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ABSOLUTE DATING OF THE GIHON SPRING FORTIFICATIONS, JERUSALEM

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ABSTRACT. One of the most impressive structures in Jerusalem's ancient landscape is the tower that was built to surround and protect the Gihon Spring, Jerusalem's perennial water source. The structure, first discovered by Reich and Shukron (2004), encompasses the cave in which the spring sprouts from, with walls 7 m thick built of large boulders. The Spring Tower, along with the other features relating to it, were all attributed to the Middle Bronze Age II, based on their architectural and stratigraphical relationship, the type of architecture, and the pottery found. In the continued excavations carried out by the Israel Antiquities Authority along the outer, eastern face of the Spring Tower, it was noted that at least the northeast side of the tower was not built on bedrock, but rather on layers of sediment, which were sealed by the massive boulders at the base of the tower. In order to provide an absolute dating for the structure, two sections were sampled for radiocarbon (^{14}C) dating beneath the foundation stones at two locations. Scenarios for the construction of the tower during Middle Bronze Age (MB) and Iron Age II are considered, based on the new ^{14}C data, yielding a series of dates, the latest of which falls in the terminal phases of the 9th century BCE, alongside previous excavation data.

KEYWORDS: radiocarbon dating, Iron Age, Middle Bronze Age, Gihon Spring Jerusalem, microarchaeology.

INTRODUCTION

Archaeological Background

For over 150 years, archaeological explorations in the hill known today as the City of David have indicated that this was most likely the location of the Bronze and Iron Age settlement known as Jerusalem (for a complete summary of the archaeological expeditions to the City of David, see e.g., Reich 2011). The heart of the settlement was the Gihon Spring, located at the base of the mound, in the excavation areas termed Areas C and H (Figure 1). The spring provided sufficient water throughout the year and would have certainly been the primary water source for the ancient city of Jerusalem. As such, the protection and manipulation of this water source were necessary for any urban entity, as this would have provided a secure water source during both times of peace, but more importantly, in times of war. Such protection proved to be quite significant, as Jerusalem—as opposed to other Judean cities, such as Lachish (see e.g., Ussishkin 2004)—seems to have withstood most attacking armies, until its destruction in 586 BCE.

The major water systems and fortifications discovered thus far in Jerusalem are presented in Table 1. It is important to note that certain features are dependent of one another, whereas other features cause earlier elements to go out of use. For example, as will be described below, the Spring Tower and fortified passage were certainly used together. However, the Siloam Tunnel (also known as Hezekiah's Tunnel or Tunnel VIII), which channeled the water from the Gihon Spring to the Siloam Pool, lowered the level of water flow in a manner that caused Channel II to go out of use.

The Spring Tower

The Spring Tower is located at the base of the eastern slope of the City of David, along the western banks of the Kidron Riverbed, denoted Areas C and H (Figure 1). The tower built to protect the Gihon Spring, Jerusalem's perennial water source (see e.g., Sneh et al. 2010) is composed of three walls (Figure 2), whereas the fourth (western) side is protected by the natural

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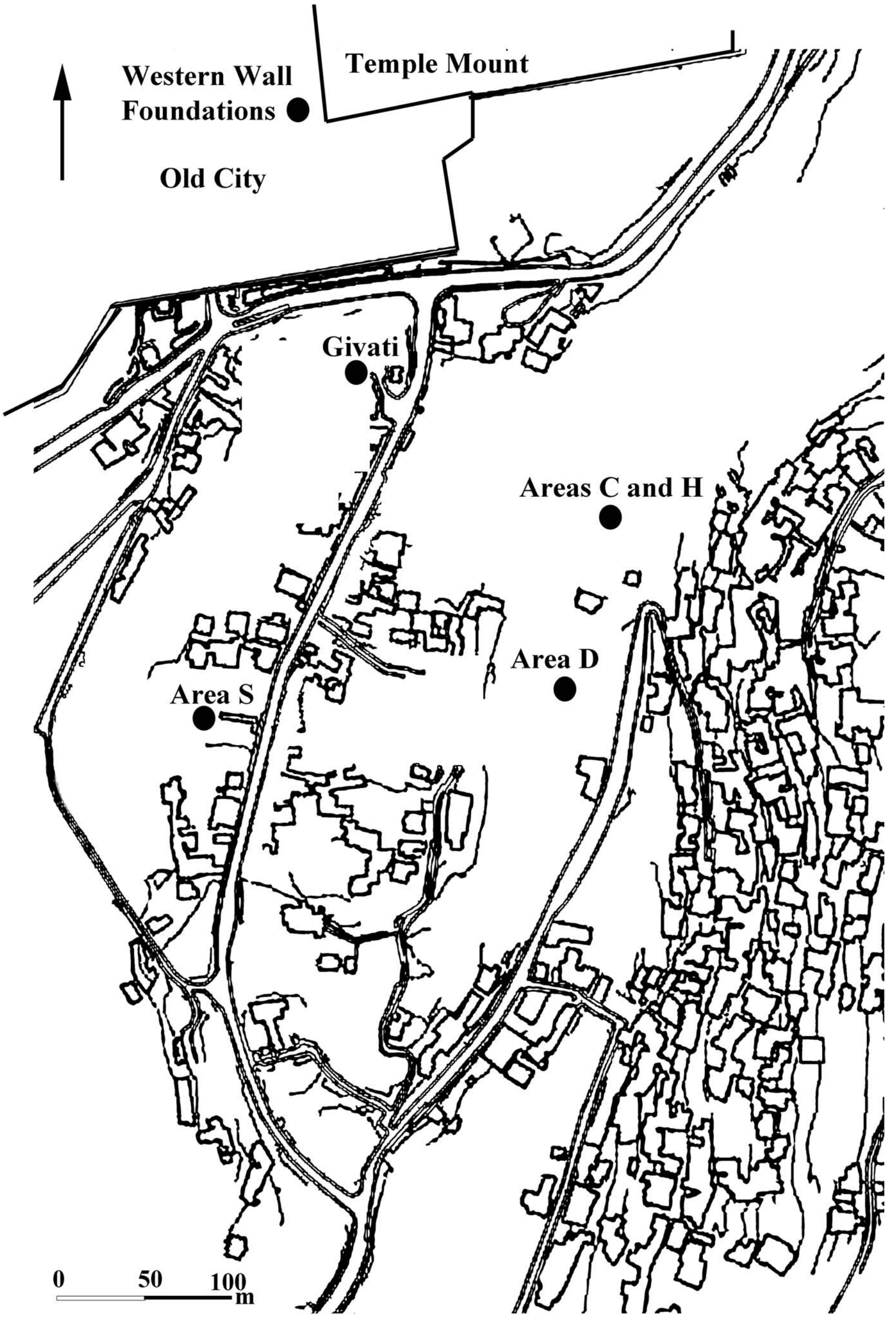

Figure 1 Map of the City of David, showing the location of various excavations with Bronze and Iron Age remains. The Gihon Spring and fortifications are located at the eastern edge of Area H.

scarp of the bedrock. The walls are roughly 7 m wide at their base, built of very large boulders, measuring up to 2 × 2 m. The boulders are unfinished and roughly cut (Figure 3). The outer face of the tower is partially covered with a layer of plaster, although it is not possible to determine

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Table 1 Fortifications and water systems discussed in the text, with suggested dating and function in the archaeological literature.

