Desert Migrations Project XVII: Further AMS Dates for Historic Settlements from Fazzan, South-West Libya

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Abstract

A group of 25 new AMS (radiocarbon) dates for historic-era sites in Fazzan is presented. These provide further confirmation of the construction of numerous fortified villages and castle-like structures (*qsur*) in two of the main oases belts of Fazzan during the Garamantian period, primarily in the third – sixth centuries AD. Further precision is also provided on the dating of a Garamantian and early Islamic urban centre called Qasr ash-Sharraba and the early modern capital of Fazzan at Murzuq.

Introduction

Radiocarbon dates have been crucial in the transformation of knowledge and understanding of prehistoric activity in the Sahara, as exemplified in the work of the Italian mission in the Tadrart Akakus, Wadi Tannzuft and Massak Sattafat (Cremaschi and di Lernia 1998; di Lernia and Manzi 2002; di Lernia *et al.* 2013). However, until recently there had been relatively limited application of radiocarbon dating technology to the historic periods of settlement (Daniels 1989; van der Veen 1992, for early dates from Zinkekra), though both Cremaschi *et al*. (2006, 150-51) and Liverani (2006, 363-74) have published some important results. Liverani, for instance, has obtained 32 dates from historic era settlements in the Ghat area, some 400 km south-west from Jarma (Aghram Nadarif, Fewet, Imassarajen and Adad). The Fazzan Project (1997-2001) commenced a major programme of AMS dating (Mattingly 2007, 294-302) and this has continued with more recent field research.

This article presents the results of a further batch of 30 samples, primarily extracted from structural mudbrick at sites identified as part of wide-ranging surveys in the Wadi al-Ajal near Jarma and in the Murzuq area to the south-east of Jarma (the methods for extracting the organic material from structural mudbrick are described in Sterry *et al.* 2012). As with previous batches of material, we have had the AMS radiocarbon dating conducted by the Oxford Radiocarbon Laboratory. Although three samples failed due to low yield and two gave a post-Atomic bomb date indicating modern intrusive material, the remaining 25 new dates add significant information about the historical pattern of human settlement and habitation (for previous dates from this part of Fazzan, see Higham *et al*. 2007; Mattingly *et al*. 2002; Sterry *et al*. 2012). These latest samples take the total number of successful radiocarbon dates for historic settlements in central Fazzan to 135 (Fig.1. For an overall location map within Libya, see Mattingly *et al.* 2007, 118, fig. 1). The Fazzan Project produced 78 published and three failed samples (see Mattingly 2007 and Pelling 2007), and 18 dates are already published for the Murzuq area, with two failed samples (Sterry *et al*. 2012). In addition, another nine (plus eight additional failed samples) soon to be published from Old Jarma (Mattingly forthcoming 2013) and four from Zuwila and one from a foggara in the Wadi al-Ajal (further articles in preparation). With limited survey and excavation currently feasible in Fazzan, AMS radiocarbon dating provides the only reliable method of

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refining the chronology for the Garamantian and later periods. All dates discussed within this article including those previously published have been calibrated with Oxcal v4.2.2 (Bronk Ramsey 2009) to the IntCal09 calibration curve (Reimer *et al*. 2009).

Conventional radiocarbon and AMS dates from excavations are particularly important. The long sequence of dates now available from the Zinkekra and Jarma excavations spans the last three millennia of human history and can be linked to stratified deposits, allowing the creation of dated ceramic typologies (Mattingly 2007, 305-431; 2010, 78; forthcoming 2013). However, while excavations remain few and far between, survey material offers the best hope of making sense of broader patterns of settlement. The method we have pioneered of extracting organic material from mudbricks of standing structures has proved successful in providing a *terminus post quem* for the manufacture of the mudbrick and construction of the buildings. By concentrating on annual crops and individual seeds (such as date stones) embedded in the mudbrick matrix, we hope to limit the potential for serious anomaly behind the apparent and actual date of construction, though there is certainly a possibility at multi-period sites of earlier material getting mixed into bricks as well as contemporary rubbish. For that reason we have tried where possible to obtain more than one date for each site (a full discussion of the methodology can be found in Sterry *et al*. 2012, 138-39).

Results

The results are presented here in standard format with date ranges to a 95.4% confidence range (2-sigma) in both tabular (Table 1) and graphical form (Fig. 2). The dates will be discussed below in broad chronological order, from the Garamantian era to the early modern period, and in terms of several groups of sites with related morphology. The majority of the samples reported on here have come from castle-like or fort-like sites (*qasr*, *qsur* plural) in the Murzuq/al-Hufra basin and the Wadi al-Ajal. In total 12 new *qsur* were dated, and additional samples from six previously dated sites were processed. Additionally, new sets of samples were taken from two key urban sites of Qasr ash-Sharraba and Murzuq (Fig. 1). All of the samples described below were organic materials that were extracted from mudbricks at the site in question.

Discussion of Individual Samples

Garamantian qsur*/forts in the Wadi al-Ajal*

The first of three newly dated *qsur* in the Wadi al-Ajal was FJJ013 (Fig.3), comprising a substantial mudbrick fortified site (57 x 45 m, with walls and traces of external towers still standing to *c*.4m height, though very slumped). This was identified in our earlier work as a Classic Garamantian site on the basis of imported pottery (Mattingly 2007, 190-91) and the AMS result now refines this indication towards a Classic-Late Garamantian date (cal AD 264 (95.4%) 534). Two other structures for which dates have been obtained were previously thought more likely to be Islamic in date (FJJ056 and GRE015). FJJ056 consists of a high-standing central *qasr c*.18 m square, within a second fortified compound *c*.33 m square. Both these fortified structures had rectangular projecting towers at the corners and the larger structure had casement buildings built against its outer wall. Traces of small ‘musket loops’ in the central building and parts of the external enceinte suggested an early modern date for the final phase of the site, though the presence of Garamantian pottery and traces of a wider settlement around the *qasr* had hinted at earlier origins (Mattingly 2007, 194-95). The new AMS date would seem to confirm a Classic/Late Garamantian date for the 33 x 33 m *qasr* and associated settlement, with the smaller *qasr* perhaps being inserted at its centre more recently.

GRE015 comprises a 25 x 30 m enceinte with rectangular corner and central towers on each side that still stand up to 8 m height (Mattingly 2007, 202). In plan there are clear similarities with FJJ056 and the high tapering towers and flat yellow mudbricks are also paralleled at the nearby larger fort of Qasr Sidi Dawud (LEK017 – near LEK018 on Fig. 1; see also Mattingly 2007, 210). Both GRE015 and LEK017 have been hitherto considered as Islamic in date on account of their outstanding preservation, though LEK017 has yielded some Garamantian-era pottery. The Late Garamantian date now obtained from the samples for GRE015 (cal AD 430 (95.4%) 579 and cal AD 422 (95.4%) 541) highlights an emerging pattern for forts in the Wadi al-Ajal. The default interpretation of large rectangular fortifications in regular mudbrick, with external rectangular towers should perhaps be that these were Garamantian rather than later in date, unless, and until, evidence to the contrary emerges. As the next section shows, this class of site has been repeatedly dated to the Garamantian era in the Murzuq area, confirming the pattern argued for in our previous report (Sterry *et al.* 2012, 139-43).

Garamantian qsur *and fortified villages in the Murzuq area*

The larger sample of AMS dates from fortified sites in the Murzuq region has clarified some aspects of the development of this densely occupied area (for location of all sites, see Fig. 1). Most importantly the new samples confirm the initial dating of these sites on the evidence of surface ceramics alone and give greater confidence in predicting the dates of settlements identified from remote sensing only. There are examples of sites with both long and short histories of construction.

