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A RADIOCARBON SEQUENCE FROM TELL ABU EN-NI'AJ, JORDAN AND ITS IMPLICATIONS FOR EARLY BRONZE IV CHRONOLOGY IN THE SOUTHERN LEVANT

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ABSTRACT. Tell Abu en-Ni'aj, an agrarian Early Bronze IV village in the northern Jordan Valley, Jordan, provides a series of 24 accelerator mass spectrometry (AMS) seed dates spanning seven stratified phases of occupation. Bayesian analysis of these ages reveals that habitation at Tell Abu en-Ni'aj began between 2600 and 2500 cal BC and ended just before 2000 cal BC. This sequence provides the longest radiocarbon record of occupation for an Early Bronze IV settlement in the southern Levant and pushes the beginning of the Levantine Early Bronze IV earlier than proposed previously. When integrated with ^{14}C dates from an array of sites in the southern Levant, Egypt, and Lebanon, this evidence aligns with recent ^{14}C-based chronologies calling for earlier ages for Early Bronze I–III, details Early Bronze IV chronology through the course of this period, and corroborates the date of the Early Bronze IV/Middle Bronze Age transition ~2000 cal BC.

KEYWORDS: Early Bronze IV, radiocarbon AMS dating, Bayesian analysis, Bronze Age chronology, southern Levant.

INTRODUCTION

The Bronze Age of the southern Levant featured the emergence of fortified towns, followed by their dramatic abandonment and redevelopment during the 4th and 3rd millennia BC. Sedentary agrarian settlements and their populations alternately aggregated or dispersed according to a variety of trajectories (Falconer and Savage 1995, 2009). Occasional walled communities in Early Bronze I (Joffe 1993; Gophna 1995; Philip 2003) preceded more nucleated settlement in the subsequent Early Bronze II and III periods, as signaled by the advent of numerous fortified towns atop mounded tell sites throughout the region (Greenberg 2002, 2014; de Miroschedji 2009, 2014). These towns were abandoned gradually across the southern Levant by the end of Early Bronze III and populations shifted to farming hamlets and seasonal pastoral encampments during Early Bronze IV (also known as the Intermediate Bronze Age) (Palumbo 1991; Dever 1995; Cohen 2009; Prag 2014). Subsequently, larger walled cities reappeared rapidly in Middle Bronze I (traditionally termed Middle Bronze IIA), growing in size, number, and scale of fortification during Middle Bronze II and III (Middle Bronze IIB and IIC) (Greenberg 2002; Bourke 2014; Cohen 2014). The Late Bronze Age experienced a recession in the abundance and size of Levantine towns (Fischer 2014; Panitz-Cohen 2014), although the period witnessed heightened commercial and political activity throughout the eastern Mediterranean, as well as the earliest textual documentation of local Levantine polities (Strange 2000; Savage and Falconer 2003; Falconer and Savage 2009).

The relative chronology and periodization of the southern Levantine Bronze Age have been derived traditionally from systematic changes in material culture within the Levant (especially in ceramic vessel morphology) and linkages of local material culture (e.g. pottery and metal weaponry) with typological parallels in Syria, Lebanon, and Egypt (Cohen 2002, 2014; Bourke 2014; de Miroschedji 2014; Prag 2014; Richard 2014). This chronology is anchored in absolute terms with particular reference to the dynastic chronology of Egypt. For example, the end of Early Bronze I is correlated with the end of Egypt's Dynasty 0 between 3025 and 2950 BC (Stager 1992; Greenberg 2002; Bronk Ramsey et al. 2010; de Miroschedji 2014; Sharon 2014). Similarly, the ascension of the 12th Dynasty has provided the chronological lynchpin for the orthodox beginning of the Levantine Middle Bronze Age at 2000 BC (Dever 1987; Stager 1992; Greenberg 2002).

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Traditionally, Early Bronze IV town abandonment has been correlated with the collapse of central political authority during the Egyptian First Intermediate Period, and sandwiched accordingly between the Old and Middle Kingdoms from 2300 to 2000 BC (Stager 1992; Dever 1995; Prag 2014). This convenient linkage, however, risks a potential tautology in using Egyptian political history to first date and then explain the social dynamics of the southern Levant (for a similar argument from an Egyptian perspective see Bruins 2007: 65). This critique is particularly appropriate for the previously accepted 2- to 3-century Early Bronze IV chronology at the end of the 3rd millennium BC. This study presents new accelerator mass spectrometry (AMS) ^{14}C sequences from Early Bronze IV Tell Abu en-Ni‘aj and Middle Bronze Age Zahrat adh-Dhra‘ 1, Jordan, which we relate to published chronological evidence from the southern Levant, Lebanon, and Egypt (Figure 1). On this basis, we introduce detailed evidence for a lengthened southern Levantine Early Bronze IV period starting between 2600 and 2500 cal BC and continuing to ~2000 cal BC.

Levantine Bronze Age chronologies and their correlation with evidence from Egypt, Lebanon, and Syria have attracted considerable critical review over the last decade. Reconsideration and modeling of Early Bronze Age ^{14}C dates from sites across the southern Levant (e.g. Bruins and van der Plicht 2001; Golani and Segal 2002; Braun and Gophna 2004; Philip 2008; Bourke et al. 2009; Regev et al. 2012a, 2012b, 2014; Shai et al. 2014) hinge on stratified evidence excavated from settlements spanning Early Bronze I–III. These investigations support a revised chronological structure that is significantly earlier than traditionally accepted timeframes. For example, the Early Bronze II/III transition may be revised “at least 200 yr earlier than the traditionally accepted dates” (Regev et al. 2012a: 561). These studies also allude to an early beginning for Early Bronze IV, based primarily on the unexpectedly early end of Early Bronze III, which implies a start for Early Bronze IV no later than ~2450 cal BC (e.g. Regev et al. 2012a: 561). In particular, the limited number of Early Bronze III/IV sites with clearly stratified ^{14}C ages hinders modeling of the beginning of Early Bronze IV.

The traditional end date for Early Bronze IV remains tied to the expected date for the Early Bronze/Middle Bronze transition ~2000 BC. Comparative studies of ^{14}C ages from Middle Bronze Age settlements estimate the beginning of Middle Bronze I at or slightly later than this orthodox date (e.g. Bruins and van der Plicht 1995, 2003; Marcus 2003, 2010, 2013; Bourke 2006; Fischer 2006; Bruins 2007; Bourke et al. 2009; Kutschera et al. 2012; cf. Höflmayer et al. 2016). However, the current Early Bronze IV chronology remains unmodeled internally and accordingly may encompass anywhere from 200 to >500 yr as inferred indirectly from preceding and subsequent periods. The difficulty in defining the boundaries of Early Bronze IV results largely from a dearth of high-resolution ^{14}C ages from Early Bronze III/IV sites and the near absence of Early Bronze IV/Middle Bronze I stratified sites in the southern Levant. The key challenges in redefining chronology through the full course of Early Bronze IV stem from this period’s paucity of excavated settlements and, more specifically, the absence of ^{14}C ages from long-term stratigraphic sequences comparable to those available from stratified Early Bronze I–III and Middle Bronze Age sites. This study presents a seven-phase sequence of 24 AMS seed dates from the excavated agrarian settlement of Tell Abu en-Ni‘aj, Jordan, that pushes the start of Early Bronze IV earlier than proposed previously, approaches the earliest Middle Bronze dates from neighboring Tell el-Hayyat and more distant Zahrat adh-Dhra‘ 1, and covers an intervening span of at least 500 yr through Early Bronze IV.

TELL ABU EN-NI‘AJ

Tell Abu en-Ni‘aj extends over 2.5 ha and lies at ~250 m below sea level in the northern Jordan Valley, where it overlooks the present floodplain of the Jordan River (Figure 1; Ibrahim et al. 1976:

Figure 1 Map of the eastern Mediterranean, including the southern Levant (modern Israel, Palestine, and western Jordan) and the Early Bronze IV and Middle Bronze Age sites incorporated in this study.

51, site 64). Judging from population densities in traditional Middle Eastern villages (generally 200–250 people/ha, see e.g. Kramer 1982), we estimate that Ni'aj housed 500 to 600 inhabitants in Early Bronze IV. Excavations at Tell Abu en-Ni'aj directed by the authors in 1985, 1996/97, and 2000 (Falconer and Magness-Gardiner 1989; Falconer et al. 1998, 2001, 2004, 2007; Falconer and Fall 2009) covered about 2.5% of the site area (Figure 2; Falconer et al. 2004: Figure 4), exposing 3.3 m of Early Bronze IV cultural deposits comprised of seven major strata of mudbrick architecture. The walls of Phase 7 structures, at the base of this sequence, are founded on archaeologically sterile Pleistocene lacustrine sediments. Phase 1 deposits incorporate ancient village remains just below the tell's modern surface. The village plan of Tell Abu en-Ni'aj is marked by closely packed mudbrick domestic and industrial structures separated by alleyways and, in Phases 5–1, sherd paved streets (Figure 3). In keeping with the original report