Feature	Function	Suggested published archaeological dating	Relationship to other features	References
Kenyon's Wall 1	City wall	Iron Age IIB		Steiner (2001)
Siloam Tunnel (also known as Tunnel VIII, Hezekiah's Tunnel)	Tunnel moving water from the spring to the Siloam Pool in the south	Iron Age IIB	Puts Channel II out of use	Reich (2011); Sneh et al. (2010); Reich and Shukron (2011)
Warren's Shaft	Rock-cut tunnel providing access to water	Middle Bronze II, Iron Age II, or two stages of use, the first in the Middle Bronze II and then once again in the Iron Age II	Could not function until the quarrying of the first portion of Siloam Tunnel (Tunnel VI)	Reich (2011)
Channel II	Channel moving water from the spring towards the south	First portion dating to the Middle Bronze Age II, second portion dating to the Iron Age II	Sealed by the southern wall of the Spring Tower. Rendered out of use once Siloam Tunnel is carved	Reich (2011)
Kenyon's Wall 3	Fortification, tower	Middle Bronze Age II	Abuts/bonds with fortified passage	Steiner (2001); Reich and Shukron (2010)
Fortified passage	Corridor providing secure passage to the spring	Middle Bronze Age II	Built together with Spring Tower	Reich and Shukron (2010); Reich (2011)
Spring Tower	Secures the spring from outside attack, prevents access to water for attacking forces	Middle Bronze Age II	Built together with fortified passage, critical for functionality of all other systems, partially seals Channel II	Reich and Shukron (2010); Reich (2011)
Rock-cut pool	Unclear	Middle Bronze Age II	Seems to be oriented and positioned in relation to other Middle Bronze II features: Channel II to the east, the fortified passage to the north	Reich and Shukron (2011); de Groot and Fadidah (2011)

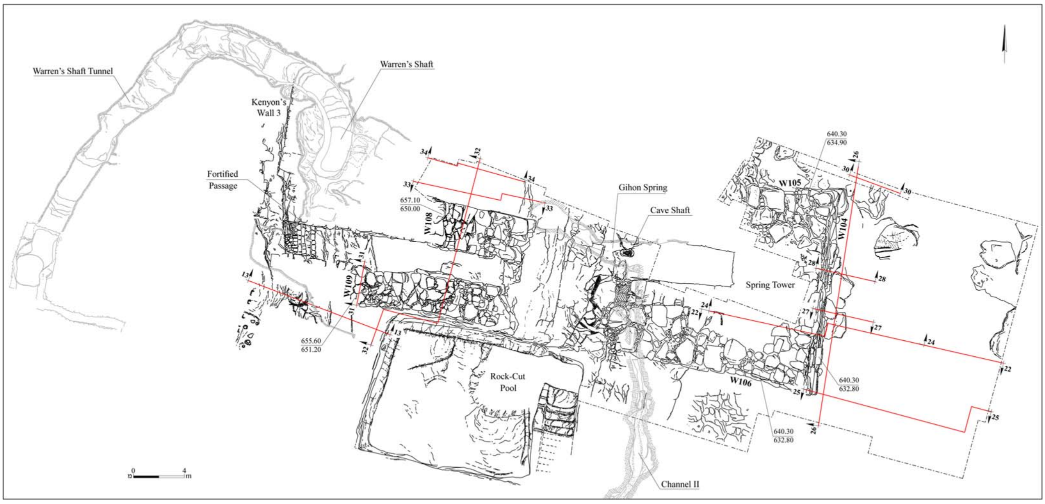

Figure 2 Plan of the fortification walls and features uncovered in the vicinity of the Gihon Spring.

Figure 3 Photograph of the outer face of the Spring Tower (Wall 104), with unfinished boulders and plaster partially coating the stones.

when the face of the tower was plastered and if this is the original coating of the tower or a later addition, as the tower would have been in use until the end of the Iron Age (see further discussion below and Uziel and Szanton 2015).

The construction of the tower was imperative for protecting the water source, as without surrounding the source of the spring, none of the other water systems (e.g. Siloam Tunnel, Channel II, Warren's Shaft) would have been effective in providing a protected source of water during times of war (for a general review of the various water systems discovered to date in Jerusalem see Reich 2011). A besieging army could have easily cut off the spring at its source and prevented it from flowing into the city. Furthermore, the Gihon would have in essence provided a water source for the attacking army, located outside of the city. Therefore, the construction of the tower would have been a focal point in any urban planning of Jerusalem. As Egyptian sources first mention the city of Jerusalem in the Execration Texts (e.g. Redford 1992; Rainey 2006),

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it would make sense that when the first city of Jerusalem rose that the Spring Tower be built. The tower seems to have functioned as part of a larger access system to the spring, which included this feature as well as the fortified passage. The fortified passage would have provided protection to those descending the slope and exiting the city wall, in order to access the spring. The procession would have begun from within the city, entering the passage through a gate or breach in the city wall and proceeding between two thick walls (W108 and 109; see Figure 2), until reaching the inner portion of the tower with access to the water source. The line of the fortification wall in the Iron Age IIB is clear, as discovered by Kenyon (Wall1; Steiner 2001) and farther south in Area E by Shiloh (De Groot 2012). The Middle Bronze Age wall likely followed a similar path, as noted in Area E. It is not clear whether Kenyon's Wall 3 served as that wall, as in excavations farther south its continuation was not discovered. Therefore, it is possible that Wall 3 served a different purpose, or that perhaps it is a buttress along the original Middle Bronze Age fortification, located along the line of the later Iron Age Wall 1.

The dating of the tower itself was based on several pieces of evidence. Reich and Shukron, who originally exposed the tower, noted the similar architectural style of the structure and the fortified passage (Reich and Shukron 2010:150). Although the two features are physically not connected, it is clear from their orientation that they relate to one another and were part of a single building project (Figure 2; W108 and W109). Despite the dismantling of a portion of the fortified passage by Parker (Vincent 1911:Pl. VI, who denoted the wall as Wall 17), it is clear that Kenyon's Wall 3 abuts or is bonded to the northern outer face of W108 of the fortified passage (Reich and Shukron 2010), and therefore Wall 3 is the later feature. While Reich and Shukron (2010) contest that this wall differs in nature from the fortified passage, its stratigraphic position must be contemporary or later than the fortified passage. As this feature was dated to the Middle Bronze Age on the basis of pottery found in the fills abutting the wall (Steiner 2001), it seems logical that the fortified passage as well as the Spring Tower should be at the latest Middle Bronze Age. Since there is little evidence for Early Bronze Age activity, a date earlier than Middle Bronze Age was excluded.

If one accepts the integral relationship between the three above-mentioned features, then the dating of each of these features affects the others as well. In this respect, the dating of Wall 3 to the Middle Bronze Age suggests an MB date for the Spring Tower as well. The same can be said for the fortified passage. The latter feature, exposed by Reich and Shukron, was dated according to the Middle Bronze Age pottery found in the constructional fill within the substructure of the passage. Although the pottery is yet to be published, the excavators attributed it—and in turn the fortified passage—to the Middle Bronze Age II (Reich and Shukron 2010).

