11. RADIOCARBON DATING OF BESTANSUR AND SHIMSHARA

Pascal Flohr, Roger Matthews, Wendy Matthews, Amy Richardson and Dominik Fleitmann

In this chapter we present eleven ^{14}C dates from Bestansur and one from Shimshara, and discuss them in relation to the previously published Sheikh-e Abad and Jani dates (Matthews *et al*. 2013c) and the wider context. The Bestansur and Shimshara samples were all analysed by Beta Analytic laboratories. The samples, their contexts and the results are provided in Table 11.1. All ^{14}C dates were calibrated in OxCal version 4.3 using the IntCal13 curve (Bronk Ramsey 2009; Reimer 2013). All dates referred to throughout this chapter, and the entire volume, are calibrated BC dates unless otherwise stated.

The aim of the dating programme was to examine the development of sedentism and early agriculture in the EFC by placing the sites in their chronological context, and by comparing them to local and regional developments and climatic and environmental change in the Zagros and Southwest Asia. A major aim of the CZAP project is to assess the chronology of continuity and change in the Zagros Neolithic (Chapter 1).

Assessment

In order to interpret the sites in their chronological and environmental framework, we first assess the reliability of the ^{14}C dates. We use several criteria that are discussed in detail in Flohr *et al*. (2015) and Marshall (2012). First, we evaluate the laboratory assessment as it indicates, among other things, whether the samples contained sufficient carbon for analysis. Secondly, the dating precision is assessed. Large standard deviations may indicate a problematic sample, while they may also make site occupation appear erroneously long. Thirdly, the reliability of the dated material is examined. Bulk samples are problematic, as the inclusion of sediment or roots will cause contamination and yield dates that are too old or too young, respectively (Gillespie 1984; van der Plicht 2001). Shell is also known to result in problematic dates, due to hard water effects and the uptake of older carbon (Bowman 1990). Other problematic material can be burnt bone, bone apatite, and bone carbonate. Finally, we consider the deviation of $\delta^{13}C$ values as this can indicate contamination (van der Plicht 2005).

If the ^{14}C determination itself appears reliable, it is furthermore important to assess whether the sample dates the context in which it was found. Small samples, like seeds, may have been transported through sediment layers, while charcoal samples may represent 'old wood' (van der Plicht 2001). It is therefore important to establish whether the samples have a clear relation to their context and whether they were likely deposited *in situ* which for bone, for example, may be indicated by articulation (Bayliss 2015).

Based on the above quality-check criteria, the seven ^{14}C dates from Sheikh-e Abad and Jani appear reliable. There were no problems reported by the laboratory, the dates have low standard deviations (≤60 ^{14}C years), they were conducted on a range of different materials that can be confirmed to be reliable (charred seeds, charcoal and bone collagen), and the $\delta^{13}C$ values are as expected for each type of material (Table 11.1). It is more difficult to assess whether the samples precisely date their contexts but this appears likely, as the dates fully agree with the stratigraphic order, between and within trenches (Matthews *et al*. 2013c). While two of the dates are on charcoal, and could potentially represent old wood, the fact that they are in chronological and stratigraphic agreement with short-lived samples, which are both on seeds and bone, makes this less likely.

Table 11.1. Radiocarbon samples and dates from CZAP sites in Iraq and Iran. Calibration was conducted in OxCal 4.3 (Bronk Ramsey 2009) and uses IntCal13 curve (Reimer et al. 2013). Start dates are the oldest date in the probability range; end dates are the youngest dates in the probability range; small gaps in the range are not indicated in the table.