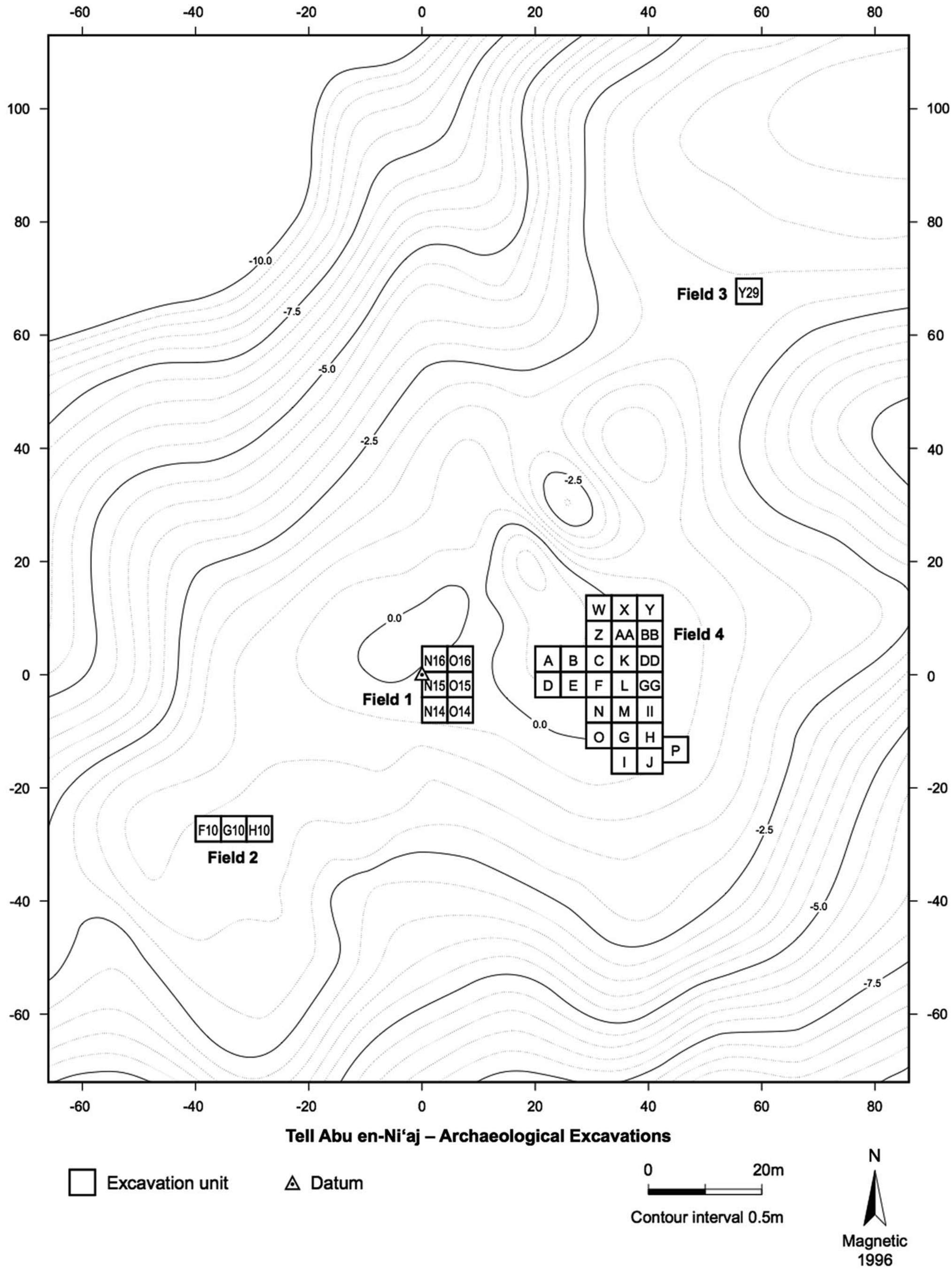

Figure 2 Topographic map of Tell Abu en-Ni'aj, Jordan showing 4 × 4 m excavation units in Fields 1–4. ^{14}C dates come from Field 4, Units B, C, GG, K, W, & X. The main site datum is ~250 m below sea level.

of the East Jordan Valley Survey (Ibrahim et al. 1976), the excavated ceramics from Tell Abu en-Ni'aj Phases 7–1 consist of characteristically fine-tempered hand-built Early Bronze IV vessels, which attest to the village's occupation solely in Early Bronze IV. Thus, Tell Abu

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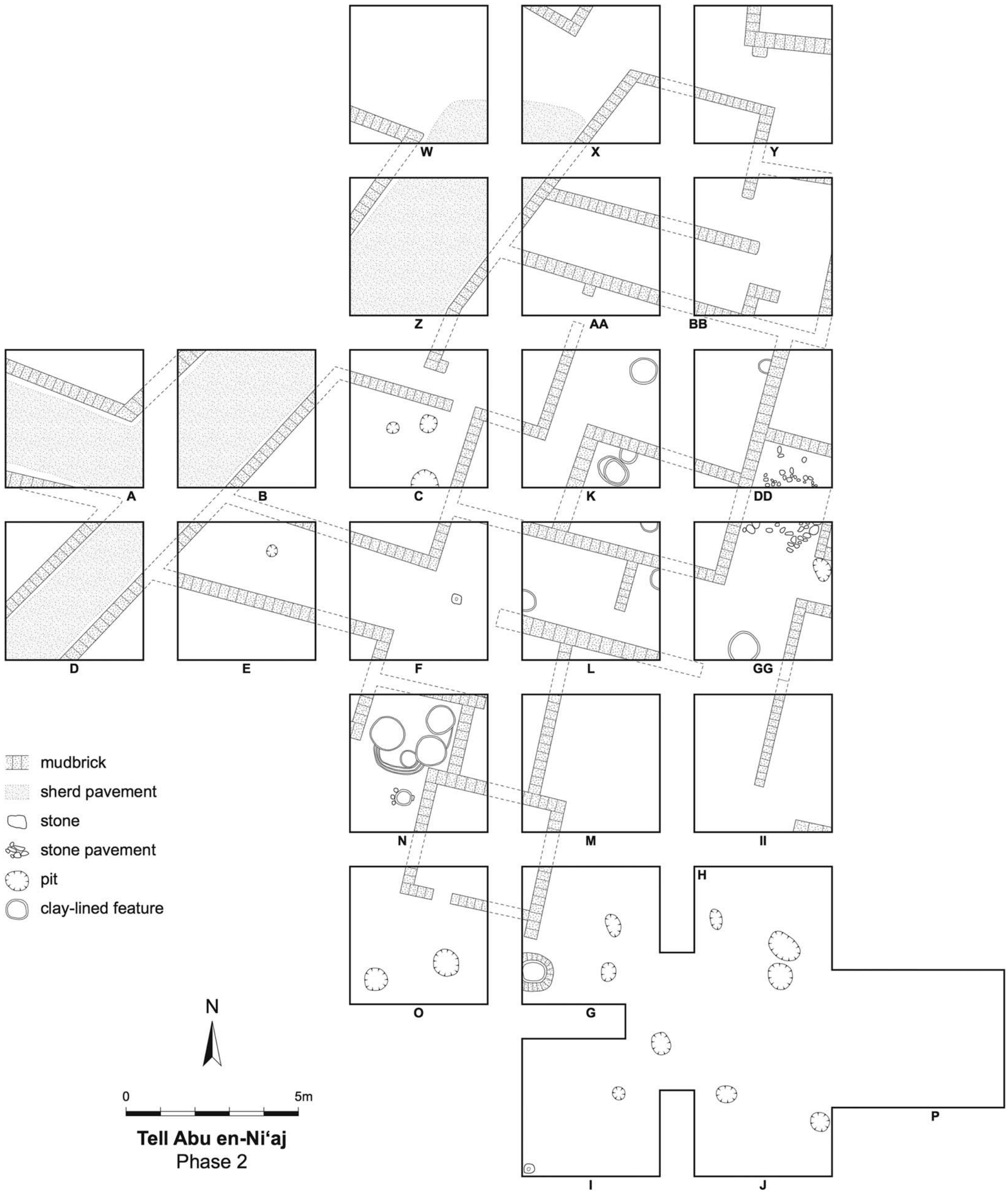

Figure 3 Excavated Phase 2 Early Bronze IV architecture in Field 4 at Tell Abu en-Ni'aj, Jordan, showing mudbrick structures, sherd-paved streets, pits, clay-lined bins, and stone pavements.

en-Ni'aj provides a rare excavated example of a deeply stratified sedentary Early Bronze IV community.

We compare the ^{14}C sequence from Tell Abu en-Ni'aj to dates from other Early Bronze IV sites in the southern Levant, Lebanon, and Egypt as a means of expanding and detailing this period within emerging revised Bronze Age chronologies. We also explore the end of Early Bronze IV with reference to Middle Bronze Age ^{14}C ages from the southern Levant and Egypt, especially early Middle Bronze I dates from Tell el-Hayyat and Zahrat adh-Dhra' 1, Jordan.

TELL EL-HAYYAT

Tell el-Hayyat lies 1.5 km northeast of Tell Abu en-Ni'aj, at ~240 m below sea level amid agricultural fields on the alluvial terrace above the Jordan River floodplain (see Figure 1; Ibrahim et al. 1976:49, site 56). This 0.5-ha settlement was inhabited by 100–150 people over the course of the Middle Bronze Age. Excavations in 1982, 1983, and 1985 (Falconer 1995; Falconer and Fall 2006) sampled about 8% of the site area and unearthed deposits almost 4 m deep that incorporate six stratified architectural phases (Falconer and Fall 2006: Figure 2.3). Basal Phase 6 produced Early Bronze IV ceramics from archaeological deposits just above sterile sediment. Phases 5–2 reveal a Middle Bronze Age settlement centered on four temples *in antis* surrounded by houses, courtyards, and alleys (Magness-Gardiner and Falconer 1994; Falconer and Fall 2006: Figure 3.1). Hand-built versions of Middle Bronze I vessel forms suggest that Phase 5 dates early in this period, while classic wheel-thrown pottery documents Middle Bronze I, II, and III habitation in Phases 4–2 (Falconer and Fall 2006: Table 4.1). Phase 1 provides fragmentary architectural remains of the village's final occupation in Middle Bronze III.

ZAHRAT ADH-DHRA' 1

Middle Bronze Age Zahrat adh-Dhra' 1 on the Dead Sea Plain is distinguished by the remains of more than 25 semi-subterranean stone built structures spread over 6 ha atop a ridge between two tributaries of the Wadi al-Karak (see Figure 1; Edwards et al. 2001, 2002; Fall et al. 2007). Eroded buildings along these wadis suggest an original settlement of at least 12 ha that has been truncated by post-Bronze Age downcutting. Field investigations directed by the authors in 1999/2000 utilized 23 excavation units to sample domestic remains across the site (Edwards et al. 2001; Fall et al. 2007). Ceramic typology and inference of abandonment patterns suggest multiple episodes of occupation and abandonment in the Middle Bronze Age (Edwards et al. 2002; Berelov 2006).

METHODS

As a routine excavation method at Tell Abu en-Ni'aj, Tell el-Hayyat, and Zahrat adh-Dhra' 1, archaeological sediments with visible burned organic content were processed by water flotation to recover plant macrofossils (Fall et al. 1998, 2002; Edwards et al. 2001; Falconer and Fall 2006: 38–43; Klinge and Fall 2010; Klinge 2013). These samples were recovered from shallow well-defined features with burned sediments (e.g. small hearths, shallow pits in surfaces). The floated organic fraction from each sample, containing carbonized seeds and charcoal, was poured through nested 4.75-mm, 2-mm, 1-mm, and 0.5-mm mesh sieves. All material 0.5 mm or larger was sorted under a binocular microscope to separate charred seeds from charcoal fragments (see detailed methods in Klinge and Fall 2010: 38–43). Seeds and seed fragments were identified using Fall's personal reference collection and comparative literature (e.g. Helbaek 1958; Renfrew 1973; Zohary and Hopf 1973; Zohary and Spiegel-Roy 1975; van Zeist 1976; Hillman 1978; van Zeist and Bakker-Heeres 1982; Hubbard 1992; Jacomet 2006). We submitted seeds representing short-lived cultigens (rather than charcoal) from Tell Abu en-Ni'aj, Tell el-Hayyat, and Zahrat adh-Dhra' 1 for AMS ^{14}C analysis in order to optimize chronological resolution.

A set of 24 ^{14}C age determinations from Tell Abu en-Ni'aj samples now contributes to the ongoing resolution of Bronze Age chronology in the southern Levant. A group of seed samples from upper phases at Tell Abu en-Ni'aj produced three age determinations from the Oxford Radiocarbon Accelerator Unit (Bronk Ramsey et al. 2002) and four ages from the Vienna Environmental Research Accelerator (previously unpublished) as part of a ^{14}C-based study of the beginning of the Middle Bronze Age conducted by Ezra Marcus (2003, 2010). Seed samples submitted more recently to the University of Arizona Accelerator Mass Spectrometry Laboratory have produced 17 further age determinations (previously unpublished). The current suite of ages now covers the entire stratigraphic sequence at Tell Abu en-Ni'aj (Phases 7–1; Table 1).

