THE CHALCOLITHIC RADIOCARBON RECORD AND ITS USE IN SOUTHERN LEVANTINE ARCHAEOLOGY

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ABSTRACT. Archaeological evidence suggests that the Chalcolithic period (5th–4th millennium BCE) in the southern Levant was a time of significant settlement expansion and increasing social complexity. Important technological and social developments during this era set the stage for the later rise of fortified sites and nascence of urbanization in the Early Bronze Age. Controversy surrounding the chronology of Chalcolithic settlement and the reconstruction of social trajectories has stimulated an interest in building a database of radiocarbon dates to measure the tempo of change and help resolve these issues. To facilitate social evolutionary research, this paper reviews and updates published ^{14}C data for the southern Levantine Chalcolithic. The now-substantial database supports the generally accepted time frame for this archaeological period and allows synchronic comparisons across diverse geographic subregions in the southern Levant. In addition, it helps to temporally place the emergence of sophisticated technologies and the development of complex social institutions within the Chalcolithic period. However, radiometrically based attempts at pan-regional internal periodization of the Chalcolithic and fine-tuning of protohistoric events such as site establishment and abandonment are frustrated by the lack of precision in ^{14}C dates, which limits their ability to resolve chronological sequence. Improved delineation of Chalcolithic social trajectories can be achieved most effectively by focussing research efforts on stratigraphic and typological investigations of deeply-stratified settlement sites such as Teleilat Ghassul and Shiqmim within their local contexts.

INTRODUCTION

The Chalcolithic period (5th–4th millennium BCE) in the southern Levant has attracted the interest of scholars since the 1920s. A growing corpus of archaeological evidence suggesting the development of new technologies (metallurgy, groundstone, agro-technology) and the elaboration of social institutions (public temples and formal burial grounds, craft specialization, settlement site hierarchies) reflects the dynamic nature of society at this time. The need to understand the sequence and tempo of Chalcolithic socioeconomic change that directly influenced the structure of Levantine urban societies in subsequent periods has contributed to an emphasis on building a data base of radiocarbon dates for this protohistoric era. Yet while the radiometric record is now substantial and provides a general time frame, it remains too coarse-grained to resolve sequences of social, political, and economic formations on its own. The purpose of this paper is then threefold: 1) to provide a current compendium of ^{14}C dates for the Chalcolithic period in the southern Levant, 2) to review the usefulness and limitations of these dates for the reconstruction of Chalcolithic social trajectories, and 3) to encourage renewed research focus on stratigraphic and typological studies within local contexts in order to illuminate patterns of societal development.

Previous Reviews of the Southern Levantine ^{14}C Record

J Lee (1973) and J Weinstein (1984) presented the first synthetic reviews of Chalcolithic ^{14}C dates for the Levant. By the 1990s the number of dates had grown significantly, establishing the groundwork for A H Joffe and J P Dessel's (1995) most recent summary of southern Levantine Chalcolithic chronology. They provided a very useful discussion of the dates available at that time and proposed an internal periodization for the southern Levant as a whole into "Early", "Developed", and "Terminal" Chalcolithic based primarily on the ^{14}C evidence. However, the clustering of dates for the "Developed" and "Terminal" Chalcolithic observed by Joffe and Dessel (1995) seems to rely largely on the use of date range midpoints. When more properly treated as probabilistic ranges, the ^{14}C dates exhibit considerable overlap. Furthermore, because Joffe and Dessel's paper included an edited list of the dates available from Chalcolithic and late Pottery Neolithic sites in Israel, Egypt,

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and Jordan at the time of publication (1995:509–510, Table I), it did not comprise a complete record of the radiometric evidence for the entire southern Levant. Their phasing scheme appears to be focused on the Mediterranean and Irano-Turanian climatic zones, which have produced the majority of the published ^{14}C dates for the Chalcolithic period. Explicitly omitted were dates from Saharo-Arabian arid zone regions of Israel and Sinai (Avner et al. 1994). ^{14}C data from these seemingly hostile environments suggest long-term, continuous human habitation and, in some cases, apparently conservative desert socioeconomic adaptations from the Late Neolithic through the Early Bronze Age that are incompatible with Joffe and Dessel's tri-partite subdivision of the Chalcolithic. Finally, the subphased temporal framework they propose has limited capacity for evaluating social processes, including as it does a ca. 800-year time span (4500–3700 BCE) for the "Developed" Chalcolithic.

In 1994, I Gilead reviewed ^{14}C dates for the Nahal Beersheva vicinity (Irano-Turanian semi-arid zone) sites of Horvat Beter, Safadi, and Shiqmim in an attempt to more finely delineate their chronological relationship. He presented a "short duration" hypothesis for Shiqmim, in which settlement may have been limited to "… one or two centuries around 4300 and 4200 BC", preceding the occupations of Horvat Beter and Safadi (Gilead 1994:7). This suggestion was based on an averaging of the complete sets of dates for Horvat Beter and Safadi and of the interquartile range of dates from Shiqmim (Gilead 1994:6). Such a procedure may be used to narrow the sigma spread for a cluster of statistically similar dates from the same archaeological context. Assuming that the relatively few dates from Horvat Beter (3; C-919 was omitted from the calculation) and Safadi (7) adequately sample their respective settlement periods, this exercise seems to bring the timing of occupation at these two sites into better focus at the turn of the 5th millennium, between about 4000 and 3900 BCE (one sigma range; Gilead 1994:4). However, as Gilead points out, when all the Shiqmim dates are considered along with their sigma ranges, one cannot reject the alternative that the settlements of Horvat Beter and Safadi may have been contemporary with that of Shiqmim, and that the duration of occupation at Shiqmim may have spanned and exceeded that of the other two sites (Gilead 1994:7). Evaluation of these different settlement scenarios must rely on stratigraphic and artifactual analysis (Gilead 1994:11). Similarly, assertions that all three sites were abandoned by 3800 BCE and that the Nahal Mishmar treasure was significantly later than habitation at these northern Negev sites cannot be confirmed on the basis of the available ^{14}C dates alone. The sigma ranges make it exceedingly difficult to chronologically pinpoint short-term events precisely.

These recent radiometrically based syntheses of Chalcolithic chronology and attempts to reconstruct settlement sequences have been unsatisfactory or inconclusive largely because ^{14}C dates, which represent ranges within which the *true* date of the sampled material *probably* falls, have limited ability to refine site contemporaneity and phasing across the southern Levant within the approximate thousand-year time span of the Chalcolithic. They can provide only gross chronological resolution. Stratigraphy and typological associations, however, can potentially contribute to finer-grained chronologies (Gilead 1994:11; Marcus and Feinman 1998:12). Thus, deeply stratified sites with superimposed floors and buildings, such as Teleilat Ghassul and Shiqmim, hold the key to better understanding of social developmental processes during the Chalcolithic. Because the tempo and nature of social trajectories may differ from subregion to subregion, sequencing must be constructed within local, rather than pan-regional, contexts. To facilitate such research, this paper provides a complete list (updated through 1999) of ^{14}C-dated 5th–4th millennium Late Neolithic/Early Chalcolithic and Chalcolithic sites in the southern Levant arranged by geographic subregion. Brief descriptions of dated occupation phases at Teleilat Ghassul and Shiqmim are presented as examples of the kind of intrasite diachronic studies needed to investigate social evolutionary sequences. On-going research

at these sites, coupled with new dates and contextual information from other recently excavated sites such as Gilat, Peqi'in Cave, Cave of the Warrior, Nahal Qanah Cave, and Abu Hamid should lead to improved temporal resolution of social evolutionary processes in the southern Levant during the Chalcolithic period.

METHODS

We have included in our compilation all available (through 1999) ^{14}C dates for sites in Israel, Jordan, and Sinai with artifact assemblages identified as belonging to Late Neolithic/Early Chalcolithic (Wadi Raba and Wadi Raba variants following Gopher and Gophna 1993) or Chalcolithic cultural complexes (see map in Figure 1). (Four 6th millennium calibrated BCE dates for Ard Tlaili in the Beqqa Valley of Lebanon, representing the northernmost extension of the Wadi Raba Late Neolithic/Early Chalcolithic cultural entity, are not included here. These are given in Gopher and Gophna (1993:305). In the case of desert regions such as southern Jordan, the southern Negev, and Sinai where many dates are from tumuli fields and assemblages and typological parallels are sparse, we have selected dates from those sites which fall within the chronological range established by excavated and dated sites with recognized Late Neolithic/Chalcolithic and Chalcolithic material assemblages. The aim here is to create an inclusive picture of broadly contemporaneous occupied areas in the southern Levant within which synchronous socioeconomic trajectories may be examined and compared. To provide as complete a radiometric record as possible, we have avoided editing dates beyond these general parameters.

The entire corpus of dates is presented in two formats. A table of the dates, organized by site and geographic region, is presented in the appendix and includes uncalibrated BP and calibrated BCE 1-sigma (68% probability) and 2-sigma (95% probability) ranges. Published BP dates have been calibrated using the CALIB 4.0 Radiocarbon Computer Program (Rev. 4.1.2) based on INTCAL98 data (Stuiver et al. 1998). Figure 2 shows the calibrated BCE date ranges (thick bar = 1-sigma range; thin bar = 2-sigma range) from all dated sites in chronological order. This provides a visual impression of the overall temporal framework of Chalcolithic society for the region as a whole.

RESULTS AND DISCUSSION

Building a Chronological Framework for the Chalcolithic of the Southern Levant

Examination of Figure 2 reveals that the 2-sigma ranges of most of the ^{14}C dates fall entirely within the 5th and 4th millennia BCE, substantiating the generally accepted time frame for the Chalcolithic cultural entity. Dates that extend into the 6th millennium BCE are primarily from sites or strata identified on the basis of their assemblages as Late Pottery Neolithic, Jericho IX/Lodian, Qatifian, or Wadi Raba (normative or variant) entities. These include Nahal Qanah Cave Late PN level, Tel Tsaf, Newe Yam, Kfar Samir, Nizzanim, Teleilat Ghassul II/III, Abu Hamid basal levels, Peqi'in Cave Wadi Raba and pre-Ghassulian levels, Tel Wadi Fidan Profile B, Nahal Issaron, Uvda 7, Megadim, Tel Hreiz, Givat Haparsa, and Qatif Y-3 (see Gopher and Gophna 1993 for classification). Conversely, Jericho IX/Lodian, Qatifian, and Wadi Raba sites/strata only rarely yield dates with 2-sigma ranges extending later than the mid-5th millennium (Ein el Jarba GX-786 and GX-787, Givat Haparsa?, Newe Yam HV-4256?, Kfar Samir RT-70 and RT-1929A). Thus, the preponderance of the available radiometric and stratigraphic evidence suggests that the Chalcolithic proper emerged during the first half of the 5th millennium BCE. Late Pottery Neolithic material culture appears to have been largely supplanted by identifiably Chalcolithic assemblages in many parts of the southern Levant no later than 4500 BCE.

