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# BAYESIAN MODELING OF A PERIPHERAL MIDDLE BRONZE AGE SETTLEMENT AT ZAHRAT ADH-DHRA' 1, JORDAN

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**ABSTRACT.** Analysis of 20 calibrated accelerator mass spectrometry radiocarbon (AMS $^{14}C$) ages reveals a chronology for the habitation of a unique peripheral settlement at Zahrat adh-Dhra' 1 (ZAD 1), Jordan during the Middle Bronze Age of the Southern Levant. Bayesian modeling distinguishes three phases of occupation between the first settlement at ZAD 1, perhaps as early as about 2050 cal BCE, and its abandonment by 1700 cal BCE. ZAD 1 represents a marginal community, both environmentally and culturally, on the hyperarid Dead Sea Plain, and exemplifies the peripheral settlements that are envisioned as important elements of Bronze Age Levantine society. Most importantly for this study, it is the only peripheral site in the Southern Levant that provides a Bayesian model for its habitation during the growth of Middle Bronze Age urbanized society. The timing of ZAD 1's constituent phases, early in Middle Bronze I, across the Middle Bronze I/II transition and in Middle Bronze II, correspond well with emerging chronologies for the Middle Bronze Age, thereby contributing to an ongoing reassessment of regional social and settlement dynamics.

**KEYWORDS:** AMS chronology, Bayesian modeling, Bronze Age Southern Levant, Dead Sea Plain, peripheral settlement.

## INTRODUCTION

The Southern Levant's Early and Middle Bronze Age populations witnessed the rise, abandonment, and rejuvenation of fortified towns atop this region's mounded tells. Levantine archaeological syntheses historically have characterized this roughly two-millennium era in terms of urban growth and recession (e.g., Cohen 2014; de Miroschedji 2014; Greenberg 2019; cf. Falconer 1994; Chesson and Philip 2003; Savage et al. 2007). Many Bronze Age communities may be considered "peripheral" by virtue of their small populations and distant locations (geographically and/or politically) from larger "centers" (e.g., see discussions in Mohr and Thompson 2023). Despite long-standing recognition of the importance of peripheral communities in early urbanized societies (e.g., Rowlands et al. 1987; Champion 1996; Maeir et al. 2003; Haour 2013; Cohen 2022), marginal settlements in the Southern Levant have not received the detailed chronometric attention that would improve their integration into Bronze Age social reconstructions. Bayesian analysis of a newly-expanded suite of calibrated AMS ages from Zahrat adh-Dhra' 1 (ZAD 1), Jordan documents this settlement's occupational history, thereby providing a detailed chronology for a unique peripheral Middle Bronze Age community amid the urbanization that has otherwise attracted the focus of archaeological attention (Figure 1). We also correlate the habitation at ZAD 1 with ongoing revisions to regional Middle Bronze Age chronology as an example of how such settlements may be integrated in larger chronometric interpretations of marginal, as well as central, components of ancient Levantine complex societies.

The pottery excavated from ZAD 1 conforms with typological parallels from the Levantine Middle Bronze Age, with no material culture evidence indicative of earlier or subsequent

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Figure 1 Map of eastern Mediterranean showing Zahrat adh-Dhra' 1, Zahrat adh-Dhra' 2, Dhra' and Bab edh-Dhra' on the Dead Sea Plain, Jordan, plus key sites that contribute radiocarbon ages for Levantine Bronze Age chronologies.

periods. More specifically, stylistic distinctions between pottery in lower and upper stratified levels indicated phases of occupation in Middle Bronze I and II (Falconer in Edwards et al. 2002a; Berelov 2006a:92, 2006b; Fall et al. 2007). Spatial analysis of pottery deposition also suggested multiple phases of occupation in which some structures (e.g., at the northwestern end

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Table 1 Traditional and revised Early and Middle Bronze Age chronologies for the Southern Levant. (Traditional chronology based on Dever 1992; Levy 1995: fig. 3; revised chronology based on Regev et al. 2012; Fall et al. 2021; Höflmayer and Manning 2022.)

| Period | Traditional (B.C.) | Revised (cal BCE) |
|---|---|---|
| MB III | 1650–1500 | 1700–1600 |
| MB II | 1800–1650 | 1850/1800–1700 |
| MB I | 2000–1800 | 2000/1950–1850/1800 |
| EB IV | 2200–2000 | 2500–2000/1950 |
| EB III | 2700–2200 | 2900–2500 |
| EB II | 3000–2700 | 3000–2900 |
| EB I | 3500–3000 | 3500–3000 |

of ZAD 1) were occupied in Middle Bronze I, while others across the site were occupied in Middle Bronze I and II (Berelov 2006a, 2006b; Fall et al. 2007).

Over the last two decades, Southern Levantine Bronze Age chronology has experienced significant revision with the emergence of a radiocarbon-based "High Chronology" (e.g., Regev et al. 2012; Höflmayer and Manning 2022; Fall et al. 2022), which features repositioned subdivisions for the Early, Middle, and Late Bronze Ages, and offers the opportunity to build regional chronologies and societal interpretations independent of assumed interregional historical correlations (Table 1). Until recently, both the timing and explanation of Southern Levantine Bronze Age urban dynamics have been derived from the "export" of Egyptian dynastic chronology (Bietak 2013:81), especially as derived from Tell el-Dab'a (Bietak and Höflmayer 2007; Höflmayer and Manning 2022). In the Northern Levant, Bronze Age chronologies have been influenced analogously by rich textual evidence, especially from Kültepe, Turkey and Mari, Syria (e.g., Barjamovic et al. 2012; Sasson 2015), and by dynastic sequences from the Hittite Old Kingdom and Mesopotamia's Old Babylonian Period (e.g., Pruzsinszky 2009; Roaf 2012).

In the Southern Levant, an era of town abandonment in Early Bronze IV has been both correlated with and attributed to Egyptian political disintegration during the First Intermediate Period, ca. 2200–2000 BCE (e.g., Dever 1992:2; Sharon 2014:52). Following a step-by-step historical rationale, the subsequent renewal of Southern Levantine town life in the Middle Bronze Age (starting about 2000 BCE) has been associated with the improved political and economic milieu of the Egyptian 12th Dynasty (linked to Middle Bronze I) and 13th Dynasty (paralleling Middle Bronze II) (e.g., Bietak 1991; Dever 1992; Sharon 2014:54). In turn, the end of the Middle Bronze Age has been attributed to the disruptions associated with Egypt's 18th Dynasty ca. 1550–1500 BCE (Mumford 2014). These synchronisms stem traditionally from seriation of Levantine pottery excavated from Tell el-Dab'a (ancient Avaris) in the Nile Delta (e.g., Bietak 1991), chronologically diagnostic Egyptian artifacts (e.g., scarab stamp seals) excavated from stratified Southern Levantine sites (e.g., Weinstein 1992), and from the chronological correlation of major periods of socio-political fragmentation and coherence in Egypt in tandem with those in the Southern Levant (Mumford 2014; Sharon 2014).