Sample	*Context*	*Material*	*Details*	*Lab no*	*^{14}C (uncal) ±1σ*	*$\delta^{13}C$ (‰)*	*Cal BC 1σ*	*Cal BC 2σ*	*Assessment*
Sheikh-e Abad									
S75	T1, 512	Charred seed	*Astragalus*	Beta-258647	10130±60	N/A	10,007–9671	10,078–9456	Reliable, short-lived
S2	T1, 515	Charcoal	Unidentified	Beta-267508	9970±50	–23.8	9650–9321	9746–9299	Reliable, potential old wood effect
S68	T1, 511	Charred seed	Poaceae	Beta-267509	9730±60	–22.7	9278–9159	9303–8852	Reliable, short-lived
S65	T2, 617	Charred seed	*Vicia ervilia*	Beta-258646	8840±60	–23.2	8191–7822	8219–7750	Reliable, short-lived
S800a	T3, 800	Bone collagen	Sheep/goat	Beta-258648	8600±40	–18.9	7647–7578	7721–7567	Reliable, short-lived
Jani									
S72b	Section 23	Charred seed	Cyperaceae	Beta-258649	8860±60	–23.4	8208–7884	8230–7759	Reliable, short-lived
S11	Section 11	Charcoal	Unidentified	Beta-267510	8820±50	N/A	8169–7761	8206–7737	Reliable, potential old wood effect
Bestansur									
SA123	T5, C1078. Shell midden	Mollusc shell	*Helix salomonica*	Beta-326883	9570±40	–9.7	9125–8828	9152–8788	Unreliable, old carbon effect
SA740	T7, C1254	Charred seeds	*Lens* sp.	Beta-342482	2770±30	–23.4	973–848	997–839	Probably intrusive
SA803	T7, C1262	Charred seeds	*Lens* sp.	Beta-343963	2740±30	–22.9	906–841	971–816	Probably intrusive
	T10, C1412A. Open area	Bone collagen	Goat tibia	Beta-368934	8610±50	–19	7672–7580	7741–7552	Reliable, likely deposited in situ
RD7	T10, C1772. Butchery deposit	Bone collagen	Sheep scapula	Beta-406556	8620±30	–18.5	7647–7587	7713–7581	Reliable, probably deposited in situ
SA1223	T12, C1388. Midden area	Charred plant material	2 lentils	Beta-351365	6380±40	–21.5	5464–5315	5471–5304	Too young for associated material: unreliable
406557 supp	T13, C1386. Butchery deposit	Bone collagen	Pig carpal	Beta-408868	8130±30	–20	7141–7063	7185–7050	Reliable, articulating carpals suggest deposited in site
SA261	T10, C1781. Packing below floors	Tooth collagen	Human	Beta-533614	8640±40	–19.6	7677–7592	7736–7586	Reliable
	T10, Ext. deposits close to B5	Bone collagen	Human femur	Beta-533619	8460±30	–19	7567–7520	7579–7495	Reliable
SA851	T10, C1972. Fill of cut into B8 W57	Tooth collagen	Human	Beta-533625	8440±30	–20.3	7546–7496	7574–7482	Reliable
SA821	T10, C1868. SK6 in skull cluster	Tooth collagen	Human	Beta-533626	8330±40	–20	7471–7356	7519–7301, 7216–7204	Reliable
Shimshara									
SA757	Section	Charred nutshell	*Pistacia* sp.	Beta-342484	8230±40	–24	7322–7180	7447–7082	Reliable

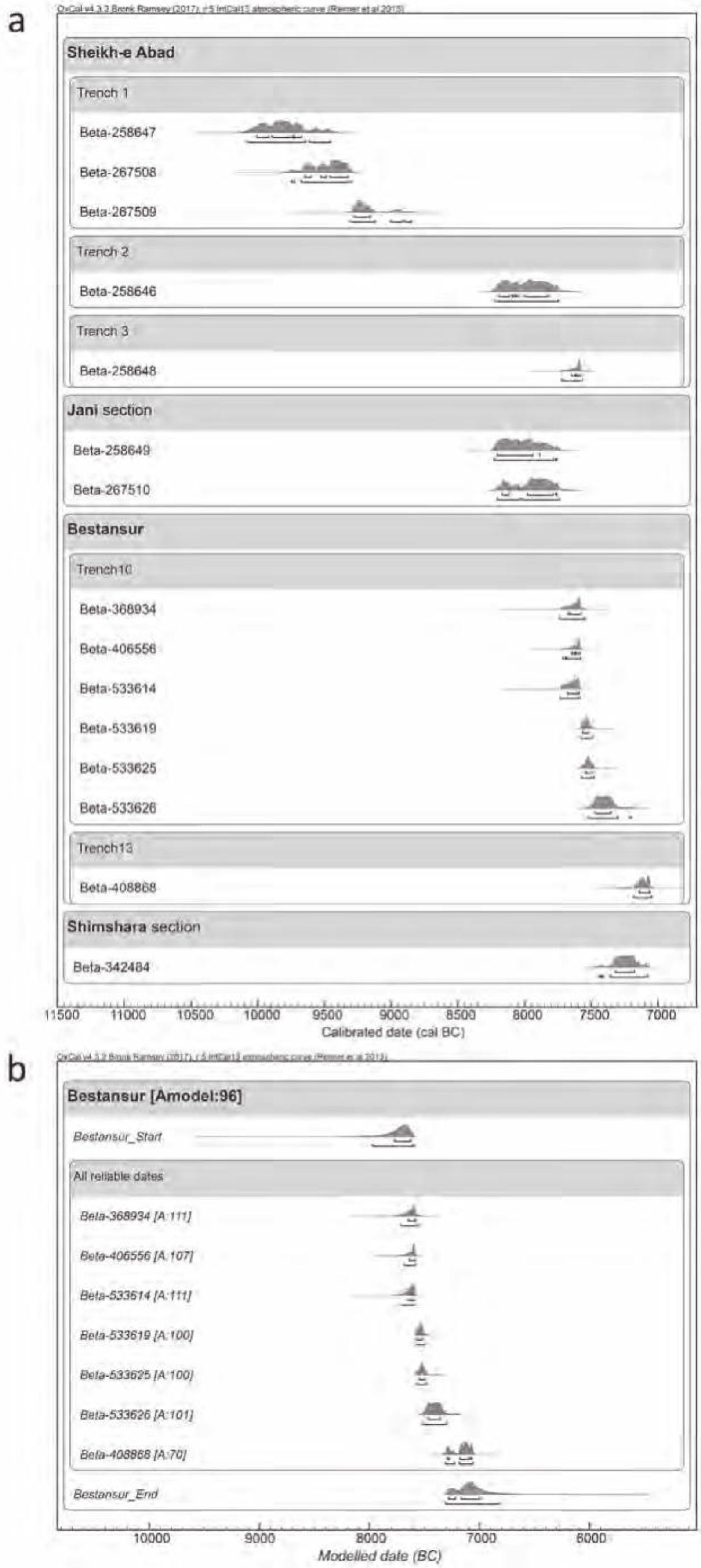

Figure 11.1. a: Calibrated reliable ^{14}C dates (cal BC) from Sheikh-e Abad, Jani, Bestansur and Shimshara, arranged by trench and, where known (for Sheikh-e Abad and Jani), stratigraphic order with the oldest sample first; b: Modelled reliable ^{14}C dates from Bestansur.