Regarding the Spring Tower, the base of the southeastern side of the tower has yet to be reached. However, due to a drop in the level of the bedrock, the northern side of Wall 104 (the eastern wall of the tower) was built on layers of sediment, rather than bedrock (Figure 4). To the east of the tower, a thin layer of hard, red-yellow packed earth was discovered (L. 13612). The layer was noted in the excavations to the east of the Spring Tower (Figure 5). This layer is also notable in the sediments beneath the tower. It is important to note that to the south, where the level of the tower drops, the layer abuts the face of Wall 104, and therefore it is possible that it may have been some kind of surface outside of the tower. The pottery from L. 13612 and beneath it dates to the Middle Bronze Age II or earlier.

With this in mind, the current project was set out to provide a more fine-tuned dating within the timespan of the Middle Bronze Age. A more exact and absolute date was seen as possibly helping attribute the structure to a given portion of the period, and in that sense, relate to

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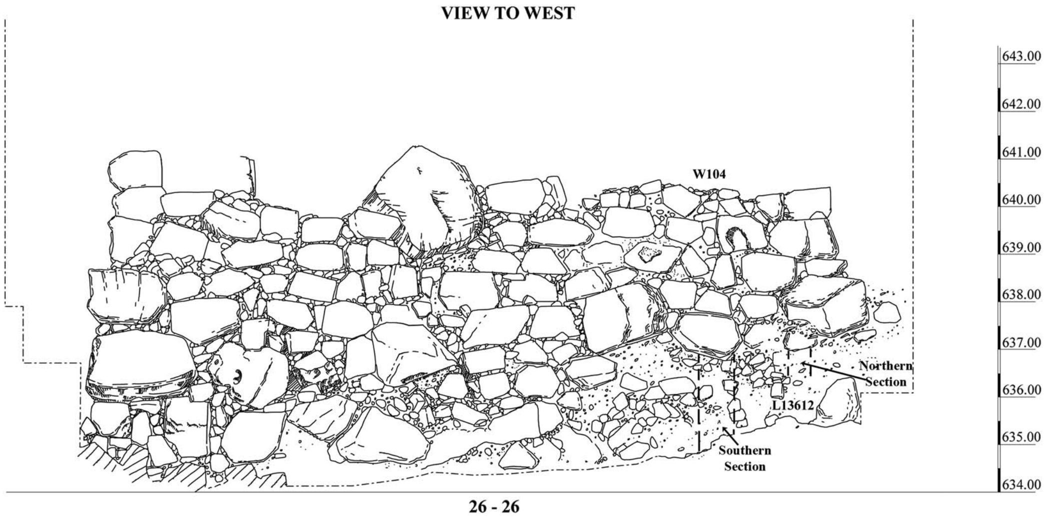

Figure 4 Drawing of the outer face of the Spring Tower (Wall 104). Note that the northern side is built on sediment layers rather than bedrock. The northern and southern sections excavated in this study are marked.

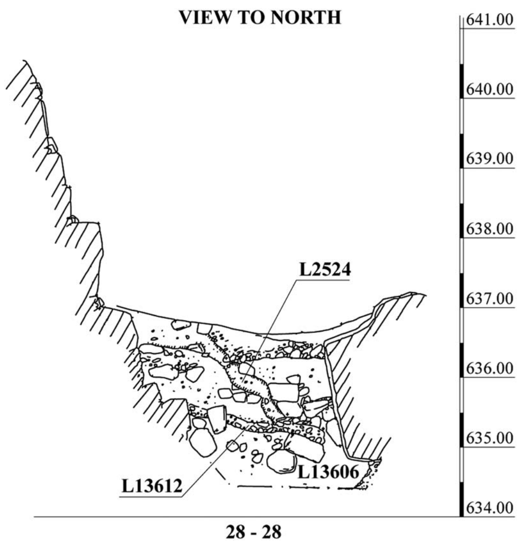

Figure 5 Section of fill excavated in the current excavations to the east of the Spring Tower.

historical events and documents and further the understanding of urban development in the Middle Bronze Age. For example, could the structure be attributed to the days of the Egyptian Middle Kingdom, in correlation with the time when Jerusalem is mentioned (for the first time) in the Execration texts (e.g. Rainey 2006), or perhaps to the later stages of the Middle Bronze Age, subsequent to the expulsion of the Hyksos, and be part of the intensive construction projects of the terminal stages of the Middle Bronze Age (Dever 1997)?

The recent publication of the finds from Shiloh's excavations in Area E (De Groot and Bernick-Greenberg 2012) provide a relative dating for Stratum 18 of Middle Bronze Age IIA according to the ceramic assemblage (Eisenberg 2012:272), contemporary with the date given for Kenyon's Wall 3 (Steiner 2001). In the Area E report, Eisenberg (2012) attributes the (as of yet unpublished) pottery from the fills to the east of the Spring Tower as belonging to the second phase of Middle Bronze Age occupation—namely Str. 17B. That said, Wall 3 must postdate or be contemporary to the fortified passage (see above). Therefore, the dating of the fills from the east of the Spring Tower may post-date the construction of the tower. Furthermore, it does not seem that this pottery originates from floor assemblages, rather from fills of secondary deposition. All of this indicates the crucial need for more fine-tuned, absolute dating of contexts in ancient Jerusalem and in this archaeological setting of the Spring Tower. Such absolute dating has been sparsely used in Jerusalem, one of the most important and heavily investigated sites in the southern Levant (for one of the few cases where absolute dating has been used, see Frumkin et al. 2003).

MATERIALS AND METHODS

In November 2014, the authors had a unique opportunity to sample the sediments underlying the Gihon Spring Tower, prior to the sealing of the section, as part of the preservation undertaken on the tower. Subsequent to our sampling, the section was covered over with plaster, as part of this preservation project, preventing any further sampling at this point.

Sampling Locations

Archaeological sampling of two sections (approximately 2 m apart) was performed beneath wall W104, aimed to collect samples for radiocarbon (^{14}C) dating of the layers beneath the Spring Tower. The northern section, exposed below a relatively small stone (0.6 × 0.3 m visible), located almost directly beneath a large protruding foundation boulder (almost 2 m long) of the Spring Tower, included Loci 14700–14703. The southern section, located directly beneath a large foundation stone (1.5 m long) of the Spring Tower, included Loci 14704–14711. Figures 6 and 8 show the relative positions of the loci and baskets in the two sections.

Sampling Methods

The sections were cleaned by removing about 5 cm of sediment from the sections' surfaces, until clear stratigraphy could be identified. The sections were divided to loci based on the macroscopically identifiable stratification in the sediment. This separation in sequential strata based on visible differences has been verified independently by the analyses of sediments using Fourier transform infrared analysis (FTIR). Samples of 5–10 g of sediment were collected into small bags for micro-archaeological analyses prior to the removal of the sediments for sieving. Then sediments were collected according to loci penetrating roughly 20 cm into the section. If further subdivision was found to be necessary, the loci were subdivided into baskets. Identified charred botanical remains, as seeds, were collected using metal tweezers directly into aluminum foil envelopes. All the sediments were dry sieved through a set of botanical sieves (5 mm, 2 mm, and 1 mm). The charred material was gathered, separating seeds and charcoal. Pottery, bones, and flint were also collected. In total, 23 sediment samples and 26 envelopes of charred remains from various contexts for possible ^{14}C candidates were collected.

