Desert Migrations Project XVI: Radiocarbon Dates from the Murzuq Region, Southern Libya

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Abstract

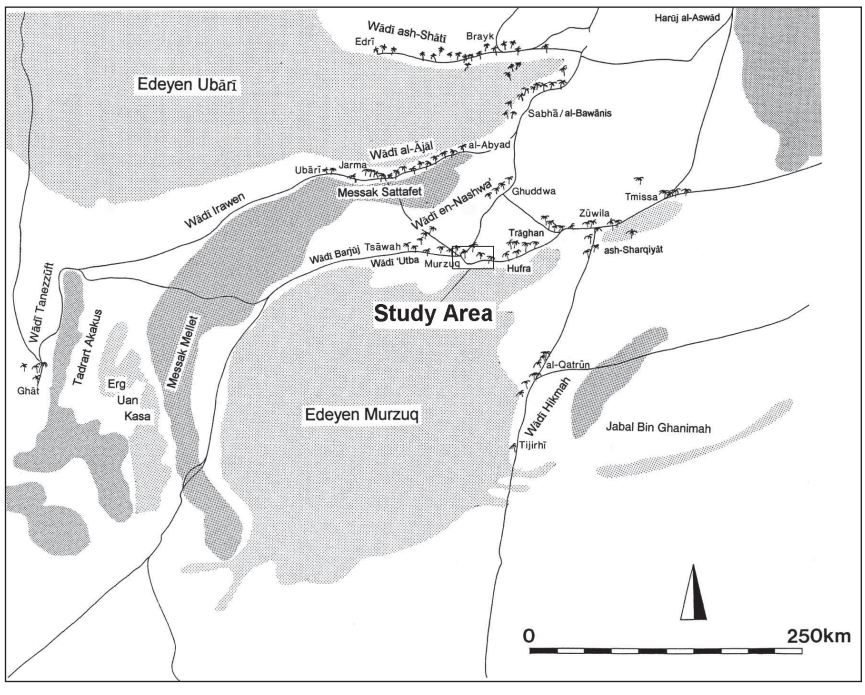
This article concerns a series of 20 samples submitted for AMS radiocarbon dating from historic sites in the Libyan Sahara. The sites had been identified initially from remote sensing analysis, then visited on the ground in 2011 and organic samples suitable for a dating programme obtained. With the help of an award from the NERC-AHRC National Radiocarbon Facility, this initial suite of dates has been provided. The results are important in several ways. They demonstrate very clearly that settlement in this hyper-arid desert landscape reached its densest pattern in the late Garamantian era, broadly the fourth–fifth centuries AD. In the Islamic era that followed, though the overall population appears less dense, our dates throw light on several possible phases of settlement renewal.

Introduction

The absolute dating of settlement sites of historical periods remains a key priority of Saharan archaeology. In combination, the work of the Fazzan Project and the Desert Migrations Project (DMP) on the Garamantes and Islamic era sites in the Wadi al-Ajal is an exception to a general neglect of historical periods in the archaeology of the central Sahara. Previous suites of AMS (Accelerator Mass Spectrometry) dates provided a pioneering dataset for the region (Higham *et al.* 2007; Mattingly *et al.* 2002; Mattingly 2007, 294–302), supplemented by some limited dates from Italian work in the area close to Ghat (Liverani 2006, 363–74). The rise of the Garamantian civilisation in the course of the first millennium BC is now well established, with its apogee reached in the first half of the first millennium AD (Mattingly 2003; 2007; 2010). However, the Wadi al-Ajal is only one of three bands of oases in Fazzan, and there are further isolated groups of oases to north-east, south-east and south-west, which were arguably all once part of the Garamantian kingdom. The contrasts between the evidence from the heartlands around the Garamantian capital of Jarma in the Wadi al-Ajal and the peripheral oases of the Wadi Tanzufft near Ghat have already demonstrated the potential inapplicability of the dated sequence from the heartlands with other regions of Fazzan (Liverani 2006, 375–78). This article addresses the dating of sites in another of the major oases zones of Fazzan, the Murzuq/al-Hufra basin, situated *c.* 100 km south-east from Jarma (Fig. 1).