Additional samples from HHG006-008 (Fig. 3) provide dating evidence for all three of the *qsur* in this large unenclosed and agglomerated settlement (Sterry and Mattingly 2011, 108-09; Mattingly and Sterry 2013, 510-11, fig. 6). The spread of calibrated dates demonstrates the long-lived nature of this site and its continuing development with at least two phases of construction over at least 144 years and more likely several centuries: cal AD 76 (95.4%) 254 (HHG006), cal AD 139 (95.4%) 341 (HHG007), cal AD 398 (95.4%) 535 (HHG008). This site can be contrasted with HHG001, a rectangular fortified village site with a central *qasr* (Mattingly and Sterry 2013, 510-11, fig. 5), where three samples have had a consistent date for the construction of the *qasr* and enceinte: cal AD 425 (95.4%) 541, cal AD 415 (95.4%) 546 and cal AD 424 (95.4%) 541. It thus seems likely that this site was built in a single event

In each of the three areas near Murzuq for which multiple sites have now been dated (sites on Fig. 1 prefixed by HHG, GAT, ZZW) there are examples of both earlier and later sites within the Garamantian era. This does not support the idea of a single “pioneer” event in which the landscape was divided up and multiple villages established. Instead settlement density probably grew in all areas of the Murzuq basin in several phases of oasis development, over time creating clusters of *qsur*. The oasis development here starting in the first or second centuries AD appears to have occurred later than in the Wadi al-Ajal. However, it should be noted that the focus of our survey has been on the most visible structures (fortified villages and *qsur*), which are evidently of Classic and Late Garamantian date. It does not preclude the possibility that some of these settlements originated earlier as undefended sites or that there are additional undefended sites in the landscape that are not susceptible to remote identification on the satellite images.

Two of the new samples come from sites that were initially considered to have been medieval or later in date. MZQ007 produced a previous AMS date of cal AD 1308 (95.4%) 1409 (OxA-25825, Sterry *et al.* 2012, 140) and as the site is associated with Islamic burials there was certainly activity of that era here. However, a second sample now suggests that the site could have originated in the Late Garamantian phase: cal AD 389 (95.4%) 535. ZZW101 is a tower-like *qasr* with high upstanding walls and possible musket loops, but the AMS date, obtained from mudbrick at foundation level, suggests earlier origins: cal AD 440 (95.4%) 619. While it is still possible that this site also underwent alterations, perhaps quite substantially, the initial constructions may perhaps be dated to the fifth-seventh centuries AD.

Garamantian and early Islamic urban sites: Qasr ash-Sharraba

Three new samples were dated from Qasr ash-Sharraba (SCH020 on Fig. 1), a significant Garamantian and early Islamic town (Mattingly 2007, 262-65; Mattingly and Sterry 2013). The site is of urban scale (15 ha) with a substantial fort with projecting towers at its centre. There is a smaller *qasr* set within the fort's north-east corner (*qasr* A) and a separate castle-like building (*qasr* B) further west within the town. Previous dates (all from *qasr* A) had indicated activity across several centuries: cal AD 237 (95.4%) 411, cal AD 568 (95.4%) 659, cal AD 1029 (95.4%) 1186. The new dates include a sample from *qasr* B cal AD 259 (95.4%) 417 and an additional date from *qasr* A of cal AD 439 (95.4%) 614. The final date came from a tower on the larger fort structure, which appeared to be earlier than *qasr* A, and the late date may thus relate to a repair there. It provides confirmation that activity at this site continued until at least the thirteenth century AD (cal AD 1212 (95.4%) 1274).

Later Islamic qsur *and villages*

FUG022 (Qasr Tuwiwa) is a *c.*20m square mudbrick castle with thick walls standing up to 10m high at the centre of the small early modern village of Tuwiwa. It was notable for employing the same mud-lump construction technique as found in the walls at Old Jarma and in fortified villages in the Murzuq area. A sample taken from the *qasr* (and divided into two sub-samples) suggests a date of cal AD 1440 (95.4%) 1619 or cal AD 1448 (95.4%) 1630. This is in keeping with other dated samples of this construction type (GER001.065, LEK018, MZQ021, HHG012) and seems to indicate a period of renewed building activity within the Wadi al-Ajal and Murzuq basin.

A new sample (OxA-2475-37) from the walls of a fortified village MZQ021 has a very late date, cal AD 1686 (95.4%) 1927. A previous sample from the central citadel (*qasabah*) at this site (OxA-25796) gave a date of cal AD 1411 (95.4%) 1450 for that structure. The new sample was taken on a small rodent bone in a crevice within the wall and could potentially relate to either a repair or perhaps intrusive material (a bird pellet?).

Islamic towns: Murzuq

Three new samples were dated from the town of Murzuq (MZQ001 on Fig. 1) allowing for substantial refinement of our knowledge of this site, which was the early modern capital of Fazzan. One further sample - AMS Sample 34 - was re-dated, but this again gave a post-Atomic bomb date. OxA-26492 relates to a mudbrick used in the original wall circuit round the southern sector of the town and suggests a construction date in the fifteenth or sixteenth century. A very similar date (OxA-26735) has also come from a mudbrick from one of the houses in the abandoned south part of the town. The consistency of these dates combined with the regular street layout is suggestive of some form of planning occurring in this part of the city. There is a clear chronological separation between these structures and the strengthening of the town walls with D-shaped towers (see below). It is tempting to suggest that these samples date the construction of the city itself, but there is a lack of data from the northern part of the site and no excavation has ever taken place here. However, the dates do correspond with the period when Murzuq emerged as the largest settlement and capital of Fazzan in the late fifteenth or early sixteenth centuries with the establishment of the Awlad Muhammad dynasty (el-Hesnawi 1990, xiii).

The sample OxA-26734, from one of the D-shaped towers in the wall, has a very similar calibrated date range to OxA-25827, also from a D-shaped tower at Murzuq (Sterry *et al.* 2012, 140-41). The latter part of the date range can be excluded as the southern part of the circuit with its D-shaped towers was by abandoned by the nineteenth century (Barth 1857, 152). The D-shaped towers are also described by Lyon (1821, 97): "The walls are of mud, having round buttresses with loopholes for musketry, rudely built, but sufficiently strong to guard against attack, they are about fifteen feet in height and at the bottom eight feet in thickness, tapering, as all the walls in this country do, towards the top." Assuming that these were the result of a single construction phase, they thus give a combined calibrated date of cal AD 1696 (95.4%) 1727 (Fig. 4). This was also the period of renewed Ottoman domination of Fazzan under Muhammad al-Ghazayl al-Mukni and Ali al-Mukni, involving several sieges of the city from 1682-1733 (Mattingly 2003, 100). Barth (1857, 152) attributes Murzuq's old wall to al-Mukni, which would fit with an Ottoman inspired refurbishment and the addition of the D-shaped towers in the late seventeenth or very early eighteenth century. Barth also recorded the reduction of the defended area as having taken place in the reign of the last Awlad Muhammad sultan, Abd al-Jalil (1830-42), though a record of demolition of part of the walls of Murzuq by Ottoman forces in 1732-33 could provide an earlier context for this (Mattingly 2003, 101).

In combination the suite of dates now available from Murzuq suggest the following sequence of events:

1. The construction of the town walls and houses in the southern part of the city, most likely during the late fifteenth century or early sixteenth century (a further peak in the calibrated date range in the early seventeenth century is less probable for the construction of town walls and housing here, though if so it would coincide with a revival of Khurman power from 1623-27, Mattingly 2003, 100).

2. The reinforcement of the town walls with D-shaped towers at the end of the seventeenth century or the start of the eighteenth century.