FTIR Analysis

Sediment samples for FTIR were collected from the different layers in order to verify and characterize the nature of the sequence of sediments and the presence of anthropogenic-related activities, such as burnt clay (Berna et al 2007), phosphate (Weiner 2010), and disordered calcite (Regev et al. 2010). The FTIR analysis made it possible to verify that these are indeed layers and not a random accumulation deposited in a single episode in the past, but rather a

Figure 6 Photo of the southern section. Loci (white), baskets (black), and ^{14}C sample numbers (red) are indicated. Picture was taken after cleaning the section and prior to removal of sediments for collecting ^{14}C samples. The stones and plaster on the left side of the scale bar are part of the restoration. (Color refers to online version.)

sequence of strata. Sediments for FTIR analysis were prepared as follows: a few milligrams of sediment were crushed in an agate mortar with an agate pestle. A small amount of KBr was added, mixed and pressed under 2 tons to form a 7-mm pellet. The pellet was then measured with a Nicolet 380 (Thermo) FTIR instrument in 4 cm^{-1} resolution.

Grain Mount Slide Analysis

This analysis was performed on some of the samples to determine the presence of phytoliths (plants remains), ash pseudomorphs (verifying presence of wood ash), and dung spherulites (verifying the presence of dung) as proxies of anthropogenic activities (Weiner 2010) and for a better characterization of the ^{14}C sample and context (Boaretto 2015). Furthermore, the

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identification of coccoliths and sponges originating mainly from chalk indicates soil formation from chalk or transported sediments.

Botanical Identification

Prior to ^{14}C analysis, all charred remains measured were botanically identified using a binocular microscope (M80, Leica).

Sample Preparation for ^{14}C Dating and Measurement

The samples were pretreated for ^{14}C dating with the acid-base-acid (ABA) protocol (Yizhaq et al. 2005; Rebollo et al. 2008). Due to the very small size of the single charred remains, for some samples (RTD 7901, 7902, 7903, 7904, 7905) it was necessary to mix several fragments from the same context. After pretreatment, the combustion and oxidation to CO_2 was performed at 900°C in vacuum with CuO. The produced CO_2 was graphitized and pressed into cathodes for ^{14}C determination of ^{14}C concentration using an accelerator mass spectrometer. All samples were measured at the Dangoor Research Accelerator Mass Spectrometer (D-REAMS) at the Weizmann Institute (Regev et al. 2017). The samples selected with the information about context, species, and stratigraphic and cultural association and ^{14}C dates are provided in Tables 2 and 3. ^{14}C ages are reported in conventional ^{14}C yr BP (Before Present, where "present" is defined as the year 1950) in accordance with international conventions (Stuiver and Polach 1977). The ^{14}C ages were calibrated using the OxCal software version 4.2.3 (Bronk Ramsey et al. 2009) according the IntCal13 atmospheric curve (Reimer et al. 2013). The intervals for $\pm 1\sigma$ and $\pm 2\sigma$ are given.

RESULTS

Archaeological Context

A summary of the following sections is given in Table 2. The macroscopic comparison of the four uppermost sediment layers identified in the two sections showed similarity both in their macro- and micro-attributes. The parallel loci are mentioned below and appear in Table 2 accordingly. The major calcite component in all the samples checked with FTIR was of geogenic origin, indicating no pure ash deposit or plaster. Coccoliths were present in varying quantities, while only few dung spherulites were identified. FTIR analyses of the matrix from the different loci in stratigraphic sequence are shown in Figure 7.

Southern Section: Loci 14704–14711

The height of the entire section from the bottom of the foundation stone of the tower to the bottom of the sampled section, which did not reach bedrock, was 120 cm, and the width was about 40 cm (Figure 6).

L14704 is the uppermost layer in the section. It consisted of brown sediment with small (up to 1 cm) white calcareous grits. Three liters of sediment were sieved. Little charred material was recovered, including one very small seed and one mineralized grape, four 2–3-cm bones, and over 20 smaller bones. The bones had low splitting factor (2.7–2.9) based on the FTIR peaks of carbonated apatite and as high as 8% of collagen (by weight), both attesting to a minor bone diagenesis (Weiner et al 1995). Since the bones were exceptionally well preserved, it suggests both rapid burial and a well-protected environment after the burial (Weiner 2010). FTIR analysis of the sediment indicated a much higher calcite component than clay (Figure 7). The clay major absorbance peak was at 1036–7 cm^{-1}. While this value is only 2–3 wavenumbers

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Table 2 Summary of data and archaeological context.

Southern section						Northern section					
Locus	Baskets	Macro-description	Micro-description	Finds	^{14}C samples	Locus	Baskets	Macro-description	Micro-description	Finds	^{14}C samples
14704	147009	3 L in volume. Sediment directly under fortification stone. Ca. 5 cm thick layer of brown sediment with small white grits (up to 1 cm, mostly 1–2 mm). Many small bones. Few flat lying sherds at the bottom of this layer	Calcite as major component, presence of phosphate, phytoliths. Clay slightly heat altered. The small white grits are of limestone origin. Bones are well preserved	Pottery (20 small sherds), 23 bone fragments (1–2 cm) and 4 fragments over 3 cm, little charcoal, 1 tiny seed, 1 mineralized grape	RTD 8065, 7962						
14705	147010	5 L in volume. Soft grey/brown sediment with many flecks of charred material	Bulk: Clay as major component, phytoliths. Sediment on sherds: Calcite as major component, possibly altered clay, presence of phosphate	Pottery (8 sherds), little charred material consists mainly charcoal and few seed fragments	RTD 7903, 7963	14701	147001 147003	Upper charcoal rich layer, beneath the stone. Soft grey/brown color sediment	Clay as major component, phytoliths	Pottery, 2 small seed fragments	
14706	147011	1 L in volume. 2 cm thick sediment layer with 1–10 mm calcite grits	Calcite as major component, few phytoliths.	1 bone, 1 pottery shard, charcoal		14702	147002	5-cm-thick layer of brown sediment with white inclusions/small pebbles	Clay and calcite in similar quantities, few phytoliths	Few seed fragments, charcoal	RTD 7902
14707	147012–147015	Soft grey-brown sediment with fragile charred material, similar to L14705 B147012: 8-cm-thick layer above a layer of sherds B147013: a layer of sherds B147014: 10-cm-thick layer of	Bulk: Clay as major component, phytoliths B147014: Clay as major component, presence of phosphate Sediment on sherds: Clay and calcite in similar quantities, presence of phosphate	B147012: 4 L in volume, olive fragment, charcoal B147013: Pottery (4 large and 3 small pieces) B147014: 5 L in volume, pottery (30 sherds), olive, cereal fragments, charcoal B147015: pottery (30 sherds)	RTD 7904, 8064	14700	147000 147004 147005	2 L in volume. Lower charcoal rich layer, soft grey/brown color sediment	Clay as major component, phytoliths	Pottery Cereal fragments, olive fragments, charcoal	RTD 7901
						14703	147006	Reddish brown sediment with some charred material flecks	Clay as major component, phytoliths	Pottery, seed fragments, charcoal	

		sediment below sherds B147015: a layer of sherds directly overlying yellow/red color sediment	B147015: Sediment on sherds: Clay as major component, no phosphate		
14708	147016–147019	5-cm-thick layer of yellow/red, hard sediment with separate grey lumps of sediment B147018: sherds at the bottom of the layer	Yellow sediment: Exclusively calcite Grey sediment: clay as major component	B147016: 3 L in volume, almost sterile, micro-charcoals B147019: 2 L in volume, some charcoal	
14709	147020	Dark grey-brown color sediment under yellow/red sediment of L14708.	Bulk: Calcite as major component with possible trace of dolomite, phytoliths Sediment on sherds: Calcite and clay in similar quantities. Trace of dolomite.	Pottery (25 pieces), seed fragments (olive), charcoal	RTD 7905
14710	147021	1.5 L in volume. Dark brown color sediment with ca. 10-cm-sized stones	Clay as major component, few phytoliths	Little charcoal, 2 tiny seed fragments	
14711	147022	3 L in volume. Sediment at the bottom of the section, many white/yellow stones (up to 1 cm) mixed with brown sediment	Calcite as major component, few phytoliths	1 tiny charcoal piece, mineral coated bone	

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Table 3 Samples measured from the two sections under the tower.