^{14}C analyses for seed samples from Tell el-Hayyat Phases 5 and 4 include four AMS ages from the University of Arizona (Falconer and Fall 2006: Table 4.2; Marcus 2003, 2010), which were followed by four determinations from Oxford, and five ages from the VERA lab (Marcus 2010). These dates address the beginning of MB I based on evidence recovered in close proximity to Tell Abu en-Ni'aj. A suite of six previously unpublished seed dates from the ANTARES AMS Facility at ANSTO documents the span of Middle Bronze Age occupation at Zahrat adh-Dhra' 1, including ^{14}C ages early in Middle Bronze I.

All ^{14}C ages in this study were calibrated using OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) and the IntCal13 calibration curve (Reimer et al. 2013). The modeling tools in OxCal v 4.2.4 were used for Bayesian analysis of the calibrated dates. Bayesian analysis of ^{14}C ages enables the coordinated analysis of large suites of calibrated ^{14}C determinations, which are becoming increasingly common in archaeology (see especially Bronk Ramsey 2009a). Further, it accommodates the non-normally distributed probabilities of calibrated ^{14}C ages, and provides a means for archaeologists to build modeled ^{14}C sequences on prior stratigraphic information.

RESULTS

Tell Abu en-Ni'aj

Tell Abu en-Ni'aj provides a sequence of 24 seed dates spread over seven stratigraphic phases (Table 1). We organized these dates in a series of contiguous phases based on the uninterrupted stratigraphic record of occupation at Ni'aj; within each phase dates were ordered from older to younger based on ^{14}C ages. Bayesian modeling suggests a starting boundary for Phase 7 with a 1σ range of 2591–2486 cal BC and an ending boundary range for Phase 1 of 2118–1970 cal BC (Figure 4). After removal of two outliers (AA-90067; AA-90071) (Bronk Ramsey 2009b), the A_{model} = 122.7. Removal of these outliers caused minimal shifts in modeled boundaries (<10 yr change in medians). This model generates an occupation span of ~500 yr or roughly 70–75 yr per phase. On this basis, each of the earlier strata (Phases 7–3) represents about 35–55 yr of habitation (as estimated by differences between boundary medians), while Phases 2 and 1 reflect longer episodes of roughly 150 yr each. In overview, Bayesian modeling suggests that the Early Bronze IV occupation at Tell Abu en-Ni'aj began 2600–2500 cal BC and ended 2100–2000 cal BC.

Tell el-Hayyat

Thirteen seed dates span Phases 5 and 4 at Tell el-Hayyat (Table 2). We assembled these ages in two contiguous phases within which dates were ordered from older to younger on the basis of ^{14}C determinations. Bayesian modeling suggests a starting boundary for Phase 5 with a 1σ range of 1937–1823 cal BC and an ending boundary range for Phase 4 of 1835–1759 cal BC (Figure 5). The first samples submitted from Tell el-Hayyat produced relatively large uncertainties, and when three of them (AA-1237, AA-1238, AA-1239) are treated as outliers, A_{model} = 119.8. This model estimates an occupation span of about 100 yr for these two phases, in which Phase 5 began around 1900 cal BC and Phase 4 ended about 1800 cal BC.

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Table 1 AMS radiocarbon results for seed samples from Tell Abu en-Ni‘aj, Jordan (ordered by lab and sample number). Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013). Stratigraphic phases at Tell Abu en-Ni‘aj start with Phase 7 (the earliest, basal stratum) and end with Phase 1 (the latest, uppermost stratum). Context is indicated according to Excavation Unit, Locus, and Bag (e.g. C.066.239 = Unit C, Locus 066, Bag 239).

Lab number	$\delta^{13}C$ (‰)	$F^{14}C$	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal BC	Material dated
AA-90067	–23.1	0.6088 ± 0.0042	3986 ± 56	2617–2611 (1.1%) 2581–2456 (65.4%) 2417–2409 (1.8%) 2326–2300 (1.7%)	2834–2818 (1.3%) 2662–2647 (1.0%) 2637–2332 (91.5%)	2513	Phase 4, C.066.239, mudbrick wall *Hordeum, Cerealia* grains
AA-90069	–22.7	0.6157 ± 0.0032	3896 ± 42	2464–2339 (68.2%)	2478–2277 (91.2%) 2252–2228 (3.0%) 2222–2210 (1.2%)	2381	Phase 4, C.071.236, burned surface *Hordeum*
AA-90070	–23.0	0.6177 ± 0.0033	3870 ± 42	2456–2417 (16.7%) 2409–2292 (51.5%)	2468–2272 (83.6%) 2258–2207 (11.8%)	2353	Phase 4, C.073.284, ash pit *Triticum* (emmer)
AA-90071	–23.4	0.6092 ± 0.0034	3981 ± 44	2570–2515 (40.5%) 2502–2466 (27.7%)	2620–2391 (89.9%) 2386–2346 (5.5%)	2511	Phase 5, C.075.278, burned surface *Hordeum*
AA-90072	–23.2	0.6088 ± 0.0034	3986 ± 44	2570–2514 (41.8%) 2502–2468 (26.4%)	2621–2399 (91.3%) 2383–2347 (4.1%)	2518	Phase 6, C.091.406, burned surface *Triticum* (emmer)
AA-90073	–23.5	0.6143 ± 0.0034	3915 ± 44	2471–2343 (68.2%)	2564–2533 (3.5%) 2495–2283 (90.6%) 2249–2233 (1.3%)	2398	Phase 5, C.089.386, ash pit *Hordeum*
AA-90075	–22.2	0.6058 ± 0.0033	4026 ± 43	2581–2476 (68.2%)	2836–2816 (3.1%) 2671–2465 (92.3%)	2546	Phase 6, C.086.387, burned surface *Cerealia* grains
AA-90076	–23.4	0.6150 ± 0.0034	3905 ± 45	2468–2340 (68.2%)	2551–2537 (1.2%) 2491–2276 (90.4%) 2253–2228 (2.7%) 2223–2210 (1.1%)	2388	Phase 6, C.106.494, stone-lined hearth *Triticum* (emmer)
AA-94177	–22.8	0.6043 ± 0.0030	4046 ± 39	2622–2551 (38.4%) 2537–2491 (29.8%)	2848–2813 (6.4%) 2692–2690 (0.2%) 2679–2471 (88.9%)	2572	Phase 7, GG.105.331, shallow fire pit *Cerealia* grains

AA-94178	–23.7	0.6145 ± 0.0030	3912 ± 39	2469–2346 (68.2%)	2550–2537 (1.1%) 2491–2286 (93.8%) 2247–2236 (0.5%)	2397	Phase 5, GG.065.185, ash lens *Hordeum*
AA-94179	–24.3	0.6209 ± 0.0030	3828 ± 39	2344–2202 (68.2%)	2458–2416 (7.7%) 2411–2196 (83.4%) 2171–2147 (4.4%)	2281	Phase 3, GG.015.49, burned surface *Prosopis* seeds
AA-94180	–23.4	0.6142 ± 0.0030	3915 ± 39	2470–2391 (45.0%) 2386–2346 (23.2%)	2559–2536 (2.0%) 2491–2287 (93.4%)	2400	Phase 5, GG.100.289, fire pit *Prosopis* seeds
AA-94183	–21.8	0.6336 ± 0.0030	3665 ± 38	2132–2084 (28.7%) 2057–2010 (26.6%) 2001–1977 (12.8%)	2191–2181 (1.2%) 2143–1940 (94.2%)	2045	Phase 1, W.005.70, burned surface *Olea europaea* seed
AA-94184	–21.4	0.6365 ± 0.0030	3630 ± 38	2111–2104 (2.7%) 2036–1937 (65.5%)	2132–2084 (13.3%) 2057–1894 (82.1%)	1994	Phase 1, W.004.76, burned layer *Olea europaea* seeds
AA-94185	–24.2	0.6319 ± 0.0030	3688 ± 38	2137–2028 (68.2%)	2198–2166 (6.9%) 2150–1959 (88.5%)	2080	Phase 1, X.009.98, hearth *Olea europaea* seed
AA-107227	–23.8	0.6126 ± 0.0019	3937 ± 24	2479 –2440 (37.2%) 2420–2404 (11.6%) 2379–2349 (19.4%)	2559–2536 (3.7%) 2491–2342 (91.7%)	2439	Phase 6, GG.098.295 *Pisum*, *Hordeum* & *Triticum* (einkorn)
AA-107228	–23.3	0.6136 ± 0.0019	3924 ± 25	2471–2436 (30.3%) 2421–2404 (14.1%) 2379–2349 (23.8%)	2481–2336 (92.9%) 2323–2307 (2.5%)	2413	Phase 6, C.111.548 *Pisum*, *Hordeum* & *Triticum* (einkorn)
OxA-10990	–23.3	—	3932 ± 38	2480–2395 (47.0%) 2386–2346 (21.2%)	2565–2532 (6.9%) 2496–2296 (88.5%)	2418	Phase 3, K.018.030, clay-lined pit *Hordeum vulgare*; Bronk Ramsey et al. 2002; Regev et al. 2012a
OxA-10991	–22.4	—	3877 ± 40	2455–2418 (17.8%) 2408–2299 (50.4%)	2470–2275 (87.1%) 2255–2209 (8.3%)	2364	Phase 2, B.024.172, ash pit *Hordeum*; Bronk Ramsey et al. 2002; Regev et al. 2012a
OxA-10992	–22.8	—	3886 ± 40	2458–2338 (62.5%) 2322–2310 (5.7%)	2472–2278 (90.3%) 2251–2229 (3.7%) 2221–2211 (1.4%)	2348	Phase 2, B.010.063, fire pit *Cerealia* grains; Bronk Ramsey et al. 2002; Regev et al. 2012a

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Table 1 (*Continued*)

Lab number	$\delta^{13}C$ (‰)	$F^{14}C$	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal BC	Material dated
VERA-2041	–22.9 ± 1.4	—	3900 ± 50	2467–2338 (63.1%) 2322–2309 (5.1%)	2559–2536 (1.8%) 2491–2270 (86.7%) 2260–2207 (6.8%)	2381	Phase 3, K.018.030, clay-lined *Hordeum*
VERA-2042	–20.0 ± 1.5	—	3820 ± 35	2336–2323 (5.0%) 2308–2201 (63.2%)	2456–2418 (4.4%) 2407–2375 (5.0%) 2367–2362 (0.5%) 2351–2192 (78.5%) 2179–2142 (7.0%)	2264	Phase 2, B.024.172, ash pit *Hordeum*
VERA-2043	–23.7 ± 1.6	—	3810 ± 35	2298–2198 (63.6%) 2164–2152 (4.6%)	2450–2445 (0.4%) 2436–2420 (1.4%) 2405–2378 (3.0%) 2350–2138 (90.7%)	2251	Phase 2, C.037.126, fire pit *Hordeum,* humic acids
VERA-2044	–21.8 ± 1.4	—	3830 ± 40	2389–2386 (0.9%) 2346–2202 (67.3%)	2459–2196 (91.5%) 2170–2148 (3.9%)	2285	Phase 2, B.010.063, fire pit *Triticum* and *Hordeum*, humic acids