3. The abandonment of the southern area sometime during the eighteenth century or first half of the nineteenth century.

4. The strengthening of the qasabah walls between the late seventeenth and early twentieth century.

General dating of fortified buildings and settlements (*qsur*) in Fazzan

The new dates, combined with those previously published, take the total number of AMS datings of Garamantian *qsur* in central Fazzan to 26 (Fig. 5; although the date of TAG011: cal BC 352 (95.4%) cal AD 83, looks suspiciously early and is considered unreliable in the analyses below). Additionally, a further 34 have been dated on the basis of ceramics or construction techniques. This is a substantial corpus and it is worth revisiting the initial dating schema proposed (Mattingly 2003, 146-54). It was argued that the origins of the *qsur* could be placed in the Garamantian period, with a large percentage dated to the third-sixth centuries AD and that TEK010 a rectangular *qasr* with projecting towers and an attached mosque shows some continuation of the form into the Islamic era (the AMS date provides a *TPQ* for this site of cal AD 860-1020). Nonetheless, for many of the *qsur* published in the gazetteer of *AF2* (Mattingly 2007), the Islamic period was considered the default period if no other diagnostic dating material was located in site visits, especially if the walls were particularly upstanding (as at GRE015). Sites that had been identified only on aerial photographs and not visited on the ground, were generally ascribed the time period 'Garamantian to Early Modern'. The data now available suggest that *qsur* were constructed predominantly in the Garamantian period. Later Islamic period constructions can typically be identified through their use of mud lump construction instead of the large flat mudbricks. Although there are a few exceptions, the bulk of the *qsur* with regular mudbrick walls and square/rectangular plan and with external corner and central towers on the outer wall appear to be Garamantian in origin. There does, however, seem to have been re-use of some of the *qsur* during later periods. Elaborating on the scale and frequency of later adaptation should be a key aim of future research.

Cumulative probability curve

Used with some caution a summed probability function (the sum of multiple probability curves) can show an underlying trend in the data and can narrow down when the majority of the *qsur* were constructed. Williams (2012) has suggested that a minimum of 500 dates should be used in any such analysis for the results to be considered representative. This number of dates is not available for Fazzan nor will it be for some time as such this should be treated as a tentative model to test and challenge with future data. However, the dates can be constrained to ask a more precise question than varying levels of activity within a period. A total of 25 dates relate to the primary construction of *qsur* from a total sample of c.250. Furthermore these *qsur* were selected for survey and dating as a representative sample of site types and areas (although the Wadi al-Ajal is a little underrepresented in comparison to the Murzuq basin). Following the method proposed by Armit et al. (2013), a null hypothesis that *qsur* were constructed evenly throughout the Garamantian period was used as a comparative data set. This was created by creating 100 sets of 25 samples of 1500-2000 BP ± 20-40 from which mean, interquartile and minimum and maximum curves were derived. These can then be compared to the actual data (Fig. 6a). The curve for the *qsur* deviates substantially from the interquartile range and lies outside the minimum and maximum ranges in three places, prior to cal AD 135, cal AD 346-440 and cal AD 481-530. This suggests that *qsur* were infrequently constructed before the mid-second century and that there was a definite peak in construction between the mid-fourth and early sixth centuries. It is possible that there were two different peaks of construction that can be more precisely dated to the late fourth-early fifth century and the late fifth-early sixth century. The summed probability function of the *qsur* can be further compared to the random data set through the use of a 100-year rolling Pearson's correlation coefficient (Armit et al. 2013: 436-37). The resulting graph (Fig. 6b) shows that the possible peaks in construction are significantly correlated to those of the randomly generated data set. Therefore these secondary peaks may relate primarily to variation in the radiocarbon calibration curve. Finally, the limits of the small sample size are likely to hide other important peaks and troughs in the data and we fully expect this model to develop as more dates are acquired.

Following the typology of Garamantian settlements (Mattingly 2003, 151-54; revised in Mattingly and Sterry 2013), it is possible to propose a development of *qasr* form, similar to that suggested for Tripolitanian *qsur* (Barker *et al.* 1996, 155-58). Key traits of the corpus of the sampled *qsur* have been tabulated, ordered by date and split into three broad phases: early, middle and late (Table 2). Of these, variations in ditches, towers, gates do not have a strong association with date, but are partly linked to size (a larger *qasr* allows a more complex form, for example with intermediate towers). Two aspects do appear to be linked to dating: the size of *qsur* (Fig. 7a) – with a wider range in the later periods – and the type of associated settlement (Fig. 7b) – with extramural settlements more common in the earlier period and walled settlements more common in the later period. It is particularly notable that quite a number of *qsur* in both the Murzuq area and the al-Ajal appear to have been founded or fortified as late as the fifth-sixth centuries AD, when Garamantian society has previously been thought to be in decline. Therefore the significant investment represented by these fortified structures may require some reconsideration of the vitality of the Late Garamantian period.

Conclusion

Our programme of dating historic era settlement in the central Sahara is important because it provides both confirmations and corrections to assumptions based on surface ceramics, which for many periods are not closely diagnostic, and literary record of oral traditions. The new dates highlight the importance of the Garamantian era in the settlement record and allow us to propose some new relationships between settlement morphology and chronology. In particular, the prevalence and density of Late Garamantian fortified settlements are very striking. While distinctive Islamic era *qsur* and fortified villages have also been recognised they seem to have been much more thinly distributed in the landscape of Fazzan than the earlier Garamantian settlements.

Another feature of our work has been to show the potential to achieve greater precision in modelling the rather broad chronological range of AMS dates from early modern sites, where historical sources can help narrow down dating boundaries. This is particularly apparent at the site of Murzuq where we have been able to identify several phases despite a group of dates with significantly overlapping ranges of several centuries. This has implication for work at other historical towns in Africa.

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Figure 1: Location map of dated ^{14}C AMS samples presented in this article and previous samples from Sterry et al. *2012 and Mattingly 2007. The lower image represents an enlarged view of the rectangular area marked to bottom right of the upper image. Imagery copyright ESRI.*

Figure 2. Calibrated radiocarbon results from central Fazzan showing normalised probability curves. For each sample the 1σ and 2σ ranges are shown, meaning that there is a 68.2% and a 95.4% chance respectively of the actual date of the sample falling within the range indicated by the upper and lower brackets respectively.

Figure 3. Comparative plans of newly dated qsur. Top row (Wadi al-Ajal): FJJ013, FJJ056; GRE015; b) Bottom row (Murzuq region): HHG006-008 and HHG001

Figure 4. Calibrated radiocarbon results from Murzuq, 2σ ranges are marked. The Tower Fortification probability curve is calculated using the Combine function on the likelihood that the two dates on different towers: <35> OxA-25827 and <37> OxA-26734, relate to the same construction event and that must lie within the chronological boundaries of AD 1650-1750.

Figure 5. Calibrated radiocarbon results of all dated qsur *showing normalised probability curves. For each sample the 1σ and 2σ ranges are shown, meaning that there is a 68.2% and a 95.4% chance respectively of the actual date of the sample falling within this range the range indicated by the upper and lower brackets respectively.*

Figure 6. a) Summed Probability Function (SPF) of all dated qsur *compared to a dataset of 100 randomly generated ^{14}C proxy curves (mean, interquartile ranges and maximum and minimum values shown) b) Running correlation coefficient of SPF with mean of 100 randomly generated ^{14}C proxy curves. Significance level $\rho=0.05$ illustrated.*

Figure 7. a) Scatter graph of size vs mean calibrated date of qsur*; b) Bar chart of associated settlement types of* qsur *by phase*