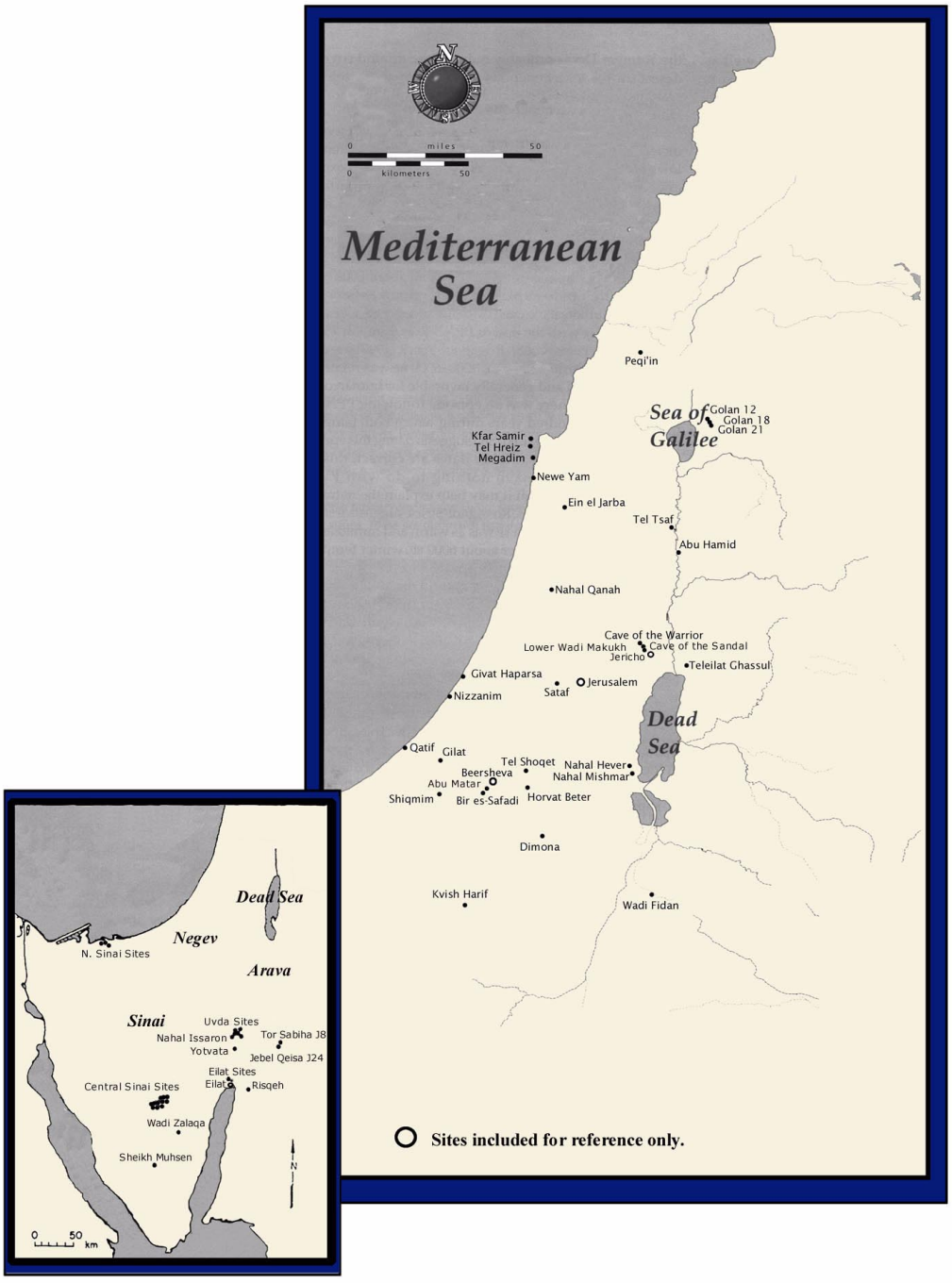

Figure 1 Map of Late Neolithic/Early Chalcolithic and Chalcolithic sites with ^{14}C dates

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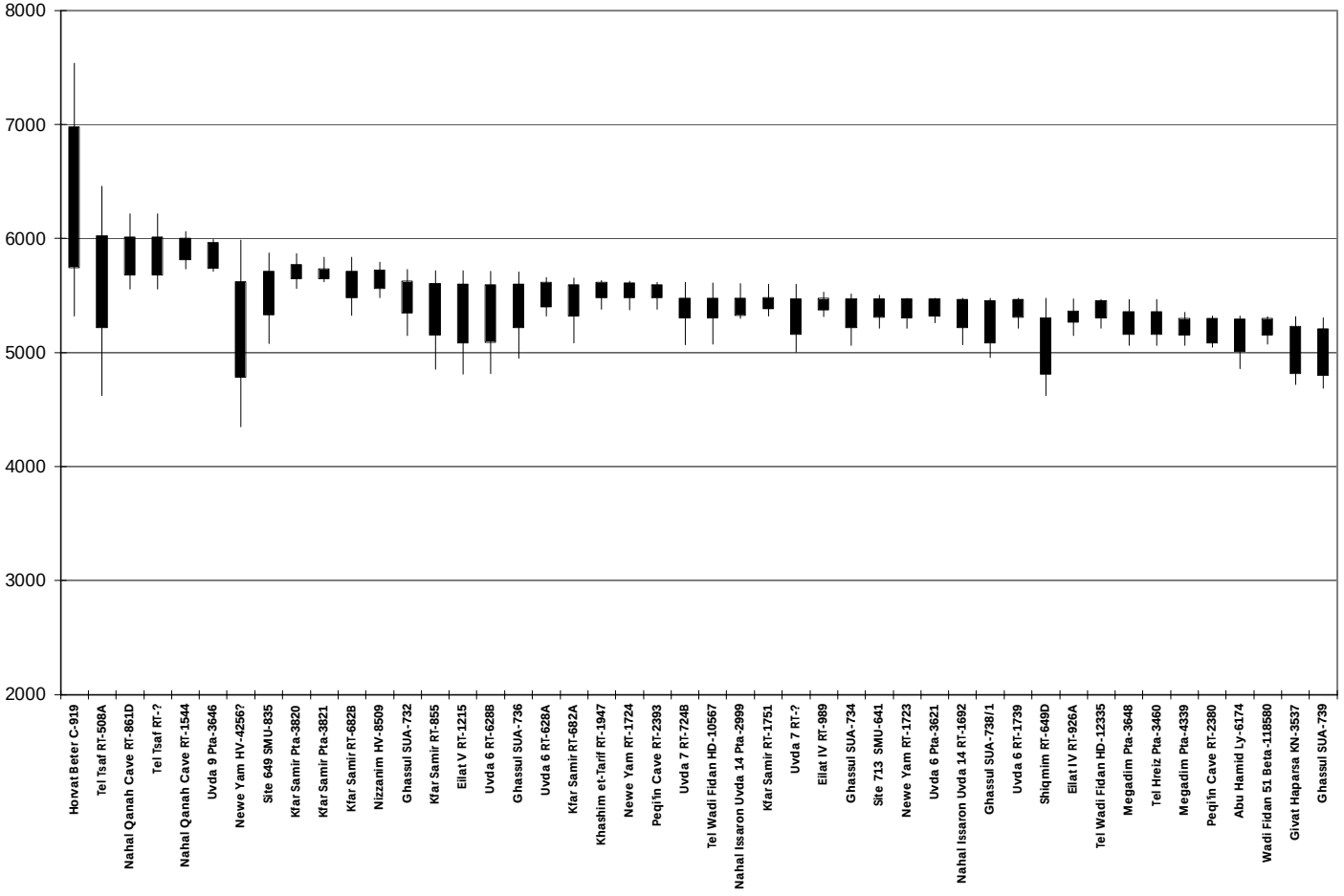

Figure 2 (1 of 5) Calibrated ^{14}C dates for Late Neolithic/Early Chalcolithic and Chalcolithic sites in the Southern Levant

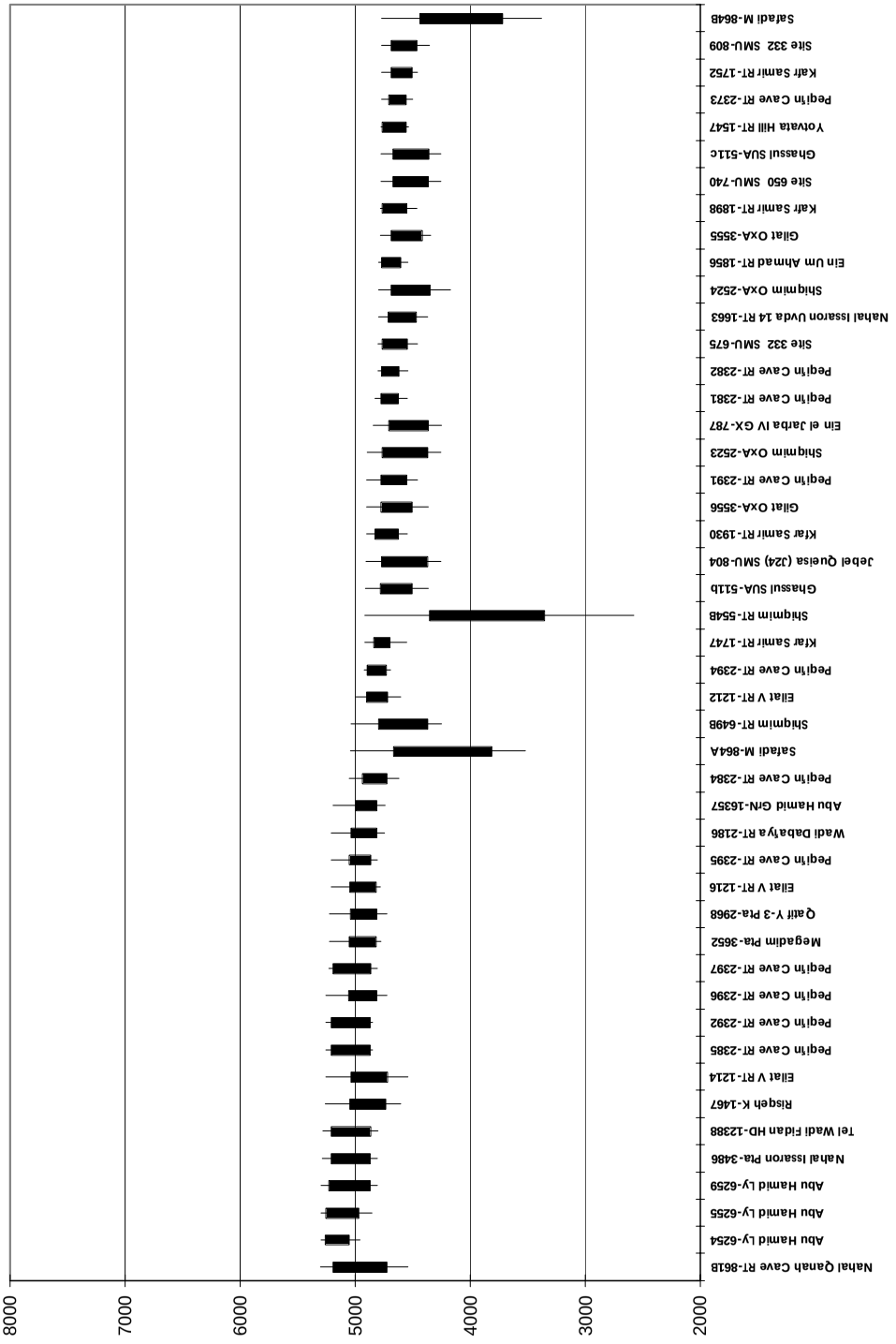

Figure 2 (Continued; 2 of 5)