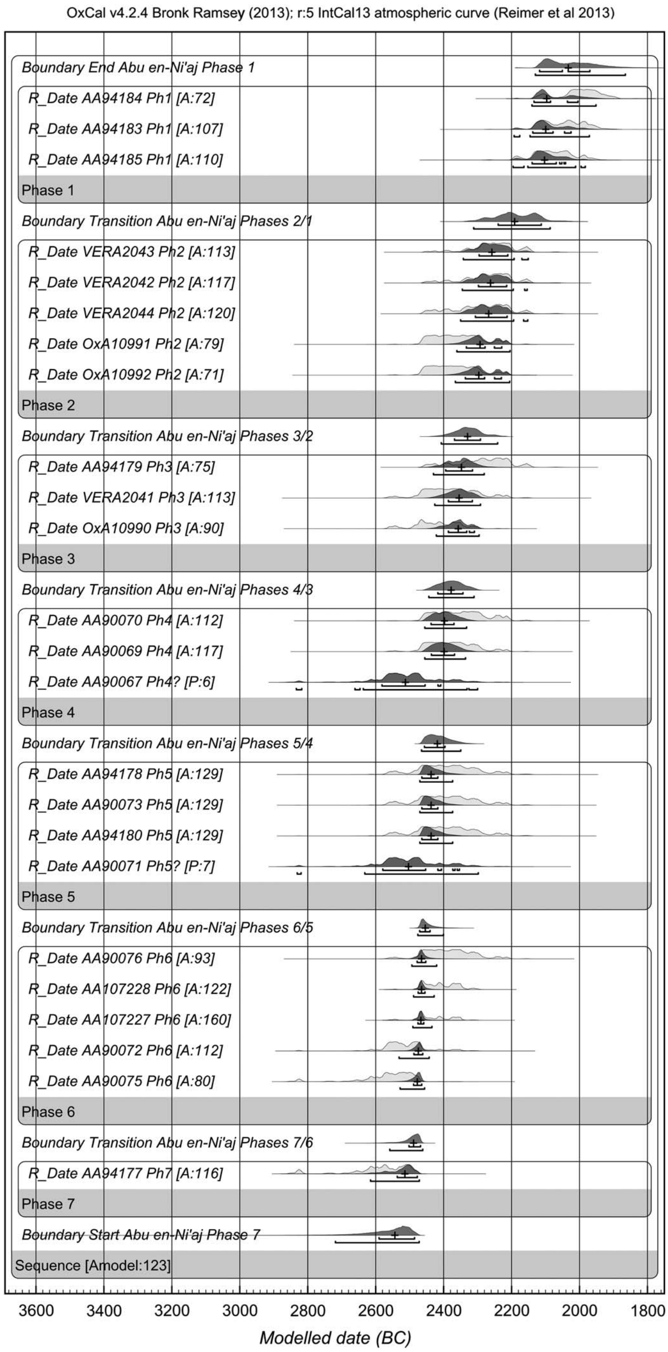

Figure 4 Bayesian sequencing of ^{14}C dates for seed samples from Phases 7–1 at Tell Abu en-Ni'aj, Jordan. Light gray curves indicate single-sample calibration distributions; dark curves indicate modeled calibration distributions. Calibration and Bayesian modeling based on OxCal v 4.2.4 (Bronk Ramsey 2009a; Bronk Ramsey 2013 and Lee) using the IntCal13 atmospheric curve (Reimer et al. 2013).

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Table 2 AMS radiocarbon results for seed samples from Tell el-Hayyat, Jordan (ordered by lab and sample number). Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013). Stratigraphic phases at Tell el-Hayyat start with Phase 6 (earliest, basal stratum) and end with Phase 1 (latest, uppermost stratum). Context is indicated according to Excavation Unit, Locus, and Bag (e.g. F.049.288 = Unit F, Locus 049, Bag 288).

Lab number	$\delta^{13}C$ ‰	$F^{14}C$	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context material dated; references
AA-1236	−30.2	0.650 ± 0.008	3460 ± 100	1897–1657 (66.7%) 1652–1645 (1.5%)	2031–1527 (95.4%)	1783	Phase 5, F.049.288, surface *Lens culinaris*; Falconer & Fall 2006: table 4.2; Marcus 2003, 2010
AA-1237	−26.0	0.665 ± 0.009	3280 ± 100	1665–1446 (68.2%)	1876–1842 (1.7%) 1820–1797 (0.9%) 1781–1376 (90.7%) 1346–1304 (2.1%) 1346–1304 (2.1%)	1568	Phase 4, F.040.235, surface *Olea europaea* seeds; Falconer & Fall 2006: table 4.2; Marcus 2003, 2010;
AA-1238	−23.1	0.639 ± 0.005	3600 ± 60	2111–2105 (1.4%) 2036–1883 (66.8%)	2136–1865 (85.3%) 1850–1773 (10.1%)	1961	Phase 4, C.070.001, surface *Lens culinaris*; Falconer & Fall 2006: table 4.2; Marcus 2003, 2010; reported previously as AA-1239, Phase 5
AA-1239	−25.1	0.694 ± 0.007	2930 ± 80	1257–1251 (1.3%) 1231–1013 (66.9%)	1386–1340 (4.2%) 1316–920 (91.2%)	1134	Phase 5, F.045.258, ash lens *Punica granatum* seeds; Falconer & Fall 2006: table 4.2; Marcus 2003, 2010; reported previously as AA-1238, Phase 4
OxA-10986	−22.4	—	3470 ± 36	1877–1841 (24.8%) 1822–1796 (16.6%) 1782–1744 (26.8%)	1887–1692 (95.4%)	1799	Phase 5, E.102, ash lens *Triticum aestivum*; Falconer & Fall 2006: table 4.2; Marcus 2010
OxA-10987	−22.9	—	3497 ± 37	1882–1860 (13.8%) 1854–1771 (54.4%)	1919–1739 (92.7%) 1713–1698 (2.7%)	1820	Phase 5, H.067, ash lens *Triticum aestivum*; Falconer & Fall 2006: table 4.2; Marcus 2010
OxA-10988	−21.3	—	3502 ± 37	1884–1860 (15.0%) 1854–1771 (53.2%)	1924–1741 (93.6%) 1711–1700 (1.8%)	1823	Phase 4, E.092, tabun fill *Olea europaea* seed; Falconer & Fall 2006: table 4.2; Marcus 2010

OxA-10989	−21.3	—	3523 ± 39	1909–1866 (23.9%) 1849–1774 (44.3%)	1952–1744 (95.4%)	1840	Phase 4, J.074, ash lens *Olea europaea* seed; Falconer & Fall 2006: table 4.2; Marcus 2010
VERA-2037	−21.1 ± 1.3	—	3555 ± 40	1955–1876 (52.8%) 1842–1820 (9.1%) 1797–1781 (6.3%)	2020–1993 (5.1%) 1983–1768 (90.3%)	1901	Phase 5, E.102, ash lens *Triticum aestivum*, humic acids; Falconer & Fall 2006: table 4.2; Marcus 2010
VERA-2038	−21.9 ± 2.1	—	3530 ± 60	1938–1771 (68.2%)	2025–1735 (92.6%) 1717–1695 (2.8%)	1857	Phase 5, H.067, ash lens *Triticum aestivum*; Falconer & Fall 2006: table 4.2; Marcus 2010
VERA-2038W	−22.5 ± 0.6	—	3565 ± 30	1956–1881 (68.2%)	2021–1992 (5.2%) 1983–1872 (79.0%) 1845–1812 (6.7%) 1802–1777 (4.5%)	1916	Phase 5, H.067, ash lens *Triticum aestivum*; Falconer & Fall 2006: table 4.2; Marcus 2010
VERA-2039	−23.4 ± 1.5	—	3495 ± 35	1880–1771 (68.2%)	1911–1739 (92.8%) 1713–1698 (2.6%)	1818	Phase 4, E.092, tabun fill *Olea europaea* seed, humic acids; Falconer & Fall 2006: table 4.2; Marcus 2010
VERA-2040	−24.0 ± 1.5	—	3500 ± 35	1883–1861 (14.0%) 1853–1771 (54.2%)	1919–1741 (93.8%) 1711–1700 (1.6%)	1822	Phase 4, J.074, ash lens *Olea europaea* seeds; Falconer & Fall 2006: table 4.2; Marcus 2010

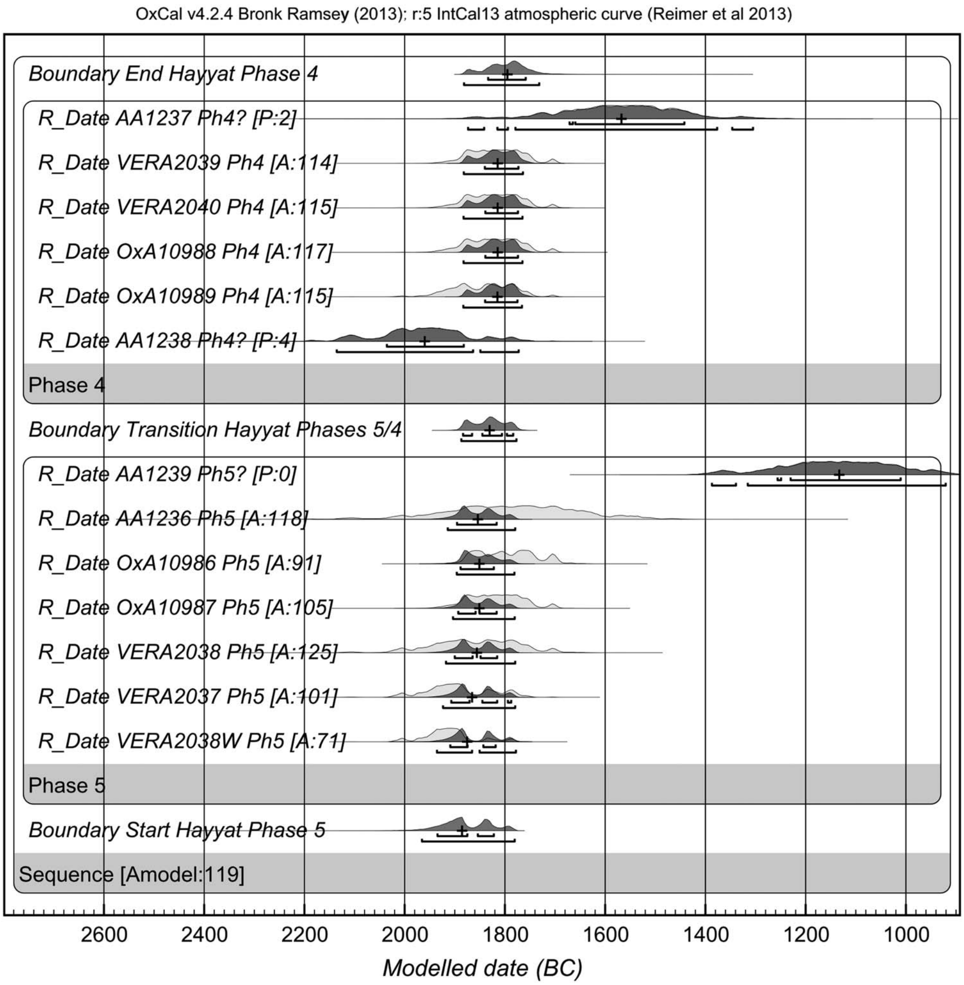

Figure 5 Bayesian sequencing of ^{14}C dates for seed samples from Phases 5 and 4 at Tell el-Hayyat, Jordan. Light gray curves indicate single-sample calibration distributions; dark curves indicate modeled calibration distributions. Calibration and Bayesian modeling based on OxCal v 4.2.4 (Bronk Ramsey 2009a; Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013).