The dating project reported here follows up the Peopling the Desert Project (PDP), which has mapped from air photographs and high resolution satellite imagery exceptionally well-preserved ancient settlements and landscapes in the Murzuq region of Fazzan, southern Libya. As reported in *Libyan Studies* last year (Sterry and Mattingly 2011),

Figure 1. Location map showing the Murzuq region and Fazzan.



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a short ground survey was made by us in January 2011 of a representative sample of the mapped settlement sites to the immediate east of Murzuq. Rather to our surprise, the indications from the surface pottery we collected were that most of the fortified villages and *qsur* were Garamantian in date (Sterry and Mattingly 2011, 113). However, the pottery collected was not very closely dateable either for the Garamantian or Islamic settlements and it was clearly important to obtain clarification on the dating of all the categories of site by scientific methods. Accordingly, during the course of the survey, organic samples were collected for dating purposes from a range of mudbrick structures. Samples were taken from castle-like buildings (*qsur*), abandoned villages (of both nucleated and dispersed form), and from the town walls and *qasabah* of the city of Murzuq. An initial batch of 20 samples (Fig. 2) was processed and measured by AMS at the Oxford Radiocarbon Accelerator Unit, with grant support from the NERC-AHRC National Radiocarbon Facility programme.

Methods

Following a technique pioneered by the Fazzan Project (see Mattingly *et al*. 2002) organic inclusions were removed from standing mudbrick buildings for dating. In most cases this involved breaking up a mudbrick with a hammer and retrieving a sample from within the matrix of the brick (Fig. 3). The bricks selected were normally loose, but identifiably part of the standing walls from which they were extracted. Where no loose brick was available, a single brick was cut out of the standing wall section. A few samples were taken from the mud/gypsum bonding between the bricks.

Where possible the material submitted for dating comprised a single seed, representing the annual produce of a plant. Date stones (*Phoenix dactylifera*) were ideal, but where these were not found, we concentrated on thin plant stems and twigs, for reasons explained below. In a few cases organic material was very rare in the mudbrick and only filaments were recovered, leading to some problems with sample viability. All samples were processed by the Oxford Radiocarbon Accelerator Unit (ORAU). There were two failures, P30803 and P30819, both due to very low yields. The dates are presented (Table 1) uncalibrated in radiocarbon years BP (Before Present = AD 1950) using the half life of 5568 years and calibrated to the IntCal09 dataset (Reimer *et al*. 2009) using the OxCal 4.1.7 software package (Bronk Ramsey 2010).

Possible Problems of Interpretation

It is assumed that the organic samples taken would have entered the matrix of the structure when the mudbricks were made. For this reason, possibly