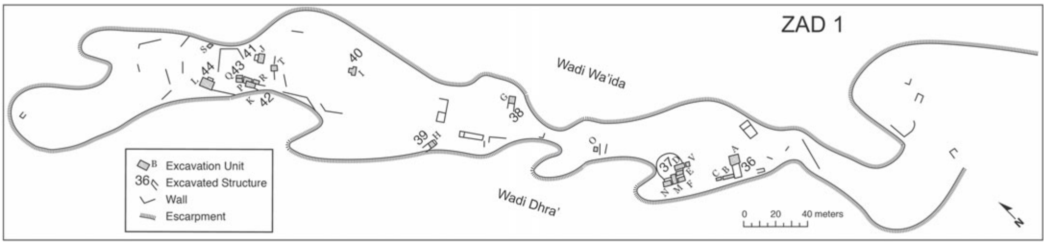


Figure 2 Site plan of Zahrat adh-Dhra‘ 1, Jordan, showing visible wall lines, enumerated structures and lettered excavation units.

An ever-growing body of radiocarbon analysis (e.g., Regev et al. 2012, 2019; Höflmayer 2021; Höflmayer et al. 2014, 2016a, 2016b) has transformed Southern Levantine Bronze Age chronology by disarticulating it from Egyptian dynastic history. Among its most significant changes, the recession of town life in Early Bronze IV now stretches over a half-millennium or more (Höflmayer et al. 2014; Regev et al. 2012; Lev et al. 2021; Fall et al. 2021, 2022), rivaling the lengths of the urbanized Early Bronze II/III and Middle Bronze eras, and thereby drawing attention to the chronometric investigation of non-urban settlements in the ancient Southern Levant. Likewise, these studies show that the constituent subperiods of the Middle Bronze Age no longer coincide with the convenient dynastic alignments of the Egyptian Middle Kingdom. In the context of this newly-independent interpretation of Levantine chronology and society, our Bayesian modeling of radiocarbon ages elucidates the habitation of ZAD 1, a unique peripheral Middle Bronze Age settlement, in conjunction with this era’s revised regional chronology.

### Archaeological Setting of Zahrat adh-Dhra‘ 1 (ZAD 1)

The ancient settlement of ZAD 1 lies at about –180 msl on the hyperarid Plain of Dhra‘, a highly eroded landscape perched above the eastern shore of the Dead Sea (−410 msl). ZAD 1 is marked by more than 40 semi-subterranean rectangular stone structures varying from single wall remnants to multiple room compounds with adjoining enclosure walls (Fall et al. 2019). The archaeological features of ZAD 1 cover about 6 ha along a narrow 600-m-long ridge bounded by the Wadi Dhra‘ and Wadi Wa‘ida (Figure 2), two spring-fed tributaries of the Wadi Kerak, which flows west from the Transjordanian Plateau to the Dead Sea. Truncated structural walls along the southwestern edge of this ridge, as well as 200 meters across the Wadi Dhra‘, suggest that ZAD 1 originally extended over roughly 12 ha prior to stream down cutting. Three earlier sedentary agrarian settlements on the Plain of Dhra‘ attest to the presence of springs on the Dead Sea Plain: Pre-Pottery Neolithic A Dhra‘, upslope near the spring of ‘Ain Dhra‘ (Kuijt and Mahasneh 1998), PPNA Zahrat adh-Dhra‘ 2, just east of Zahrat adh-Dhra‘ 1 (Edwards et al. 2001, 2002b; Edwards and House 2007), and Early Bronze Age Bab edh-Dhra‘, about 4 km downstream along the Wadi Kerak (Rast and Schaub 2003). For example, the remains of freshwater mollusks (*Melanopsis praemorsa*) were excavated from Zahrat adh-Dhra‘ 2 (Edwards et al. 2001, 2002b). During the Middle Bronze Age, local wadis similarly would have flowed at or near the plain level of ZAD 1, as indicated by ubiquitous evidence of hydrophilic wild sedges (Cyperaceae) recovered in flotation samples (Fall et al. 2019). Freshwater mollusks at the PPNA site of ZAD 2 and an abundance of sedges at Middle Bronze Age ZAD 1 both suggest the presence of springs on the Plain of Dhra‘ between about 9000 and 2000 cal BCE. The lack of subsequent Late Bronze or Iron Age sites on the Plain of

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Figure 3 Photo of Wadi adh-Dhra', Jordan showing Zahrat adh-Dhra' 1 illuminated at top of photo and down cutting of wadi; see crew member crossing wadi bed at bottom of photo.

Dhra' and the presence of Middle Bronze Age structures at ZAD 1 on both sides of the Wadi Dhra' suggests that wadi downcutting occurred during or immediately following the Middle Bronze Age occupation of ZAD 1 and may have forced its abandonment (Figure 3). Wadi incision on the Plain of Dhra' could have resulted from long-term lowering of the Dead Sea in the mid-Holocene (Frumkin et al. 2001; Bookman (Ken-Tor) et al. 2004; Migowski et al. 2006; Torfstein et al. 2013; Neugebauer et al. 2014; Guillerm et al. 2023).

Chronologically diagnostic pottery from ZAD 1 includes vessel forms most closely paralleled in Middle Bronze I and II assemblages from sites across the Southern Levant (see discussions in Falconer in Edwards et al. 2002a; Berelov 2006a:92, 2006b; Fall et al. 2007). The ZAD 1 ceramics also have a dearth of transitional Early Bronze IV/Middle Bronze I forms (e.g., as seen in Tell el-Hayyat Phase 5; Falconer and Fall 2006:46–49) and lacks several hallmark Middle Bronze III types altogether (e.g., ovoid cooking pots, highly profiled jar and bowl rims, high-footed bowls or chalices; also seen in Tell el-Hayyat Phases 2 and 1; Falconer and Fall 2006:56–60). These factors led to an original estimation of occupation between mid-Middle Bronze I and mid-Middle Bronze II (Falconer in Edwards et al. 2002a; Berelov 2006b).