Locus	Basket	Sample material	Sample number	Age UnCal BP	Calibrated range ±1σ BCE	Calibrated range ±2σ BCE
Southern section						
14704	147009	Vicia (wild type)	RTD 8065	2650 ± 22	820 (68.2%) 800	836 (95.4%) 795
14704	147009	Bone	RTD 7962	2800 ± 30	995 (68.2%) 915	1030 (92.0%) 890 875 (3.4%) 850
14705	147010	Pomoideae	RTD 7963	2720 ± 21	895 (68.2%) 835	910 (95.4%) 820
14705	147010	An olive pit fragment and a cereal fragment	RTD 7903	3140 ± 27	1445 (63.7%) 1395 1335 (4.5%) 1325	1495 (6.0%) 1475 1465 (75.3%) 1375 1345 (14.1%) 1305
14707	147012	An olive pit fragment and a fruit seed fragment.	RTD 7904	3520 ± 25	1895 (17.8%) 1870 1845 (28.2%) 1810 1805 (22.2%) 1775	1920 (95.4%) 1760
14707	147014	Olive pit fragment	RTD 8064	3430 ± 22	1755 (68.2%) 1690	1870 (7.3%) 1845 1810 (1.3%) 1805 1775 (86.8%) 1665
14709	147020	An olive pit fragment and a pulse	RTD 7905	3460 ± 26	1875 (21.6%) 1845 1815 (8.4%) 1800 1780 (31.1%) 1740 1710 (7.1%) 1700	1880 (82.9%) 1730 1720 (12.5%) 1695
Northern section						
14702	147002	A cereal, olive pit fragment and twig with bark	RTD 7902	3530 ± 28	1920 (34.9%) 1875 1845 (19.4%) 1815 1800 (13.9%) 1780	1945 (95.4%) 1765
14700	147000 and 147005	A cereal and an olive pit fragment	RTD 7901	4025 ± 26	2575 (20.0%) 2550 2540 (48.2%) 2490	2620 (3.3%) 2605 2600 (1.4%) 2595 2590 (90.7%) 2475

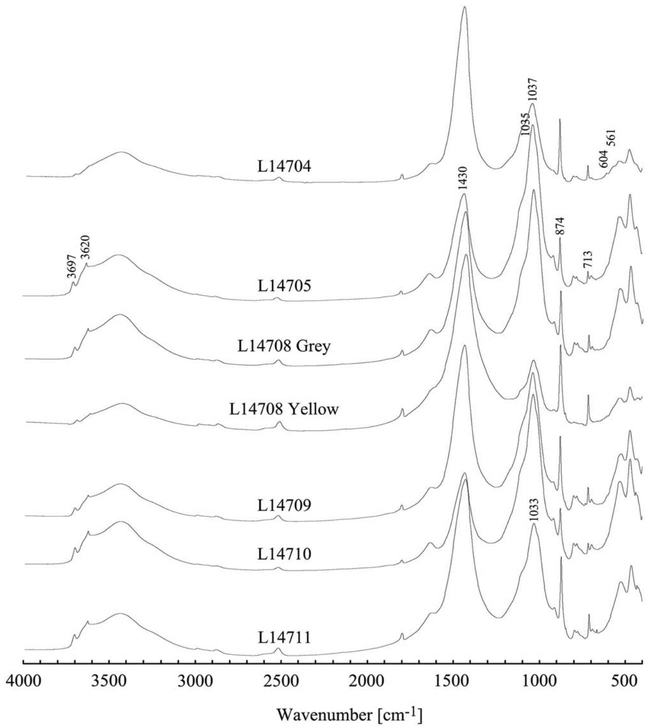

Figure 7 Representative infrared spectra of the sediments sampled in the various loci. Calcite peaks are at 713, 874, and 1430 cm^{-1}, clay main peak is at ~1035 cm^{-1}, and the phosphate peaks are 561 and 604 cm^{-1}. The peaks at 3620 and 3697 cm^{-1} are associated with the presence of water in clay and are indicative for clay alteration (Berna et al. 2007).

higher than the value for the natural clay (1034 cm^{-1}), it is the highest recorded for the whole section. The structural water peaks of the clay (3697, 3620 cm^{-1}) are the smallest in the sediments sampled, suggesting some clay alteration. This locus has the clearest phosphate presence (604, 561 cm^{-1}) of all the samples (usually as a result of decayed organic remains) in the bulk sediments in the section, albeit the shoulder of peak 604 cm^{-1} is slightly visible in loci 14705–14709 as well (the clay peak at around 520 cm^{-1} is somewhat masking it), suggesting low phosphate presence (Regev et al. 2015). ^{14}C samples RTD 8065 (seed) and RTD 7962 (bone) were dated from this context.

L14705 consisted of soft gray/brown clay rich sediment with charred material flecks. The charred material was very fragile and most of it crumbled in the collection procedure and the dry sieving process. Thus, only little charred material was recovered from 5 L of sifted sediment. Few seed fragments were found and dated as sample RTD 7903. Another sample dated, RTD 7963, was a piece of a charred fruit tree. As fruit trees do not generally exceed 50 years of age, and branches are frequently pruned and burned, relatively small old wood effect is expected.

L14706 consists of brown sediment (possibly alluvial deposition) with 1–10-mm-size white grits, and was defined as a 2-cm-thick layer dividing between L14705 and L14707. The main mineral is calcite, with a minor clay component. From the 1 L of sifted sediment, bone, some pottery and charcoal were retrieved.

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L14707 is similar soft gray/brown sediment as L14705. This layer was divided into several baskets. The uppermost basket (147012) was about 8 cm thick and consisted of sediment taken above stratified sherds. From 4 L of sediments, olive fragments and charcoal were retrieved. Sample RTD 7904 was measured from small fragments of fruit seed and olive pit combined. Basket 147013 included a thin layer of sediment within which horizontally lying potsherds were found. From this layer no charred material was found. Basket 147014 consisted of 5 L of similar sediment below the layer of sherds and above another lower concentration of sherds yielding some seed fragments and charcoal. A small olive fragment was dated as sample RTD 8064. Phosphates were found in sediment adjacent to pottery.