Zahrat adh-Dhra‘ 1

Zahrat adh-Dhra‘ 1 contributes six new seed dates from three structures across the site (Table 3). Unlike the stratified deposits at Tell Abu en-Ni‘aj and Tell el-Hayyat, the samples from Zahrat adh-Dhra‘ 1 come from dispersed, nonstratified contexts in five different stone walled rooms. Therefore, we did not model these dates in separate phases, although patterns of structural abandonment and ceramic deposition suggest multiple habitation episodes (e.g. Berelov 2006; Fall et al. 2007). When compared with ceramic assemblages from settlements closer to Middle Bronze Age towns, the rather idiosyncratic pottery repertoire from marginally located Zahrat adh-Dhra‘ 1 led us to infer occupation primarily in Middle Bronze I and II (Edwards et al. 2002; Berelov 2006; Fall et al. 2007). Bayesian modeling of the ^{14}C ages from Zahrat adh-Dhra‘ 1 generates a starting boundary with a 1σ range of 2163–1952 cal BC and an ending boundary range of 1657–1438 cal BC (Figure 6; A_{model} = 92.0). Thus, the ^{14}C evidence

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Table 3 AMS radiocarbon results for seed samples from Zahrat adh-Dhra‘ 1, Jordan (ordered by lab and sample number). Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013). Context is indicated according to Excavation Unit, Locus, and Bag (e.g. I.012.72 = Unit I, Locus 012, Bag 72).

Lab number	δ^{13}C ‰	F^{14}C	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context; material dated
OZH-756	−25.0	0.6337 ± 0.0040	3670 ± 50	2135–2010 (57.9%) 2001–1977 (10.3%)	2199–2161 (6.2%) 2153–1921 (89.2%)	2054	Structure 40, I.012.72, surface with hearth *Hordeum*
OZH-757	−25.0	0.6495 ± 0.0047	3470 ± 60	1881–1740 (62.4%) 1713–1698 (5.8%)	1936–1641 (95.4%)	1795	Structure 40, I.014.98, ash pit *Vitis vinifera*
OZH-758	−25.0	0.6422 ± 0.0036	3560 ± 50	2008–2004 (1.2%) 1975–1876 (52.9%) 1842–1820 (8.3%) 1797–1781 (5.7%)	2030–1753 (95.4%)	1906	Structure 37, Eastern Room, F.015.98, surface Legume seeds
OZH-759	−25.0	0.6652 ± 0.0046	3280 ± 60	16229–1498 (68.2%)	1691–1431 (95.4%)	1562	Structure 37, Western Room, N.012.37, floor deposit *Hordeum, Vitis vinifera, Pisium sativum*
OZI-635	−25.0	0.6557 ± 0.0047	3390 ± 60	1765 (68.2%)	1879–1838 (6.6%) 1829–1791 (4.8%) 1786–1530 (83.9%)	1689	Structure 42, Western Room, K.019.117, occupational debris on surface; *Hordeum*
OZI-636	−25.0	0.6488 ± 0.0064	3480 ± 80	1897–1692 (68.2%)	2022–1990 (2.3%) 1985–1617 (93.1%)	1805	Structure 42, Eastern Room, K.014.177, occupational debris on surface; *Hordeum*

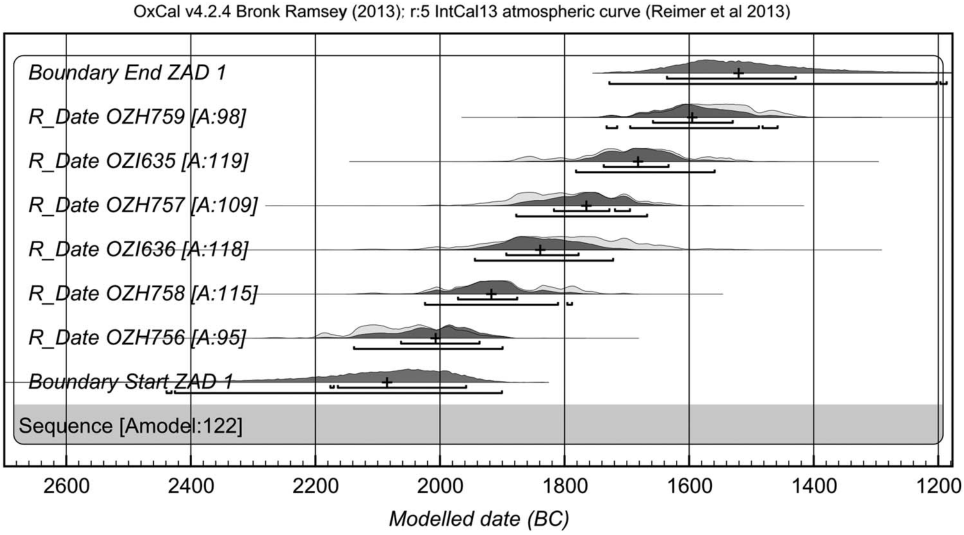

Figure 6 Bayesian phase model of ^{14}C dates for seed samples from Zahrat adh-Dhra‘ 1 (ZAD 1), Jordan. Light gray curves indicate single-sample calibration distributions; dark curves indicate modeled calibration distributions. Calibration and Bayesian modeling based on OxCal v 4.2.4 (Bronk Ramsey 2009a; Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013).

suggests occupation at Zahrat adh-Dhra‘ 1 at a series of points over the entire traditional range of the Middle Bronze Age between 2000 and 1500 cal BC.

Comparative Evidence for Early Bronze IV

The stratified sequence of habitation and ^{14}C ages from Tell Abu en-Ni‘aj links a limited number of possibly earlier dates at the beginning of Early Bronze IV with a larger array of dates from later Early Bronze IV contexts elsewhere in the southern Levant and at key sites in Lebanon and Egypt (Figure 7). All of the ^{14}C determinations from the other southern Levantine Early Bronze Age sites derive from charcoal samples, except for three ostrich eggshell samples from Be’er Resisim (Table 4). The earliest ages from Ni‘aj slightly predate the first dates from a variety of locales, including Nahal Refaim in the Levantine Hill Country, Khirbet Iskander east of the Dead Sea, and Ein Ziq in the Negev. Two other sites in the Negev, Be’er Resisim, and Ha-Gamal, provide slightly earlier dates, although Resisim’s dates could be revised later based on the tendency for ostrich egg shell dates to run about 150 yr too early (Freundlich et al. 1989; Vogel et al. 2001). Bab edh-Dhra‘, on the Dead Sea Plain, provides one ^{14}C age (SI-2870) from a context reported originally as late Early Bronze III (Rast and Schaub 1980) then revised to Early Bronze IV (Rast and Schaub 2003). This date may be anomalously early or indicate a pre-Early Bronze IV context, as published originally. The balance of the southern Levantine Early Bronze IV ^{14}C sequences (ranging between two and five dates each) include a determination from Khirbet Iskander ~2400 cal BC, followed by subsequent ages from Nahal Refaim, Ein Ziq, and Bab edh-Dhra‘, and end with a date just after 2000 cal BC from Bab edh-Dhra‘ (SI-2875).

Beyond the southern Levant, the evidence for Early Bronze IV occupation of Tell Fadous-Kfarabida, Lebanon begins with two dates earlier than 2600 cal BC, and continues with a series of four more ages ending between 2300 and 2100 cal BC (Genz 2014; Höflmayer et al. 2014). The Early Bronze IV sequence at Tell Arqa, Lebanon, begins with a single charcoal age with a

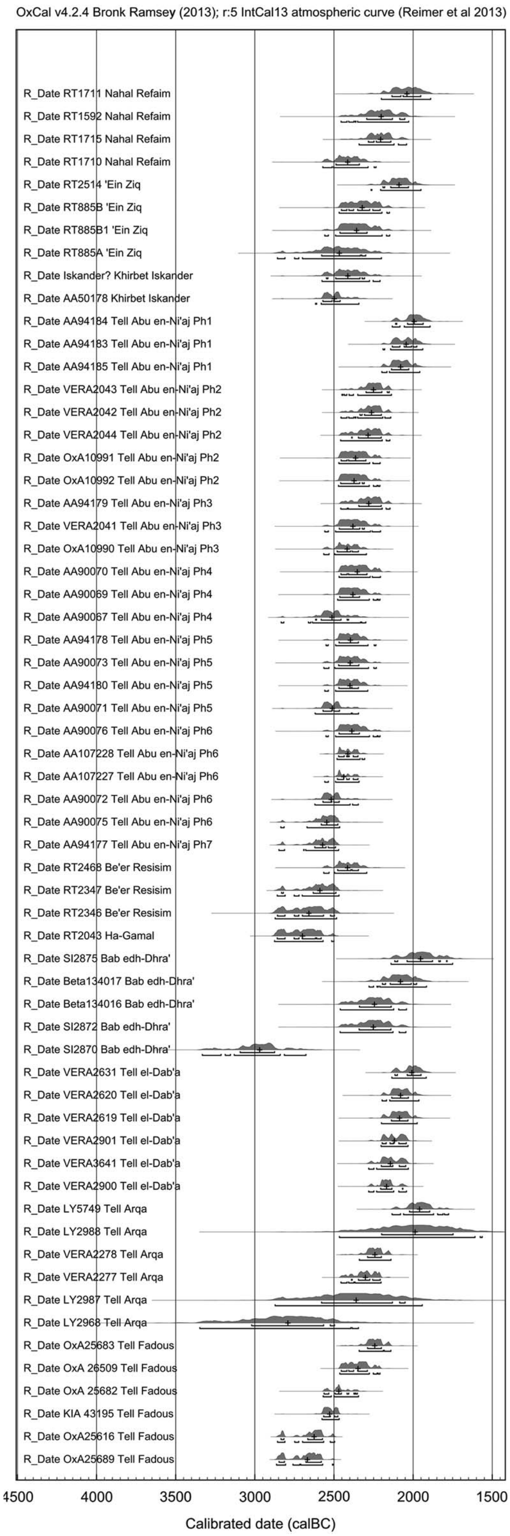

Figure 7 Single-sample calibration distributions for ^{14}C dates for seed and charcoal samples from Early Bronze IV sites in the southern Levant, Lebanon, and Tell el-Dab'a, Egypt. Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013).

