better understand the connection between human activity and sediment deposition. This paper presents the use of the OSL method in archaeology through a review of published studies, focusing on the Southern Levant.

3 | A Computational Model for Absolute Chronology in Archaeology

Eythan Levy

pp. 17*–33*

This paper presents a recent approach to chronological modelling in archaeology, based on the ChronoLog modelling software (chrono.ulb.be). The paper first reviews the theoretical foundations of our approach, based on the notions of chronological networks and chronological propagation. It then presents the main features of ChronoLog, a powerful software tool for building and checking complex chronological models, and it ends with a few conclusive remarks and directions for future research.

4 | The Secret of the Chalcolithic Shaft Site of 2 Nissim Aloni Street, Tel Aviv: Insights from the Portable Luminescence Method (POSL)

Oren Ackermann, Eriola Jakoel, Edwin C.M. van den Brink, Yaakov Anker, Yotam Asscher and Joel Roskin

pp. 21–38

An inspection and salvage excavation was conducted at 2 Nissim Aloni Street, Tel Aviv, ca. 200 m west of Naḥal Ayalon. This late Chalcolithic site of 4 dunams (0.4 hectares) includes a remarkable number of 113 pits and shafts. They were classified into four morphological types: round pits, bell-shaped pits, deep narrow shafts and underground void shafts. The shafts also differ in their physical and artifactual fill properties.

Relative age analysis by portable Luminescence (POSL) profiling of the shaft fills and their host sediments demonstrates that only some of the shafts remained unfilled for substantial periods, and they probably fulfilled a specific role. Others seem to have been rapidly filled with sediment and refuse. A circular niche in the lower third part of the narrow shaft type suggests that this type of shaft was designed to serve as a well. However, environmental circumstances seem to have constrained many of these pits and shafts from reaching the water table.

5 | Geological and Geochemical Character and Relative Age Analysis by Portable Luminescence (POSL) of Calcic-quartz Sand Enable the Interpretation of a Hellenistic Burial Site in Shaʿari Nikanor Street (Jaffa)

Joel Roskin, Lior Rauchberger, Galit Tal and Yotam Asscher

pp. 39–50

Excavations in Shaʿari Nikanor Street, Jaffa, uncovered two Hellenistic-period pit graves within a homogeneous calcic-quartz sand unit, 2 m deep. The fill within the pit graves appeared identical to the calcic-quartz sand hosting the

pits, making the interpretation of the burial technique complex and suggesting the possibility of post-burial sediment deposition. A reference section of the calcic-quartz sand unit revealed a unimodal fine sand content with a high carbonate content and abundant irregular calcium carbonate concretions.

The unit was submitted to analytical-geochemical and portable luminescence analysis (POSL) that allowed the assignment of a relative chronological framework within the unit and the burial fill. A linear accumulation pattern of the bulk OSL signal in the hosting calcic sand unit suggests gradual aeolian deposition. During the Ottoman period the upper part of the quartz sand unit was cut in order to lay street foundations and was mixed with dark brown sediments with very low OSL values in relation to the calcic quartz sand. Accordingly, in the Hellenistic period this land was probably marginal and unsuitable for agriculture; it was therefore suitable for burial graves, which was then left untouched until the Ottoman period. Calcic sand fill infilling the hypothesized pit graves reveals a wide range of BOSL signals. This find suggests that the interval between tomb digging to burial and tomb infilling was short. Accordingly, POSL appears to be a robust tool to investigate burial practices.

6 | The Fields of Yavne: Archaeological Evidence for a Place Where Time Stood Still?