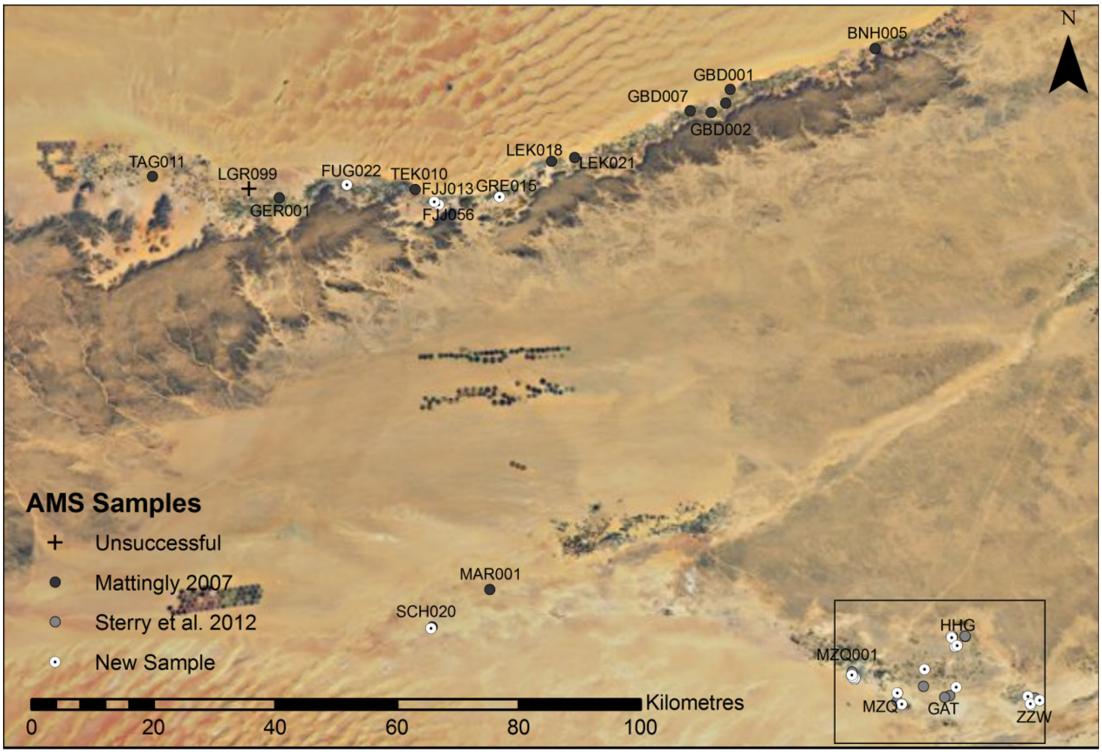
Table 1. New radiocarbon results from Fazzan.

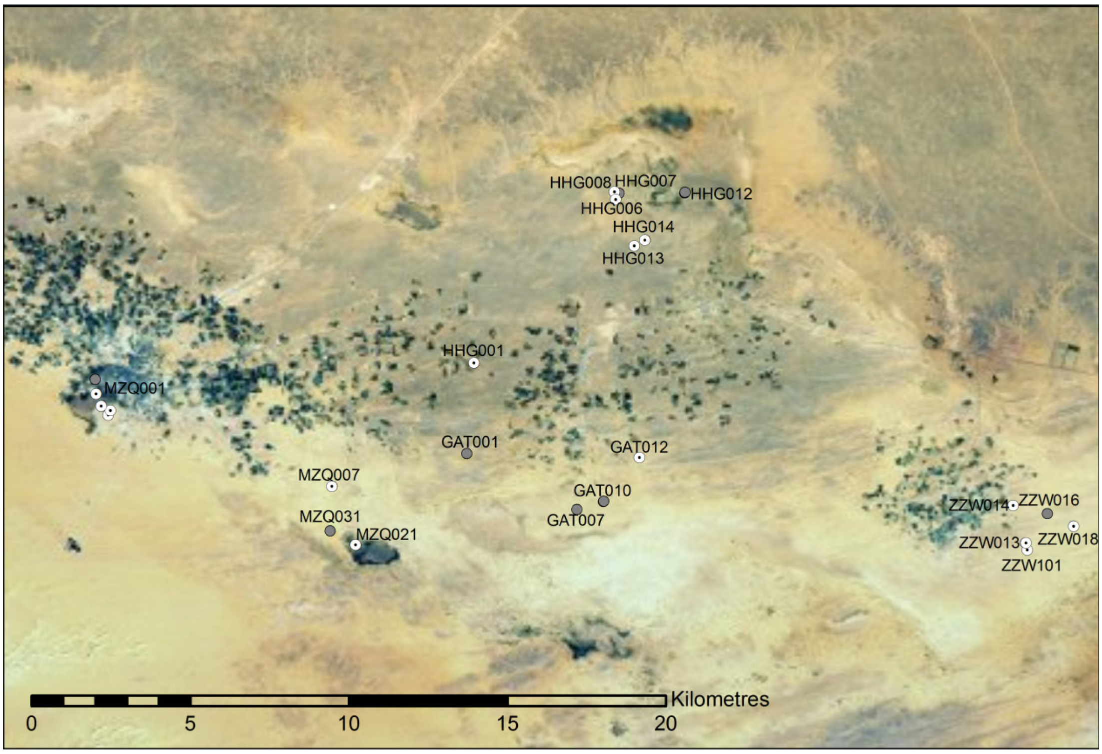
Table 2. Main attributes of dated qsur

Site code	Lab code	Sample codes	Material dated	Description	^{14}C age BP	Calibrated date range (2σ confidence)
FJJ013	OxA-26493	AMS Sample 45	plant remains, unknown	Mudbrick from Et wall of *qasr*	1645 ± 31 BP	cal AD 264 (1.6%) 275 cal AD 332 (80.3%) 466 cal AD 481 (13.6%) 534
FJJ056	OxA-26736	AMS Sample 46	plant remains, *Phoenix dactylifera*	Mudbrick from the corner of the base of the outer enceinte around the upstanding *qasr*	1687 ± 25 BP	cal AD 259 (14.7%) 295 cal AD 321 (80.7%) 417
FUG022	OxA-26737	AMS Sample 47	seeds, *Phoenix dactylifera*	Wall fabric from the Tawiwa *qasr* gate	399 ± 23 BP	cal AD 1440 (83.7%) 1516 cal AD 1596 (11.7%) 1619
FUG022	OxA-26738	AMS Sample 47	seeds, *Phoenix dactylifera*	Wall fabric from theTawiwa *qasr* gate	374 ± 23 BP	cal AD 1448 (64.1%) 1523 cal AD 1572 (31.3%) 1630
GAT012	P-31787	AMS Sample 25		Failed due to low yield		
GAT012	OxA-26491	AMS Sample 24	plant remains, cereal	Mudbrick from the *qasr*	1783 ± 29 BP	cal AD 134 (65.2%) 265 cal AD 274 (30.2%) 335
GRE015	OxA-26750	AMS Sample 86	charcoal, *Phoenix dactylifera*	Mudbrick from the *qasr*	1542 ± 25 BP	cal AD 430 (95.4%) 579
GRE015	OxA-26751	AMS Sample 86	charcoal, *Phoenix dactylifera*	Mudbrick from the *qasr*	1581 ± 25 BP	cal AD 422 (95.4%) 541
HHG001	OxA-26487	AMS Sample 8	plant remains, unknown	Mudbrick from the SW corner of the outer enceinte	1581 ± 30 BP	cal AD 415 (95.4%) 546
HHG001	OxA-26726	AMS Sample 7	plant remains, unknown	Mudbrick from the gate of the *qasr*	1578 ± 24 BP	cal AD 424 (95.4%) 541
HHG006	OxA-26490	AMS Sample 16	plant remains, unknown	Mudbrick from the NE corner of the *qasr*	1840 ± 38 BP	cal AD 76 (95.4%) 254
HHG008	OxA-26728	AMS Sample 15	plant remains, unknown	Mudbrick from the NE corner of the *qasr*	1614 ± 24 BP	cal AD 398 (95.4%) 535
HHG013	OxA-26488	AMS Sample 10	plant remains, chaff	Mudbrick from theSW corner of *qasr*	1714 ± 31 BP	cal AD 250 (95.4%) 403
HHG014	OxA-26489	AMS Sample 12	plant remains, unknown	Mudbrick from the central tower on top of the *qasr*	1.36896 ± 0.00437 BP	
HHG014	OxA-26727	AMS Sample 13	charcoal, *Phoenix dactylifera*	Material from a possible abandonment phase	1630 ± 24 BP	cal AD 350 (3.1%) 368 cal AD 381 (68.1%) 470 cal AD 477 (24.3%) 534
MZQ001	OxA-26492	AMS Sample 36	plant remains, chaff	Mudbrick from the S-side of the town wall	415 ± 31 BP	cal AD 1427 (84.9%) 1521 cal AD 1591 (10.5%) 1620
MZQ001	OxA-26733	AMS Sample 34	seeds, *Phoenix dactylifera*	Mudbrick from the SW-side of the town wall	1.04707 ± 0.00289 BP	
MZQ001	OxA-26734	AMS Sample 35	plant remains, unknown	Mudbrick from Date D-shaped tower on S-side of the town wall	71 ± 22 BP	cal AD 1694 (24.1%) 1728 cal AD 1812 (22.4%) 1862 cal AD 1867 (48.9%) 1919
MZQ001	OxA-26735	AMS Sample 38	plant remains, unknown	Wall fabric from house in abandoned S area	380 ± 23 BP	cal AD 1446 (69.0%) 1523 cal AD 1573 (26.4%) 1627