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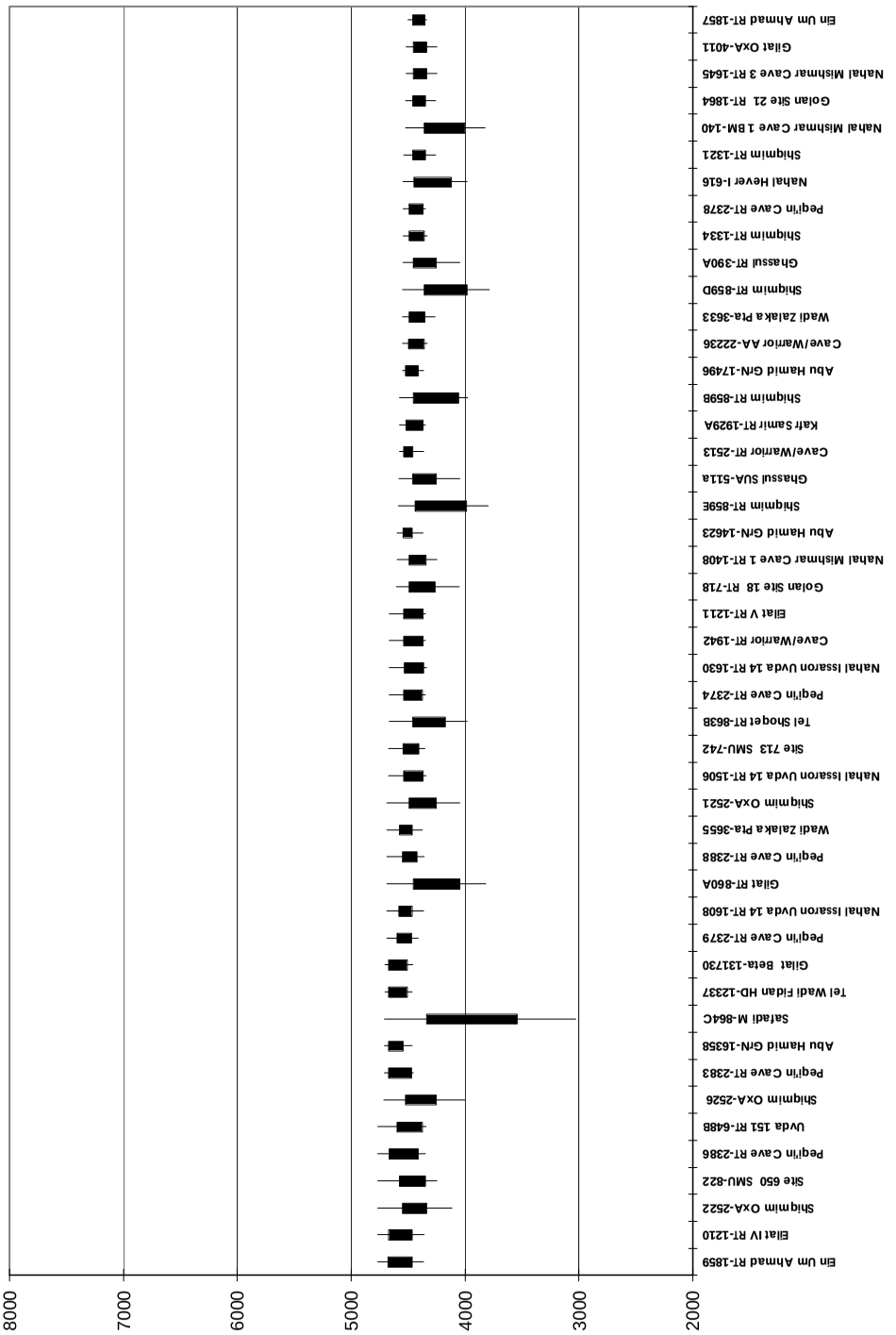

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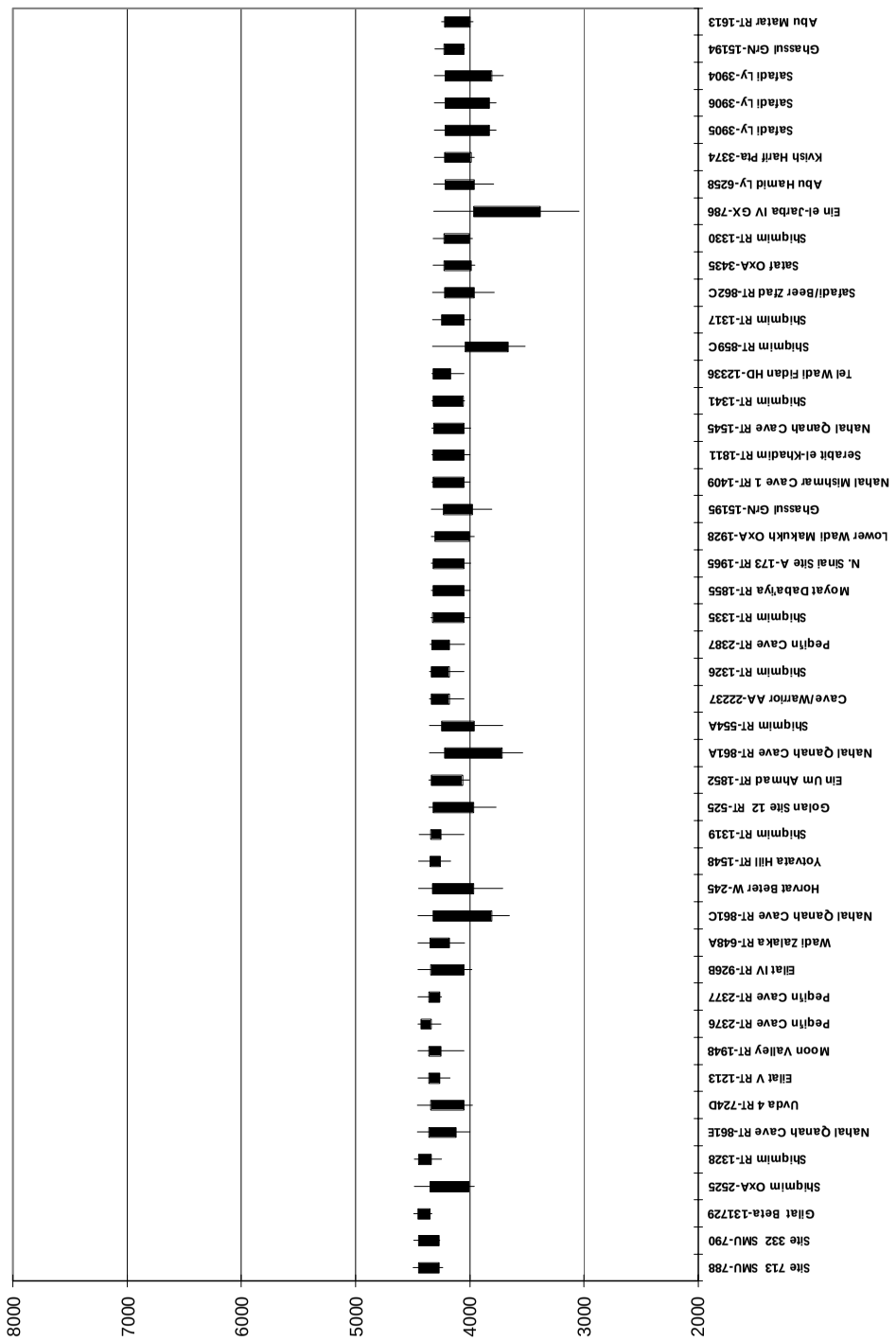

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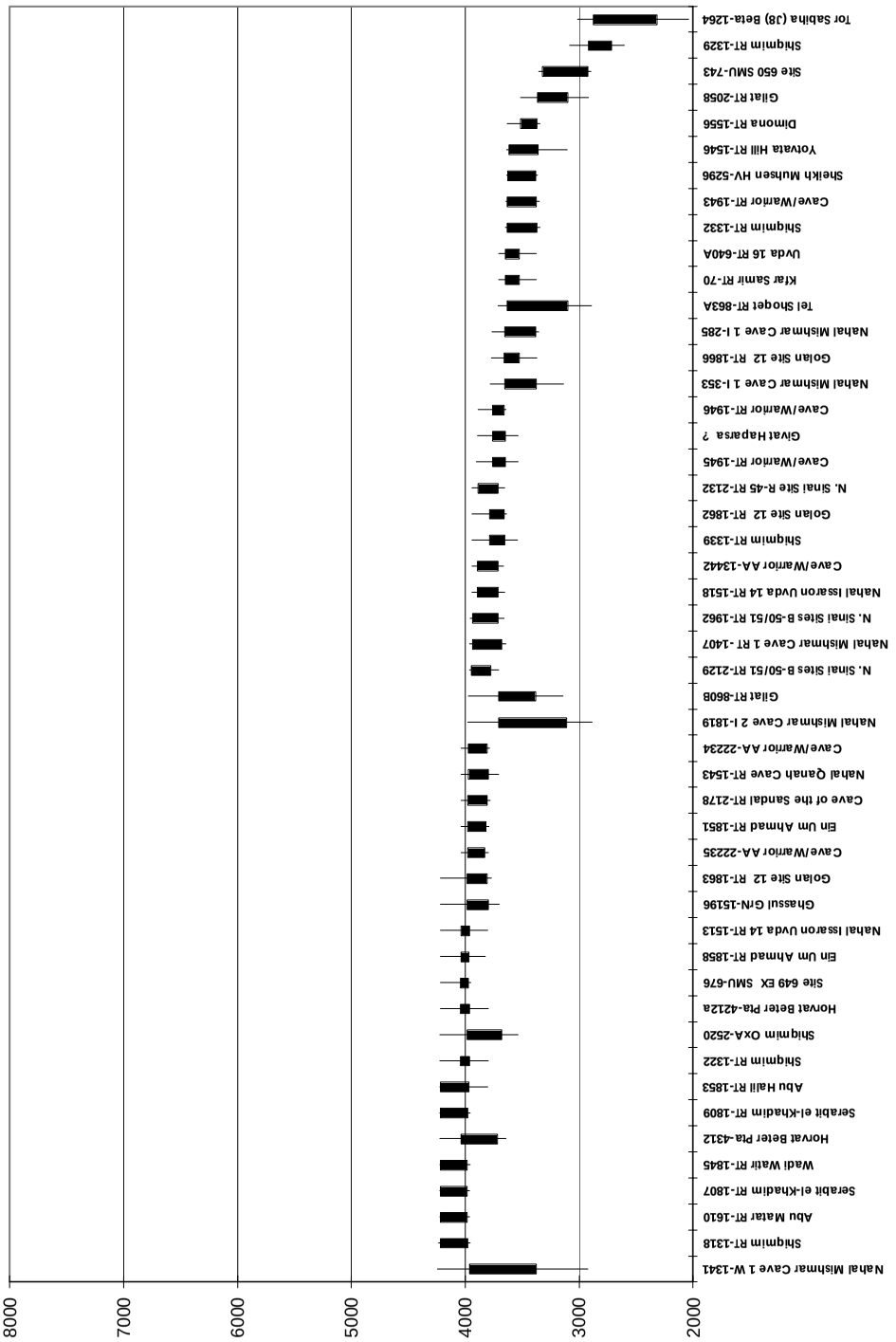