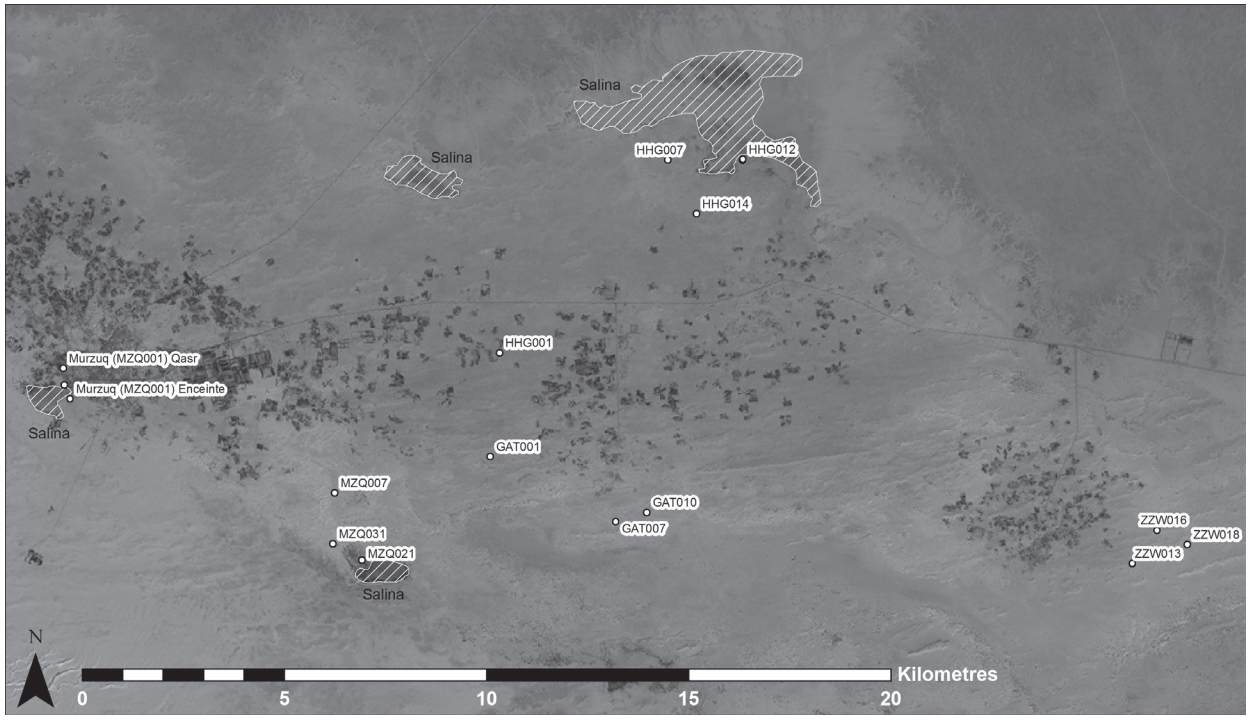


Figure 2. Location map of the sites from which AMS samples have been processed. Landsat Image courtesy of USGS.

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Figure 3. A date stone within the matrix of a mudbrick (AMS sample 6, site HHG001).

intrusive organic materials, e.g. insect casings, have been avoided and so-called annual material – twigs, palm fibres and especially date stones – was chosen over larger pieces of wood or charcoal. There are two main possible problems of interpretation. Firstly, it is unknown how long organic materials may have been in existence before being incorporated into a mudbrick, although the favouring of annual material probably reduces this to no more than a few years. Secondly, is not known how long a formed mudbrick might have been kept before being used. Both these issues could lead to an interpretation that dates the construction of the building to be earlier than it is in reality. However, there is no indication that building materials were stockpiled for any lengthy period of time.

Re-use of mudbricks is unlikely to have taken place. It is quite easy to form new mudbricks and it would take more effort to remove them and build them into a new structure (removing and breaking one brick was a fairly lengthy procedure during survey). A greater problem is recognising whether a mudbrick came from the primary construction or a later repair or modification. All effort was taken to identify the phase of wall from which the mudbrick came, but given the heavily eroded and sand covered nature of the monuments a more complex building sequence is a strong possibility at many of the sites visited. On the other hand, in two cases when samples were taken from different phases of the same building or site (GAT010 and HHG012) the resulting date ranges were almost identical.

There is a radiocarbon plateau for the period AD 1700–1950 in which there were several fluctuations of ^{14}C. This affects three of the samples which consequently have very long date ranges although the descriptions of nineteenth-century travellers can potentially provide a *terminus ante quem* for these sites. The similarity of date ranges for sites with a ^{14}C age of *c.* 1580 BP is also due to a small plateau of just over 100 years from AD 420–540. Therefore this is not evidence of contemporaneous construction (although neither is this possibility ruled out). The clustering of dates even to a particular century may be representative of a broad trend in settlement construction.

Results

The new AMS dates are presented in Table 1 and Figure 4, with the discussion that follows organised by site type.