MZQ007	OxA-26725	AMS Sample 2	wood	Mudbrick from the SW corner of the *qasr*	1621 ± 23 BP	cal AD 389 (95.4%) 535
MZQ021	OxA-X-2475-37	AMS Sample 3	bone, rodent	Wall fabric from the N-side of the enceinte	97 ± 26 BP	cal AD 1686 (26.5%) 1731 cal AD 1808 (68.9%) 1927
SCH020	OxA-26740	AMS Sample 92	charcoal, *Phoenix dactylifera*	Mudbrick from wall of *Qasr* B	1687 ± 24 BP	cal AD 259 (14.2%) 295 cal AD 322 (81.2%) 417
SCH020	OxA-26741	AMS Sample 93	plant remains, multiple species	Mudbrick from NW tower of the larger fort structure	795 ± 23 BP	cal AD 1212 (95.4%) 1274
SCH020	OxA-26742	AMS Sample 107	plant remains, *Phoenix dactylifera*	Mudbrick from wall of *Qasr* A	1509 ± 24 BP	cal AD 439 (8.3%) 485 cal AD 532 (87.1%) 614
ZZW013	P-31788	AMS Sample 26		Failed due to low yield		
ZZW013	P-31790	AMS Sample 28		Failed due to low yield		
ZZW013	OxA-26729	AMS Sample 27	plant remains, cereal	Mudbrick from the SE corner of the secondary *qasr*	1589 ± 23 BP	cal AD 420 (95.4%) 539
ZZW014	OxA-26731	AMS Sample 31	plant remains, unknown	Mudbrick from the SE corner of the *qasr*	1587 ± 24 BP	cal AD 419 (95.4%) 540
ZZW018	OxA-26732	AMS Sample 41	plant remains, unknown	Mudbrick from the SE corner of the *qasr*	1552 ± 24 BP	cal AD 430 (95.4%) 564
ZZW101	OxA-26730	AMS Sample 30	plant remains, unknown	Mudbrick from the SE corner of the *qasr*	1507 ± 25 BP	cal AD 440 (7.9%) 485 cal AD 532 (87.5%) 619

Site	Start Date	End Date	Mean Date	Size (m^2)	Ditch	Central Tower	Corner Towers	Intermediate Towers	Gates	Enclosed Settlement	Extramural Settlement	E-facing building	Rebuilds
TAG011	-352	83	-85	325			Circular		E		Yes		
HHG006	76	254	174	333	Yes		Square		E		Yes		
GAT012	134	335	244	374			Square		N	Yes	Yes		Yes
HHG007	139	341	266	506	Yes	Yes	Square		E		Yes		
ZZW018	245	385	310	1087			Square	?	N		Yes		
SCH020A	237	411	318	371			Square	Square	S?	Yes	Yes		
HHG013	250	403	325	1136	Yes?		Square	Square	?		Yes		
GBD007	256	426	353	223			Square		W?				
FJJ056 (outer)	259	417	353	482 (1402)	Yes		Square		E		Yes		Yes
SCH020B	259	417	354	302			Square	Square	N		Yes		
ZZW016	261	432	382	420	Yes		Square		E	Yes		Yes	
GBD002	259	533	394	959					S				
FJJ013	264	534	410	2272			Square	Square	?				
ZZW013	336	533	410	2400	Yes		Square		E	Yes		Yes	Yes
LEK021	342	536	434	72		Yes			?				
HHG014	350	534	437	857	Yes	Yes	Square		E?		Yes		
MZQ007	389	535	453	1310			Square	Square	N		Yes		Yes
GBD001	355	542	459	848			Square		?	Yes			
HHG008	398	535	463	590	Yes		Square		?		Yes		
MAR001	382	560	470	87		Yes			?				
ZZW014	419	540	481	2624	Yes	Yes	Square	Square	E?	Yes			Yes
GAT001	424	539	483	726	Yes		Square		N	Yes		Yes	
GAT010	423	541	483	899	Yes		Square?	?	E/N	Yes			Yes
GRE015	422	541	483	996			Square	Square	N				
HHG001	415	546	483	1966	Yes		Square	Square	E	Yes		Yes	
ZZW101	440	619	560	736		Yes	Circular		?				Yes