Analysis of excavated plant remains and animal bones provides a portrait of lifeways and landscape at ZAD 1. Charcoal evidence shows that the settlement's occupants relied on fuel wood from desert and riparian trees (e.g., *Acacia* spp. and *Tamarix* spp.), complemented with

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dung fuel from animals browsing on wild and domesticated plants (Klinge and Fall 2010). A modest faunal assemblage reflects sheep/goat husbandry, based on 323 bone specimens, of which 30 of 31 identifiable elements represent domestic sheep (*Ovis aries*) or goat (*Capra hircus*), while one identifiable bone comes from a domestic pig (*Sus scrofa*) (Metzger in Edwards et al. 2001; Fall et al. 2007; Fall et al. 2019). The seed evidence reveals more abundant deposition of barley than wheat, suggesting arid-adapted cereal cultivation, while the presence of figs and grapes and a lack of olive form a crop combination more common at marginal agrarian settlements elsewhere in the Levant (Fall et al. 2002, 2019). Highly variable ubiquities among both cultivated and wild plant taxa, and increasingly sporadic seed deposition across structures and through time attests to habitation by small numbers of scattered households practicing non-intensive irrigated agriculture in an isolated, extremely dry environment where inhabitants exploited desert and riparian trees and utilized water from local springs. In overview, the botanical and environmental evidence from ZAD 1, combined with its rectilinear semi-subterranean structures and decidedly marginal setting, make this settlement a unique example of a peripheral agrarian community on the verge of urbanized Southern Levantine Middle Bronze Age society.

## METHODS

During winter 1999/2000, excavation of 24 units sampled the interiors, exteriors, and enclosures associated with nine structures (Structures 36–44) (Falconer in Edwards et al. 2001). Material culture and organic remains were recovered primarily from interior deposits consisting of upper and lower stratified sediment layers. In some cases, these sediments were separated clearly into earlier and later layers by thin lenses of fine-grained aeolian sediment (Falconer in Edwards et al. 2001), which may have been deposited in single- to multiple-season episodes. The interior concentration of trash deposits (including restorable whole vessels) and the apparent absence of exterior middens, despite the excavation of promising midden locations (e.g., units O, S, and T), suggest occupation by small populations who periodically inhabited and vacated these structures, leaving interior trash behind (Schiffer 1985; Wilson 1994).

All archaeological sediments with visible burned organic remains were processed by non-mechanized water flotation to recover plant macrofossils (Fall et al. 2019). Each flotation sample received a unique spatial identifier consisting of a structure number, an excavation area, a locus number associated with a three-dimensional archaeological feature, and a bag number. All plant remains larger than 0.25 mm were sorted using a binocular microscope at 6–40× magnification and were identified on the basis of reference material and published keys in accordance with established methods of archaeobotanical recovery and analysis (Fall et al. 2019; Porson et al. 2021).

Twenty-two seed samples recovered from seven structures at ZAD 1 were selected for AMS analysis by the University of Arizona Accelerator Mass Spectrometry Laboratory, the University of Georgia Center for Applied Isotope Studies, and the Australian Institute of Nuclear Science in the Australian Nuclear Science and Technology Organisation (ANSTO) (Table 2). These seeds were pretreated prior to analysis with an acid/alkali/acid protocol. The uncalibrated radiocarbon age for each sample is indicated in radiocarbon years BP based on the $^{14}C$ half-life of 5568 years. The error for each uncalibrated date is shown as one standard deviation and reflects both statistical and experimental errors. These dates have been corrected for isotope fractionation using $\delta^{13}C$ values.

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Table 2 Seed samples from Zahrat adh-Dhra‘ 1, Jordan submitted for radiocarbon analyses. Excavation context shown according to Excavation Unit, Locus and Bag, (e.g., A.012.41 = Unit A, Locus 012, Bag 41).

| # | Lab number | Phase; structure; sediment layer; context | Taxa dated |
|---|---|---|---|
| 22 | OZH-759 | 0; 37; upper; N.012.37 | *Hordeum, Vitis, Pisum* |
| 21 | OZI-635 | 2; 42; upper; K.019.117 | *Hordeum* |
| 20 | UGAMS-51993 | 2; 44; upper; L.006.35 | *Cerealia* frags. |
| 19 | AA-109799 | 2; 41; upper; J.014.30 | *Vitis* |
| 18 | UGAMS-51989 | 2; 37; upper; E.003.62 | *Vicia faba* |
| 17 | AA-110724 | 2; 36; upper; A.010.41 | *Triticum* frags. |
| 16 | AA-109802 | 2; 44; upper; L.010.10 | *Hordeum* |
| 15 | OZI-636 | 2; 42; upper; K.014.177 | *Hordeum* |
| 14 | OZH-757 | 3; 40; lower; I.014.98 | *Vitis* |
| 13 | AA-110727 | 3; 44; lower; L.012.23 | *Cerealia* frags. |
| 12 | UGAMS-48550 | 3; 41; lower; J.030.107 | *Vitis* |
| 11 | UGAMS-51995 | 3; 44; lower; L.023.99 | *Hordeum vulgare* & *Cerealia* |
| 10 | UGAMS-51996 | 3; 37; lower; M.012.82 | *Ornithogalum* & Cerealia |
| 9 | UGAMS-51991 | 3; 40; lower; I.011.67 | *Cerealia* frags. |
| 8 | UGAMS-51992 | 3; 40; lower; I.014.86 | *Cerealia* frags. |
| 7 | AA-110726 | 3; 42; lower; K.020.126 & K.022.202 | *Cerealia* frags. |
| 6 | AA-110725 | 3; 36; lower; A.012.72 | *Cerealia* frags. |
| 5 | AA-109798 | 3; 39; lower; H.007.28 | *Cerealia* frags. |
| 4 | OZH-758 | 4; 37; lower; F.015.98 | *Vitis* |
| 3 | UGAMS-48549 | 4; 37; lower; E.010.46 | *Hordeum nudum* |
| 2 | OZH-756 | 4; 40; lower; I.012.72 | *Hordeum* |
| 1 | AA-109800 | 0; 41; lower: J.031.113 | *Triticum* |

The AMS samples from ZAD 1 were grouped into three phases based on *a priori* stratigraphic information (see Berelov 2006a:23–53; Fall et al. 2019). The seven structures that provide these ages have stratigraphically defined upper and lower sedimentary layers according to which seven samples from upper layers were grouped into Phase 2, and 10 samples from lower layers were grouped in Phase 3. Structures 37 and 40 had additional, lowermost sedimentary layers that provided three samples from basal earthen floors (Falconer in Edwards et al. 2001; Berelov 2006a:26, 35) that were grouped in Phase 4. Phases 4–2, which were defined *a priori* by stratigraphy and its associated ceramic typology in our previous chronological modeling of ZAD 1 (Fall et al. 2019), also included an anomalously late AMS age from a disturbed context (OZH-759), which we designated originally as Phase 1 (see discussion in Supplementary Material).