Figure 2 (Continued; 5 of 5)

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The end of the Chalcolithic period—the Chalcolithic/Early Bronze I (Early EB I or EB IA) transition—has been described as a case of social, political, economic, and demographic collapse (Gophna 1998). Gaps in our knowledge probably serve to accentuate apparent disjunctions in settlement patterns and artifact assemblages. Still, current stratigraphic and radiometric evidence indicates that most large Chalcolithic sites were abandoned by the mid-4th millennium BCE and not resettled, although some may have had limited and ephemeral occupation extending into what may be termed the Early Bronze IA (EB IA). It is difficult at present to temporally place this cultural horizon more precisely, and concerted research efforts are needed on this subject. Known, well-described sites with stratified Chalcolithic/EB IA sequences are rare. The problem is exacerbated by the relatively few published ^{14}C dates from southern Levantine sites that span the centuries from about 3600 to 3200 BCE. Only Golan Site 12 (RT-1866), Cave of the Warrior (RT-1943), Nahal Mishmar (W-1341, I-353, I-285, I-1819), Shiqmim (RT-1332, RT-1329), Gilat (RT-860B, RT-2058), and Tel Shoqet (RT-863A) have thus far yielded dates that range into the late 4th millennium BCE from clearly-defined Chalcolithic cultural contexts.

The validity of some of these previously published late dates now in fact seems questionable, with new testing of the Nahal Mishmar "Treasure" mat suggesting a 5th millennium BCE date (Aardsma 2001). Braun's (1996:155–70) review of late 4th millennium BCE ^{14}C dates from early EB I sites, many of which are from tombs used for considerable spans of time, outlines the significant interpretation problems inherent in that corpus of dates. Some new ^{14}C dates from settlement sites identified as early EB I (e.g. Afridar Area G: E Braun [personal communication], and Ashqelon: Segal and Carmi [1996:91] on Israel's Coastal Plain; Wadi Fidan 4 in Jordan: Adams and Genz [1995:19]) imply that the beginning of this period could be placed at around 3600 BCE, earlier than previously thought. Other very recent information—such as new AMS determinations from Teleilat Ghassul (Bourke et al. 2001)—seems to corroborate an early 4th millennium BCE denouement of the Chalcolithic, at least in some subregions (cf. Gilead 1994:11).

Such a "high chronology" would be consistent with the early work of J Mellaart (1979:19; Figure 1), whose synthesis of Near Eastern historical and ^{14}C chronologies posited the beginning of Palestine's EB at around 4000 BCE (see also Lee 1973). Yet firm conclusions in this regard require an evaluation of the late dates from the Golan, Cave of the Warrior, Gilat, Tel Shoqet, and Shiqmim. Furthermore, the final occupation levels of Shiqmim were inadequately sampled and additional dates from this site are needed to clarify a local Beersheva valley Chalcolithic terminus. Forthcoming reports on Nahal Tillah/Halif Terrace, one of very few habitation sites with continuous stratified occupation sequences from the Chalcolithic into the late Early Bronze Age (EB IB), may also contribute to chronological and typological delineation of this transition (cf. Levy et al. 1997). Even as more evidence comes to light it should be acknowledged that absolute chronological boundaries between archaeological periods, which represent taxonomic constructs imposed on social developmental continua, are likely to remain shifting and locally defined.

An internal periodization of the main Chalcolithic time period (ca. 4500–3600 BCE) continues to be elusive despite the more than 200 ^{14}C dates now available. The lack of obvious gaps in Figure 2's chronologically arranged sequence of dates suggests that there is no occupational lacuna within the southern Levantine Chalcolithic as a whole. There is no apparent clustering of dates when the sigma ranges are considered. Furthermore, the general homogeneity and stability of Chalcolithic material culture has so far offered little in the way of high-resolution temporal markers. Thus, pan-regional subdivisions of the period proposed on the basis of ^{14}C dates and uneven typological evidence, such as Joffe and Dessel's (1995) "Developed" and "Terminal" Chalcolithic, seem premature. Attention should be directed instead toward detailed studies of sites on a subregional basis. Gilead's (1994:11–

2) effort to reconstruct the history of Beersheva valley Chalcolithic settlement, though inconclusive and hindered by the incomplete stratigraphic and artifactual data available for some of the sites involved, provides an example of the spatial and analytical scale needed to delineate social trajectory.

Reconstructing Subregional Social Trajectories

The geographically-arranged table of ^{14}C dates (Appendix) facilitates chronological comparisons within and across subregions of the southern Levant. Detailed discussion of each set of dates is beyond the scope of this paper. However, some general observations may be made that serve to illustrate the usefulness as well as the limitations of the ^{14}C data.

First, it is clear from the radiometric record that a variety of environmental zones were occupied during the 5th–4th millennium BCE. Chalcolithic societies were distributed throughout most areas of the southern Levant including the Golan, the Galilee, Samaria, the Judean mountains, the Judean desert, the Jordan valley, the northern, central, and southern Negev desert, southern Jordan, and the Sinai peninsula. ^{14}C dates play an especially important role in determining chronological parameters for settlement in extreme arid zones such as the southern Negev and Sinai where human habitation was previously thought to have been intermittent or absent before the beginning of the Bronze Age (Avner et al. 1994: 267; Rothenberg and Glass 1992:141). This is because relative dating of desert sites, many of which are cult or burial sites, is complicated by re-use over long periods by many social groups, frequently sparse artifact assemblages, and lack of typological parallels with material culture from more humid parts of the Levant. Scholars have identified the Timnian complex, a tool kit adapted to desertic economic strategies, as a dominant material tradition in southern Jordan, the southern Negev, and Sinai, in contrast to the Ghassulian/Beersheva complexes of regions to the north (Henry 1995:353–4; Kozloff 1974:47–8; Rothenberg and Glass 1992:145).

^{14}C data for Timnian sites in Sinai and southern Jordan indicate a very wide chronological range (6th–3rd millennium BCE), which suggests a relatively slow rate of technological change in these arid zone assemblages and a developmental trajectory that was to some extent independent of that experienced in better-watered areas of the southern Levant (Rothenberg and Glass 1992:152). Meanwhile Avner (1998) has recently outlined a developmental sequence for sites in the Uvda valley, in the southernmost Negev, that corresponds to the traditional Late Neolithic-Chalcolithic-Early Bronze Age classification. The Uvda valley seems to have experienced relatively high population densities throughout the 6th–3rd millennia BCE compared to other desert areas and, based on an analysis of changes in architecture and artifacts, an evolution from hunter-gatherer to desert agricultural economies (Avner 1998:188). Thus, while other kinds of archaeological evidence are needed to clarify the details of socio-economic process and possible interaction among Levantine subregions, ^{14}C dates have contributed greatly to our ability to identify such broadly synchronous yet divergent social patterns between and within different environmental zones.

Second, ^{14}C dates from a number of sites have helped to chronologically place significant technological and social innovations within the Chalcolithic period. For example, ossuaries and rich grave goods, including gold ingots, were found in association with child and adult skeletal remains in the Chalcolithic level at Nahal Qanah Cave and dated to the late 5th–early 4th millennium BCE (RT-861A, RT-861C, RT-861E, RT-1545) (Gopher 1996:217). ^{14}C dates for the Nahal Mishmar Cave "Treasure"—a unique cache of fine carved ivory and manufactured copper maceheads, standards, and "crowns"—are too imprecise to pinpoint the deposition event (BM-140, W-1341, I-285, and I-353 are associated with the "treasure" itself; see Bar-Adon 1980:199, 216; see also new dates, Aardsma 2001). They do, however, securely place the manufacture of these technologically sophisticated items within the main Chalcolithic time frame, providing independent corroboration of the

original attribution based on artifact parallels. Specialized metallurgy, prestige objects, and the association of rich grave goods with child burials are important archaeological correlates of complex society. Their ^{14}C dating to this time period lends support to models that posit the emergence of social inequality in some parts of the southern Levant during the Chalcolithic. Additional radiometric, stratigraphic, and other archaeological evidence is needed to more finely resolve the tempo of these social processes within the Chalcolithic period.