L14708 was a thin 5-cm layer located above a layer of pottery. The sediment consisted of yellow-red hard sediment, mixed with separate gray component. This sediment was almost sterile, and sieving of 3 L yielded only some micro-charcoals. The yellow-red sediment consisted mostly of calcite with a minor clay component. The gray sediment was mainly clay. This suggests the yellow-red layer is crushed/eroded natural calcareous rock, while the gray component is clay. This layer shows very little human activity as seen by the scarcity of pottery and charred material. It could be manmade building material underlying a living surface or a naturally formed layer. As mentioned above, this layer was identified to the east of the tower as well (labeled L13612), and may have been a surface or life level outside and beneath the tower.

L14709 consisted of dark gray-brown sediment beneath the hard yellow-red surface. Sieved sediment from this context yielded seed fragments and charcoal. Two seed fragments were measured as sample RTD 7905. In this locus, the clay component is in similar quantity to the calcite one.

L14710 is a dark brown (clay-rich), almost sterile layer with stones around 10 cm in size. From 1.5 L of sediment, little charred material was recovered, including two small seed fragments.

L14711 is the lowermost context sampled. This context did not reach the bedrock. The sediment was in peculiar lumps and contained many white/yellow stones (up to 1 cm) mixed with brown sediment. The 3 L of sediment that were sieved were also (as the layer above) almost sterile, yielding 1 small piece of charcoal and 1 mineral coated bone. This sediment is calcite-rich.

Interestingly, the loci with little indications of anthropogenic activity (lowest Loci 14710–14711 and in the dividing “yellow/red” layer Locus 14708), have the main clay absorbance peak located at 1033 cm^{-1}, while the remaining loci with more anthropogenic proxies have the clay peak location slightly higher, between 1035 and 1037 cm^{-1}, seemingly corresponding to the micro and macro finds (Figure 7).

Grain-mount slides were prepared for the loci of this section and for three small stones found inside the layers. In the upper loci, 14704–14707, phytoliths, coccoliths and sponges, some possible spherulites and few ash pseudomorphs were identified. However, in the lower loci no spherulites or ash pseudomorphs were detected. In Locus 14708 very little phytoliths were present and coccoliths were present. In Locus 14709, very few coccoliths were noted. Locus L147010 had quite many coccoliths and very few phytoliths, while the lowermost layer, Locus 147011 had very few coccoliths or phytoliths. The microscope slides support the macroscopic finds, where the upper layers had pottery, bones, and charcoal attesting to the anthropogenic activity, while the lower layers have smaller amounts of phytoliths. The results however only

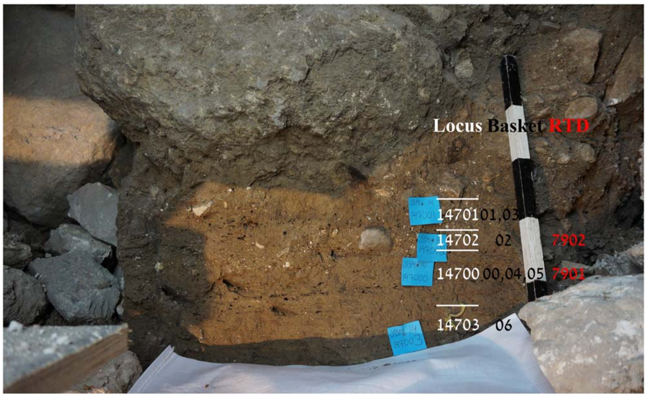

Figure 8 Photo of the northern section. Loci (white), baskets (black) and ^{14}C sample numbers (red) are indicated. Picture was taken after cleaning the section and prior to removal of sediments for collecting ^{14}C samples. (Color refers to online version.)

provide rough estimates as they are based on grain-mounts rather than actual phytolith/spherulite/ash pseudomorph extraction and counting procedures.

Small stones of different character were taken from three baskets in order to see if they contained microfossils or coccoliths. From Basket 147008—white soft stone, from B147009—a yellow hard stone, and from B147020—a white and pink hard stone were taken. The stones were gently ground with mortar and pestle and viewed under the microscope. No coccoliths or sponges were identified.

Northern Section: Loci 14700–14703

Four loci were discerned in this section (40-cm height, 50-cm width) which may be equivalent to some of the layers noted in the southern section (Figure 8). Note that the loci are described from top to bottom, while locus 14700 is between 14702 and 14703.

The uppermost layer in this section, labeled L14701, is defined by brown/gray sediment with flecks of charred material. The clay is the major component in this layer. This layer may be parallel to L14705.

L14702 is a 5-cm-thick brown sediment with white inclusions/small pebbles. It is located between two brown/gray layers dotted with charred material. Charcoal and a few seed fragments were gathered through sieving. For sample RTD 7902 a cereal, an olive fragment, and a twig with bark were combined. The clay and calcite components are roughly equal in quantity here. This layer could be parallel to L14706.

L14700 is similar to L14701, defined by brown/gray clay-rich sediment with flecks of charred material. From 2 L of sediment, few seeds and charcoal were recovered. Sample RTD 7901 consists of seeds from this layer. L14700 could be parallel to the upper part of L14707.

L14703 is brown clay-rich sediment similar to the sediment above it, albeit with less charred flecks. It is possibly parallel to the upper part of L14707 as well.

^{14}C Dating

Altogether, nine ^{14}C samples were measured from the two sections under the tower (Table 3), two samples from the small northern section, and seven samples from the larger southern section. As very little charred material in the form of small fragments was found in most of the loci, it was decided to first date five of the samples combining two or three seed fragments together from the same basket, in order to maximize the chance of getting sufficient amount of carbon for dating. Although the combination of several seeds for measurements make the chronological interpretation more complicated, these samples still provide important information. Because of our identification of a stratigraphic sequence of the sediments (see above), we suggest that intrusive samples of younger ages can be excluded, while residual older samples might have been present in the layer. Based on this scenario the "true" age could be either the measured one or younger. The dates of the mixed samples therefore still provide a *terminus post quem* for the layer.

In an ideal situation, seeds from contexts such as the ones sampled in this study should not be combined together, as these were not *in situ* burnt contexts (Regev et al. 2014) or clusters of seeds, but rather scattered seeds from unaltered clay within 5–15-cm-thick layers consisting of a few liters of sediment. As one of the samples gave a later date than the expected MB period, a second group of four samples, originating from the larger southern section was analyzed, this time each date consisting of a single organic remain. Single samples dated were charcoal of a fruit tree (therefore a relatively short living tree species), a bone, and two small single seeds dated separately. The calibrated ranges distributions are presented in Figure 9. In the figure, the samples composed of 2–3 seed fragments from a same basket are marked as "mix." Samples are ordered according to their stratigraphic position in the sections and they cover a period from the 26th century BCE to the 9th century BCE.

In general, there is a strong correlation between the ^{14}C dates and the stratigraphic position of the samples. This is also maintained when excluding the dates that were obtained after mixing different seeds.

Three samples, two from directly beneath the building stone (RTD 8065 and RTD 7962), and one from a layer 0–5 cm beneath it (RTD 7963), yielded ranges in the 10th and 9th centuries BCE. The bone (RTD 7962) measured from the layer directly beneath the building stone has a calibrated 1σ range between 988–906 BCE, while the very small single seed (RTD 8065) from the same context falls on a steep slope on the calibration curve yielding a very precise date between 822 and 801 BCE. The lower layer of sediment, located 5–15 cm below the foundation stone, yielded the single piece of charcoal (RTD 7963) of a fruit tree, with 1σ range between 893 and 834 BCE, which could potentially have an old wood effect of up to 50 yr. Another sample (RTD7903) taken from the same locus, consisting of an olive fragment and cereal combined, was measured to the Late Bronze Age, with a 1σ range of 1445–1335 BCE. It is important to note that this date likely does not depict an actual LB horizon, but could as well be the combination of two different ages. The third and lowest sample measured from this gray/brown sediment (RTD 7904) consisted also of two seeds combined into one sample. This sample is slightly earlier than the samples beneath it, suggesting mixed ages in the gray/brown sediment of baskets 147010–147012. If indeed, as suggested above, the northern section is the continuation of this accumulation, it is further evidence that this gray/brown sediment divided by white grits contains residual material from earlier periods.