The radiocarbon ages from ZAD 1 were calibrated using OxCal 4.4.4 (Bronk Ramsey 2009) and the IntCal20 atmospheric curve (Reimer et al. 2020; van der Plicht et al. 2020). OxCal 4.4.4 also was used for Bayesian modeling of the calibrated dates. Bayesian analysis accommodates the non-normally distributed probabilities of calibrated $^{14}$C ages and enables probabilistic modeling of calibrated $^{14}$C determinations using prior stratigraphic information (Bronk Ramsey 2009). Agreement values (A, $A_{model}$) provide a means of assessing the reliability of the individual calibrated ages in Bayesian models and the quality of overall models. Values of A calculate the likelihood of overlap of the non-modeled distribution for each calibrated age with its posterior Bayesian modeled distribution. Values of A > 60 approximate values of $p < 0.05$

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for a $\chi^2$ significance test (Manning 2013:496, fig. A5), and values of $A_{model} > 60$ identify statistically robust Bayesian models. The radiocarbon ages from ZAD 1 were organized for modeling using the "Phase" function in Oxcal, in which each phase consists of a group of unordered events. The "Difference" function in Oxcal was used to assess the statistical probability of gaps between phases.

## RESULTS

A suite of 22 calibrated AMS radiocarbon seed ages from ZAD 1 was considered for Bayesian modeling of site occupation (Table 3). Our preferred model incorporates 20 ages in three sequential phases of occupation and excludes two additional ages ($A_{model}$=101.9; Figure 4). This model groups these ages in sequential phases since they come from non-contiguous strata in varying combinations of seven distinct structures through time. We do not assume that these phases of occupation equate from start to finish between structures. Rather, we envision these phases as chronological windows within which varying combinations of structures were inhabited during each phase. Further, our three-phase model produces more parsimonious results than those from alternative one-phase or two-phase models, which make less effective use of this prior stratigraphic information. (Alternative phasing schemes are presented in Supplementary Figures 1–3, and their results are summarized in Supplementary Table 1.)

Phase 4, which documents the earliest phase of occupation at ZAD 1, is indicated by three samples from two structures (Table 4) whose modeled 2σ distributions lie between about 2100 and 1900 cal BCE. Modeled boundary 1σ distributions frame this phase between about 2050 and 1900 cal BCE. The modeled boundaries for the end of Phase 4 and the start of Phase 3 indicate a gap between these phases at the 1σ confidence level (e.g., as shown by their disjunct 1σ probability distributions and by the "Difference" function in Oxcal).

Phase 3 is characterized by a set of 10 AMS ages from seven structures with 1σ and 2σ modeled distributions ranging from just after 1900 to just after 1800 cal BCE. These remarkably consistent modeling results suggest a well-defined phase of settlement during the 19th century cal BCE. Our model does not reveal a gap between Phases 3 and 2, as shown by overlapping 1σ and 2σ probability distributions for the modeled boundaries at the end of Phase 3 and the start of Phase 2. Phase 2 at ZAD 1 is represented by another consistent sequence of seven modeled dates from five structures, in this case suggesting settlement in the early 18th century BCE, based on 1σ probability distributions between about 1790 and 1740 cal BCE. Phase 2 is estimated to conclude by 1700 cal BCE, as shown by the 2σ probability distribution for its end boundary.

In sum, our 20-age Bayesian model for ZAD 1 commences with three ages from lower sediments in two structures suggesting occupation in Phase 4 most likely between about 2050 and 1950 cal BCE. Phase 3 signals occupation probably within the 19th century cal BCE based on 10 calibrated ages from lower sediments in all seven sampled structures. In Phase 2, seven ages from upper sediments in five structures provide particularly focused evidence for settlement in the early to mid-18th century cal BCE, prior to the apparent abandonment of ZAD 1 by about 1700 cal BCE.

## DISCUSSION

Our new Bayesian analysis of calibrated AMS ages from ZAD 1 (a) revises and clarifies the chronology for the occupation of ZAD 1 within the Middle Bronze Age, (b) provides the only

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Table 3 Unmodeled and modeled calibrated AMS radiocarbon seed ages from Zahrat adh-Dhra‘ 1, Jordan. Uncalibrated $^{14}C$ ages are indicated in BP with their 1σ uncertainty. Calibration based on OxCal 4.4.4 (Bronk Ramsey 2009, 2017) using the IntCal20 atmospheric curve (Reimer et al. 2020; van der Plicht et al. 2020). Stratigraphic phases at Zahrat adh-Dhra‘ 1 run from Phase 4 (the earliest phase) to Phase 2 (the latest phase). Samples are tabulated by phase and ordered chronologically according to conventional $^{14}C$ age within each phase.

| # | Lab number | $^{14}C$ age BP | 1σ range cal BCE | 2σ range cal BCE | Modeled 1σ range cal BCE | Modeled 2σ range cal BCE |
|---|---|---|---|---|---|---|
| 22 | OZH-759 | 3260±60 | 1612–1453 | 1686–1417 | | |
| 21 | OZI-635 | 3410±60 | 1867–1620 | 1881–1540 | 1861–1742 | 1871–1730 |
| 20 | UGAMS-51993 | 3430±21 | 1862–1689 | 1873–1634 | 1858–1740 | 1871–1729 |
| 19 | AA-109799 | 3475±24 | 1875–1746 | 1882–1699 | 1780–1744 | 1870–1741 |
| 18 | UGAMS-51989 | 3480±21 | 1876–1750 | 1883–1742 | 1781–1745 | 1870–1742 |
| 17 | AA-110724 | 3489±21 | 1879–1767 | 1884–1746 | 1783–1745 | 1869–1743 |
| 16 | AA-109802 | 3500±24 | 1882–1772 | 1891–1745 | 1786–1745 | 1869–1743 |
| 15 | OZI-636 | 3500±80 | 1932–1696 | 2110–1614 | 1859–1743 | 1871–1736 |
| 14 | OZH-757 | 3450±60 | 1879–1687 | 1931–1612 | 1881–1792 | 1884–1782 |
| 13 | AA-110727 | 3468±21 | 1874–1744 | 1881–1696 | 1880–1796 | 1882–1779 |
| 12 | UGAMS-48550 | 3490±20 | 1879–1768 | 1883–1747 | 1880–1795 | 1884–1777 |
| 11 | UGAMS-51995 | 3490±21 | 1879–1768 | 1884–1746 | 1880–1795 | 1884–1778 |
| 10 | UGAMS-51996 | 3490±21 | 1879–1768 | 1884–1746 | 1880–1795 | 1884–1778 |
| 9 | UGAMS-51991 | 3500±21 | 1881–1772 | 1887–1749 | 1881–1794 | 1885–1776 |
| 8 | UGAMS-51992 | 3500±21 | 1881–1772 | 1887–1749 | 1881–1794 | 1885–1776 |
| 7 | AA-110726 | 3503±21 | 1881–1774 | 1890–1748 | 1881–1794 | 1885–1777 |
| 6 | AA-110725 | 3527±21 | 1896–1776 | 1933–1769 | 1882–1791 | 1888–1776 |
| 5 | AA-109798 | 3528±22 | 1898–1776 | 1936–1768 | 1882–1791 | 1888–1776 |
| 4 | OZH-758 | 3580±50 | 2022–1831 | 2127–1768 | 2021–1946 | 2042–1891 |
| 3 | UGAMS-48549 | 3660±20 | 2127–1978 | 2135–1953 | 2032–1956 | 2119–1941 |
| 2 | OZH-756 | 3670±60 | 2138–1961 | 2268–1890 | 2026–1949 | 2111–1901 |
| 1 | AA-109800 | 3982±25 | 2564–2468 | 2574–2461 | | |