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Table 4 Radiocarbon results for seed and charcoal samples from Levantine Early Bronze IV contexts (ordered by site, lab, and sample number). Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013). *No Lab number indicated.

Site name	Lab number	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context; material dated; references
Bab edh-Dhra‘	Beta-134016	3800 ± 60	2340–2139 (68.2%)	2461–2123 (88.9%) 2092–2043 (6.5%)	2245	Field XVI.4, Str I, L7; charcoal; Rast and Schaub 2003; Regev et al. 2012a
Bab edh-Dhra‘	Beta-134017	3690 ± 60	2195–2175 (6.2%) 2145–2013 (55.7%) 1999–1979 (6.3%)	2279–2251 (2.5%) 2229–2221 (0.6%) 2211–1916 (92.3%)	2081	Field XVI.1, Str I, L12; charcoal; Rast and Schaub 2003; Regev et al. 2012a
Bab edh-Dhra‘	SI-2870	4320 ± 85	3093–2876 (68.2%)	3332–3214 (9.0%) 3188–3155 (1.8%) 3131–2840 (73.9%) 2814–2678 (10.6%)	2970	Field X.3, L29; charcoal; Rast and Schaub 1980, 2003; Weinstein 1984; Regev et al. 2012a
Bab edh-Dhra‘	SI-2872	3805 ± 60	2342–2141 (68.2%)	2462–2128 (90.2%) 2089–2046 (5.2%)	2252	Field X.3, L49; charcoal; Rast and Schaub 1980, 2003; Weinstein 1984; Regev et al. 2012a
Bab edh-Dhra‘	SI-2875	3595 ± 70	2117–2098 (4.1%) 2039–1878 (61.2%) 1838–1829 (2.0%) 1790–1786 (0.8%)	2140–1751 (95.4%)	1954	Field X.3, L60; charcoal; Rast and Schaub 1980; Weinstein 1984; Regev et al. 2012a
Be’er Resisim	RT-2346	4085 ± 70	2858–2810 (13.6%) 2751–2723 (7.0%) 2700–2567 (41.2%) 2522–2498 (6.3%)	2872–2484 (95.4%)	2659	Constr 8c, Area A, L8064, B268; ostrich egg shell; Segal and Carmi 2004 Regev et al. 2012a
Be’er Resisim	RT-2347	4050 ± 50	2832–2821 (3.8%) 2632–2488 (64.4%)	2859–2809 (10.1%) 2752–2722 (3.6%) 2701–2469 (81.7%)	2590	Constr 42, Area B, L42010, B11; ostrich egg shell; Segal and Carmi 2004 Regev et al. 2012a

Ein-Ziq	RT-2514	3700 ± 45	2191–2181 (4.3%) 2142–2030 (63.9%)	2266–2261 (0.4%) 2206–1951 (95.0%)	2090	L13, B463; wood; Cohen 1999; Avner and Carmi 2001; Regev et al. 2012a
Ein-Ziq	RT-885A	3960 ± 90	2578–2333 (63.5%) 2325–2300 (4.7%)	2858–2810 (3.3%) 2750–2723 (1.3%) 2700–2201 (90.8%)	2467	L53, B282; charcoal; Cohen 1999; Avner and Carmi 2001; Regev et al. 2012a
Ein-Ziq	RT-885B	3850 ± 50	2453–2419 (11.0%) 2406–2377 (10.3%) 2351–2275 (30.6%) 2255–2209 (16.2%)	2468–2198 (93.5%) 2166–2151 (1.9%)	2322	L79, B422; charcoal; Cohen 1999; Avner and Carmi 2001; Regev et al. 2012a
Ein-Ziq	RT-885B1	3880 ± 60	2463–2292 (68.2%)	2559–2536 (1.5%) 2491–2197 (92.5%) 2169–2149 (1.4%)	2358	L79, B422; charcoal; Cohen 1999; Avner and Carmi 2001; Regev et al. 2012a
Ha-Gamal	RT-2043	4115 ± 50	2859–2810 (17.7%) 2752–2722 (10.3%) 2702–2617 (31.1%) 2610–2582 (9.0%)	2876–2570 (93.7%) 2515–2501 (1.7%)	2700	Sq M29b, L41; charcoal; Segal and Carmi 1996; Regev et al. 2012a
Khirbet Iskander	Iskander?*	3930 ± 60	2548–2539 (2.6%) 2490–2336 (61.3%) 2323–2308 (4.3%)	2576–2276 (91.7%) 2253–2210 (3.7%)	2413	Ph 2, Area C, L2030; *Olea* wood; Holdorf 2010; Regev et al. 2012a
Khirbet Iskander	AA-50178	3975 ± 43	2571–2513 (38.4%) 2503–2462 (29.8%)	2617–2610 (0.6%) 2581–2343 (94.8%)	2499	Ph 2 or 3, Area C, L2043; charcoal; Holdorf 2010; Regev et al. 2012a
Nahal Refaim	RT-1592	3775 ± 60	2294–2131 (60.2%) 2085–2053 (8.0%)	2456–2418 (2.9%) 2407–2375 (3.0%) 2367–2362 (0.3%) 2351–2029 (89.2%)	2203	L1601, B19; charcoal; Segal and Carmi 1996; Regev et al. 2012a
Nahal Refaim	RT-1710	3930 ± 50	2488–2340 (68.2%)	2571–2513 (11.3%) 2504–2285 (83.2%) 2247–2235 (0.9%)	2414	L749, B195; charcoal; Segal and Carmi 1996; Regev et al. 2012a
Nahal Refaim	RT-1711	3660 ± 60	2134–2078 (23.2%) 2064–1953 (45.0%)	2201–1890 (95.4%)	2040	L753, B245; charcoal; Segal and Carmi 1996; Regev et al. 2012a

Table 4 (*Continued*)

Site name	Lab number	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context; material dated; references
Nahal Refaim	RT-1715	3780 ± 40	2283–2248 (19.0%) 2233–2141 (49.2%)	2342–2121 (87.8%) 2094–2042 (7.6%)	2206	L748, B313; charcoal; Segal and Carmi 1996; Regev et al. 2012a
Tell Arqa	LY-2968	4205 ± 173	3021–2566 (65.5%) 2542–2497 (2.7%)	3348–2394 (94.1%) 2386–2346 (1.3%)	2792	Level 16E; charcoal; Thalmann 2006:230
Tell Arqa	LY-2987	3883 ± 169	2579–2131 (64.8%) 2086–2051 (3.4%)	2872–1943 (95.4%)	2360	Level 16D-E; charcoal; Thalmann 2006:230
Tell Arqa	LY-2988	3609 ± 164	2200–1748 (68.2%)	2466–1610 (95.0%) 1577–1564 (0.4%)	1988	Level 16D; charcoal; Thalmann 2006:230
Tell Arqa	LY-5749	3600 ± 50	2023–1896 (68.2%)	2134–2080 (7.7%) 2061–1871 (81.5%) 1846–1812 (3.6%) 1803–1777 (2.6%)	1960	Level 15A, seeds, Thalmann 2006:230
Tell Arqa	VERA-2277	3842 ± 28	2390–2386 (1.6%) 2346–2274 (42.0%) 2256–2209 (24.6%)	2456–2418 (8.4%) 2408–2375 (9.6%) 2368–2203 (77.3%)	2302	Level 16A-B; seeds; Thalmann 2006:230
Tell Arqa	VERA-2278	3804 ± 29	2288–2201 (68.2%)	2340–2141 (95.4%)	2242	Level 16A-B; seeds; Thalmann 2006:230
Tell el-Dab'a	VERA-2619	3697 ± 37	2138–2033 (68.2%)	2201–1975 (95.4%)	2087	Phase N/1; seed, *Lolium* type, Poaceae; Kutschera et al. 2012
Tell el-Dab'a	VERA-2620	3688 ± 36	2136–2030 (68.2%)	2197–2169 (6.0%) 2148–1964 (89.4%)	2080	Phase N/1; seed, *Lolium* type, Poaceae; Kutschera et al. 2012
Tell el-Dab'a	VERA-2631	3643 ± 35	2115–2100 (8.0%) 2038–1951 (60.2%)	2135–1918 (95.4%)	2009	Phase M; seeds, Cerealia, *Lolium* type; Kutschera et al. 2012
Tell el-Dab'a	VERA-2900	3755 ± 26	2206–2135 (66.9%) 2068–2065 (1.3%)	2281–2249 (8.6%) 2231–2123 (73.2%) 2091–2043 (13.6%)	2169	Phase N/2–3; seeds, *Lolium* type; Kutschera et al. 2012

Tell el-Dab'a	VERA-2901	3725 ± 30	2196–2171 (17.7%) 2147–2124 (15.6%) 2091–2044 (34.9%)	2203–2033 (95.4%)	2119	Phase N/2–3; seeds, Poaceae; Kutschera et al. 2012
Tell el-Dab'a	VERA-3641	3739 ± 38	2202–2129 (46.0%) 2088–2047 (22.2%)	2281–2249 (95.4%) 2231–2031 (89.0%)	2145	Phase N/2–3; seeds, *Lolium* type; Kutschera et al. 2012
Tell Fadous-Kfarabida	KIA-43195	3998 ± 30	2566–2524 (46.2%) 2497–2476 (22.0%)	2576–2468 (95.4%)	2528	Phase V; *Olea* seed; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	OxA-25682	3952 ± 30	2563–2534 (17.3%) 2494–2454 (39.5%) 2418–2408 (4.8%) 2375–2368 (2.8%) 2363–2353 (3.9%)	2569–2518 (22.4%) 2500–2346 (73.0%)	2470	Phase V; *Olea* seeds; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	OxA-25683	3805 ± 29	2289–2202 (68.2%) 2183–2141 (12.4%)	2341–2189 (83.0%)	2243	Phase V; *Olea* seeds; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	OxA-25689	4104 ± 29	2847–2814 (16.3%) 2678–2581 (51.9%)	2864–2806 (23.0%) 2760–2717 (11.0%) 2710–2572 (61.0%) 2510–2506 (0.4%)	2669	Phase V; *Olea* seeds; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	OxA-25616	4082 ± 29	2835–2817 (10.5%) 2666–2573 (57.7%)	2857–2811 (16.5%) 2749–2723 (3.9%) 2699–2566 (68.8%) 2524–2497 (6.2%)	2626	Phase V; *Olea* seeds; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	OxA-26509	3865 ± 31	2454–2419 (16.6%) 2407–2376 (15.9%) 2351–2290 (35.7%)	2464–2277 (87.0%) 2252–2228 (6.1%) 2222–2210 (2.4%)	2349	Phase V; Seed; Genz 2014; Höflmayer et al. 2014

relatively large standard deviation (LY-2968) that may be anomalously early or offer isolated evidence of habitation in the early 3rd millennium BC (Thalmann 2006, 2008). The remaining five ages from Tell Arqa (two charcoal and three seed dates) stretch between the late 3rd and very early 2nd millennia BC. In tandem, these two Lebanese sites suggest Early Bronze IV occupations ~2600–2000 cal BC, based on ^{14}C ages earlier in the period at Tell Fadous-Kfarabida and primarily later in the period at Tell Arqa. A set of six dates from Tell el-Dab'a, Egypt, reflects Early Bronze IV habitation in the Nile Delta at the end of the 3rd millennium BC (Kutschera et al. 2012). This comparative evidence hints at an early beginning of Early Bronze IV at Tell Fadous-Kfarabida and continues discontinuously at Tell Arqa and Tell el-Dab'a through the balance of the period.