The 11 ^{14}C dates from Bestansur are more challenging to assess. All dated contexts were Neolithic based on the associated material, but the calibrated ^{14}C dates range from *c.* 9000 to 900 BC. Because of, initially, limited amounts of charred seeds, charcoal and bone collagen preserved in the materials sampled from this site, concessions had to be made in choosing ^{14}C samples. Consequently, one of the samples, Beta-326883, was a mollusc shell. Land snail shell has often been shown to be too old for its context, by as much as up to 3000 years, due to the snail uptaking old, ^{14}C-depleted carbon, probably calcium carbonate derived from limestone (Rubin 1963; Goodfriend 1983; 1987; Quarta 2007). While there are cases in which no offset is present or it can be corrected for (Pigati 2010; Carvalho 2015), in the case of Beta-326883 the date is clearly too old compared to the other ^{14}C dates and the archaeological material. While the date indicates that the occupation was probably Neolithic, it is not more precise than that and has to be treated as unreliable.

The two youngest Bestansur dates are probably reliable as ^{14}C determinations, with low standard deviations, reliable material and expected $\delta^{13}C$ values. They are clearly too young for the associated Neolithic material, however, at *c.* 1000–800 BC, and are therefore intrusive from Iron Age levels at the site. As seeds, they could easily have moved through sediment layers (van der Plicht 2001; Finlayson 2011). Moreover, the seeds were found in well-defined circular and ovoid patches of 6–13cm, about the size of a rodent hole. After submission of these two samples for ^{14}C dating, more of such caches were found and it was established that they were associated with well-preserved rodent remains (Chapters 12 and 18). Charring may have occurred post-deposition by burning of field stubble, nowadays a common practice in the region, or the lentils may have been gathered in a charred state. We therefore have to discard these dates as reliably representing Neolithic contexts. The Iron Age dates are clearly associated with the Iron Age settlement at Bestansur.

Beta-351365 represents charred plant material but was a mixture of charred remains from the same deposit. The context comprises short-lived midden-like deposits between laid surfaces and is potentially a reliable context. The Chalcolithic date of the sample, however, does not match the Neolithic material in these contexts. As no Chalcolithic-type material has been found during the survey or excavations at Bestansur (Chapter 9; Altaweel *et al*. 2012). It is more likely therefore that it represents a mixture of Neolithic and intrusive Iron Age material, especially since different charred remains from this context were combined for this sample to provide enough datable material. Bioturbation was observed to be a problem in the upper 0.5m of Trench 12, from where the sample was derived (Chapter 9).

While these dates, and others discussed in Chapter 18, show a degree of intrusion of small charred materials into Early Neolithic levels, we do not believe they significantly impact the contextual and chronological security of the excavated Neolithic levels at Bestansur. Apart from some elements of the charred plant assemblages, all recovered materials from our Neolithic levels are clearly of Early Neolithic date as confirmed by: 1) all radiocarbon dates on animal and human bones (Table 11.1); 2) consistent and coherent lithic assemblages exclusively of eighth millennium BC date (Chapter 20), and; 3) the complete absence of even very small ceramic sherds from any excavated context interpreted by us to be Early Neolithic in date.

This evaluation of the security of the dates, therefore leaves seven samples from Bestansur which have a Neolithic date and which are reliable as ^{14}C dates. Beta-533614, -533619, -533625 and -533626 are human tooth and bone collagen from Trench 10 from reliable contexts. For the remaining three Neolithic dates, the *in situ* and articulated nature of the dated bones strongly argues that they too come reliable contexts. Beta-406557 was one of several articulating pig carpals, which suggests it was freshly deposited. Beta-368934 was from a goat tibia that also appeared to have been deposited *in situ*. Beta-406556 was assayed from a sheep scapula in an extensive butchery deposit and is therefore also likely to be reliable. We therefore accept these seven dates as reliably dating Neolithic Bestansur, pending an increased number of dates in future studies. This acceptance is strongly supported by chronological comparisons to well-dated material from other sites based on stylistic studies reported on in this volume. The material culture, chipped stone and small finds in particular, support assignation of a date of mid–late eighth millennium BC date to the main excavated levels at Bestansur and a later eighth millennium BC date to excavated levels at Shimshara.

A single sample from a charred nutshell in basal deposits of Shimshara was ^{14}C dated. This date appears to be reliable but, as a nutshell, it cannot be completely ruled out as intrusive. Nonetheless, its visible association with ash and grey mixed lenses makes a functional relation to the context likely. We tentatively accept this sample as reliable, but additional samples are needed for confirmation.