Finally, it should be recognized that in certain archaeological contexts and depending on the rate of stylistic change, ^{14}C dates may not always be helpful in distinguishing chronological trends in artifact assemblages and cultural differentiation. This is especially true in the case of burial caves which may have been used by different social groups and where earlier deposits may be disturbed by later interments. Peqi'in Cave, discovered in the Galilee in 1995, has yielded 22 ^{14}C dates from Early Chalcolithic (dwelling) and Ghassulian Chalcolithic (burial) levels (Segal et al. 1998). The numerous artifacts, including elaborate ossuaries found in disarrayed burial contexts, show clear links with other, better known areas of Chalcolithic settlement, including the Golan, the Jordan valley, the Coastal plain, the Judean desert, and the northern Negev. This diverse collection at a single site is unique and may be interpreted as representing a chronological development. Alternatively, the finds may be the products of a previously unrecognized, syncretistic Upper Galilee Chalcolithic culture. It is also possible that the cave served as a common burial site for social groups from different areas thus providing evidence of the co-existence of these subregional Chalcolithic cultures (Gal et al. 1997:154, 1999:15). The ^{14}C dates do not help sort out these different interpretations, indicating only that the main Chalcolithic period of use occurred between about 4500 and 4000 BCE. The Cave of the Warrior in the northern Judean desert near Jericho presents a somewhat different case. ^{14}C dates confirmed the chronological sequencing of two superimposed burials as "Ghassulian Chalcolithic" and "late Chalcolithic" (Jull et al. 1998:111). Unfortunately, and despite the remarkable nature of the preserved perishable artifacts such as straw mats, fine textiles, and wooden implements, the lack of pottery and flint makes it difficult to establish links with most settlement sites. Recognizable and widely distributed typological markers correlated with reliable stratigraphy are needed in order to extrapolate chronological sequencing from site to site. Therefore, while artifacts from these Chalcolithic burial caves are interpreted as providing evidence of social ranking (Gal et al. 1999:14; Schick 1998:19–22) and suggest the possibility of interaction between distinct social groups—and the ^{14}C dates place this activity in the 5th–4th millennium BCE, evolutionary trajectories must be charted primarily on the basis of well-stratified settlement sites within their subregional cultural contexts.

Studying Deeply Stratified Sites: Teleilat Ghassul and Shiqmim

Teleilat Ghassul in Jordan's Dead Sea valley and Shiqmim in Israel's northern Negev desert are the two most deeply stratified Chalcolithic settlement sites now known in Palestine. Continuing investigation of stratigraphic and typological sequences at these sites can potentially provide the key to understanding social evolutionary change in their respective subregions.

A series of intermittent excavations at Teleilat Ghassul, beginning in 1929 and renewed by the University of Sydney in the 1990s, has revealed at least ten major building phases with over 100 successive floor levels extending from the late Pottery Neolithic through the main phase of the Chalcolithic. The 12 ^{14}C dates available in 1999 for Teleilat Ghassul are shown in Figure 3. According to Bourke (1997:410–1), the earlier set of five dates (SUA-732, 734, 736, 738/1, 739) corresponds to Ghassul's "Middle" or "pre-Classic" phase (Hennessy Phase G-E), and thus does not represent Neolithic assemblages (Hennessy Phase I-H) but rather what may be termed "Early Chalcolithic" (see also new

AMS dates for this phase in Bourke et al. 2001). Middle Phase ceramic finds include the first appearance of churns, cornets, and fenestrated stand vessels (Bourke 1997:407–8). Bourke notes that despite the overlap in ^{14}C dates from other Late Neolithic/Early Chalcolithic assemblages, ceramic parallels can be drawn only with the pottery of nearby Tel Tsaf, also in the Jordan valley. The "Classic Ghassulian" or "Late Phase" levels at Teleilat Ghassul are sampled radiometrically by seven dates (SUA-511a,b,c; RT-390A; and GrN-15194, 15195, 15196). Taken conservatively, these dates suggest that fully developed Chalcolithic material at Teleilat Ghassul—marked by sanctuary architecture and a significant degree of specialization and refinement in art and manufactured goods—probably falls within a time frame of approximately 4900–3700 BCE, broadly contemporaneous with similar developments exemplified in northern Negev assemblages. While the dates are extremely important in terms of confirming general stratigraphic-typological sequence at Ghassul, the sample of seven shown here (with overlapping sigma values) may be too small and imprecise to define possible occupation horizons within the Classic Ghassulian phase at the site. In 1997, Bourke (1997:411) commented that the dated samples did not represent either the earliest or the latest Classic Ghassulian strata and that Chalcolithic settlement at Teleilat Ghassul may have continued well into the mid-4th millennium BCE. More recently, he has proposed a final date of around 4000 BCE for significant Chalcolithic occupation at the site (Bourke et al. 2001). Additional ^{14}C dates and detailed material analyses from this key site should help to clarify Chalcolithic social trajectory in the Jordan Valley.

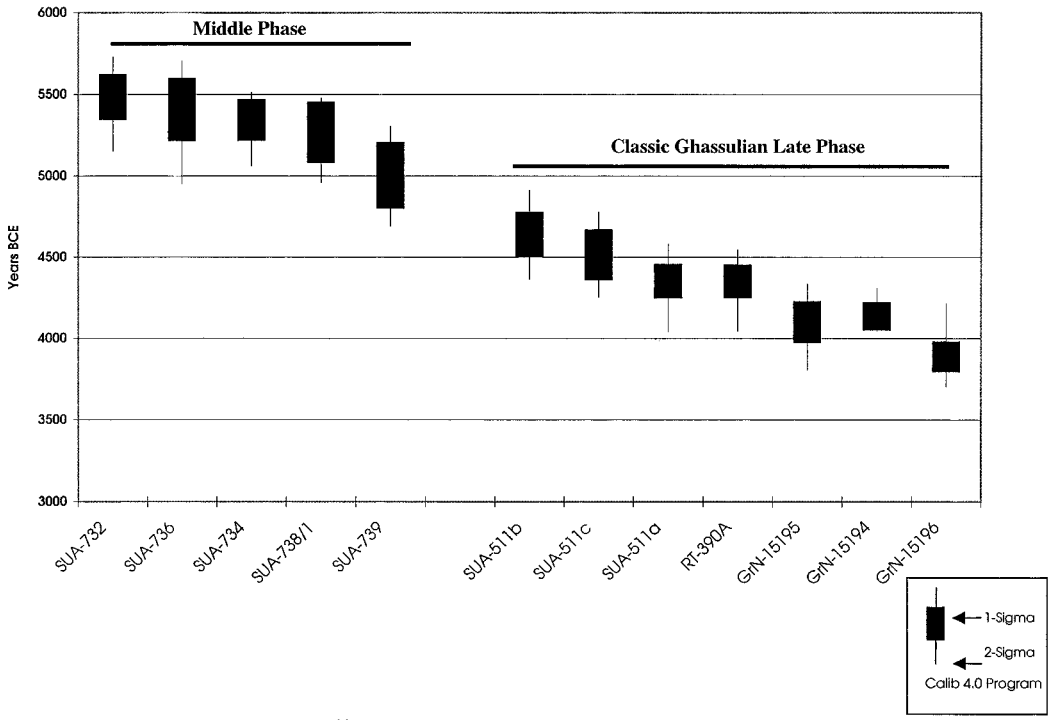

Figure 3 Teleilat Ghassul calibrated ^{14}C dates

Excavations between 1978 and 1993 at Shiqmim, one of the largest Chalcolithic sites in western Palestine, have revealed four main stratigraphic levels corresponding to three principal occupation phases (Levy et al. 1991). Twenty-nine ^{14}C dates, more than from any other Chalcolithic site in Palestine, have been published from all four levels including the system of subterranean rooms and tun-

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nels. Figure 4 shows 27 of these dates, grouped according to stratigraphic level and defined as "Early", "Main", and "Final" occupation phases (after Levy et al. 1991; the two dates not shown in the figure are RT-554B, which has a very large estimate of error, and RT-1329, which falls almost entirely within the 3rd millennium and probably represents later intrusive activity). It should be noted that the available dates from Shiqmim are biased in that Stratum I, the "Final" occupation, is underrepresented. Only four of the 27 dates shown are from this last phase. More ^{14}C dates are needed to clarify the terminus of settlement at Shiqmim which is most likely coincident with the breakdown of northern Negev Chalcolithic societies. A further complication in interpreting Shiqmim dates from the underground room network is that these systems appear to have been frequently re-used, re-configured, and subject to infilling and collapse during and possibly even after the Chalcolithic settlement period (see RT-1329 above). Overall, the lack of a significant chronological break in the current Shiqmim ^{14}C date record shown in Figure 4 suggests continuity of settlement probably occurring within temporal boundaries of about 5500–3300 BCE, conservatively speaking. The ^{14}C dates support the possibility that Shiqmim was part of a regional Chalcolithic settlement system including contemporary polities such as Horvat Beter, Safadi, Abu Matar, Gilat, and other sites yet to be dated with radiometric methods. The corpus of dates also highlights the importance of stratigraphy for defining occupation phases and hence refinements of developmental trajectory. In short, the individual ^{14}C dates alone are too imprecise to distinguish cultural sequencing within less than about a 200-year period (however, where there are multiple dates from the same archaeological context averaging may help to restrict this range). Detailed typological studies are presently being carried out for Shiqmim and another stratified northern Negev settlement center, Gilat (Alon and Levy, in press). These results may help to explain Chalcolithic social evolutionary processes in the northern Negev region.

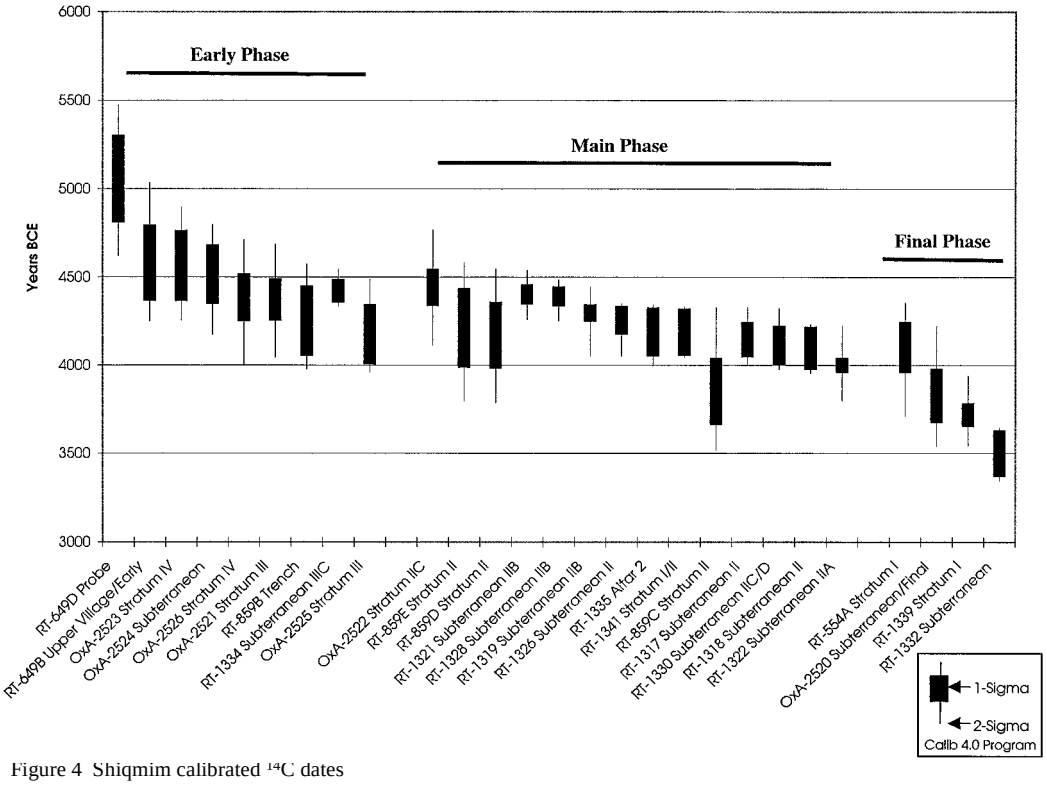

Figure 4 Shiqmim calibrated ^{14}C dates

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Although of limited use within narrow time scales, sets of ^{14}C dates for a number of multi-level Chalcolithic sites, both settlement and burial, suggest possible hypotheses for further research. In this example dates from "early Chalcolithic" or "pre-Ghassulian" contexts as defined by the excavators are not included.