N
BNH005
GBD001
GBD007
GBD002
LEK018
LEK021
TAG011
LGR099
FUG022
TEK010
FJJ013
GRE015
GER001
FJJ056
AMS Samples
Unsuccessful
Mattingly 2007
Sterry et al. 2012
New Sample
MAR001
SCH020
HHG
MZQ001
MZQ
GAT
ZZW
0
20
40
60
80
100
Kilometres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HHG012
HHG006
HHG014
HHG013
HHG001
MZQ001
GAT001
GAT012
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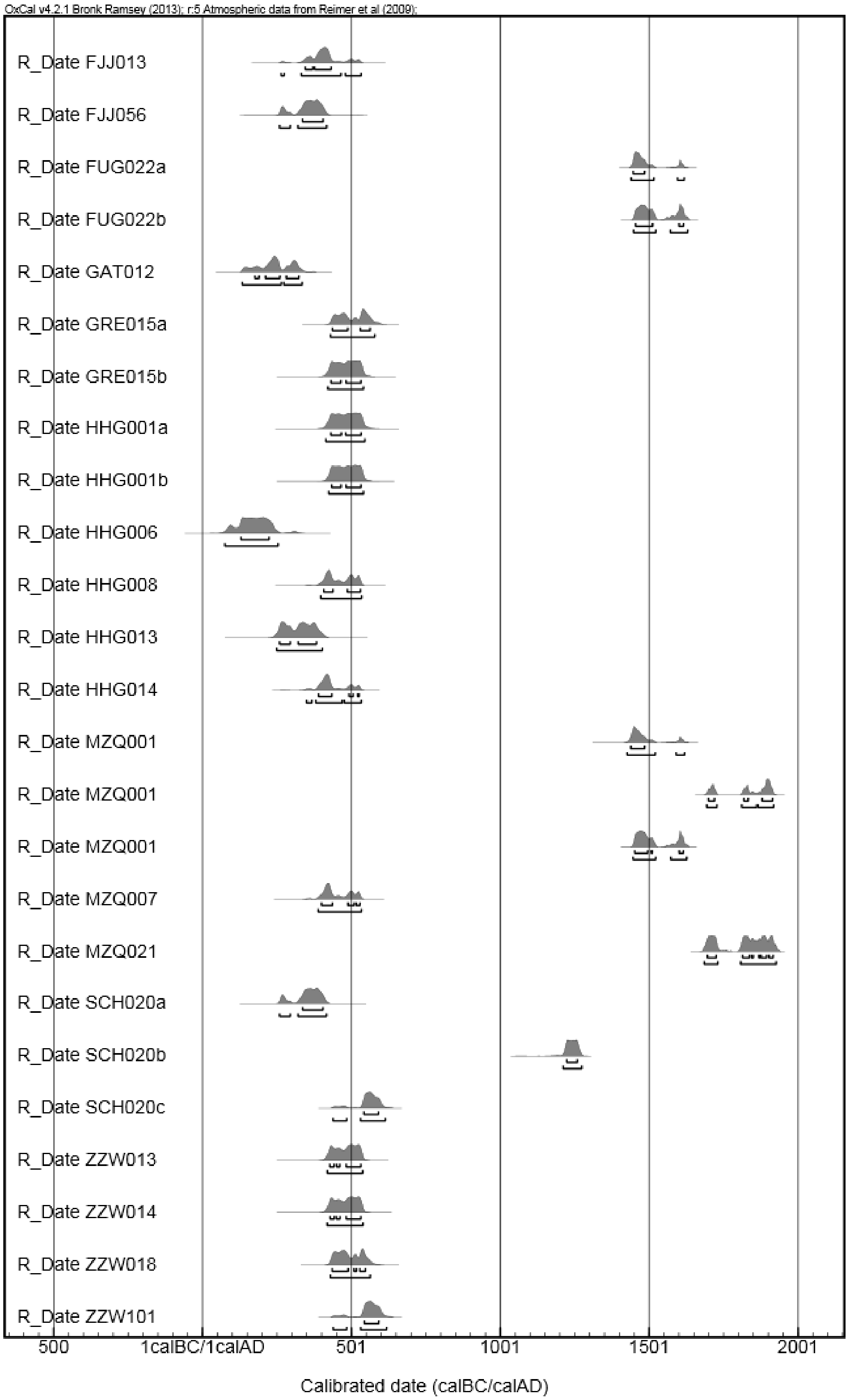
5
10
15
20
Kilometres



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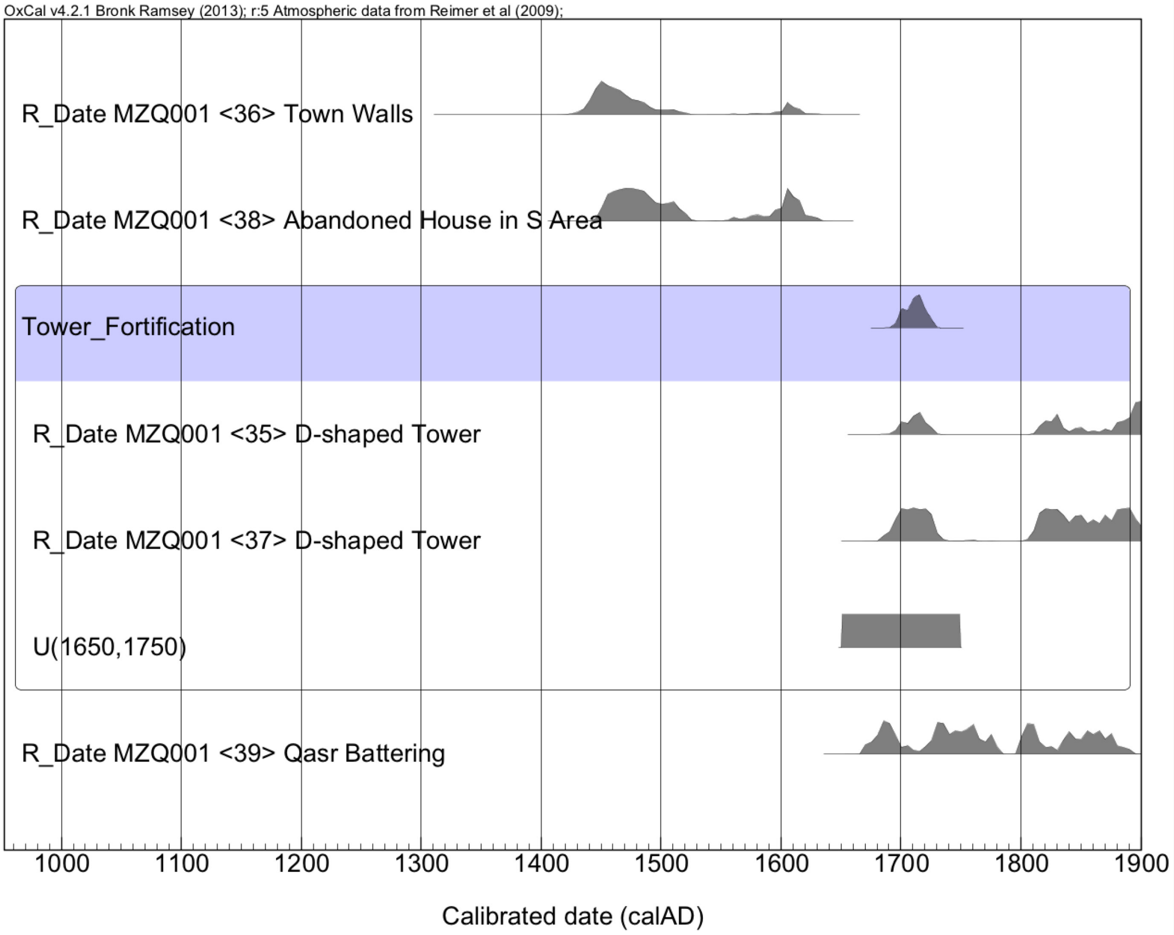
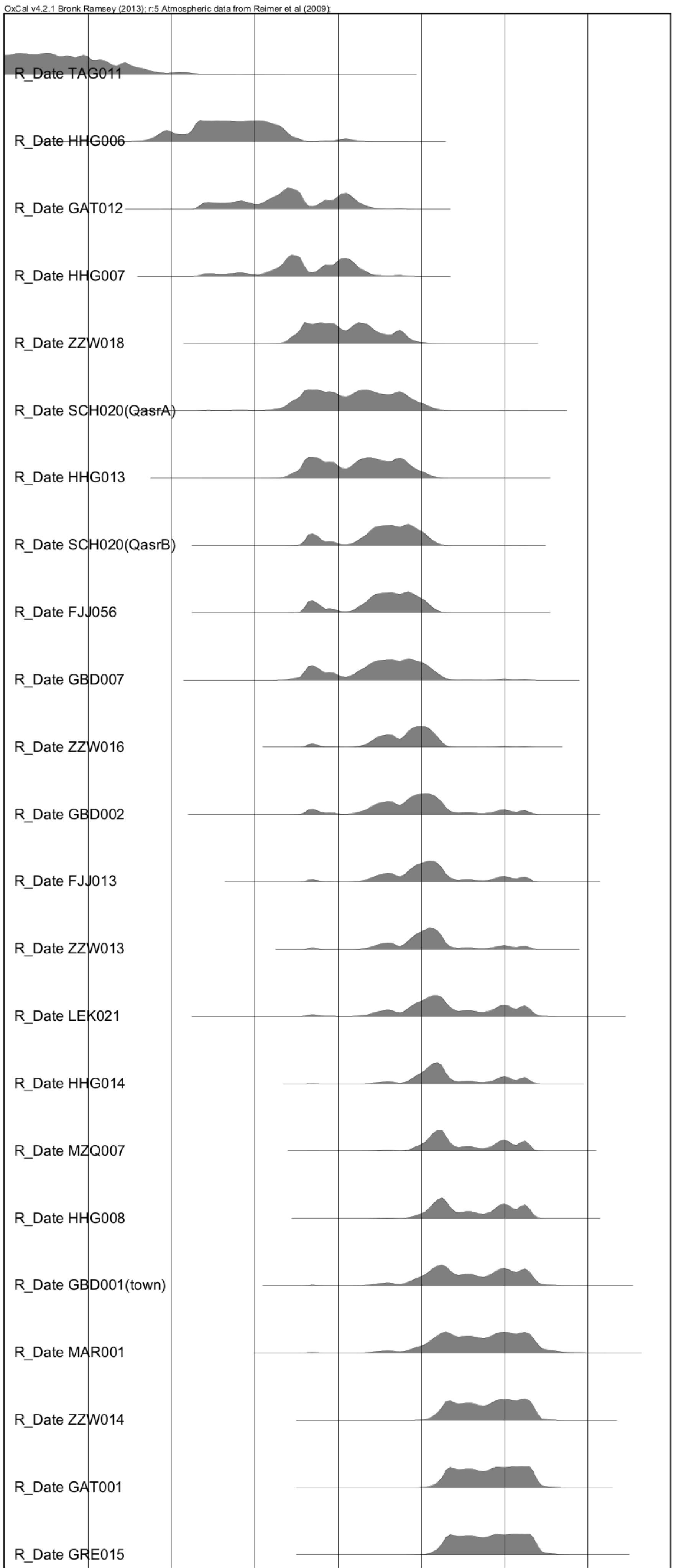
R_Date FJJ013
R_Date FJJ056
R_Date FUG022a
R_Date FUG022b
R_Date GAT012
R_Date GRE015a
R_Date GRE015b
R_Date HHG001a
R_Date HHG001b
R_Date HHG006
R_Date HHG008
R_Date HHG013
R_Date HHG014
R_Date MZQ001
R_Date MZQ001
R_Date MZQ001
R_Date MZQ007
R_Date MZQ021
R_Date SCH020a
R_Date SCH020b
R_Date SCH020c
R_Date ZZW013
R_Date ZZW014
R_Date ZZW018
R_Date ZZW101
500
1calBC/1calAD
501
1001
1501
2001
Calibrated date (calBC/calAD)