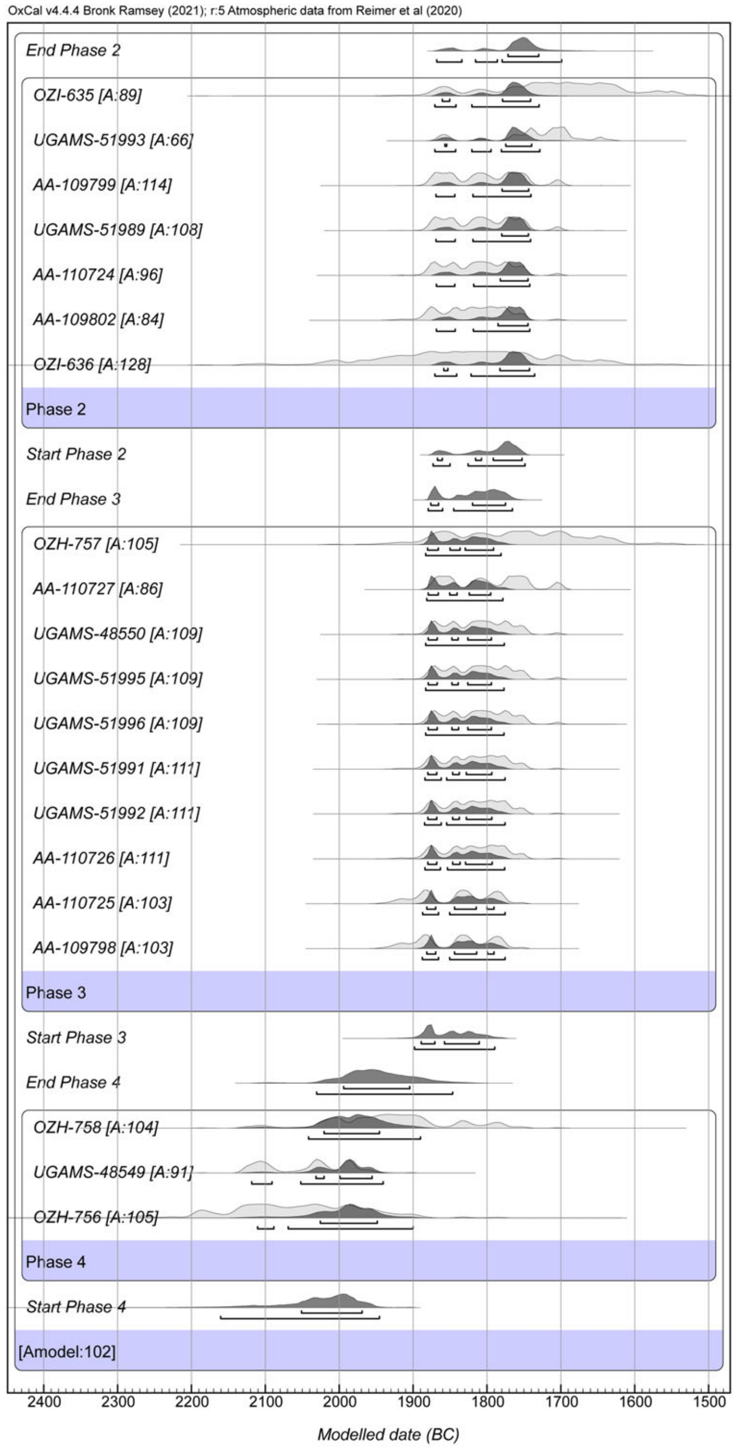


Figure 4 Bayesian sequencing of 20 calibrated $^{14}C$ ages for seed samples from Phases 4–2 at Zahrat adh-Dhra' 1, Jordan. $A_{model} = 101.9$. Light gray curves indicate single-sample calibration distributions; dark curves indicate modeled calibration distributions. Calibrations and Bayesian modeling based on OxCal 4.4.4 (Bronk Ramsey 2009) using the IntCal20 atmospheric curve (Reimer et al. 2020; van der Plicht et al. 2020).

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Table 4 Structures at Zahrat adh-Dhra‘ 1 shown according to phases of occupation and numbers of radiocarbon dates in each phase, based on three-phase Bayesian model of 20 AMS ages (see Figure 4).

| Phase | Structure | | | | | | |
|---|---|---|---|---|---|---|---|
| | 36 | 37 | 39 | 40 | 41 | 42 | 44 |
| 2 | 1 | 1 | | | 1 | 2 | 2 |
| 3 | 1 | 1 | 1 | 3 | 1 | 1 | 2 |
| 4 | | 2 | | 1 | | | |

radiocarbon-based model for a peripheral Bronze Age settlement in the Southern Levant, and (c) bolsters the emerging radiocarbon-based Middle Bronze Age chronology and its implications for more independent interpretation of the development of Levantine complex society. The importance of peripheral communities has been noted in archaeological syntheses of growing and receding town life in Levantine Bronze Age societies (e.g., Prag 2014; Cohen 2022). Most notably, the Early Bronze IV Period offers evidence of seasonal encampments, upland cemeteries and small villages that figure prominently in long-standing characterization of Early Bronze IV society in terms of urban abandonment (e.g., Dever 1980, 1995; Prag 2014). Nevertheless, only a handful of Early Bronze IV marginal settlements (e.g., Be’er Resisim, Ein-Ziq, Nahal Refaim, Ha-Gamal) provide a modest corpus of largely charcoal radiocarbon ages that has been used to initiate a discussion of a general chronology for the period (e.g., Regev et al. 2012; Fall et al. 2022), but which is insufficient for formal modeling of occupation at any given site. During the Middle Bronze Age resurgence of fortified towns, marginal populations remained important social and economic elements of Levantine society (e.g., Cohen 2002). To date, however, ZAD 1 provides the only example of a peripheral settlement that offers a Bayesian model specifying its chronological articulation within the Middle Bronze Age.