^{14}C boundaries (BCE) for Chalcolithic activity

Settlement Sites	BCE
Abu Hamid (GrN-16358, 17496, 14623)	4700–4300
Ghassul (SUA-511a,b,c; RT-390A; GrN-15195, 15194, 15196)	4900–3700
Shiqmim (all dates except RT-1329)	5500–3300
Burial Caves	
Peqi'in Cave (RT-2376, 2377, 2387)	4500–4000
Nahal Qanah (RT-861E, 861C, 861A, 1545)	4500–3500
Cave of the Warrior (all dates)	4700–3300

While the date ranges provide no assurance that human activity was continuous between the end points of the range or indeed occurred at any particular intermediate point, they do bound the *possible* points of contemporaneity (subject to sampling problems as described above). Thus where there is a lack of overlap we may begin to ask questions such as: What factors may have precipitated the abandonment of Jordan valley Chalcolithic centers Teleilat Ghassul and Abu Hamid by the early 4th millennium while significant occupation at Shiqmim in the Beersheva valley may have endured for several more centuries? Or, why did use of the Peqi'in Cave for elite burials cease by 4000 BCE, possibly 400–700 years before the apparent collapse of Chalcolithic chiefdom societies? The completeness and accuracy of the underlying ^{14}C data base must be verified before proceeding, but it does provide an important foundation for social evolutionary studies.

CONCLUSION

In this paper we have provided a compilation of currently available ^{14}C dates for the Chalcolithic of the southern Levant. This work builds on the important earlier studies of Gilead (1994), Joffe and Dessel (1995), Lee (1973), and Weinstein (1984). The now-substantial radiometric data base has established general chronological parameters for the Chalcolithic period (ca. 4500–3600 BCE) within which social evolution in the southern Levant may be charted. In addition, the data has significantly contributed to our appreciation of the existence of broadly contemporaneous human settlement across diverse environmental zones at this time. Because these subregions experienced different socioeconomic trajectories reflected in distinctive material traditions, such a finding could not have been supported on the basis of typological parallels alone. Furthermore, and of crucial importance to our understanding of social prehistory, ^{14}C dating has helped to securely placed technological and socio-political innovations connected with the emergence of southern Levantine complex societies within the Chalcolithic era.

It is clear, however, that the large standard deviations observed in ^{14}C dates permit only a gross resolution of cultural sequence. Temporal subphases of the main Chalcolithic period cannot be determined by exclusive appeal to the current radiometric record. More refined evaluations of settlement patterns, social interaction spheres, and developmental trajectories during this protohistoric period depend on stratigraphic and typological analyses, including detailed seriation studies, carried out on a subregional scale. Settlement sites such as Shiqmim and Teleilat Ghassul—with multiple occupation levels, abundant material remains, and stratigraphically controlled excavations—appear to have

the greatest potential to further delineate patterns of southern Levantine social development and organization within their respective locales during the 5th–4th millennium BCE.

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APPENDIX

Radiocarbon Dates for Late Neolithic/Early Chalcolithic and Chalcolithic Sites in the Southern Levant

Site	Sample	Uncalibrated BP	Calibrated BCE (1-sigma)	Calibrated BCE (2-sigma)	Geographic Region	Reference
Golan Site 18	RT-718	5540 +- 110	4488-4256	4601-4052	Golan	Carmi and Segal 1998: 343
Golan Site 21	RT-1864	5565 +- 60	4457-4343	4520-4260	Golan	Carmi and Segal 1998: 343
Golan Site 12	RT-525	5270 +- 140	4320-3960	4359-3771	Golan	Carmi and Segal 1998: 343, Weinstein 1984: 335
Golan Site 12	RT-1863	5130 +- 70	3982-3803	4215-3770	Golan	Carmi and Segal 1998: 343
Golan Site 12	RT-1862	4945 +- 65	3787-3653	3939-3638	Golan	Carmi and Segal 1998: 343
Golan Site 12	RT-1866	4810 +- 90	3660-3519	3773-3369	Golan	Carmi and Segal 1998: 343
Kfar Samir	Pta-3820	6830 +- 80	5773-5640	5868-5563	Northern Coast	Gopher and Gophna 1993: 305
Kfar Samir	Pta-3821	6830 +- 60	5737-5643	5838-5624	Northern Coast	Gopher and Gophna 1993: 305
Kfar Samir	RT-682B	6670 +- 140	5715-5479	5837-5325	Northern Coast	Gopher and Gophna 1993: 305
Kfar Samir	RT-855	6420 +- 200	5606-5148	5719-4855	Northern Coast	Carmi and Segal 1992: 119
Kfar Samir	RT-682A	6470 +- 130	5597-5316	5655-5084	Northern Coast	Carmi 1987: 100, Gopher and Gophna 1993: 305
Kfar Samir	RT-1751	6495 +- 55	5482-5381	5603-5324	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-1747	5890 +- 70	4837-4691	4918-4552	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-1930	5870 +- 70	4827-4623	4904-4547	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-1898	5790 +- 55	4766-4549	4780-4465	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-1752	5750 +- 60	4690-4501	4771-4457	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-1929A	5630 +- 55	4518-4364	4577-4347	Northern Coast	Segal and Carmi 1996: 85
Kfar Samir	RT-70	4800 +- 70	3650-3521	3706-3375	Northern Coast	Gopher and Gophna 1993: 305
Newe Yam	HV-4256?	6310 +- 395	5624-4780	5988-4349	Northern Coast	Gopher and Gophna 1993: 306
Newe Yam	RT-1724	6565 +- 70	5611-5475	5625-5373	Northern Coast	Segal and Carmi 1996: 85
Newe Yam	RT-1723	6390 +- 70	5470-5302	5480-5213	Northern Coast	Segal and Carmi 1996: 85
Megadim	Pta-3648	6310 +- 70	5359-5153	5469-5067	Northern Coast	Gopher and Gophna 1993: 305
Megadim	Pta-4339	6270 +- 50	5303-5147	5356-5065	Northern Coast	Gopher and Gophna 1993: 305
Megadim	Pta-3652	6060 +- 70	5050-4812	5226-4779	Northern Coast	Gopher and Gophna 1993: 305
Tel Hreiz	Pta-3460	6310 +- 70	5359-5153	5469-5067	Northern Coast	Gopher and Gophna 1993: 306
Peqi'in Cave	RT-2393	6545 +- 50	5596-5475	5615-5382	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2380	6245 +- 55	5300-5079	5320-5046	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2385	6120 +- 55	5206-4864	5257-4850	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2392	6120 +- 55	5206-4864	5257-4850	Galilee	Segal et al. 1998: 711

Peqi'in Cave	RT-2396	6055 +- 85	5056-4807	5256-4724	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2397	6100 +- 55	5193-4860	5228-4810	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2395	6085 +- 50	5054-4858	5207-4808	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2384	5960 +- 85	4939-4722	5051-4620	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2394	5930 +- 50	4897-4723	4920-4693	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2391	5815 +- 90	4778-4546	4901-4458	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2381	5840 +- 50	4774-4620	4830-4549	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2382	5825 +- 50	4771-4616	4802-4545	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2373	5790 +- 45	4712-4551	4773-4502	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2386	5685 +- 80	4666-4405	4767-4350	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2383	5725 +- 50	4670-4464	4709-4456	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2379	5710 +- 45	4598-4463	4688-4415	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2388	5675 +- 60	4550-4414	4687-4359	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2374	5645 +- 60	4540-4370	4667-4350	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2378	5615 +- 45	4493-4363	4542-4349	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2376	5510 +- 45	4428-4334	4454-4252	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2377	5490 +- 55	4359-4257	4453-4245	Galilee	Segal et al. 1998: 711
Peqi'in Cave	RT-2387	5410 +- 50	4334-4170	4347-4049	Galilee	Segal et al. 1998: 711
Ein el Jarba IV	GX-787	5690 +- 140	4710-4359	4845-4251	Galilee	Kaplan 1969: 27, Weinstein 1984: 333
Ein el Jarba IV	GX-786	4920 +- 240	3967-3379	4317-3043	Galilee	Kaplan 1969: 27, Weinstein 1984: 333
Nahal Qanah Cave	RT-861D	6980 +- 180	6015-5672	6219-5557	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-1544	7054 +- 78	6005-5812	6063-5734	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-861B	6010 +- 150	5195-4718	5301-4540	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-861E	5440 +- 100	4357-4114	4460-3999	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-861C	5240 +- 180	4323-3803	4452-3653	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-861A	5150 +- 190	4222-3710	4355-3537	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-1545	5340 +- 57	4317-4045	4333-3995	Samaria	Carmi 1996: 206
Nahal Qanah Cave	RT-1543	5090 +- 75	3971-3789	4039-3706	Samaria	Carmi 1996: 206
Sataf	OxA-3435	5270 +- 75	4223-3980	4324-3957	Judean Mountains	Hedges et al. 1992: 352
Cave of the Warrior	RT-1942	5640 +- 60	4538-4366	4666-4347	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	RT-2513	5660 +-40	4538-4456	4578-4364	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	AA-22236	5600 +- 65	4495-4355	4549-4335	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	AA-22237	5420 +- 50	4336-4174	4352-4051	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	AA-22235	5140 +- 50	3980-3824	4040-3798	Judean Desert	Jull et al. 1998: 110-112