Discussion of individual Samples

The Qsur

The majority of dates relate to the defensive structures commonly described as *qsur*. The vast majority of these can now be confirmed to be of Garamantian date, though these dates suggest that in the Murzuq area there was little activity before the Late Garamantian period. The earliest settlements appear to be HHG007 and ZZW018, which could be third century AD. These are both *qsur* of modest size with substantial unenclosed settlements (the former is a part of a complex that includes two further *qsur*). The other two dated settlements from the Zizaw area (ZZW013 and ZZW016), both *qsur* with enceintes, and the rest of the fortified villages, appear to be fourth–fifth century in origin. Further AMS samples are required to understand better the development of this micro-region (see Sterry and Mattingly 2011, fig. 3), but the dated samples do support the interpretation that the vast majority of archaeological remains relate to the end of the Classic Garamantian period or early in the Late Garamantian period (broadly AD 300–500). These sites are of comparable date to the *qsur* noted in the UNESCO Libyan Valley Surveys in Tripolitania, the majority of which had been constructed by the

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Table 1. Radiocarbon results from the PDP 2011 survey.

Site code	Lab code	Sample codes	Material dated	Description	^{14}C age BP	Calibrated date range (2σ confidence)
GAT001	OxA-25833	AMS Sample 9	plant remains, unknown	Mudbrick from S wall of *qasr*	1582 ± 22 BP	cal AD 424 (95.4%) 539
GAT007	OxA-25834	AMS Sample 23	plant remains, *Phoenix dactylifera*	Wall fabric from one of the buildings in dispersed village	117 ± 21 BP	cal AD 1682 (27.8%) 1737 cal AD 1804 (53.7%) 1895 cal AD 1903 (13.8%) 1936
GAT010	OxA-25822	AMS Sample 20	seeds, possible *Olea Europaea*	Mudbrick from the original E wall of *qasr*	1577 ± 22 BP	cal AD 426 (95.4%) 541
GAT010	OxA-25823	AMS Sample 21	seeds, *Phoenix dactylifera*	Mudbrick used in the outermost layer of enlargement and buttressing of the NE tower of *qasr*.	1580 ± 24 BP	cal AD 423 (95.4%) 541
HHG001	OxA-25821	AMS Sample 06	seeds, *Phoenix dactylifera*	Mudbrick from SW corner of *qasr*	1577 ± 23 BP	cal AD 425 (95.4%) 541