The growing evidence for a high Southern Levantine Bronze Age radiocarbon chronology features a lengthened Early Bronze IV beginning by 2500 cal BCE and continuing after its traditional end about 2000 cal BCE (Fall et al. 2021, 2022). Likewise, growing radiocarbon evidence questions the assumed correlation between the beginning of the subsequent Levantine Middle Bronze Age and the accession of the Egyptian 12th Dynasty ca. 2000 BCE (e.g., Höflmayer 2021; Höflmayer et al. 2016a). Accordingly, the timing for the transition between Early Bronze IV and the subsequent Middle Bronze Age has been shifted as late as 1925 cal BCE (Cohen 2002) or even later (e.g., as modeled about 1900 cal BCE at Tell el-Hayyat; Fall et al. 2021). The interval modeled here for Phase 4 at ZAD 1, therefore, might seem unexpectedly early, unless we consider the possibility that the newly-flexible Early/Middle Bronze Age transition might have been time-transgressive, as well as less dependent on Egyptian history, potentially appearing in southern locations like ZAD 1 earlier than in more northerly settlements. Following a possible gap between Phases 4 and 3 (modeled at a 1σ confidence level), Phase 3 habitation in the 19th century cal BCE accords with current modeling of late Middle Bronze I, including the Middle Bronze I/II transition about 1850–1800 cal BCE (e.g., Höflmayer and Manning 2022). Thereafter, Phase 2 occupation at ZAD 1 most likely in the early to mid-18th century cal BCE is consistent with current chronological definition of Middle Bronze II and ends clearly before the proposed Middle Bronze II/III transition about 1700 cal BCE (Höflmayer and Manning 2022). In the larger context of regional chronology, Phase 4 at ZAD 1 lies early in Middle Bronze I, potentially beginning as early as, or slightly before, the traditional outset of this period around 2000 cal BCE. Phase 3

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accords with the MB I/II transition as now dated between about 1850 and 1800 cal BCE, based on data from sites across the Southern Levant (Höflmayer and Manning 2022), while Phase 2 lies squarely in the midst of Middle Bronze II in the early 18th century cal BCE in keeping with continued emergence of a high chronology for the Levantine Bronze Age. ZAD 1 thereby provides a uniquely detailed occupational history for a peripheral settlement during the burgeoning town life of the Southern Levantine Middle Bronze Age.

Modeling of the Middle Bronze Age habitation of ZAD 1 appears amid increasingly ambitious efforts over the last decade to synthesize radiocarbon-based chronologies across regions of the Eastern Mediterranean and Near East previously separated according to geography and archaeological tradition (e.g., Lebeau 2011; Peltenburg 2013; Finkbinder et al. 2015). Among recent breakthroughs, Manning (2022) models the chronological linchpin eruption of Thera in the early to mid-16th century cal BCE, thereby providing another instance of shifted historical correlation between the ancient Mediterranean world and Egypt. Similarly, Herrmann et al. (2023) use modeled AMS ages from Zincirli, Turkey to connect Mesopotamian and Eastern Mediterranean chronologies at the close of the Middle Bronze Age in the decades following the abandonment of ZAD 1. In this context, ZAD 1 illuminates the life history of a Southern Levantine peripheral community on the verge of the ensuing emergence of Late Bronze Age empires.

## CONCLUSIONS

The excavation and analysis of ZAD 1 have illuminated this unique, non-intensively occupied settlement on the cultural and geographical margin of Middle Bronze Age urbanized society in the Southern Levant. Bayesian modeling of 20 calibrated AMS ages provides an occupational chronology unique to the Middle Bronze Age and unparalleled in detail among peripheral sites from other periods, most notably Early Bronze IV. Three sequential phases of occupation at ZAD 1 and their associated pottery articulate well with the emerging regional radiocarbon chronology for Middle Bronze I and II, thereby bolstering increasingly independent interpretation of the Levantine Bronze Age. The radiocarbon chronology presented here also exemplifies the potential for detailed chronological investigation of peripheral sites and their integration into increasingly nuanced archaeological chronologies for the development of early complex societies in greater Southwestern Asia and the Eastern Mediterranean. In particular, the radiocarbon evidence from ZAD 1 illuminates the prehistory of a unique Middle Bronze Age settlement as a means of broadening archaeological comprehension of the full range of communities that constituted Bronze Age society in the Southern Levant.

## SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2023.99.

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## AUTHOR CONTRIBUTIONS

Fall: conceptualization, methodology, investigation, resources, writing original draft and editing; Ridder: methodology, analysis, visualization, data curation, manuscript revision and editing; Pilaar Birch: methodology, analysis, investigation, manuscript revision and editing; Falconer: conceptualization, methodology, investigation, resources, writing original draft and editing.

## DECLARATION OF COMPETING INTERESTS

The authors declare no conflicts or competing interests.

## REFERENCES

Barjamovic GT, Hertel T, Larsen. 2012. Ups and downs at Kanesh: chronology, history and society in the Old Assyrian period. Publications de l'Insitut Historique-Archéologique Néerlandais de Stamboul 120. Leiden: Nederlands Instituut voor het Nabije Oosten.

Berelov I. 2006a. Occupation and Abandonment of Middle Bronze Age Zahrat adh-Dhra' 1, Jordan. British Archaeological Reports, International Series 1493. Oxford: Archaeopress.

Berelov I. 2006b. Signs of sedentism and mobility in an agro-pastoral community during the Levantine Middle Bronze Age: interpreting site function and occupation strategy at Zahrat adh-Dhra' 1 in Jordan. Journal of Anthropological Archaeology 25(1):117–143.

Bietak M. 1991. Egypt and Canaan during the Middle Bronze Age. Bulletin of the American Schools of Oriental Research 281:27–72.

Bietak M. 2013. Antagonisms in historical and radiocarbon chronology. In: Shortland AJ, Bronk Ramsey C, editors. Radiocarbon and the chronologies of ancient Egypt. Oxford: Oxford University Press. p. 76–109.

Bietak M, Höflmayer F. 2007. Introduction: High and Low Chronology. In: Bietak M, Czerny E, editors. The synchronisation of civilisations in the Eastern Mediterranean in the second millennium B.C. III: Proceedings of the SCIEM 2000 – 2nd EuroConference, Vienna 28th of May – 1st June 2003. Contributions to the Chronology of the Eastern Mediterranean 9. Vienna: Österreichischen Akademie der Wissenschaften. p. 13–23.

Bookman R (Ken-Tor), Enzel Y, Agnon A, Stein M. 2004. Late Holocene lake levels of the Dead Sea. GSA Bulletin 116(5-6):555–571. https://doi.org/10.1130/B25286.1

Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. Radiocarbon 51(1):337–360.

Bronk Ramsey C. 2017. Methods for summarizing radiocarbon datasets. Radiocarbon 59(2):1809–1833.

Champion TC, editor. 1996. Centre and periphery. Comparative studies in archaeology. One World Archaeology 11. London: Routledge

Chesson MA, Philip G. 2003. Tales of the city? "Urbanism" in the Early Bronze Age Levant from Mediterranean and Levantine perspectives. Journal of Mediterranean Archaeology 16:3–16.