Previously, four samples were dated from the now largely eroded Pottery Neolithic levels at Shimshara (Mortensen 1970). Unfortunately, these dates are not reliable as they had a very low carbon content (0.16–0.32%). Because the material dated was temper in potsherds, there is an increased chance that the dates are contaminated by organic matter in the clay or post-depositional uptake of carbon in the porous sherds. Contamination is possibly also reflected in the large standard deviations (≥150 ^{14}C years) and the very old date for K-981 (10030 ±160 ^{14}C years).

Chronology of the CZAP sites

The calibrated reliable ^{14}C-dates from the four CZAP sites are shown in Figure 11.1. Sheikh-e Abad is the earliest of these sites. It was first occupied in the early tenth millennium BC at the very beginning of the Holocene, perhaps even commencing in the Younger Dryas (see also below), and its later dates fall within the early–mid-eighth millennium BC (Matthews *et al*. 2013c). A Bayesian model of the Sheikh-e Abad dates is shown in Figure 11.2, although it should be stressed that the number of dates is too low to take the results with certainty, and the start and end boundaries in the model should be seen as approximate indications only. It is likely, however, that the available dates bracket the occupation span as the earliest date, Beta-258647, comes from the basal level, while the latest date, Beta-258648, comes from the top of the mound. It is so far not certain whether occupation is continuous between the earliest and latest dates but if it is the site has at least a 2000-year span, dating from the early tenth millennium BC to the first half of the eighth millennium BC.

The available Jani dates are of late ninth or early eighth millennium BC and show that the site is likely to have been contemporaneous with the later (Trench 2) occupation at Sheikh-e Abad. The two Jani dates come from deposits within the cleaned and sampled section of the exposed mound (W. Matthews *et al*. 2013h; 2019b). Below both dated samples there are *c*. 2m of intact Neolithic deposits, while above them there are *c*. 4m of Neolithic and Early Chalcolithic deposits. As such, it is possible to compare developments at these two sites in highland Zagros in Iran for this period.

The oldest three Bestansur dates, which are statistically the same as each other, are almost exactly contemporaneous with the youngest Sheikh-e Abad date. A 'difference' analysis in OxCal suggests that the sites might have been occupied at the same time, with the start date of Bestansur very likely before the end date of Sheikh-e Abad (by 32–2323 years, 95%). The end boundary of Sheikh-e Abad is, however, based on a single date only. The 'difference' between the oldest reliable Bestansur date, Beta-533614, and this youngest Sheikh-e Abad date, Beta-258648, is 151 years (overlap) to –87 years (no overlap), on average 34 years. It is therefore currently not completely possible to say for certain whether Bestansur was only occupied immediately after Sheikh-e Abad was abandoned, or whether there is an overlap in

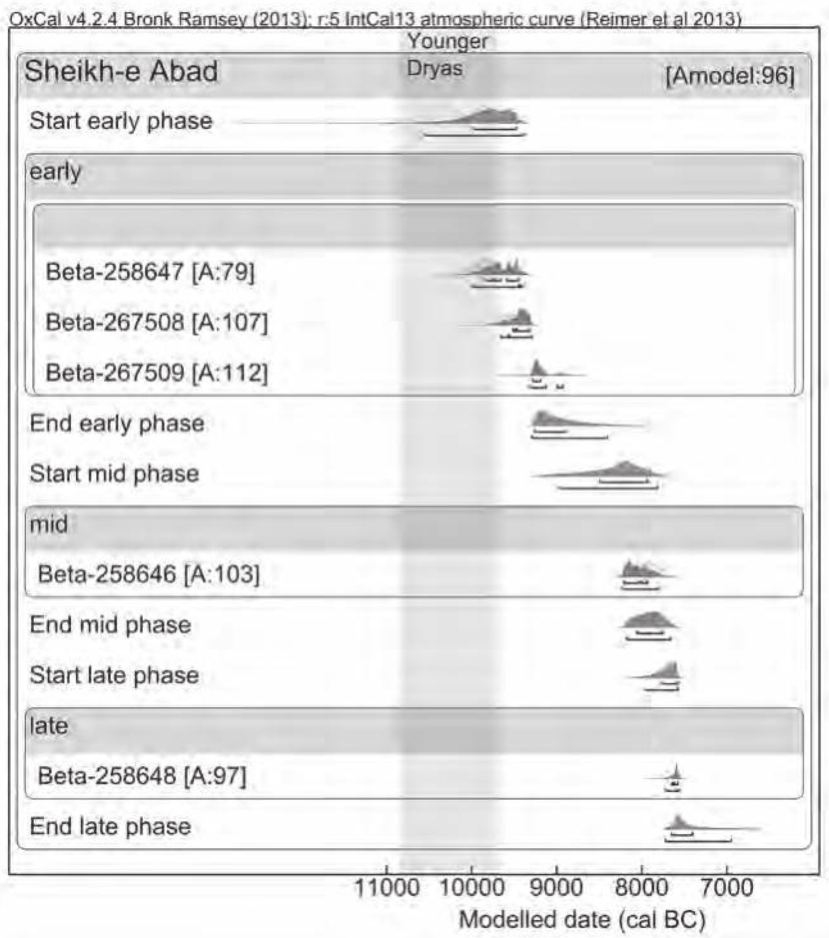

Figure 11.2. Modelled ^{14}C dates from Sheikh-e Abad. The end of the Younger Dryas is indicated (dating after Vinther 2006).

occupation. As the basal layers of Bestansur are still below the ^{14}C-dated layers (Chapters 6 and 9), the latter is the likelier option.