HHG007	OxA-25829	AMS Sample 14	plant remains, *Phoenix dactylifera*	Mudbrick from the NE corner of *qasr*	1772 ± 26 BP	cal AD 139 (9.1%) 195 cal AD 209 (86.3%) 341
HHG012	OxA-25830	AMS Sample 17	wood, *Phoenix dactylifera*	Wall fabric from the S side of the mosque in *medina*	530 ± 22 BP	cal AD 1327 (8.9%) 1342 cal AD 1394 (86.5%) 1436
HHG012	OxA-25831	AMS Sample 18	seeds, *Phoenix dactylifera*	Wall fabric from the outside of the SE wall of the *qasabah* in *medina*	543 ± 21 BP	cal AD 1321 (23.6%) 1349 cal AD 1391 (71.8%) 1432
HHG014	OxA-25832	AMS Sample 11	wood, *Phoenix dactylifera*	Mudbrick from S wall of qasr	1585 ± 23 BP	cal AD 421 (95.4%) 540
MZQ001	OxA-25826	AMS Sample 34	seeds, *Phoenix dactylifera*	Mudbrick in 0.6m thick section of the city wall on SW side	1.06715±0.002 72 F14C	
MZQ001	OxA-25827	AMS Sample 37	seeds, *Phoenix dactylifera*	Mudbrick from D-shaped tower in city walls on abandoned S side	98 ± 21 BP	cal AD 1691 (26.3%) 1730 cal AD 1810 (69.1%) 1925
MZQ001	OxA-25828	AMS Sample 39	seeds, *Phoenix dactylifera*	Outer skin of mud buttressing on W side of the *qasabah* in the city of Murzuq	143 ± 22 BP	cal AD 1669 (15.9%) 1707 cal AD 1719 (29.5%) 1780 cal AD 1797 (11.9%) 1826 cal AD 1832 (21.2%) 1886 cal AD 1913 (16.9%) 1945
MZQ007	OxA-25825	AMS Sample 01	charcoal, *Acacia*	Mudbrick from SW corner lower foundations of *qasr*	572 ± 24 BP	cal AD 1308 (58.7%) 1362 cal AD 1386 (36.7%) 1419
MZQ021	OxA-25796	AMS Sample 04	plant remains, unknown	Fabric of the outside wall on the NW side of the *qasabah* in *medina*	477 ± 26 BP	cal AD 1411 (95.4%) 1450
MZQ031	OxA-25797	AMS Sample 05	plant remains, *Tamarix*	Wall fabric from a foundation level of one of the buildings in dispersed village	270 ± 28 BP	cal AD 1519 (40.4%) 1594 cal AD 1618 (49.1%) 1668 cal AD 1782 (5.8%) 1798
ZZW013	OxA-25824	AMS Sample 29	plant remains, Phoenix dacty-lifera	Wall bonding from the stone and mud foundations of the SE tower of secondary *qasr*	1644 ± 26 BP	cal AD 336 (83.6%) 443 cal AD 450 (1.3%) 462 cal AD 484 (10.5%)533
ZZW016	OxA-25869	AMS Sample 32	plant remains, unknown	Mudbrick in the S wall of the *qasr*	1662 ± 25 BP	cal AD 261 (3.7%) 280 cal AD 326 (91.7%) 432
ZZW018	OxA-25870	AMS Sample 33	charcoal, *Phoenix dactylifera*	Mudbrick in the SE tower of the *qasr*	1730 ± 25 BP	cal AD 245 (95.4%) 385