Elie Haddad, Liat Nadav-Ziv and Jon Seligman

pp. 51–78

Tel Yavne rises above its flat surroundings, surmounted by a minaret that survived from the Mamluk era. Over the past few years, a large-scale archaeological excavation is being conducted in the fields southeast of the tell, where wheat was grown until recently. For the first time, archaeological remains are being revealed from ancient periods that were not known and/or uncovered in the past only through excavation of the tell and its immediate surroundings. The excavations showed that just below the tell, there had been an industrial

estate in the past in an extensive area stretching from east to west. In the western part of the excavation (Area A), a unique rectangular industrial facility for liquids (ca. 35 × 20 m) was exposed, consisting of rows of pools with white plaster; it dates to the Persian period (5th–4th centuries BCE). From these pools liquids flowed to vats of various depths and forms. Later, during the Hellenistic period, four oval pottery kilns were erected in the area. To the east (Area B), a large Byzantine-period building was found, with a row of rooms around a large courtyard. During the Early Islamic period, the building underwent changes, and the area become an industrial area, which 16 pottery kilns were uncovered. There is no evidence of Persian and/or Hellenistic remains in Area B.

In this article, we show the essential difference between these two adjacent areas from a geographical and geomorphological point of view, emphasizing their physical and chronological differences. Trenching between the two excavated areas shows that no archaeological remains existed in the gap between them, and we will attempt to understand the physical reasons for this lack of finds. Through archaeological evidence, we can distinguish between the various land uses during the periods. Using maps and aerial photographs from the Mandatory period, as well as historical sources—mainly the accounts of travelers and researchers who visited Yavne during the 19th century—we will try to understand the nature of the agriculture during these periods, especially in the eastern part of Yavne. What were the size of the agricultural plots? Can we trace which crops were grown in Yavne and its environs in the distant and recent past? Finally, we will try to determine the central crop that dominated the fields of Yavne in each period.

7 | “The People Who Walked in Darkness Have Seen a Great Light”: The Kafr Bara Cave between the Neolithic Period and the Early Bronze Age

Avraham S. Tendler, Lena Brailovsky-Rokser and Shahar Krispin

pp. 79–100

Trial excavations conducted in 2019 on behalf of the Israel Antiquities Authority in the close vicinity of Kafr Bara, situated along the southern bank of Naḥal Qanah in central Israel, revealed *inter alia* an artificial cave that had been first hewn in the Pre-Pottery Neolithic B and then substantially extended, with far-reaching passages, in the Pottery Neolithic. During these periods it had been used for non-domestic, possibly ritualistic, purposes. It was reused during the Late Chalcolithic and Early Bronze I as a burial cave. This paper focuses on the cave and the lithic finds from the various periods and their contexts. The newly probed cave is part of a broader phenomenon observed in several natural caves in approximately the same region, such as the Naḥal Qanah cave, the Elqanah cave and the Tsredah cave, which contain similar non-domestic sequences from the periods under discussion. Kafr Bara Cave 19 differs from the other three natural caves in the fact that its interior had been hewn by man, possibly to artificially create a similar environment as the deep natural caves.

8 | Tel Yaham: Remains of a Fortified Settlement between the Middle Bronze and Iron Ages in Northern Sharon

Dor Golan and Durar Masarwa

pp. 101–113

During archaeological excavations conducted at Tel Yaham, in the northern Sharon Plain, on behalf of the Israel Antiquities Authority, the remains of a fortified settlement were uncovered. The settlement was built in the Middle Bronze Age and continued to exist until the Iron Age, with little secondary use

in the Byzantine period. This article presents the results of the excavation and their significance. Four layers were revealed, with several levels. In Level IV, dated to the MB IIB, a massive fortification system was established, including a double wall abutted by a rampart. This level was uncovered mainly around the wall. Settlement remains in the next phase, Level III, also dated to the MB IIB, were uncovered throughout the excavation area. This settlement includes a warehouse system that abutted the wall and residential buildings. Level III, containing three layers, was probably built toward the end of the period. A destruction layer was discovered at the end of the period, mainly visible in the vicinity of the wall and the warehouses. In Level II, dated to the Late Bronze Age and the Iron I, a decline is evident in the settlement, and buildings from Level III were reused. Few buildings and facilities have been discovered, and continuity was identified from the Late Bronze Age to the Iron I. In Level I, dated to the Iron IIA, a new settlement was established, the remains of which were discovered throughout the excavation area. These include buildings and installations, as well as the use of the upper part of the Middle Bronze Age wall. This level is rich in finds and includes several figurines. The excavation revealed three rock-hewn underground cavities that were not excavated but were partially documented. They appear to have been part of a water-supply system.