Below B. 147012 is a horizon of pottery (B. 147013) from which sample RTD 8064 gave 1σ range between 1750 and 1690 BCE.

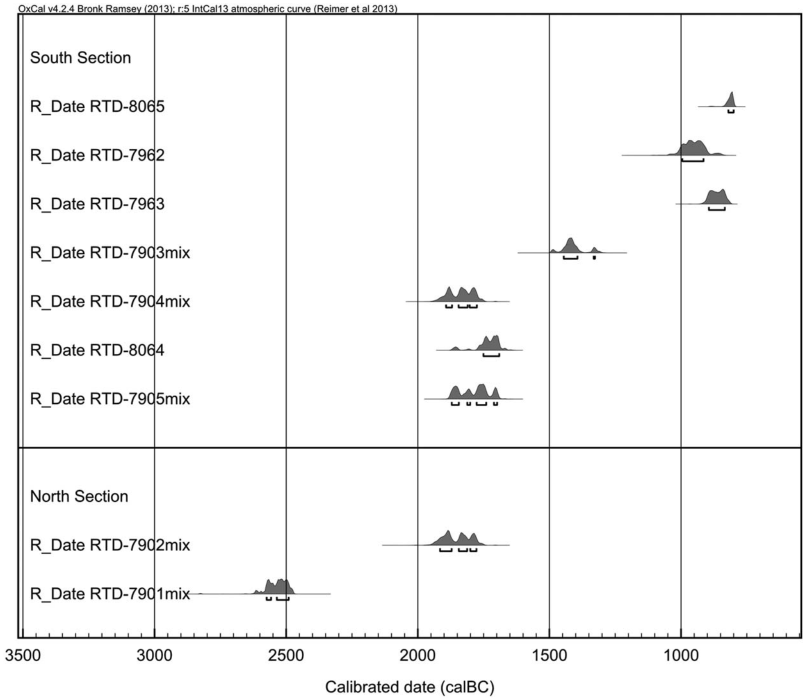

Figure 9 Probability distribution of the calibrated ranges of the ^{14}C samples measured for the two sections. The samples are ordered according to stratigraphy from bottom to top. If more than one sample is from the same basket, they are ordered according to the ^{14}C age; "mix" indicates a dated sample that was prepared from several seed fragments within the same basket.

Sample RTD 7905 is stratigraphically the lowest sample measured in the southern section. It originated from underneath yellow/red layer, which had pottery on top of it and below it. The date has 1σ range between 1870 and 1700 BC.

The latest date of the charred material from the sediment underlying the foundation stone, deposited prior to the foundation of the tower, or alternatively deposited at the time of repair works/modifications conducted on the tower, is most likely to represent the closest time this event took place. It should be noted that the uppermost layer contained relatively many bones compared to the rest of the layers, while it had only very little charred material. Furthermore, the preservation of the bones was excellent, suggesting fairly rapid burial. Despite this, the 1σ range of the bones predates by at least 80 yr the 1σ range of the date retrieved from the seed dated from the same context.

Overall, the two major results of this study are the presence of organic materials dating to Iron Age II just beneath one of the massive foundation stones of the Spring Tower fortification, and a lower horizon beneath the tower containing charred material with a date in the MB period, which is the first date in this range in the City of David.

DISCUSSION

The new set of dates from samples sealed beneath the Spring Tower provides a consistent chrono-stratigraphic picture. Whereas the lower/earlier layers of sediment suggest Middle

Bronze Age activity surrounding the spring, which seemingly predate the construction of the of the tower itself, the Iron Age IIA dates, which do not likely present a single event as evidenced by the range in dates, set the building of the tower in the late 9th century BCE. As the tower is associated with other archaeological features—namely the fortified passage and Wall 3 (see e.g. Reich 2011), changing the date of the tower's construction would also affect the dating of these features. The new dates therefore challenge the previous chronological interpretations based on architecture and pottery typology from other areas (e.g., Steiner 2001; Eisenberg 2012 in referencing the material from Areas C and H). Considering this discrepancy, several possible scenarios are discussed below: (1) the Iron Age and LB dates should be considered intrusive, meaning the tower was built in MB; (2) the tower was built originally in the MB, likely in the late 18th century BCE, but repairs were undertaken during the Iron Age, introducing later material under the tower; and (3) the tower was built originally during the Iron Age, or more precisely in the late 9th century BCE.

Option 1. The 9th century BCE dates are not representative of the construction date of the tower and should be interpreted as intrusive.

This option should be considered, as sediments in general, and directly under stones in particular, could have animal burrows, root channels and/or water transported material filling in voids. However, after the two sampled sections were cleaned, no signs of such intrusions/bioturbations were noted in the sequence of layering. Furthermore, as three samples measured from the two separate uppermost layers yielded dates in the 10th–9th century BCE, each of a different material (one bone out of many, charcoal, seed), and a fourth sample contained material of a clearly post-MB date, a scenario of intrusive independent specimens is very unlikely. Therefore, the only possible explanation for the samples being "intrusive" is if the entire top part of the section (35 cm height, 50 cm width cm of sediment) was removed and filled in later on. However, as the section sampled 2 m to the north appeared as the continuation of the layers identified in the south, it implies that the removal event and substitution should have been at least 2 m wide and 50 cm deep, making it an even less likely scenario. The clear layering of the separate loci, as evident by the naked eye, was further confirmed and characterized by macroscopic and microscopic analyses. These loci can be grouped into deposition events based on the ^{14}C measurements. The ^{14}C measurements in both of the sections appear in rough chronological order, with some residual material present within the layers (as explained in the case of the mixed samples above). The ^{14}C dates, from combined and single short-lived samples, are following by large the stratigraphic sequence of younger at the top to older at the bottom.

These factors strongly suggest that the whole deposit, and especially the top layers, could not have originated as redeposited mixed archaeological sediments. In light of the above, we consider the possibility that the Iron Age samples are intrusive very unlikely.

Option 2. The Spring Tower was originally built during the Middle Bronze Age and underwent renovations during the Iron Age IIA.

Assuming the tower underwent renovations during the Iron Age, this repair would be detected as a fill including Iron Age material beneath the boulders, to a maximum depth of 35 cm underneath the large boulder of the main section. Four dates, three measured from the southern section 35–50 cm beneath the large boulder and one from the northern section, yielded MB dates. As three of them were measured from a combination of several seeds per sample, they cannot be used for precise chronological determinations, albeit it must be noted they are all very similar in age, in the 19th–18th centuries BCE. The latest MB measurement (RTD 8064) originated under the topmost layer of horizontal pottery and was measured from a single olive pit. In a scenario where the layers under the horizontal pottery level were deposited prior to the building of the tower and the sediments above the pottery level are layers laid down as fill in the course of construction works of the tower, this date (1750–1690 BCE at 1σ, RTD 8064) would provide a *terminus post quem* date for the building of the tower (for a recent discussion on MB chronology see Höflmayer et al. 2016a, 2016b).