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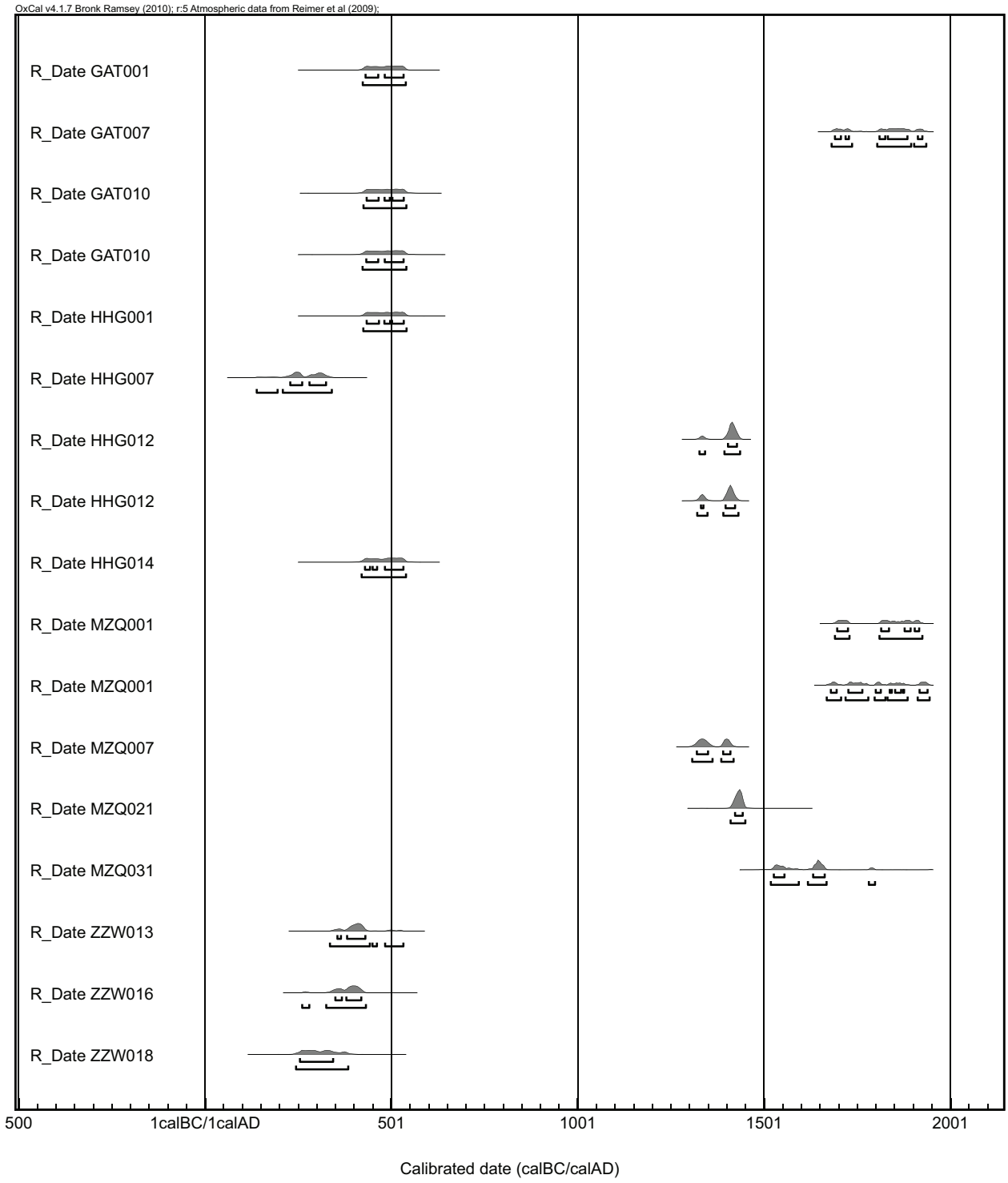
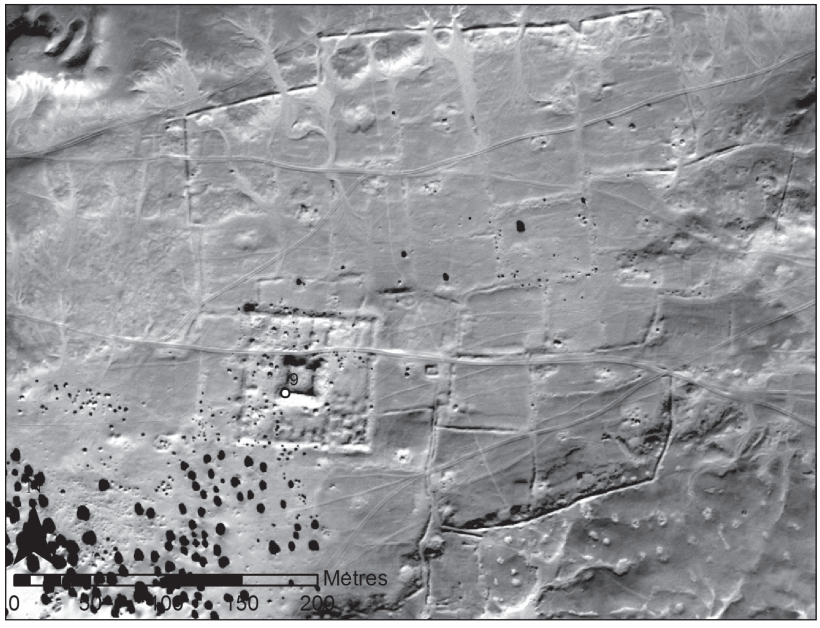