Cohen SL. 2002. Canaanites, chronologies, and connections. The relationship of Middle Bronze IIA Canaan to Middle Kingdom Egypt. Studies in the archaeology and history of the Levant 3. Winona Lake (IN): Eisenbrauns.

Cohen SL. 2014. The southern Levant (Cisjordan) during the Middle Bronze Age. In: Steiner ML, Killebrew AE, editors. The Oxford handbook of the archaeology of the Levant. Oxford: Oxford University Press. p. 451–464.

Cohen SL. 2022. The Negev in the Intermediate Bronze Age: questions of subsistence, trade, and status. Journal of Ancient Near Eastern History 9(2):221–241. https://doi.org/10.1515/janeh-2021-0012

de Miroschedji P. 2014. The southern Levant (Cisjordan) during the Early Bronze Age. In: Steiner ML, Killebrew AE, editors. The Oxford handbook of the archaeology of the Levant. Oxford: Oxford University Press. p. 307–329.

Dever WG. 1980. New vistas on the EB IV ('MB I') Horizon in Syria-Palestine. Bulletin of the American Schools of Oriental Research 232:35–64.

Dever WG. 1992. The chronology of Syria-Palestine in the second millennium B.C.E.: a review of

current issues. Bulletin of the American Schools of Oriental Research 288:1–25.
Dever WG. 1995. Social structure in the Early Bronze IV Period in Palestine. In: Levy TE, editor. The archaeology of society in the Holy Land. New York: Facts on File. p. 282–296.
Edwards PC, Falconer SE, Fall PL, Berelov I, Davies C, Meadows J, Meegan C, Metzger MC, Sayej GJ. 2001. Archaeology and environment of the Dead Sea Plain: preliminary results of the first season of investigations by the joint La Trobe University/Arizona State University Project. Jordan: Annual of the Department of Antiquities 45:135–157.
Edwards PC, Falconer SE, Fall PL, Berelov I, Czarzasty J, Day C, Meadows J, Meegan C, Sayej GJ, Swoveland T, Westaway M. 2002a. Archaeology and environment of the Dead Sea Plain: preliminary results of the second season of investigations by the joint La Trobe University/Arizona State University Project. Annual of the Department of Antiquities, Jordan 46:51–92.
Edwards PC, House E. 2007. The third season of investigations at the Pre-Pottery Neolithic A site of Zahrat adh-Dhra' 2 on the Dead Sea Plain, Jordan. Bulletin of the American Schools of Oriental Research 347:1–19.
Edwards PC, Meadows J, Sayej G, Metzger MC. 2002b. Zahrat adh-Dhra' 2: a new Pre-Pottery Neolithic A site on the Dead Sea Plain in Jordan. Bulletin of the American Schools of Oriental Research 327:1–15.
Falconer SE. 1994. The development and decline of Bronze Age civilisation in the Southern Levant: a reassessment of urbanism and ruralism. In: Mathers C, Stoddart S, editors. Development and Decline in the Mediterranean Bronze Age. Sheffield: Sheffield Academic Press. p. 305–333.
Falconer SE, Fall PL. 2006. Bronze Age rural ecology and village life at Tell el-Hayyat, Jordan. British Archaeological Reports, International Series 1586. Oxford: Archaeopress.
Fall PL, Falconer SE, Edwards PC. 2007. Living on the edge: settlement and abandonment on the Dead Sea Plain. In: Levy TE, Daviau PMM, Younker RW, Shaer M, editors. Crossing Jordan: North American contributions to the archaeology of Jordan. London: Equinox Publishing. p. 225–232.
Fall PL, Falconer SE, Höflmayer F. 2021. New Bayesian radiocarbon models and ceramic chronologies for Early Bronze IV Tell Abu en-Ni'aj and Middle Bronze Age Tell el-Hayyat, Jordan. Radiocarbon 63(1):41–76. https://doi.org/10.1017/RDC.2020.104
Fall PL, Falconer SE, Lines L. 2002. Agricultural intensification and the secondary products revolution along the Jordan Rift. Human Ecology 30:445–482. http://dx.doi.org/10.1023/A:1021193922860
Fall PL, Falconer SE, Porson S. 2019. Archaeobotanical inference of intermittent settlement and agriculture at Middle Bronze Age ZAD 1, Jordan. Journal of Archaeological Science: Reports 26:101884. https://doi.org/10.1016/j.jasrep.2019.101884
Fall PL, Richard S, Pilaar Birch SE, Ridder E, D'Andrea M, Long JC Jr, Hedges-Knyrim G, Porson S, Metzger M, Falconer SE. 2022. New AMS chronology for the Early Bronze III/IV transition at Khirbat Iskandar, Jordan. Radiocarbon 64(2):237–252. https://www.doi.org/10.1017/RDC.2022.22
Finkbinder U, Novak M, Sconzo P, editors. 2015. ARCANE: Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean. Volume IV. Middle Euphrates. Turnhout: Brepols.
Frumkin A, Kadan G, Enzel Y, Eyal Y. 2001. Radiocarbon chronology of the Holocene Dead Sea: attempting a regional correlation. Radiocarbon 43(3):1179–1189. https://doi.org/10.1017/S0033822200038479
Greenberg R. 2019. The archaeology of the Bronze Age Levant. From urban origins to the demise of city-states, 3700–1000 BCE. Cambridge: Cambridge University Press.
Guillerm E, Gardien V, Waldmann ND, Brall NS, Ariztegui D, Schwab MJ, Neugebauer I, Lach A, Caupin F. 2023. Reconstruction of Dead Sea lake level and mass balance back to 237 ka BP using halite fluid inclusions. Quaternary Science Reviews 303:107964. https://doi.org/10.1016/j.quascirev.2023.107964
Haour A. 2013. Outsiders and strangers: an archaeology of liminality in West Africa. Oxford: Oxford University Press.
Herrmann VR, Manning SW, Morgan KR, Soldi S, Schloen D. 2023. New evidence for Middle Bronze Age chronology from the Syro-Anatolian frontier. Antiquity 97(393):654–673.
Höflmayer F. 2021. Tel Nami, Cyprus, and Egypt: radiocarbon dates and early Middle Bronze Age chronology. Palestine Exploration Quarterly 154(1):1–18 https://doi.org/10.1080/00310328.2020.1866329
Höflmayer F, Dee MW, Genz H, Riehl S. 2014. Radiocarbon evidence for the Early Bronze Age Levant: the site of Tell Fadous-Kfarabida (Lebanon) and the end of the Early Bronze III Period. Radiocarbon 56(2):529–542.
Höflmayer F, Kamlah, J, Sader H, Dee MW, Kutschera W, Wild EM, Riehl S. 2016a. New evidence for Middle Bronze Age chronology and synchronisms in the Levant: radiocarbon dates from Tell El-Burak, Tell El-Dabʿa, and Tel Ifshar compared. Bulletin of the American Schools of Oriental Research 375:53–76.
Höflmayer F, Manning S. 2022. A synchronized early Middle Bronze Age chronology for Egypt, the