It is difficult to estimate the duration of occupation at Bestansur with the currently available ^{14}C dates. In addition there are still unexcavated levels beneath the current trenches, and the total depth of Neolithic deposits under the Iron Age mound may be from longer-lived occupation than that sampled at the edges of the mound. Nonetheless, the ^{14}C dates clearly indicate that Bestansur was occupied during the mid and latter half of the eighth millennium BC. The current date range is from *c*. 7640 to 7170 BC with an approximate error of 40–70 years to either side. It is therefore most (95%) likely that the currently excavated contexts at Bestansur were in use some time between c. 7700 and 7100 BC. This date range agrees with multiple components of the excavated archaeological materials at Bestansur, including the rectilinear architecture, chipped stone materials such as Çayönü tools, and small finds such as alabaster bracelets (Chapters 12, 20, 21). As the earliest and latest dates come from different, stratigraphically unconnected trenches, it is not yet certain whether the site was continuously occupied throughout this range, and earlier deposits remain undated (Chapter 6; Fig. 6.6).

The Shimshara date of 7320–7180 BC (1σ; 2σ 7445–7080 BC) overlaps with the later part of the Bestansur Neolithic dating. This date comes from the lowest deposits in the cleaned section (Chapter 10), about 3m below level 16, the lowest, aceramic level excavated in the 1950s (Mortensen 1970). It therefore probably indicates when the site was first occupied, as it directly overlies natural and is from the centre of the mound.

In the 1950s the later prehistoric layers on the mound at Shimshara, levels 13–9, were excavated and dated to the Hassuna period. While the ^{14}C dates are unfortunately unreliable because of their low carbon content and large standard deviations, three of them agree with the general assignment of this pottery style to the late seventh millennium BC. It was remarked at the time that these Pottery Neolithic levels 13-9 overlay Aceramic Neolithic levels (Levels 16–14 and unexcavated deposits below) (Mortensen 1970), which are now shown to go back to at least *c*. 7100 BC. As at Bestansur, this dating is confirmed by the chipped stone assemblage and marble bracelets found in proximate contexts (Chapters 9, 20, 21). Severe erosion of the upper layers of the high mound at Shimshara since its inundation in the late 1950s (www.nino-leiden.nl/projects/rania-plain-tell-shemshara) has probably removed any prospect of more accurately dating the upper prehistoric layers, as these have been washed away.

Investigating these four sites within one project is highly informative, as it allows for an assessment of chronological development and variation between the ecological and socio-cultural zones in the highland and lowland Zagros. The four sites together span the entire Early Neolithic. Because the sites also partially overlap in time (e.g. Sheikh-e Abad Trench 2 and Jani; Sheikh-e Abad Trench 3 and Bestansur Trench 10; Bestansur Trench 13 and early Shimshara), a spatial and cultural comparison is possible at least for these time spans.

The CZAP sites in their regional contexts

Figure 11.3 shows the dates from the CZAP sites in their regional context, compared to other sites in the EFC from which reliable dates are available (further details in the appendix, available at www.czap.org). The sites are also compared to the PPNA–PPNB periodisation commonly used in the Levant and southeast Anatolia, with the dating of these periods following Benz (www.exoriente.org/associated_projects/ppnd). It is important to note that the black boxes and lines in Fig. 11.3 are based on ^{14}C evidence only and that actual site occupation may have been shorter or longer than indicated in the figure.

The comparison of the CZAP sites with other sites in the EFC is complicated because of the low number of reliable ^{14}C dates from this region. Many sites here were dated in the 1960s and 1970s, and these dates are frequently unreliable because of large standard deviations or because they are based on bulk samples (e.g. dates of Abdul Hosein, Seh Gabi, Tepe Siahbid, Chogha Sefid, Tepe Sabz, Jarmo, Shimshara, M'lefaat and Nemrik; see appendix 11.1 at www.czap.org). Nonetheless, some conclusions can be drawn and, for this discussion at least, Neolithic occupation can be divided into four approximate periods.

First, at the start of the Holocene, and perhaps within the end of the Younger Dryas, the early occupation at Sheikh-e Abad is contemporary with that at Chogha Golan and Tang-e Bolaghi. Slightly later, but probably contemporary with at least the later part of this early phase at Sheikh-e Abad, is occupation at the Central Zagros site of Asiab (Bangsgaard *et al.* 2019). Evidence of occupation at Asiab comes in the form of ashy layers, pits, and a large semi-subterranean structure (Bangsgaard *et al.* 2019). At lower elevations, Qermez Dere, and potentially M'lefaat and Nemrik, are probably contemporary with Sheikh-e Abad, while further afield there are PPNA sites with early dates, for example WF16 in Jordan (Mithen 2007; Wicks 2018) and Körtik Tepe in southeast Anatolia (Benz 2012; Coşkun 2012).