FJJ013
FJJ056
GRE015
N
Metres
0
50
100
150
200
HHG001
HHG008
HHG007
HHG006



OxCal v4.2.1 Bronk Ramsey (2013); r:5 Atmospheric data from Reimer et al (2009);
R_Date MZQ001 <36> Town Walls
R_Date MZQ001 <38> Abandoned House in S Area
Tower_Fortification
R_Date MZQ001 <35> D-shaped Tower
R_Date MZQ001 <37> D-shaped Tower
U(1650,1750)
R_Date MZQ001 <39> Qasr Battering
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
Calibrated date (calAD)



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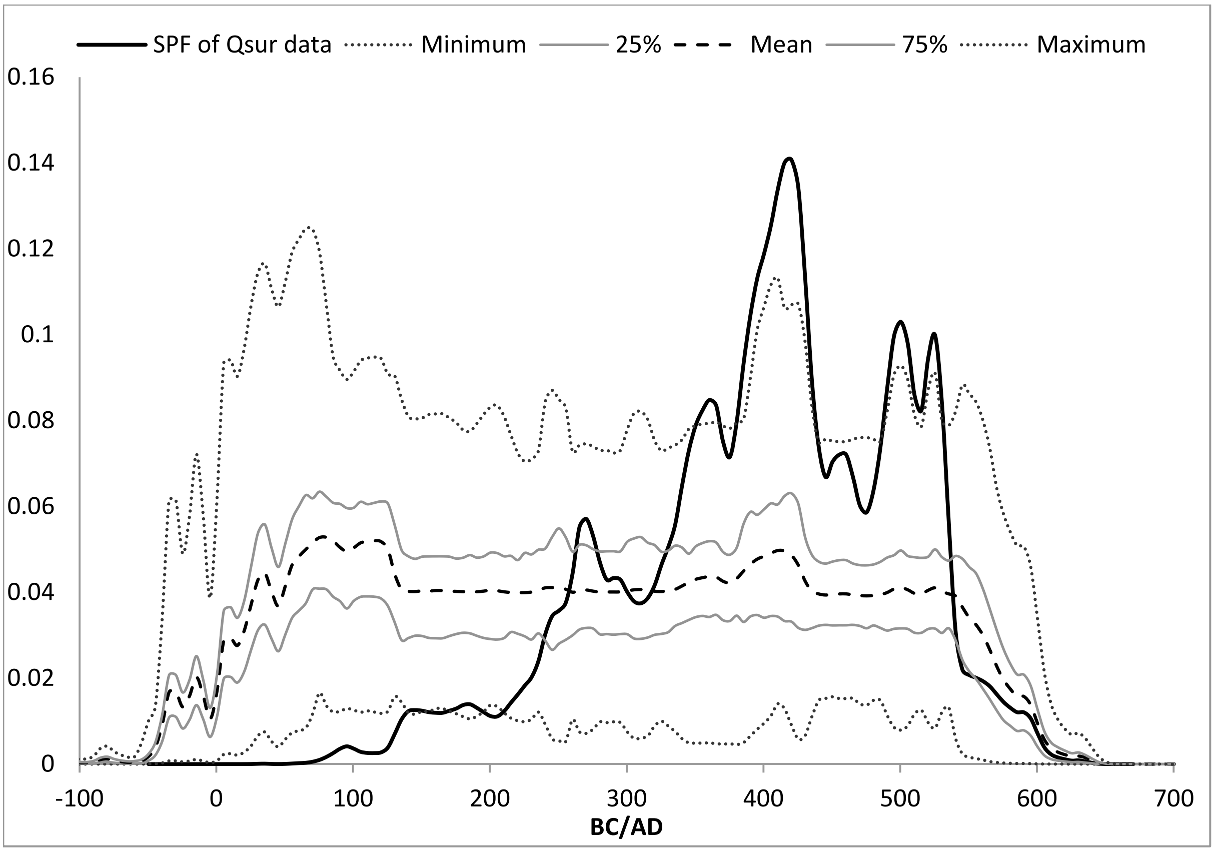
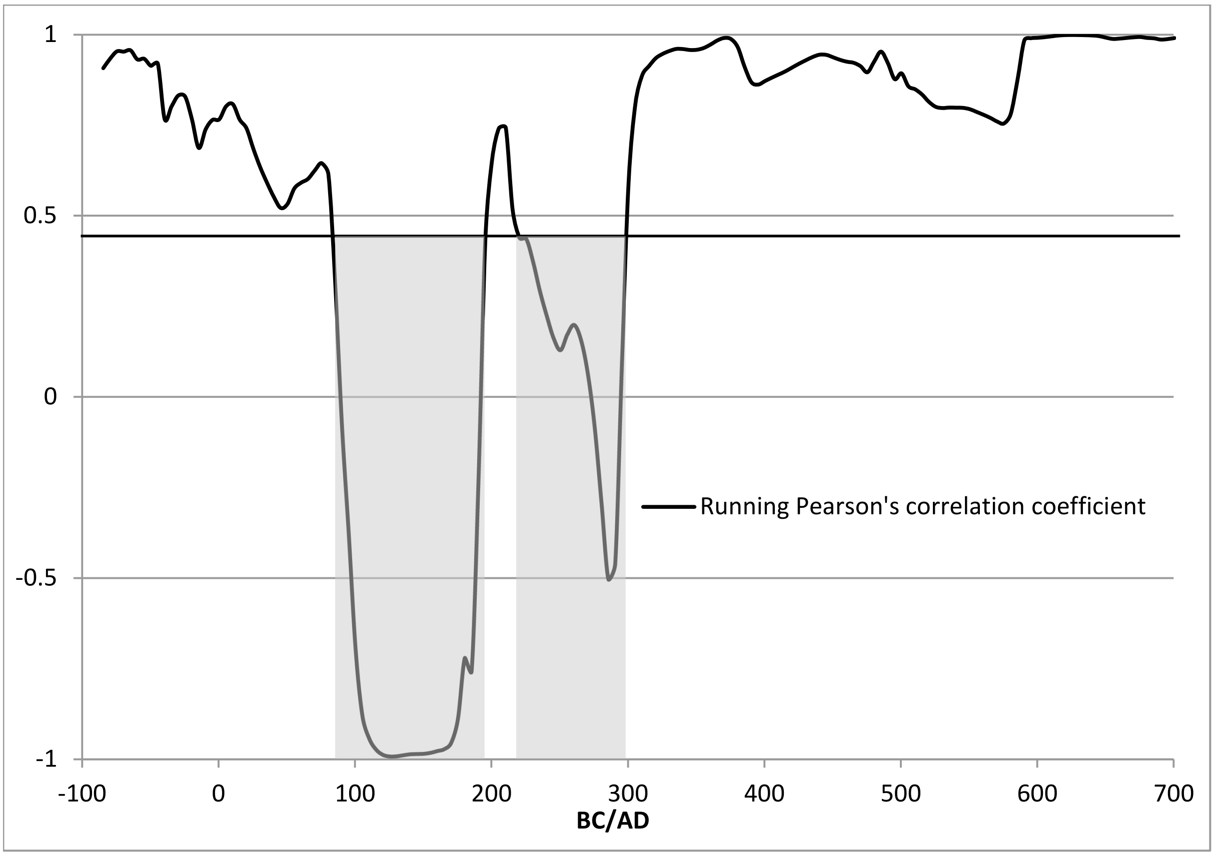
R_Date TAG011
R_Date HHG006
R_Date GAT012
R_Date HHG007
R_Date ZZW018
R_Date SCH020(QasrA)
R_Date HHG013
R_Date SCH020(QasrB)
R_Date FJJ056
R_Date GBD007
R_Date ZZW016
R_Date GBD002
R_Date FJJ013
R_Date ZZW013
R_Date LEK021
R_Date HHG014
R_Date MZQ007
R_Date HHG008
R_Date GBD001(town)
R_Date MAR001
R_Date ZZW014
R_Date GAT001
R_Date GRE015