Cave of the Warrior	AA-22234	5120 +- 55	3976-3804	4038-3785	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	AA-13442	4995 +- 45 (avg)	3893-3708	3942-3661	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	RT-1945	4910 +- 65	3761-3643	3905-3539	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	RT-1946	4925 +- 50	3761-3651	3887-3640	Judean Desert	Jull et al. 1998: 110-112
Cave of the Warrior	RT-1943	4700 +- 75	3632-3369	3644-3348	Judean Desert	Jull et al. 1998: 110-112
Nahal Hever	I-616	5460 +- 125	4448-4113	4542-3984	Judean Desert	Aharoni 1962: 189, Weinstein 1984: 335
Nahal Mishmar Cave 1	RT-1408	5575 +- 90	4494-4339	4598-4248	Judean Desert	Segal and Carmi 1996: 93
Nahal Mishmar Cave 1	BM-140	5390 +- 150	4357-4000	4521-3825	Judean Desert	Bar-Adon 1980: 199, 216; Weinstein 1984: 335
Nahal Mishmar Cave 1	RT-1409	5355 +- 55	4321-4048	4335-4000	Judean Desert	Carmi and Segal 1992: 131
Nahal Mishmar Cave 1	W-1341	4880 +- 250	3960-3370	4246-2925	Judean Desert	Bar-Adon 1980: 199, 216; Weinstein 1984: 335
Nahal Mishmar Cave 1	RT-1407	4990 +- 70	3935-3672	3960-3644	Judean Desert	Carmi and Segal 1992: 131
Nahal Mishmar Cave 1	I-353	4760 +- 120	3654-3372	3780-3136	Judean Desert	Bar-Adon 1980: 86-87; Weinstein 1984: 335
Nahal Mishmar Cave 1	I-285	4780 +- 100	3654-3379	3764-3357	Judean Desert	Bar-Adon 1980: 199, 216; Weinstein 1984: 335
Nahal Mishmar Cave 2	I-1819	4725 +- 230	3709-3104	3978-2885	Judean Desert	Bar-Adon 1980: 199, Weinstein 1984: 335
Nahal Mishmar Cave 3	RT-1645	5535 +- 75	4455-4333	4519-4246	Judean Desert	Segal and Carmi 1996: 93
Lower Wadi Makukh	OxA-1928	5310 +- 80	4307-3997	4336-3963	Judean Desert	Housley 1994: 65
Cave of the Sandal	RT-2178	5125 +- 60	3978-3804	4040-3782	Judean Desert	Segal and Carmi 1996: 90
Tel Tsaf	RT-508A	6720 +- 460	6023-5215	6460-4623	Jordan Valley	Gopher and Gophna 1993: 306
Tel Tsaf	RT-?	6980 +- 180	6015-5672	6219-5557	Jordan Valley	Weinstein 1984: 334
Ghassul	SUA-732	6550 +- 160	5625-5344	5731-5151	Jordan Valley	Weinstein 1984: 333
Ghassul	SUA-736	6430 +- 180	5602-5213	5708-4948	Jordan Valley	Weinstein 1984: 334
Ghassul	SUA-734	6370 +- 105	5472-5215	5513-5062	Jordan Valley	Weinstein 1984: 334
Ghassul	SUA-738/1	6300 +- 110	5457-5079	5478-4958	Jordan Valley	Weinstein 1984: 334
Ghassul	SUA-739	6070 +- 130	5208-4798	5305-4689	Jordan Valley	Weinstein 1984: 334
Ghassul	SUA-511b	5796 +- 115	4780-4498	4913-4362	Jordan Valley	Bourke 1997: 410, personal communication 1999
Ghassul	SUA-511c	5661 +- 120	4672-4357	4777-4253	Jordan Valley	Bourke 1997: 410, personal communication 1999
Ghassul	SUA-511a	5507 +- 120	4458-4247	4582-4043	Jordan Valley	Bourke 1997: 410, personal communication 1999
Ghassul	RT-390A	5500 +- 110	4455-4248	4546-4045	Jordan Valley	Weinstein 1984: 335
Ghassul	GrN-15195	5270 +- 100	4230-3973	4336-3806	Jordan Valley	Bourke 1997: 410, personal communication 1999
Ghassul	GrN-15194	5330 +- 25	4224-4049	4307-4044	Jordan Valley	Bourke 1997: 410, personal communication 1999
Ghassul	GrN-15196	5110 +- 90	3982-3793	4217-3702	Jordan Valley	Bourke 1997: 410, personal communication 1999
Abu Hamid	Ly-6174	6200 +- 80	5296-5005	5320-4859	Jordan Valley	Lovell et al. 1997: 361
Abu Hamid	Ly-6254	6190 +- 55	5259-5049	5300-4957	Jordan Valley	Lovell et al. 1997: 361
Abu Hamid	Ly-6255	6160 +- 70	5256-4964	5300-4854	Jordan Valley	Lovell et al. 1997: 361
Abu Hamid	Ly-6259	6135 +- 80	5227-4862	5299-4807	Jordan Valley	Lovell et al. 1997: 361
Abu Hamid	GrN-16357	6030 +- 60	4995-4807	5191-4739	Jordan Valley	Dollfus and Kafafi 1993: 244

Abu Hamid	GrN-16358	5745 +- 35	4673-4539	4707-4464	Jordan Valley	Dollfus and Kafafi 1993: 245
Abu Hamid	GrN-14623	5670 +- 40	4543-4457	4597-4371	Jordan Valley	Dollfus and Kafafi 1993: 245
Abu Hamid	GrN-17496	5651 +- 40	4522-4409	4550-4362	Jordan Valley	Dollfus and Kafafi 1993: 245
Abu Hamid	Ly-6258	5205 +- 95	4218-3956	4316-3789	Jordan Valley	Lovell et al. 1997: 361
Nizzanim	HV-8509	6740 +- 90	5722-5561	5795-5482	Southern Coast	Gopher and Gophna 1993: 306
Givat Haparsa	KN-3537	6100 +- 120	5228-4810	5316-4718	Southern Coast	Gopher and Gophna 1993: 306
Givat Haparsa	?	4900 +- 70	3757-3641	3893-3535	Southern Coast	Gopher and Gophna 1993: 306
Horvat Beter	C-919	7420 +- 520	6978-5741	7540-5323	Northern Negev	Dothan 1959: 42, Weinstein 1984: 334
Horvat Beter	W-245	5280 +- 150	4326-3960	4447-3714	Northern Negev	Dothan 1959: 42, Weinstein 1984: 334
Horvat Beter	Pta-4312	5100 +- 130	4038-3712	4224-3643	Northern Negev	Levy and Alon 1987: Table 6.4
Horvat Beter	Pta-4212a	5180 +- 70	4041-3956	4221-3798	Northern Negev	Levy and Alon 1987: Table 6.4
Shiqmim	RT-649D	6150 +- 180	5305-4808	5477-4620	Northern Negev	Carmi 1987: 104, Levy et al. 1991: 402
Shiqmim	RT-649B	5750 +- 180	4797-4363	5037-4248	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-554B	5050 +- 490	4357-3351	4915-2580	Northern Negev	Weinstein 1984: 335
Shiqmim	OxA-2523	5710 +- 140	4766-4363	4899-4255	Northern Negev	Levy et al. 1991: 402
Shiqmim	OxA-2524	5650 +- 140	4685-4345	4799-4174	Northern Negev	Levy et al. 1991: 402
Shiqmim	OxA-2522	5600 +- 130	4548-4335	4769-4114	Northern Negev	Levy et al. 1991: 402
Shiqmim	OxA-2526	5540 +- 150	4520-4248	4713-4000	Northern Negev	Levy et al. 1991: 402
Shiqmim	OxA-2521	5530 +- 130	4492-4250	4686-4043	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-859E	5390 +- 180	4440-3984	4584-3796	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-859B	5460 +- 140	4452-4052	4576-3977	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-859D	5370 +- 180	4359-3979	4548-3786	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1334	5590 +- 60	4489-4353	4544-4335	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1321	5570 +- 65	4459-4343	4539-4258	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	OxA-2525	5385 +- 130	4347-4004	4487-3959	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1328	5520 +- 60	4447-4332	4486-4249	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1319	5450 +- 60	4345-4247	4445-4053	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-554A	5250 +- 140	4248-3956	4355-3712	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1326	5420 +- 50	4336-4174	4352-4051	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1335	5370 +- 65	4327-4049	4343-3999	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1341	5370 +- 40	4321-4053	4332-4046	Northern Negev	Carmi and Segal 1992: 125
Shiqmim	RT-859C	5080 +- 180	4042-3660	4328-3519	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1317	5330 +- 50	4246-4045	4327-3996	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1330	5300 +- 60	4224-4000	4324-3976	Northern Negev	Carmi and Segal 1992: 124
Shiqmim	RT-1318	5240 +- 65	4219-3975	4233-3955	Northern Negev	Carmi and Segal 1992: 124

Shiqmim	RT-1322	5190 +- 75	4043-3957	4223-3798	Northern Negev	Levy et al. 1991: 402
Shiqmim	OxA-2520	5060 +- 140	3982-3673	4222-3539	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1339	4940 +- 70	3787-3650	3940-3543	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1332	4700 +- 80	3633-3368	3647-3345	Northern Negev	Levy et al. 1991: 402
Shiqmim	RT-1329	4260 +- 80	2918-2710	3082-2602	Northern Negev	Carmi and Segal 1992: 124
Qatif Y-3	Pta-2968	6040 +- 80	5043-4805	5225-4723	Northern Negev	Gilead 1988: 401
Safadi	M-864A	5420 +- 350	4667-3807	5042-3519	Northern Negev	Perrot 1987: 18, Weinstein 1984: 334
Safadi	M-864B	5270 +- 300	4439-3712	4770-3377	Northern Negev	Perrot 1987: 18, Weinstein 1984: 334
Safadi	M-864C	5120 +- 350	4336-3538	4707-3028	Northern Negev	Perrot 1987: 18, Weinstein 1984: 334
Safadi	Ly-3905	5190 +- 100	4217-3825	4310-3771	Northern Negev	Perrot 1987: 18
Safadi	Ly-3906	5190 +- 100	4217-3825	4310-3771	Northern Negev	Perrot 1987: 18
Safadi	Ly-3904	5170 +- 110	4216-3803	4310-3708	Northern Negev	Perrot 1987: 18
Safadi/Beer Zfad	RT-862C	5220 +- 105	4221-3957	4326-3785	Northern Negev	Carmi and Segal 1992: 125
Gilat	OxA-3556	5790 +- 105	4774-4499	4902-4365	Northern Negev	This paper
Gilat	OxA-3555	5700 +- 100	4688-4404	4777-4342	Northern Negev	This paper
Gilat	Beta-131730	5730 +- 40	4669-4500	4705-4460	Northern Negev	This paper
Gilat	RT-860A	5440 +- 180	4456-4042	4688-3816	Northern Negev	Carmi and Segal 1992: 125
Gilat	OxA-4011	5540 +- 70	4455-4335	4516-4249	Northern Negev	This paper
Gilat	Beta-131729	5560 +- 50	4455-4344	4494-4332	Northern Negev	This paper
Gilat	RT-860B	4800 +- 135	3705-3377	3973-3141	Northern Negev	Carmi and Segal 1992: 125
Gilat	RT-2058	4530 +- 85	3367-3093	3515-2921	Northern Negev	This paper
Tel Shoqet	RT-863B	5490 +- 140	4458-4168	4668-3984	Northern Negev	Carmi and Segal 1992: 126
Tel Shoqet	RT-863A	4620 +- 170	3635-3095	3710-2893	Northern Negev	Carmi and Segal 1992: 126
Abu Matar	RT-1613	5275 +- 55	4221-3991	4248-3969	Northern Negev	Segal and Carmi 1996: 93
Abu Matar	RT-1610	5250 +- 55	4219-3980	4225-3961	Northern Negev	Segal and Carmi 1996: 93
Kvish Harif	Pta-3374	5269 +- 60	4221-3984	4314-3963	Central Negev	Rosen 1984: 119
Tel Wadi Fidan	HD-10567	6410 +- 118	5479-5298	5614-5075	Southern Jordan	Gopher and Gophna 1993: 306, Najjar et al. 1990: 32
Tel Wadi Fidan	HD-12335	6360 +- 45	5455-5301	5469-5215	Southern Jordan	Gopher and Gophna 1993: 306, Najjar et al. 1990: 32
Tel Wadi Fidan	HD-12338	6110 +- 75	5207-4858	5280-4802	Southern Jordan	Gopher and Gophna 1993: 306, Najjar et al. 1990: 32
Tel Wadi Fidan	HD-12337	5740 +- 35	4671-4504	4705-4463	Southern Jordan	Najjar et al. 1990: 32
Tel Wadi Fidan	HD-12336	5375 +- 30	4320-4165	4329-4050	Southern Jordan	Najjar et al. 1990: 32
Wadi Fidan 51	Beta-118580	6260 +- 40	5300-5147	5317-5075	Southern Jordan	Levy et al. in press
Risqeh	K-1467	6010 +- 120	5049-4728	5260-4604	Southern Jordan	Avner et al. 1994: 269
Jebel Queisa (J24)	SMU-804	5720 +- 149	4770-4363	4908-4254	Southern Jordan	Henry 1992: 139, Weinstein 1984: 335
Tor Sabiha (J8)	Beta-1264	4040 +- 175	2878-2309	3017-2039	Southern Jordan	Henry 1995: 58