A second period of dated occupation in the Zagros can be correlated with contemporary occupation in the Levantine Middle PPNB, based on the later period of occupation at Sheikh-e Abad, occupation at Jani, and Chogha Golan, East Chia Sabz, and Ganj Dareh.

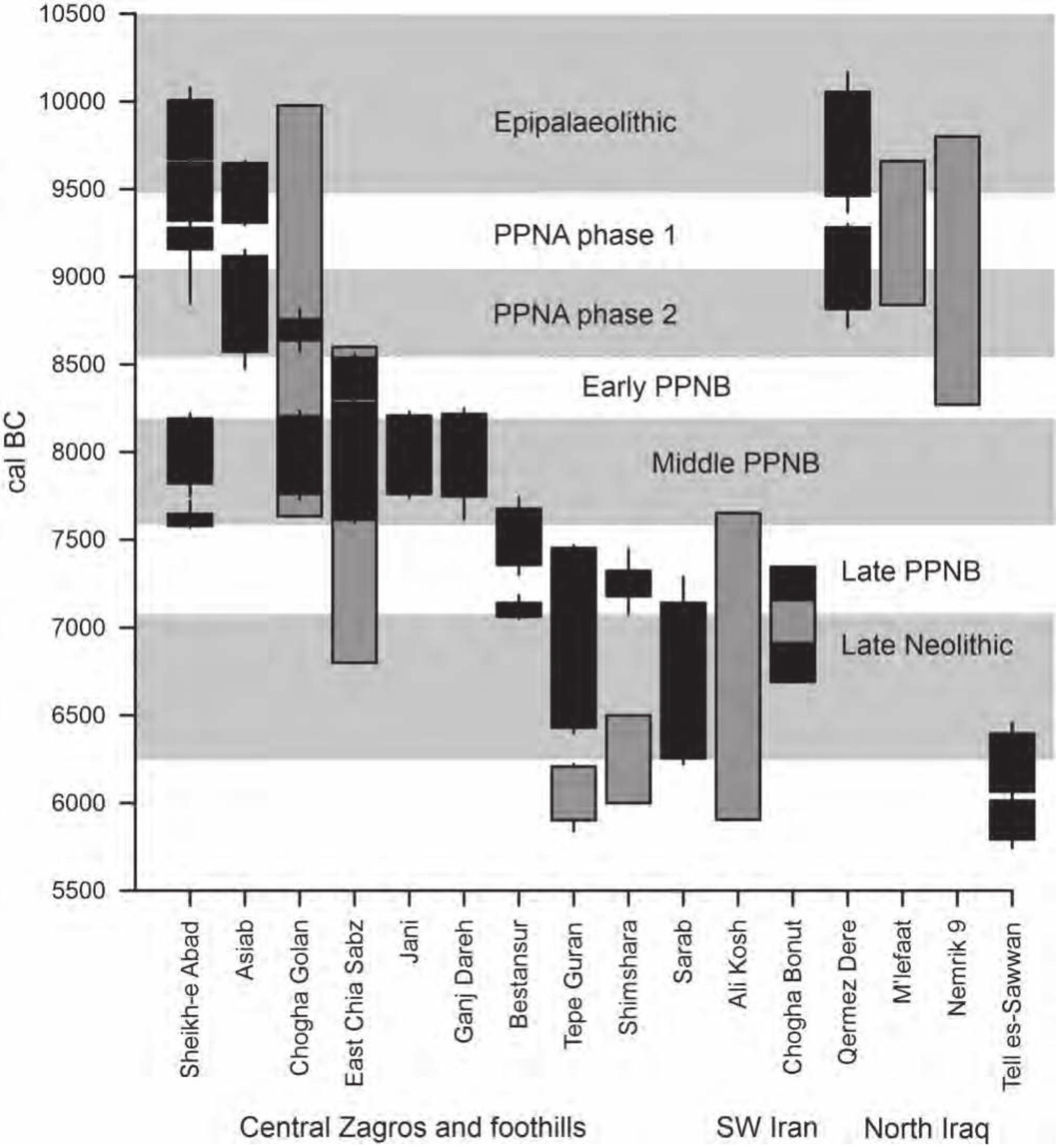

Figure 11.3. Overview of ^{14}C dated Neolithic site occupation in the EFC. The black boxes give the 1σ ranges of the available reliable ^{14}C dates, while the lines indicate the 2σ range. Contemporaneity with WFC periodisation illustrated by shaded bands.

It is likely that occupation at Bestansur started in this period. At most of the Zagros sites, substantial architectural structures were constructed in this period. It is interesting that a cessation of occupation at sites appears to have taken place around 7600/7500 BC, with no ^{14}C evidence for occupation at Sheikh-e Abad, Chogha Golan, Jani, and Ganj Dareh after this date, although later flexed Neolithic burials were dug into Building 1 at Sheikh-e Abad, suggesting at least some occupation post 7600 BC. Around the same time in the southern Levant settlements to the west of the Jordan river were abandoned, while those in the east grew and new sites were occupied there (Kuijt 2002). Nonetheless, no such shift appears in other regions, and the potential 'cessation of occupation' in the EFC may only be the result of limited research and the erosion of upper deposits. For example, while no ^{14}C dates are yet present post *c.* 7500 BC at East Chia Sabz, it is clear from the stratigraphy and material culture that the site continued until at least 7000 BC (Darabi

2013). In addition, Bestansur was probably inhabited from before 7600 until after 7200 BC.