In the southern Levant, Tell Abu en-Ni'aj provides the only detailed continuous ^{14}C record of habitation through Early Bronze IV. Bayesian modeling estimates a beginning date before 2500 cal BC, which lies among a handful of the earliest Early Bronze IV dates anywhere in the Levant or Egypt. Unlike other southern Levantine records, the Tell Abu en-Ni'aj sequence documents Early Bronze IV habitation over the ensuing 5 centuries, and ends concurrently with the latest comparative dates for the period ~2000 cal BC.

Comparative Evidence for the Beginning of the Middle Bronze Age

Tell el-Hayyat, Zahrat adh-Dhra' 1 and other key sites in the southern Levant, Egypt, and Lebanon provide ^{14}C ages for the beginning of the Middle Bronze Age, thereby defining a *terminus ante quem* for the Early Bronze/Middle Bronze transition (Table 5; Figure 8). Unlike the array of previously published dates for Early Bronze IV, these results derive primarily from seed samples with smaller uncertainties than those produced by charcoal samples. Zahrat adh-Dhra' 1, where the earliest pottery conforms with Middle Bronze I vessel typology, reveals a ^{14}C chronology starting slightly before 2000 cal BC and continuing to the mid-2nd millennium. Tell el-Hayyat Phase 5, featuring a ceramic assemblage ascribed typologically to early Middle Bronze I, contributes a series of ^{14}C ages modeled ~1900–1850 cal BC. Phase 4 at Hayyat, with ceramics dated to Middle Bronze I, provides four tightly clustered dates modeled ~1830–1800 cal BC. Elsewhere in the northern Jordan Valley, Gesher contributes a single wood date around 2000 cal BC, while a seed-based sequence from Pella running between 2000 and 1700 cal BC accords well with the dating of Hayyat Phases 5 and 4. The Hayyat and Pella ^{14}C sequences, as well as material culture and architectural forms, indicate the contemporaneity of the Phase 5 and 4 temples at Hayyat with the Phase 1 and 2 Early Mudbrick temples of Pella (Falconer and Fall 2006: 33–43; Bourke 2012).

^{14}C ages from Tell el-Ifshar and Tell Nami on the Mediterranean Coastal Plain document settlement ~1900–1800 cal BC. Comparable Middle Bronze dates early in the 2nd millennium BC derive from Tell el-Dab'a, Egypt and Tell el-Burak, Lebanon (Höflmayer et al. 2016). Two of three ^{14}C ages from Tell Fadous-Kfarabida, Lebanon (not included in Figure 8) lie very early in the 3rd millennium BC and probably indicate seeds mixed from earlier stratigraphic contexts (Höflmayer et al. 2014: 534). A later sample from Tell Fadous-Kfarabida (VERA-5420) provides a more likely Middle Bronze Age date early in the 2nd millennium BC. The latter portions of the Middle Bronze Age in the Jordan Valley are reflected in several dates from Jericho ~1700–1500 cal BC, which follow those from Hayyat and Pella. When integrated with sequences from elsewhere in the Jordan Valley, the coastal southern Levant and the Nile Delta, ^{14}C ages from Tell el-Hayyat and Zahrat adh-Dhra' 1 provide radiometric corroboration of a beginning date for the Levantine Middle Bronze Age about 2000 cal BC.

Table 5 Radiocarbon results for seed samples from Middle Bronze Age contexts in the southern Levant and Tell el-Dab'a, Egypt (ordered by site, lab, and sample number). Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013).

Site name	Lab number	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context; material dated; references
Gesher	OxA-1955	3640 ± 70	2133–2082 (16.8%) 2060–1920 (51.4%)	2205–1870 (91.5%) 1846–1811 (2.2%) 1804–1776 (1.7%)	2014	Tomb 13; wood; Hedges et al. 1990; Housely 1994; Garfinkel and Cohen 2007: 3, fig. 1.3, table 6.2
Jericho	GrN-18539	3312 ± 14	1623–1607 (24.2%) 1583–1559 (36.4%) 1553–1546 (7.6%)	1629–1596 (34.1%) 1589–1531 (61.3%)	1576	HAF.XII-XIII.1ii.1iii; *Hordeum vulgare* grains; Bruins and van der Plicht 1995, 2003; Marcus 2010
Jericho	GrN-18542	3288 ± 20	1610–1573 (34.2%) 1565–1531 (34.0%)	1616–1511 (94.5%)	1567	HAF.XII-XIII.1ii.1iii; *Triticum* sp. grains; Bruins and van der Plicht 1995, 2003; Marcus 2010
Jericho	GrN-18543	3331 ± 18	1657–1653 (3.2%) 1645–1609 (54.0%) 1578–1564 (11.1%)	1683–1672 (2.2%) 1666–1599 (68.0%) 1586–1533 (25.2%)	1621	HAF.XII-XIII.1ii.1iii; *Triticum* sp. grains; Bruins and van der Plicht 1995, 2003; Marcus 2010
Jericho	GrN-18544	3312 ± 15	1623–1607 (24.1%) 1583–1559 (36.3%) 1553–1546 (7.8%)	1630–1531 (95.4%)	1577	HAF.XII-XIII.1ii.1iii; cereal grains fragmented; Bruins and van der Plicht 1995, 2003; Marcus 2010
Jericho	GrN-19063	3240 ± 18	1530–1496 (55.6%) 1475–1461 (12.6%)	1603–1584 (6.7%) 1544–1448 (88.7%)	1508	HAF.XII-XIII.1ii.1iii; *Hordeum vulgare* grains; Bruins and van der Plicht 1995
Jericho	GrN-19064	3375 ± 25	1691–1631 (68.2%)	1741–1711 (16.1%) 1699–1618 (79.3%)	1668	HAF.XII-XIII.1ii.1iii; cereal grains fragmented; Bruins and van der Plicht 1995
Jericho	Rome-1175	3110 ± 60	1436–1289 (68.2%)	1501–1221 (95.4%)	1364	Area F, L305, Op 5a; charcoal; Lombardo and Piloto 2000
Jericho	Rome-1176	3330 ± 60	1684–1595 (41.7%) 1589–1532 (26.5%)	1753–1494 (93.7%) 1479–1456 (1.7%)	1615	Area F, L305, Op 5a; charcoal; Lombardo and Piloto 2000
Pella	OZG-611	3630 ± 40	2112–2102 (3.9%) 2036–1936 (64.3%)	2134–2081 (14.3%) 2061–1892 (81.1%)	1995	XXXIID 65.14; cereal grain; Bourke et al. 2009

Table 5 (*Continued*)

Site name	Lab number	Conventional ^{14}C age yr BP	Calibrated 1σ ranges yr BC (probability)	Calibrated 2σ ranges yr BC (probability)	Median age cal yr BC	Archaeological context; material dated; references
Pella	OZG-613	3470 ± 40	1878–1840 (22.5%) 1827–1793 (18.3%) 1784–1743 (24.6%) 1708–1702 (2.9%)	1894–1687 (95.4%)	1798	XXXIID 25.3; cereal grain; Bourke et al. 2009
Pella	OZI-640	3395 ± 50	1747–1628 (68.2%)	1877–1840 (5.8%) 1825–1795 (3.3%) 1783–1604 (82.1%) 1584–1544 (4.0%) 1538–1535 (0.2%)	1694	XXXIIF 61.5, Temple Phase 3; Bourke and Zoppi 2007
Pella	OZI-643	3390 ± 50	1744–1626 (68.2%)	1876–1841 (4.7%) 1821–1797 (2.3%) 1781–1598 (82.2%) 1587–1533 (6.2%)	1687	XXXIIZ 14.5, Temple Phase 3; Bourke and Zoppi 2007
Pella	OZJ-035	3560 ± 60	2014–1998 (4.6%) 1979–1872 (45.4%) 1845–1813 (10.4%) 1802–1777 (7.8%)	2120–2095 (2.0%) 2041–1742 (92.9%) 1709–1701 (0.5%)	1905	XXXIIW 10.3, Temple Phase 1; Bourke and Zoppi 2007
Tell el-Dab'a	VERA-2618	3593 ± 34	2011–2000 (7.5%) 1978–1902 (60.7%)	2111–2104 (0.5%) 2036–1878 (94.3%) 1838–1829 (0.7%)	1949	Phase H; seed, *Lolium* type; Kutschera et al. 2012
Tell el-Dab'a	VERA-3638	3522 ± 37	1904–1866 (22.1%) 1849–1774 (46.1%)	1946–1746 (95.4%)	1839	Phase H; seed, *Lolium* type; Kutschera et al. 2012
Tell el-Dab'a	weighted mean of VERA-3639 OxA-15951 OxA-15952	3551 ± 17	1926–1883 (68.2%)	1949–1876 (85.5%) 1843–1820 (6.6%) 1796–1781 (3.4%)	1902	Phase H; seeds, *Lolium* type; Kutschera et al. 2012

Tell el-Ifshar	OxA-5355	3550 ± 65	1973–1866 (41.9%) 1849–1773 (26.3%)	2119–2096 (1.6%) 2040–1735 (91.8%) 1717–1695 (1.9%)	1891	Phase B; *Vicia faba*; Marcus 2003
Tell el-Ifshar	OxA-5356	3485 ± 55	1885–1745 (68.2%)	1944–1665 (95.4%)	1810	Phase B/C; horse bean; Marcus 2003
Tell el-Ifshar	OxA-5357	3505 ± 55	1894 (68.2%)	1972–1689 (95.4%)	1828	Phase E; emmer wheat; Marcus 2003
Tell el-Ifshar	OxA-5358	3585 ± 55	2027–1882 (68.2%)	2131–2086 (5.2%). 2051–1766 (90.2%)	1940	Phase F/G; wheat; Marcus 2003
Tell el-Ifshar	OxA-5359	3545 ± 50	1950–1870 (40.3%) 1846–1776 (27.9%)	2023–1747 (95.4%)	1884	Phase G; horse bean; Marcus 2003
Tell Fadous-Kfarabida	OxA-25895	4132 ± 28	2860–2831 (13.6%) 2821–2808 (5.6%) 2756–2720 (32.7%) 2704–2631 (32.7%)	2872–2799 (27.5%) 2793–2787 (0.9%) 2781–2618 (64.4%) 2608–2599 (1.4%) 2594–2586 (1.1%)	2727	Phase VI; *Olea* seeds; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	VERA-5419	4070 ± 40	2836–2816 (8.2%) 2668–2566 (49.3%) 2524–2497 (10.7%)	2859–2809 (13.7%) 2752–2722 (4.6%) 2701–2486 (77.2%)	2615	Phase VI; *Olea* seed; Genz 2014; Höflmayer et al. 2014
Tell Fadous-Kfarabida	VERA-5420	3495 ± 35	1880–1771 (68.2%)	1911–1739 (92.8%)	1818	Phase VI; *Olea* seed; Genz 2014; Höflmayer et al. 2014
Tell Nami	OxA-4532	3560 ± 60	2014–1998 (4.6%) 1979–1872 (45.4%) 1845–1813 (10.4%) 1802–1777 (7.8%)	2120–2095 (2.0%) 2041–1742 (92.9%) 1709–1701 (0.5%)	1905	End of first MBIIA phase; horse bean; Marcus 2003
Tell Nami	OxA-4534	3495 ± 65	1898–1742 (65.4%) 1710–1700 (2.8%)	2111–2000 (0.8%) 1978–1660 (94.6%)	1820	Second MBIIA phase; horse bean; Marcus 2003
Tell Nami	OxA-4536	3460 ± 60	1879–1838 (17.6%) 1830–1734 (40.5%) 1718–1694 (10.1%)	1923–1630 (95.4%)	1781	Final MBIIA destruction; *Lathyrus clymenum*; Marcus 2003