9 | Tel Qatra in Light of the Salvage Excavations: Preliminary Report

Alla Nagorsky and Itamar Taxel

pp. 115–127

At the northern end of the modern settlement of Gedera lies the multi-period archaeological site of Tel Qatra. In antiquity, the site was situated east of a major road connecting the Mediterranean ports of the southern coast to the cities of Lod and Ramla (today’s Route 40). The excavation, conducted in 2017–2018, focused on the eastern edge of the mound, west of Naḥal ʿEqron (a tributary of Naḥal Soreq). The excavation revealed five occupation layers dated to the Persian, Roman, Byzantine, Early Islamic and Mamluk periods. In the soil accumulations above bedrock in all the excavation areas, pottery, flint and stone objects from the Chalcolithic period, the Middle Bronze Age and the end of the Iron Age were discovered.

The excavation offers an opportunity to study the nature of the economic activity of the site's inhabitants and shows that from the Middle Bronze Age to the Roman period, the area between the mound and Naḥal ʿEqron was used for agriculture, burial and stone quarrying. The activity at the eastern foot of Tel Qatra intensified from the end of the Roman period, reaching its peak in the Byzantine period and the beginning of the Early Islamic period, when bathhouses and a complex system of plastered pools connected by open and closed channels and clay pipes were built on the site.

The area under discussion included a pottery workshop, which was established at the end of the 3rd century CE and operated until the 7th or early 8th century. It manufactured mainly storage and transport jars, primarily of the so-called "Gaza amphorae," used for marketing wines produced in southern coast wineries. The prolonged production of these jars in the Tel Qatra workshop points, *inter alia*, to the importance and continuity of viticulture in the region. Some evidence for glass and metal industry was also found.

During the ʿAbbasid and especially the Mamluk period, several residential buildings were erected at the southeastern foot of the mound, over the remains of the early bathhouses and industrial and water installations. The inhabitants of these buildings, specifically in the Mamluk period, were probably engaged in agriculture. On the floors of most of the rooms, *tabun*s of various sizes and many grinding stones were preserved, and many silos were installed within and outside the buildings. It seems, therefore, that the area east of the mound served an agricultural function.

10 | Portable Calendar Plaques from Iron-Age Judah and the 360-day Calendar in the Hebrew Bible

Jonathan Ben-Dov

pp. 129–154

Administrators in ancient Judah used schematic 30-day months and a 360-day year alongside other annual frameworks. This year was never practiced as a “calendar” for any cultic or administrative purpose, but rather served as a convenient framework for long-term planning, as well as for literary accounts that were not anchored to a concrete calendar year. Examples for such usage are attested here from Mesopotamian texts. Material evidence for the 360-day year in Judah comes from a series of small, perforated bone plaques from various sites in Iron II Judah. One such item was recently unearthed in the City of David. These objects can reasonably be understood as reflecting a schematic 360-day year, serving as desk calendars for Judahite administrators. Several priestly Pentateuchal texts are best understood against this background, such as the dating of some festivals and most notably the dates in the Flood narrative (Gen 7–8). The original dating system is best represented in LXX Gen 7:11, while the reading of MT is a late modification, inserted later when calendar debates occupied a central place in the religious discourse. The 360-day year is thus a unique case in which material culture dovetails with the literary evidence, and it may shed light on the material culture of priestly sources. This insight is significant for future studies of biblical time reckoning.