A third period of dated occupation is contemporary with the Late PPNB period in the Levant and comprises sites such as, arguably, Tepe Guran; however, Mortensen (2014) dates the site to 6700–5500 BC. It is likely that Bestansur was still inhabited, while occupation at Shimshara and Sarab appears to have started around this time. Contemporary occupation in southwest Iran includes levels at Ali Kosh.

The last period considered here is contemporary with the Late Neolithic across the Middle East. Tepe Guran, Sarab and Ali Kosh were occupied and Levels 13–9 at Shimshara probably also correspond with this phase, as do Hassuna and later Samarra sites, such as Tell es-Sawwan. Already during but especially after this period, the number of sites in the central western Zagros appears to be very low, perhaps in some cases because they may be buried below later levels on larger mound sites common in the region..

Beyond the EFC, the CZAP sites add to the trans-regional view of polycentric and reticulate socio-cultural development through the Early Neolithic of Southwest Asia (Asouti 2017). In looking west and northwards from the CZAP study region, the earliest occupation at Sheikh-e Abad coincides with significant evidence for human activity at sites such as Mureybet, Jerf el Ahmar and Dja'de in Syria, Körtik Tepe, Hallan Çemi, Göbekli Tepe, Hasankeyf Höyük and Çayönü in southeast Anatolia, and Pınarbaşı and Boncuklu in central Anatolia. The eighth millennium BC occupation at all four CZAP sites can be viewed as part of a major episode of socio-cultural transformation across all of Southwest Asia, as attested at multiple sites including Abu Hureyra 2A–2B and Halula in Syria and Nevalı Çori, Göbekli Tepe, Çayönü, Cafer Höyük, Boytepe and other sites in southeast Anatolia, as well as with Aceramic Neolithic sites of central Anatolia such as Kaletepe and Aşıklı Höyük (dates and discussion for most of these sites are available at Benz's online 'PPND' website).

Climatic and environmental context

Figure 11.4 shows that the four CZAP sites are largely dated to within the Early Holocene period (*c.* 9700–5000 BC), which was generally warmer and wetter compared to the preceding periods, although there were periods of aridity. Greenland ice core proxies show an increase in temperature (Johnsen 2001; Rasmussen 2006; Vinther 2006), and records from the eastern Mediterranean region are in agreement in suggesting such warmer and wetter conditions (Bar-Matthews 1997; Robinson 2006; Sharifi *et al.* 2015), although seasonality appears to have been pronounced (Asouti 2017). The situation in the EFC, however, remains under discussion (Chapter 3). Only a few long-term records are available from the Zagros area, namely the Zeribar and Mirabad lake core records. In these records, the end of the cold and dry Younger Dryas period is marked by a decrease in *Atriplex*-type and *Artemisia* pollen, an increase in grasses (Poaceae) and *Pistacia* trees, but an increase in oak trees does not start until after 6000 BC (Wasylikowa 2006; Schmidt 2011; Stevens 2001). These attributes suggest an end to the very cold and arid conditions of the Younger Dryas, confirmed by the Lake Neor record (Sharifi *et al.* 2015). However, the delayed increase of oak is argued to indicate that conditions were still drier than in the Late Holocene (Stevens 2001), although it likely reflects a more effective response of grassland to the new conditions in the EFC (Asouti 2017). Alternatively, there may have been human and habitat factors in the delayed tree spread (Roberts 2002; Djamali *et al.* 2010; W. Matthews 2013; Asouti and Kabukcu 2014). Nonetheless, relatively low Early Holocene lake levels have also been inferred from Lake Mirabad ostracods (Griffiths 2001) and Sr/Ca ratios (Stevens 2006) and from Lake Zeribar diatoms (Snyder 2001), and aridity is confirmed by the presence of *Chenopodium rubrum* seeds there (Wasylikowa 2005). In any case, plant stable isotopes indicate that at least occasionally plants were water stressed (Riehl *et al.* 2014).

It is currently not possible to determine whether the earliest levels of Sheikh-e Abad date back to the Younger Dryas, nor whether occupation started only at the beginning of the Early Holocene. The end of the Younger Dryas is currently dated to *c.* 9700 cal BC (Vinther 2006). The earliest Sheikh-e Abad date, on a short-lived specimen from the basal layers of the site, dates to 10,078–9456 BC (2σ). Therefore, this seed could as well date to the Younger Dryas as to the earliest Holocene period (Fig. 11.2). The interpretation is difficult because there is only a single date, and made more complicated because of the radiocarbon calibration plateau around the transition of the Younger Dryas to the Holocene (Benz 2012). It is also likely that dates from the older end of the plateau are under-represented (Benz 2012).