This latest MB date measured is contemporaneous with the reign of 13th Dynasty ruler Sobekhotep II (modeled accession date 1σ 1777–1712 BCE, based on comparison with the Egyptian ^{14}C chronology; Bronk-Ramsey et al. 2010) or his immediate successors, suggesting the building time of the tower was later than both the early group and later group of Egyptian execration texts mentioning Jerusalem (e.g. Rainey 2006).

It is possible that the entire northern portion of Wall 104 (the eastern wall of the tower) underwent rebuilding in the same area of the tower. (Figure 4). However, there is no evidence for a separation of two phases of construction, usually notable in a seam along such an architectural feature. Furthermore, the full set of new dates, including two clear chronological stages of Middle Bronze Age (i.e., late 18th century BCE) and Iron Age IIA (i.e., late 9th century BCE), fit well with the settlement data regarding the lower slope of the City of David, where it has been shown that during the late 9th century BCE (according to relative ceramic dating), the area began to be resettled and repairs may have been made to the earlier fortifications (see Uziel and Szanton 2015). The general assumptions regarding the style of architecture, using roughly cut boulders of enormous size, fits the style often attributed to the Middle Bronze Age fortifications. Such an architectural style is also known at Shechem (Campbell 2002), Shiloh (Finkelstein et al. 1993) and Hebron (Ofer 1993; Eisenberg and Ben-Shlomo 2016). Furthermore, reconstructing a two-stage thesis for the Spring Tower considers the relationship between the tower and other elements mentioned above (the fortified passage and Wall 3), which have been dated to the Middle Bronze Age II according to the excavators (Steiner 2001; Reich and Shukron 2010). An additional indication of repairs to the base of the tower may be found in numerous boulders at its base, which are not aligned with the face of the tower (see Figure 3). Finally, the Middle Bronze Age date for the tower would be also supported by the urbanization of Canaan and the hill country on a whole (e.g. Dever 1987; Ilan 1995) and the mention of Jerusalem in the Execration Texts (Rainey 1994, 2006; for different opinions regarding the relationship between the execration texts and Middle Bronze Age urbanization, see Redford 1992, 1996; Ben-Tor 2006). This is particularly significant considering the importance of the Gihon Spring as Jerusalem's perennial water source throughout its early history, until the construction of aqueducts in the Late Hellenistic period (Mazar 1989; Amit and Gibson 2014). As mentioned above, without the tower surrounding the spring, the water source would not have been protected, and brings to question the status of Jerusalem as an urban entity in the Middle Bronze Age. However, the fact that the ^{14}C dates appear in chronological sequence in the section, and that stratified layering can be identified underlying the boulders, weakens the idea of random constructional fill or repair to such fills. Reconstruction of the portion of the tower—be it the northern part of the tower or Wall 104 in its entirety—is also not supported by any existing archaeological evidence.

Option 3. The construction of the Spring Tower should be attributed to the late Iron Age IIA (the terminal phase of the 9th century BCE at the earliest)—the data presented here should be taken at face value.

If this is the case, then the Gihon Spring would have remained unprotected during the entire second millennium BCE, as well as during the period of the united monarchy (for a discussion

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of the status of Jerusalem during this period, see Finkelstein et al. 2007; A Mazar 2006; E Mazar 2007, 2009; De Groot 2012). This has far-reaching implications on the urbanization of the site, and would suggest that it is possible that only during the 9th century BCE—when there is intense growth in domestic settlement of the eastern slopes (Uziel and Szanton 2015)—is there a need to protect the spring from outside attack and siege. Perhaps it is possible that only at this point, when foreign empires, such as the Arameans and later the Assyrians, begin to campaign to the region, was it necessary to fortify the spring. However, this would call into question the need to fortify the city itself, as noted by Wall 217 in Area E of Y. Shiloh's excavations, which enclosed the city from the Middle Bronze Age until some point in the Iron Age II, while leaving the spring outside of the protected area. Finally, if one considers that the construction of the tower only occurred in the 9th century BCE, it is possible that it is part of the fortifications built along the lower slope on the western bank of the Kidron riverbed, discovered in both Area J and Area A (see Reich and Shukron 2008; e.g. Reich 2011). In this light, it is important to consider the suggestion that the first city of Jerusalem was not located at all in the area of the spring, but rather on the Temple Mount (Finkelstein et al. 2011). That said, this proposal stands in clear contrast to the findings in Shiloh's Area E as well as a complete lack of evidence from the Temple Mount itself to support such a scenario (and see De Groot and Geva 2015 for difficulties with this proposal). Regardless, the current dates presented here do give further support for such a scenario and stress the need for further absolute dating in ancient Jerusalem.

CONCLUSIONS

The new and first ^{14}C dates for the Gihon Spring Tower in Jerusalem are presented above, with three possibilities given. The first possibility—being that the dates be considered intrusive—has been ruled out, leaving two viable scenarios. The first is that the tower was originally constructed in the Middle Bronze Age II—around the 18th century BCE—and then repaired or renovated in the 9th century BCE. This option is supported by previous archaeological evidence, such as that presented by Reich and Shukron (e.g., Reich and Shukron 2010; Reich 2011), the relationship between the tower and other features attributed to the MB II, and the hypothesis already suggested (Uziel and Szanton 2015) that the tower had a long history of use, with repairs sometime in the 9th century. That said, at face value, the dates provided indicate a construction of the tower in the 10th–9th century BCE, if one only takes these dates into consideration. To a certain extent, the option of rebuilding of the tower is flawed in that it attempts to reconcile the data provided here with earlier opinions. If one considers that those opinions may have been flawed from the onset, then the dates must be taken at face value—meaning the tower and relating features should be dated solely to the late 9th century BCE or later, as this date is in essence the earliest possible date that the tower may have been constructed in.

In this light, one must consider the recent theory put forth by Ussishkin (2016), who suggested that all of the fortifications surrounding the spring—including the Spring Tower, Kenyon's Wall 3 and the fortified passage—should be attributed to the late 8th century BCE. While this theory can be supported by the ^{14}C dates provided here, it suffers from several flaws that make it difficult to accept. As already published (Uziel and Szanton 2015), this theory does not consider that a building dated to the late 9th century BCE based on pottery assemblage found inside the building, abuts the outer face of the fortified passage, meaning that the latest this feature—and in turn the Spring Tower—can date is the 9th century BCE. Therefore, while the dates provided here can be used to support the dating suggested by Ussishkin, other archaeological data seems to refute such a theory.

While our dating results of the northeastern corner of the Spring Tower have far-reaching implications for the study of Jerusalem and the understanding of the role of the Gihon Spring in the history of the site and its urban development, the full understanding of the results is dependent on the addition of more absolute dates for the various features related to the tower and the spring. From an archaeological perspective, the data presented would best seem to fit the scenario in which the tower was originally constructed in the Middle Bronze Age II and then repaired during the Iron Age II. That said, the possibility of the tower being constructed for the first time in the Iron Age IIA—at the end of the 9th century BCE must be seriously considered based on the sequential order of the ^{14}C dates obtained from the sections.

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