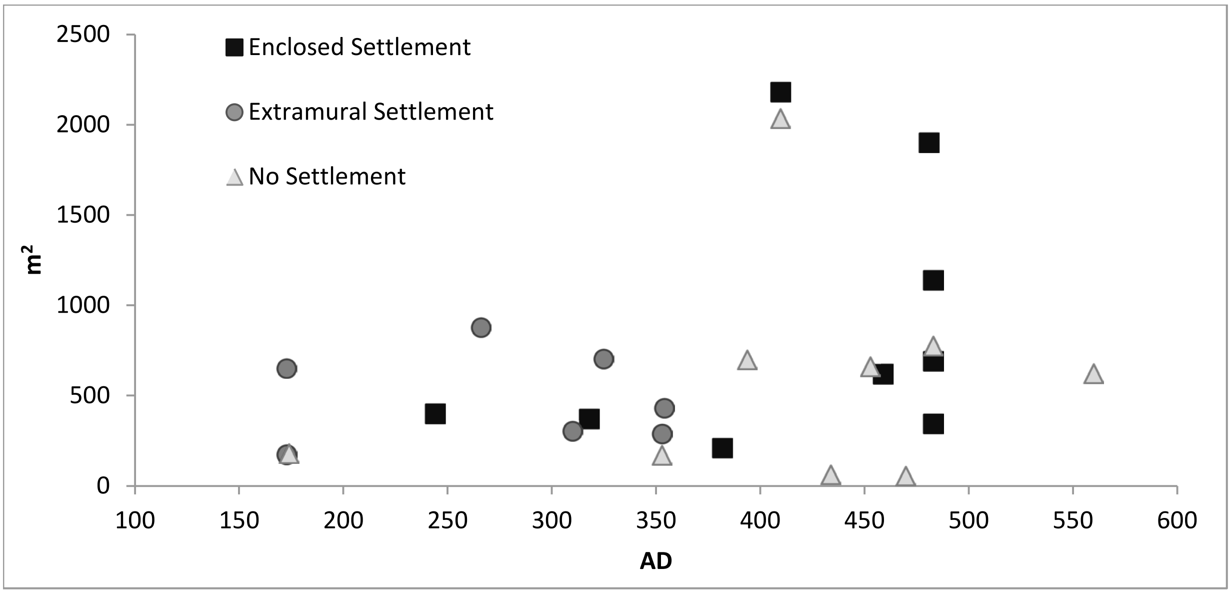
SPF of Qsur data
Minimum
25%
Mean
75%
Maximum
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-100
0
100
200
300
400
500
600
700
BC/AD

a

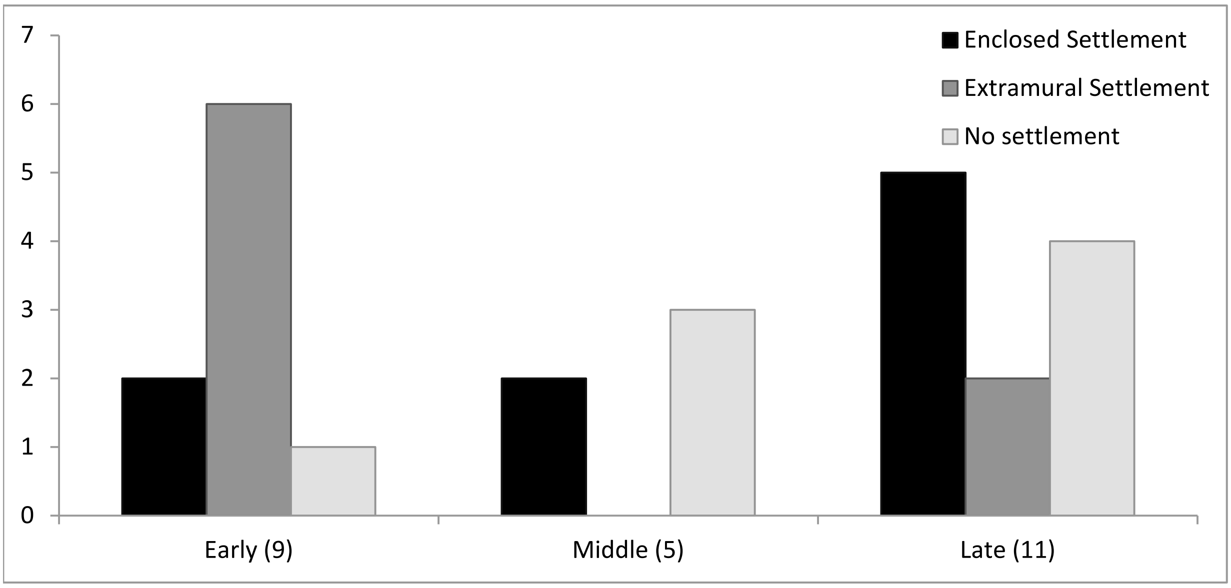


1
0.5
0
-0.5
-1
Running Pearson's correlation coefficient
-100
0
100
200
300
400
500
600
700
BC/AD

b



2500
2000
1500
1000
500
0
m2
Enclosed Settlement
Extramural Settlement
No Settlement
100
150
200
250
300
350
400
450
500
550
600
AD



7
6
5
4
3
2
1
0
Enclosed Settlement
Extramural Settlement
No settlement
Early (9)
Middle (5)
Late (11)