There is no doubt that at least the later occupation at Sheikh-e Abad as well as the occupation of Jani, Bestansur and Shimshara occurred within a longer-term period of climate stability or amelioration in the Early Holocene. Nonetheless, cold and arid events occurred during this period. The most pronounced of these is the so-called 8.2 ka event, with cold and arid conditions indicated throughout the northern hemisphere around 6250–6000 BC (Alley 1997). This event occurred later than any of the currently investigated occupation of CZAP sites, although the later levels at Shimshara may have been contemporaneous. Of more interest to the time period investigated here is the 9.2 ka event, from *c.* 7300 to 7100 BC, which was comparable to the 8.2 ka event,

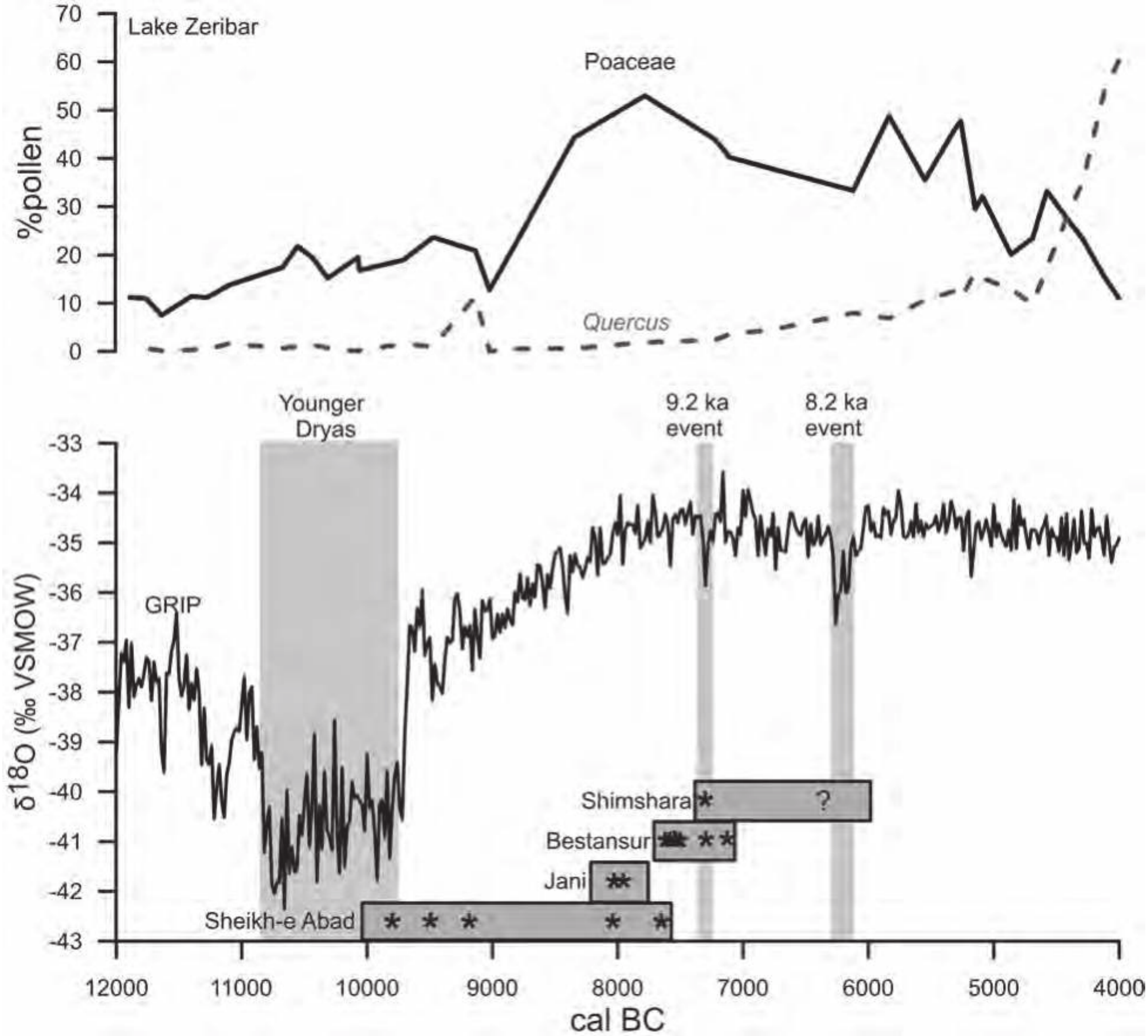

*Figure 11.4. Occupation at Sheikh-e Abad, Jani, Bestansur and Shimshara, and climate and environmental proxies. Ice core (GISP) $\delta^{18}O$ (Rasmussen 2006; Vinther 2006); Zeribar pollen from van Zeist and Bottema 1977, courtesy of M. Djamali. * = ^{14}C dates from CZAP sites.*

albeit less severe (Fleitmann 2008). Occupation at both Sheikh-e Abad and Jani appears to have ended before this event, but if occupation between Trenches 10 and 12 at Bestansur was continuous, this site spans the 9.2 ka climatic episode. Shimshara was also likely occupied during the 9.2 ka event, although it is currently not certain if it started before, during, or afterwards. From the perspective of climate and environment change, therefore, these CZAP sites are potentially very interesting as they could give insights into how Neolithic societies reacted and adapted to such adverse climatic events. While it was recently shown (Flohr *et al*. 2015) that there is no evidence for a widespread impact on societies of the 9.2 ka or 8.2 ka events, communities may have been able locally to adapt to changing climatic conditions, for which further precise site-specific studies are needed (Chapter 3).