Figure 4. Calibrated radiocarbon results from the PDP 2011 survey showing normalised probability curves. For each sample the 1σ and 2σ ranges are shown; there is a 68.2% and a 95.4% chance respectively of the actual date of the sample falling within this range.

late fourth century (Barker *et al.* 1996, 165). The relationship between these two groups of settlement, *c.* 600 km apart, is unclear, but this is more evidence that they need to be considered as part of a North African phenomenon that traversed the frontiers of the Roman Empire.

A second group of *qsur* (GAT001 – Fig. 5, GAT010, HHG001, HHG014) all produced a strikingly similar calibrated date range of cal AD 430–540. The clustering of the dates is potentially due to a plateau in the radiocarbon calibration curve, but, given the close morphological similarities between

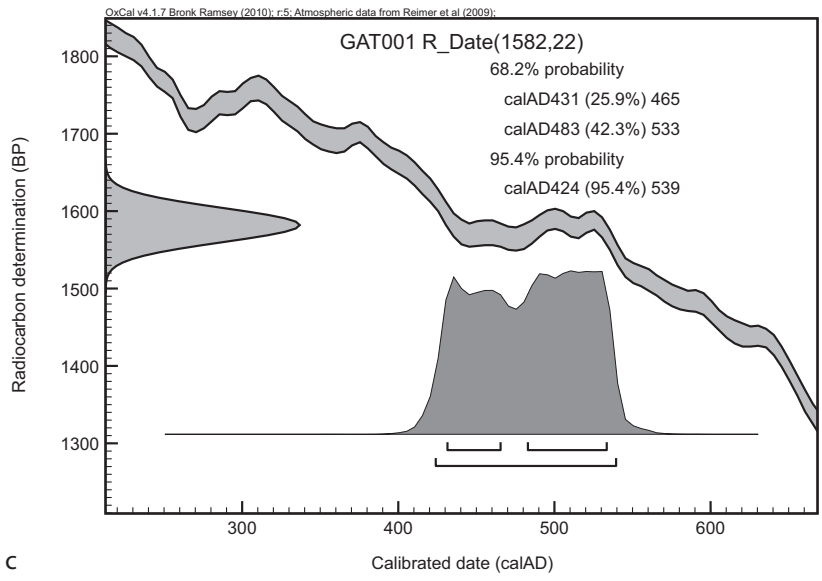
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a



b



c

Figure 5. GAT001: a) 2011 WorldView-2 image of the site; b) transcription of definite (solid line) and probable (dotted line) features; c) calibration curve for sample OxA-25833, the radiocarbon probability curve is shown on the y-axis, the IntCal09 calibration curve runs through the centre of the image and the resulting calibrated probability curve sits above the x-axis, 1σ and 2σ ranges are marked.

several of these sites, it is worth consideration that they represent a particularly intense phase of settlement development. One possibility is that this reflects a second wave of construction on slightly higher ground to the west of the ZZW area and to the south of HHG007. However, it is equally notable that this group of *qsur* can be described as having more elaborate defensive architecture, either through larger more complex *qsur*, outer enceintes or both (although note that ZZW013 and ZZW016 could also be argued to belong in this group). Again, further dates will be processed to see if this pattern is confirmed. However, the present evidence strongly suggests that the dramatic expansion of oasis agriculture in this part of Fazzan was a relatively late phenomenon, as in plan many of the fortified villages appear to be central to the layout of associated settlement and fields.

The final *qasr* MZQ007 (see Sterry and Mattingly 2011, fig. 4) was dated much later than the other *qsur* to the early fourteenth or fifteenth century. This would appear to place the construction in a similar period to that of the nucleated *medina* and *qasabah* sites (see below). The sample was