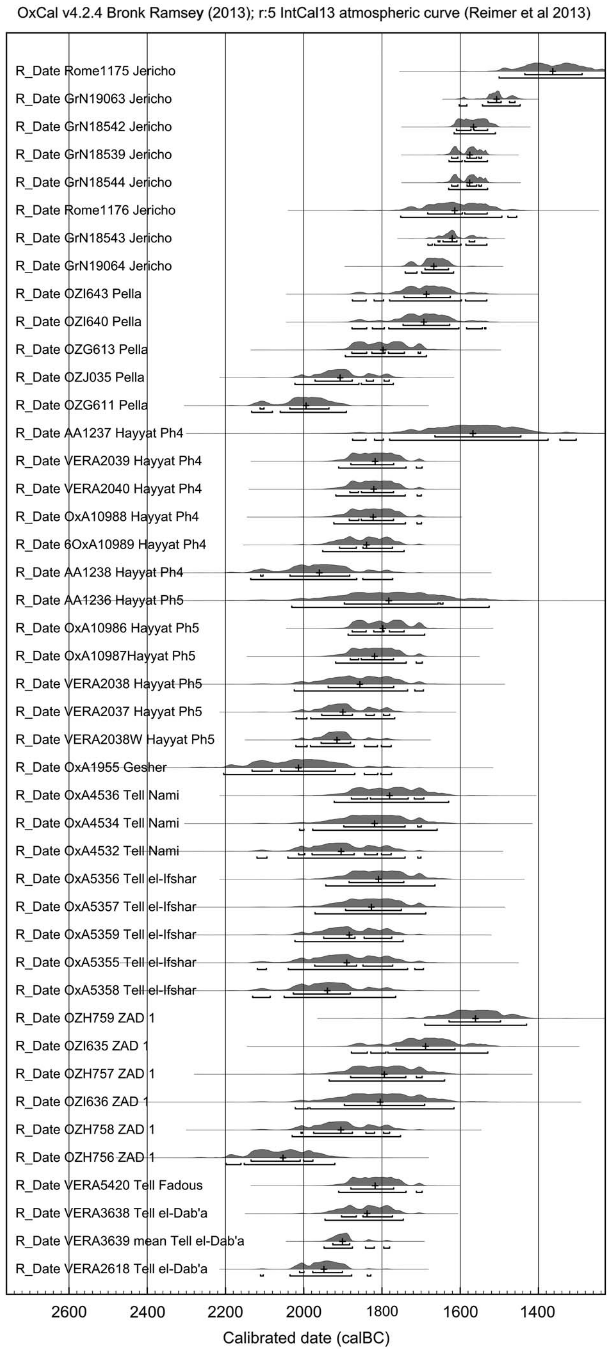

Figure 8 Single-sample calibration distributions for ^{14}C dates for seed and charcoal samples from Middle Bronze Age sites in the southern Levant, Tell Fadous-Kfarabida, Lebanon, and Tell el-Dab'a, Egypt. Outlying dates OxA-25895 and VERA-5419 (Tell Fadous-Kfarabida) and AA-1239 (Tell el-Hayyat) omitted. Calibration based on OxCal v 4.2.4 (Bronk Ramsey and Lee 2013) using the IntCal13 atmospheric curve (Reimer et al. 2013).

DISCUSSION

A variety of studies (e.g. Bruins and van der Plicht 2001; Golani and Segal 2002; Braun and Gophna 2004; Philip 2008; Bourke et al. 2009; Regev et al. 2012a, 2012b; Höflmayer et al. 2014) now infer from radiometric data that the development of Levantine town life in Early Bronze II–III unfolded significantly earlier than suggested in previous literature. This growing revision features a radical repositioning of the end of Early Bronze III approximately 300 yr earlier than established in traditional chronologies. The date for this juncture has remained somewhat fluid, and a comparable revision of Early Bronze IV chronology has remained elusive, for several reasons. For example, predominance of charcoal dates and their relatively larger errors and, in the case of Be'er Resisim, shell dates with an added factor of uncertainty, have made greater resolution of Early Bronze IV chronology particularly challenging.

More fundamentally, however, the southern Levant includes only a limited number of excavated sites with radiometrically dated Early Bronze III/IV sequences and a near absence of stratified evidence spanning the Early Bronze IV/Middle Bronze transition. Both of these factors reflect the characteristic that most Early Bronze IV sites represent cemeteries, seasonal encampments, or discontinuous settlements that rarely persist through the period. Important village sites, such as Tell Iktanu (Prag 1986, 2001) and Tell Umm Hammad (Helms 1986; Kennedy 2015), as well as reduced Early Bronze IV habitation at a few major tells (e.g. Hazor, Megiddo; Bechar 2013), remain undated radiometrically. Bab edh-Dhra' and Khirbet Iskander provide unusual examples of sedentary communities occupied in both Early Bronze III and IV. However, each provides a limited number of ages, which date early in Early Bronze IV at Khirbet Iskander and late at Bab edh-Dhra' (if we exclude SI-2870 as an anomaly). In a similar fashion, the charcoal dates from Nahal Refaim and Ein Ziq estimate Early Bronze IV occupation primarily early at Ein-Ziq and later in the period at Nahal Refaim.

Farther afield, Tell Fadous-Kfarabida (Phase VI) provides ^{14}C ages beginning early in Early Bronze IV based on seeds quite possibly mixed from earlier stratigraphic contexts (Höflmayer et al. 2014:533–4). The evidence from Tell Arqa, Lebanon, includes three charcoal dates with particularly large uncertainties, one of which lies anomalously early in the 3rd millennium, and three seed dates that provide better resolution for the latter portion of Early Bronze IV. Thus, a revised date for the beginning of Early Bronze IV remains inferred largely from new dates for the end of Early Bronze III, rather than from Early Bronze IV sites with lengthy dated sequences stretching between the beginning and end of this period.

For the purpose of dating the close of Early Bronze IV, Tell el-Dab'a, Egypt, provides ^{14}C ages that bracket the Early Bronze IV/Middle Bronze Age transition (Kutschera et al. 2012). In this case, seed dates from multiple excavation locales at the tell may be coordinated to chart Early Bronze IV occupation at the end of the 3rd millennium BC and Middle Bronze Age habitation beginning early in the 2nd millennium. When viewed jointly, these ages frame an Early Bronze IV/Middle Bronze Age transition around 2000 cal BC in the Nile Delta. Farther toward the interior of Syria, the excavated stratigraphy at Tell Mishrifeh spans the end of Early Bronze IV and the beginning of the Middle Bronze Age. Material culture and seven ^{14}C ages from Phases 25–17 (including six charcoal dates) suggest a less distinctly defined transition again about 2000 cal BC (Bonacossi 2008). Strikingly, the southern Levant has provided no comparable example, thus far, of stratified Early Bronze IV ages that can be coupled with ^{14}C evidence for the beginning of the subsequent Middle Bronze Age.

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Unlike any other radiometrically dated site in the southern Levant, the ^{14}C sequence from Tell Abu en-Niʿaj, however, can be associated with stratified ^{14}C evidence dating early in the Middle Bronze Age, in this case from the nearby village of Tell el-Hayyat. Early dates from Hayyat reveal Middle Bronze I occupation starting ~1900 cal BC, while those from Pella and Gesher to the north, as well as from ZAD 1 to the south provide earlier Middle Bronze dates around 2000 cal BC. The Middle Bronze ^{14}C sequences at Tell el-Ifshar and Tell Nami on the Coastal Plain and Jericho in the Jordan Valley commence subsequently in the early 2nd millennium BC. This body of evidence, particularly the ages from Tell el-Hayyat, Zahrat adh-Dhraʿ 1, and Pella, provides a key link between the end of the Tell Abu en-Niʿaj sequence and the immediately subsequent beginning of the Middle Bronze Age.

Most importantly, Tell Abu en-Niʿaj provides the first example from the southern Levant of a deeply stratified, multiphase agrarian village that was occupied continuously through Early Bronze IV. The lengthy ^{14}C sequence from Tell Abu en-Niʿaj addresses both chronological ends of Early Bronze IV over the course of 22 AMS seed dates modeled through seven stratigraphic phases. Bayesian modeling calculates the beginning of this sequence ~2550 cal BC. A series of five phases (Niʿaj Phases 7–3) ranging between ~35 and 55 yr each are modeled to ~2330 cal BC (as suggested by the modeled Phase 3/2 boundary), followed by two phases (Niʿaj Phases 2–1) that continue to the apparent at the end of Early Bronze IV just before 2000 cal BC.

CONCLUSIONS

Bayesian modeling of a detailed stratified sequence of ^{14}C ages from Tell Abu en-Niʿaj, Jordan, indicates occupation over the course of the Early Bronze IV period beginning between 2600 and 2500 cal BC and continuing to just before 2000 cal BC. Thus, Tell Abu en-Niʿaj provides the longest, most finely detailed ^{14}C sequence of Early Bronze IV occupation in the southern Levant. The modeled dates for the beginning of this sequence align well with recent ^{14}C-based revision of the end of Early Bronze III (e.g. Regev et al. 2012a). When compared with Early Bronze Age sites across the southern Levant, Egypt, and Lebanon, the evidence from Tell Abu en-Niʿaj pushes the beginning of Early Bronze IV 50–100 yr earlier than suggested by recent literature. In conjunction with early dates in the Middle Bronze Age from nearby Tell el-Hayyat and Pella in the Jordan Valley, and from Zahrat adh-Dhraʿ 1 by the Dead Sea, the Tell Abu en-Niʿaj sequence continues through Early Bronze IV, ending ~2000 cal BC. This evidence from Tell Abu en-Niʿaj augments the current trend of adjusting the constituent periods of the Levantine Early Bronze Age significantly earlier than suggested by traditional chronologies, while linking the end of Early Bronze IV with the beginning of the Middle Bronze Age ~2000 cal BC.

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