Levant, and Mesopotamia. Journal of Near Eastern Studies 81(1):1–24.
Höflmayer F, Yasur-Landau A, Cline EH, Dee MW, Lorentzen B, Riehl S. 2016b. New radiocarbon dates from Tel Kabri support a high Middle Bronze Age chronology. Radiocarbon 58(3):599–613.
Klinge J, Fall PL. 2010. A paleoethnobotanical analysis of Bronze Age land use and land cover in the eastern Mediterranean. Journal of Archaeological Science 37:2622–2629. http://doi.org/10.1016/j.jas.2010.05.022.
Kuijt I, Mahasneh H. 1998. Dhra': an Early Neolithic village in the southern Jordan Valley. Journal of Field Archaeology 25(2):153–161.
Lebeau M. editor. 2011. ARCANE: Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean. Volume I: Jezirah. Turnhout: Brepols.
Lev R, Bechar S, Boaretto E. 2021. Hazor EB III city abandonment and IBA people return: Radiocarbon chronology and its implications. Radiocarbon 63(5):1453–1469.
Levy TE. 1995. Preface. In: Levy TE, editor. The archaeology of society in the Holy Land. New York: Facts on File. p. x–xvi.
Maeir AM, Dar S, Safrai Z, editors. 2003. The rural landscape of ancient Israel. British Archaeological Reports, International Series 1121. Oxford: Archaeopress.
Manning SW. 2013. Cyprus at 2200 BC: rethinking the chronology of the Cypriot Early Bronze Age. In: Knapp AB, Webb JM, McCarthy A, editors. J.R.B. Stewart – an archaeological legacy. Studies in Mediterranean archaeology CXXXIX. Uppsala: Åströms Förlag. p. 1–21.
Manning SW. 2022. Second Intermediate Period date for the Thera (Santorini) eruption and historical implications. PLoS ONE 17(9):e0274835. https://doi.org/10.1371/journal.pone.0274835
Migowski C, Stein M, Prasad S, Negendank JFW, Agnon A. 2006. Holocene climate variability and cultural evolution in the Near East from the Dead Sea sedimentary record. Quaternary Research 66:421e431. https://doi.org/10.1016/j.yqres.2006.06.010
Mohr S, Thompson SM, editors. 2023. Power and identity at the margins of the ancient Near East. Denver: University Press of Colorado.
Mumford GD. 2014. Egypt and the Levant. In: Steiner ML, Killebrew AE, editors. The Oxford handbook of the archaeology of the Levant. Oxford: Oxford University Press. p. 69–89.
Neugebauer I, Brauer A, Schwab MJ, Waldmann ND, Enzel Y, Kitagawa H, Torfstein A, Frank U, Dulski P, Agnon A, Ariztegui D, Ben-Avraham Z, Goldstein SL, Stein M. 2014. Lithology of the long sediment record recovered by the ICDP Dead Sea Deep drilling project (DSDDP). Quaternary Science Reviews 102. https://doi.org/10.1016/j.quascirev.2014.08.013
Peltenburg EJ, editor. 2013. ARCANE: Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean. Volume II: Cyprus. Turnhout: Brepols.
Porson S, Falconer SE, Pilaar Birch SE, Ridder E, Fall PL. 2021. Crop management and agricultural responses at Early Bronze IV Tell Abu en-Ni'aj, Jordan. Journal of Archaeological Science 133:105435. https://doi.org/10.1016/j.jas.2021.105435
Prag K. 2014. The Southern Levant during the Intermediate Bronze Age: altered trajectories. In: Steiner ML, Killebrew AE, editors. The Oxford handbook of the archaeology of the Levant. Oxford: Oxford University Press. p. 388–400.
Pruzsinszky R. 2009. Mesopotamian chronology of the 2nd millennium BC. Vienna: Österreichischen Akademie der Wissenschaften.
Rast WE, Schaub RT, editors. 2003. Bâb edh-Dhrâ'. Excavations at the Town Site (1975–1981). Reports of the expedition to the Dead Sea Plain, Jordan 2. Winona Lake (IN): Eisenbrauns.
Regev J, de Miroschedji P, Greenberg R, Braun E, Greenhut Z, Boaretto E. 2012. Chronology of the Early Bronze Age in the Southern Levant: new analysis for a high chronology. Radiocarbon 54(3–4):525–566.
Regev J, Paz S, Greenberg R, Boaretto E. 2019. Radiocarbon chronology of the EB I–II and II–III transitions at Tel Bet Yerah, and its implications for the nature of social change in the Southern Levant. Levant 51(1):54–75.
Reimer PJ, Austin, WEN, Bard E, Bayliss A, Blackwell PG, Bronk Ramsey C, Butzin M, Cheng H, Edwards RL, Friedrich M, et al. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 kBP). Radiocarbon 62(4):725–757. https://doi.org/10.1017/RDC.2020.41
Roaf M. 2012. The fall of Babylon in 1499 NC or 1595 MC. Akkadica 133:147–174.
Rowlands MJ, Larsen M, Kristiansen K, editors. 1987. Centre and periphery in the ancient world. Cambridge: Cambridge University Press.
Sasson JM. 2015. From the Mari archives: an anthology of Old Babylonian letters. Winona Lake (IN): Eisenbrauns.
Savage SH, Falconer SE, Harrison, TJ. 2007. The Early Bronze Age city states of the Southern Levant: neither cities nor states. In: Levy TE, Daviau PMM, Younker RW, Shaer M, editors. Crossing Jordan: North American contributions to the archaeology of Jordan. London: Equinox Publishing. p. 285–297.
Schiffer MB. 1985. Is there a "Pompeii Premise" in archaeology? Journal of Anthropological Research 41(1):18–41.
Sharon I. 2014. Levantine chronology. In: Steiner ML, Killebrew AE, editors. The Oxford

handbook of the archaeology of the Levant. Oxford: Oxford University Press. p. 44–65.

Torfstein A, Goldstein SL, Stein M, Enzel Y. 2013. Impacts of abrupt climate changes in the Levant from last glacial Dead Sea levels. Quaternary Science Reviews 69:1–7. 10.1016/j.quascirev.2013.02.015

van der Plicht J, Bronk Ramsey C, Heaton TJ, Scott EM, Talamo S. 2020. Recent developments in calibration for archaeological and environmental samples. Radiocarbon 62(4):1095–1117. https://doi.org/10.1017/RDC.2020.22

Weinstein JM. 1992. The chronology of Palestine in the early second millennium B.C.E. Bulletin of the American Schools of Oriental Research 288:27–46.

Wilson DC. 1994. Identification and assessment of secondary refuse aggregates. Journal of Archaeological Method and Theory 1(1):41–68.