Uvda 9	Pta-3646	6960 +- 70	5964-5733	5989-5714	Southern Negev	Avner 1998: 153
Eilat V	RT-1215	6400 +- 210	5602-5079	5718-4810	Southern Negev	Carmi and Segal 1992: 128
Eilat IV	RT-989	6470 +- 60	5479-5368	5528-5317	Southern Negev	Carmi and Segal 1992: 128
Eilat IV	RT-926A	6340 +- 60	5367-5264	5470-5147	Southern Negev	Carmi and Segal 1992: 128
Eilat V	RT-1214	5980 +- 130	5037-4716	5258-4545	Southern Negev	Carmi and Segal 1992: 128
Eilat V	RT-1216	6060 +- 65	5046-4813	5208-4781	Southern Negev	Carmi and Segal 1992: 128
Eilat V	RT-1212	5930 +- 80	4904-4716	4996-4603	Southern Negev	Carmi and Segal 1992: 128
Eilat IV	RT-1210	5710 +- 75	4674-4458	4769-4360	Southern Negev	Carmi and Segal 1992: 128
Eilat V	RT-1211	5640 +- 60	4538-4366	4666-4347	Southern Negev	Carmi and Segal 1992: 128
Eilat V	RT-1213	5490 +- 60	4360-4255	4456-4173	Southern Negev	Carmi and Segal 1992: 128
Eilat IV	RT-926B	5400 +- 100	4343-4048	4453-3981	Southern Negev	Carmi and Segal 1992: 128
Uvda 6	RT-628B	6400 +- 200	5597-5082	5712-4814	Southern Negev	Carmi 1987: 103
Uvda 6	Pta-3621	6400 +- 60	5470-5316	5479-5263	Southern Negev	Avner et al. 1994: 269
Uvda 6	RT-628A	6560 +- 90	5615-5395	5658-5323	Southern Negev	Carmi 1987: 103
Uvda 6	RT-1739	6390 +- 60	5468-5304	5477-5215	Southern Negev	Segal and Carmi 1996: 97
Uvda 7	RT-724B	6410 +- 120	5479-5298	5615-5069	Southern Negev	Carmi and Segal 1992: 120
Uvda 7	RT-?	6360 +- 120	5473-5154	5598-5005	Southern Negev	Gopher and Gophna 1993: 306
Nahal Issaron (Uvda 14)	Pta-2999	6460 +- 80	5480-5323	5607-5299	Southern Negev	Gopher and Gophna 1993: 306
Nahal Issaron (Uvda 14)	RT-1692	6350 +- 90	5466-5214	5479-5068	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	Pta-3486	6130 +- 70	5209-4863	5289-4811	Southern Negev	Gopher and Gophna 1993: 306
Nahal Issaron (Uvda 14)	RT-1663	5755 +- 85	4713-4464	4799-4369	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	RT-1608	5690 +- 55	4580-4458	4688-4364	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	RT-1506	5635 +- 70	4540-4362	4671-4341	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	RT-1630	5625 +- 70	4535-4360	4667-4338	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	RT-1513	5170 +- 55	4037-3956	4217-3803	Southern Negev	Segal and Carmi 1996: 97
Nahal Issaron (Uvda 14)	RT-1518	4990 +- 50	3893-3706	3943-3656	Southern Negev	Segal and Carmi 1996: 97
Yotvata Hill	RT-1547	5800 +- 45	4766-4553	4775-4537	Southern Negev	Avner et al. 1994: 269
Yotvata Hill	RT-1548	5465 +- 55	4350-4251	4446-4168	Southern Negev	Segal and Carmi 1996: 98
Yotvata Hill	RT-1546	4650 +- 75	3616-3356	3637-3104	Southern Negev	Avner et al. 1994: 269
Uvda 151	RT-648B	5670 +- 85	4597-4370	4766-4342	Southern Negev	Avner 1984: 117
Uvda 4	RT-724D	5400 +- 110	4345-4047	4457-3977	Southern Negev	Carmi and Segal 1992: 120
Uvda 16	RT-640A	4800 +- 70	3650-3521	3706-3375	Southern Negev	Carmi 1987: 103
Dimona	RT-1556	4658 +- 55	3518-3364	3630-3347	Southern Negev	Avner et al. 1994: 269
Site 649	SMU-835	6594 +- 205	5711-5325	5874-5078	Sinai (Central)	Henry 1992: 139
Site 649 EX	SMU-676	5210 +- 51	4042-3966	4220-3949	Sinai (Central)	Henry 1992: 139

Khashim et-Tarif	RT-1947	6580 +- 70	5615-5477	5635-5380	Sinai (Central)	Segal and Carmi 1996: 102
Site 713	SMU-641	6403 +- 76	5473-5304	5505-5213	Sinai (Central)	Henry 1992: 139
Site 713	SMU-742	5654 +- 57	4543-4402	4669-4355	Sinai (Central)	Henry 1992: 139
Site 713	SMU-788	5523 +- 73	4451-4263	4496-4235	Sinai (Central)	Henry 1992: 139
Wadi Daba'iya	RT-2186	6045 +- 65	5037-4809	5206-4742	Sinai (Central)	Segal and Carmi 1996: 103
Site 332	SMU-675	5789 +- 70	4768-4544	4801-4460	Sinai (Central)	Henry 1992: 139
Site 332	SMU-809	5708 +- 81	4685-4457	4771-4357	Sinai (Central)	Henry 1992: 139
Site 332	SMU-790	5523 +- 69	4450-4264	4494-4264	Sinai (Central)	Henry 1992: 139
Site 650	SMU-740	5665 +- 119	4673-4358	4778-4254	Sinai (Central)	Henry 1992: 139
Site 650	SMU-822	5625 +- 115	4575-4345	4768-4248	Sinai (Central)	Henry 1992: 139
Site 650	SMU-743	4427 +- 68	3326-2921	3353-2897	Sinai (Central)	Henry 1992: 139
Ein Um Ahmad	RT-1856	5815 +- 50	4770-4600	4798-4540	Sinai (Central)	Segal and Carmi 1996: 103
Ein Um Ahmad	RT-1859	5715 +- 70	4675-4460	4769-4364	Sinai (Central)	Segal and Carmi 1996: 103
Ein Um Ahmad	RT-1857	5575 +- 50	4457-4350	4499-4336	Sinai (Central)	Segal and Carmi 1996: 103
Ein Um Ahmad	RT-1852	5400 +- 70	4336-4054	4358-4005	Sinai (Central)	Segal and Carmi 1996: 103
Ein Um Ahmad	RT-1858	5190 +- 50	4039-3961	4218-3823	Sinai (Central)	Segal and Carmi 1996: 103
Ein Um Ahmad	RT-1851	5130 +- 55	3978-3811	4040-3791	Sinai (Central)	Segal and Carmi 1996: 103
Wadi Zalaka	Pta-3655	5690 +- 50	4576-4459	4686-4372	Sinai	Avner 1984: 117
Wadi Zalaka	Pta-3633	5590 +- 70	4493-4348	4549-4262	Sinai	Avner 1984: 117
Wadi Zalaka	RT-648A	5440 +- 80	4350-4171	4453-4045	Sinai	Avner 1984: 117
Moon Valley	RT-1948	5470 +- 70	4357-4249	4455-4053	Sinai (Central)	Segal and Carmi 1996: 102
Moyat Daba'iya	RT-1855	5355 +- 60	4322-4047	4337-3998	Sinai (Central)	Segal and Carmi 1996: 103
N. Sinai Site A-173	RT-1965	5350 +- 60	4320-4046	4336-3996	Sinai (North)	Segal and Carmi 1996: 100
Serabit el-Khadim	RT-1811	5350 +- 55	4319-4047	4334-3999	Sinai (Central)	Segal and Carmi 1996: 104
Serabit el-Khadim	RT-1807	5250 +- 55	4219-3980	4225-3961	Sinai (Central)	Segal and Carmi 1996: 104
Serabit el-Khadim	RT-1809	5230 +- 55	4217-3975	4223-3957	Sinai (Central)	Segal and Carmi 1996: 104
Wadi Watir VIII	RT-1845	5240 +- 55	4218-3978	4224-3959	Sinai (Central)	Segal and Carmi 1996: 100
Abu Halil	RT-1853	5200 +- 70	4215-3960	4223-3803	Sinai (Central)	Segal and Carmi 1996: 103
N. Sinai Sites B-50/51	RT-2129	5045 +- 55	3945-3771	3965-3704	Sinai (North)	Segal and Carmi 1996: 100
N. Sinai Sites B-50/51	RT-1962	5010 +- 55	3936-3709	3958-3659	Sinai (North)	Segal and Carmi 1996: 99
N. Sinai Site R-45	RT-2132	4980 +- 45	3887-3704	3938-3656	Sinai (North)	Segal and Carmi 1996: 100
Sheikh Muhsen	Hv-5296	4710 +- 50	3628-3376	3638-3365	Sinai	Avner et al. 1994: 269