11 | A Bottomless Pit: Remains of a Settlement and Glass Industry from the Late Roman Period at Umm al-Zinat

Yael Gorin-Rosen, Limor Talmi and Dan Kirzner

pp. 155–182

During a salvage excavation at Umm al-Zinat, on the southeastern slopes of the Carmel, directed by Limor Talmy and Dani Kirzner on behalf of the Israel Antiquities Authority, the remains of a large and elaborate wine press were found and next to it a large refuse pit, rich in Late Roman–Early Byzantine finds (4th–early 5th centuries CE): pottery, oil lamps, metal objects, bone objects and glass. Among the many glass finds were vessels, objects and production debris. The debris indicates that the two production stages took place in the same industrial area during the Late Roman and Early Byzantine periods: the primary stage, which included the preparation of the raw glass, and the secondary stage in which vessels and objects were produced.

Among the remains of the primary production, raw glass chunks, floors and walls of a furnace, and partially vitrified chunks were found. These finds are among the earliest evidence of furnaces for the production of raw glass in Israel. Remains of the secondary stage include blowing debris, glass drops, glass “cakes” and deformed vessels. The wide variety of vessels and objects found in the refuse pit represents the local production and is very similar to that uncovered in Jalame on the northern slopes of the Carmel. A comparison between the two sites sheds light upon the specialization of contemporary local workshops in that region.

12 | Between Caesarea Maritima and Qaysariya: The City between 640/641 and 750 CE

Peter Gendelman and Uzi ʿAd

pp. 35*–65*

This paper deals with a somewhat forgotten episode in the history of Caesarea Maritima—a period extending over more than a hundred years, from 640/641 CE, when Caesarea was conquered by the Muslims, to 750 CE, when the last Umayyad caliph Marwan II was defeated in battle and later killed. According to the 9th-century chronicler al-Bâldhurî, Caesarea was stormed and conquered in 640/641 CE by the troops of Muʿâwiya after a prolonged siege. As a result, most of the area of the city was abandoned, the buildings were gradually destroyed and the city was left depopulated for a long period of time.

The archaeological evidence, however, shows that between the mid–late 7th century and the first half of the 8th century CE, different activities took place within the territory of the abandoned metropolis, including horticulture in the southwestern zone of the previous city, lime production, robbery and recycling of precious materials gathered from the ruins, and the dismantling and shipping of marbles and ashlars to the cities of Jund Filasṭīn and beyond. Meager remains of squatters' occupations and industrial devices were also reported from the areas that later became the Early Islamic and Medieval town of Qaysariya.

Two additional important issues concerning Caesarea history are discussed in this contribution: the question of the existence of the *ribat* and the Byzantine reconquest of the city in 685/686–690 CE.

13 | Caesarea Harbor: From Construction to Destruction—New Finds from the 2015–2022 Excavation and Survey Seasons

Jacob Sharvit, Bridget Buxton and Uri Kushnir

pp. 183–206

The ancient harbor known as Sebastos, built by King Herod the Great at Caesarea Maritima, was one of the ancient world's most ambitious engineering projects. Since scholarly study of the harbor began more than fifty years ago, archaeologists have speculated on possible reasons for the destruction of the Herodian harbor, a problem that is inseparable from the question of how it was built.

Investigating an ancient harbor presents a variety of scientific-technical challenges that are best resolved by multi-disciplinary teams and collaboration. Recent advances in marine robotics, underwater imaging and acoustics, in particular, have given underwater archaeologists powerful new tools to map and excavate submerged port structures. Since 2014, three EU-funded projects deployed some of these new tools (autonomous surface and underwater vehicles, 3D imaging and acoustic multibeam survey) to conduct new investigations of the sunken Herodian ruins at Caesarea. A team from the Israel Antiquities Authority Maritime Unit and the University of Rhode Island led the accompanying archaeological survey and excavation and reanalyzed the relevant ancient literary evidence.

The results of these 2014–2019 investigations are presented here. We offer a resolution to the discrepancies between the ancient historical records and Caesarea's visible archaeological remains, as well as a new analysis and explanation of the port's history from construction to destruction.