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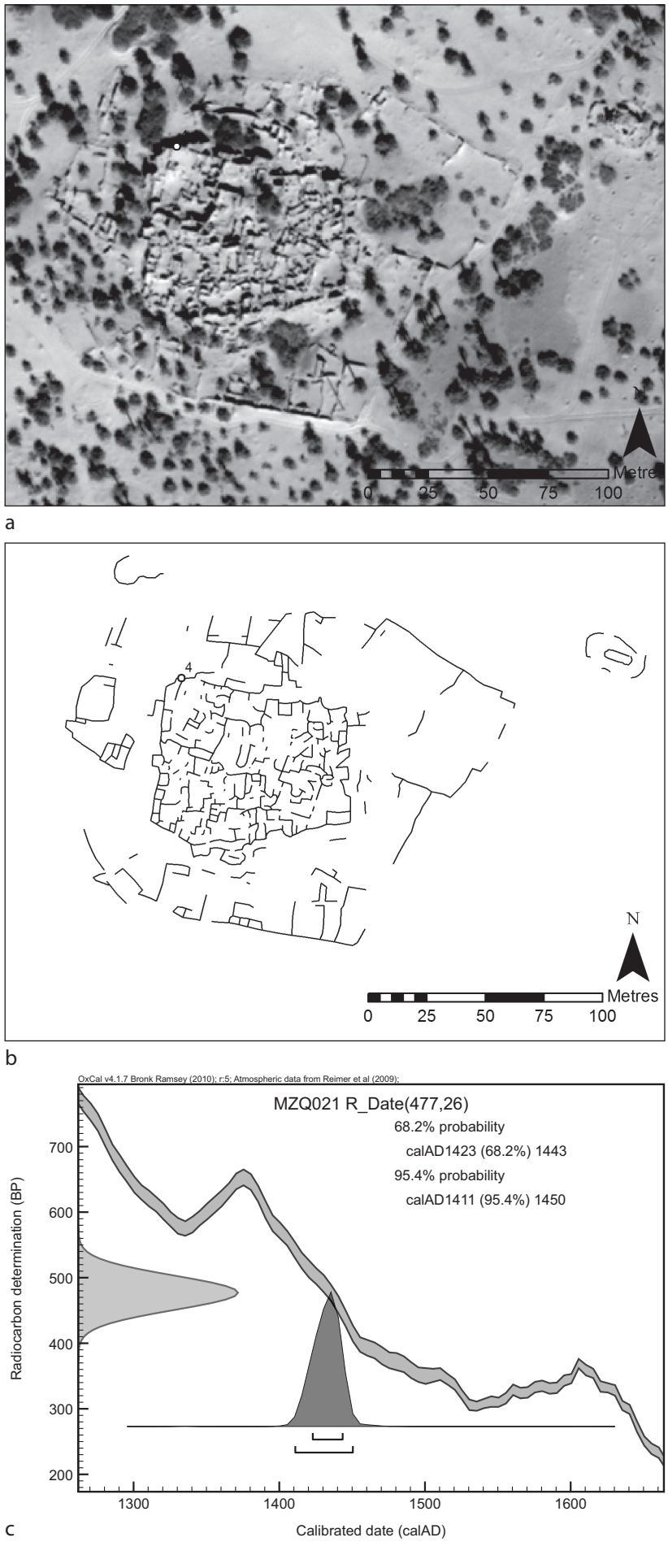


Figure 6. MZQ021: a) 2009 QuickBird image of the site; b) transcription of definite (solid line) and probable (dotted line) features; c) calibration curve for sample OxA-25796, the radiocarbon probability curve is shown on the y-axis, the IntCal09 calibration curve runs through the centre of the image and the resulting calibrated probability curve sits above the x-axis, 1σ and 2σ ranges are marked.

taken from a suspected earlier platform under the visible walls, which themselves include probable musket loops (hence dating the later phases to at least the Ottoman period), but a Garamantian origin for this site cannot be entirely ruled out due to the presence of imported Roman ceramics located during the survey of the site. Once established as an architectural form, the *qasr* had a long lifespan.

Islamic Fortified Villages (Medina)

Two Medieval nucleated villages with citadels (*qasabah*) and mosques were identified in the work. It was unclear to what part of the Islamic era these sites related, though we suspected a late Medieval or early modern date. Two samples from village HHG012 (see Sterry and Mattingly 2011, fig. 6) and one from the village MZQ021 were thus submitted for dating. Both samples from the former site gave a calibrated range suggesting either an early fourteenth- or early fifteenth-century date while the latter site is potentially slightly later (Fig. 6), with the sample probably dating to the early or mid fifteenth century. Both these sites had a very similar morphology,

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employed identical mudbrick construction (using salt enriched mud-lumps) and were located adjacent to dried up lakes (salinas). This congruence of comparable features suggests that these two sites are part of the same phenomenon and given the proximity in dating to the sample from MZQ007, a working hypothesis is that the fourteenth to fifteenth century was a period of expansion and/or increased fortification in the area.

The style of mudbrick construction of these *qasabah* sites and the apparent dating are closely comparable with the *qasabah* of Old Jarma (see Mattingly 2007, 295–296). The Jarma *qasabah* has produced two AMS dates indicating date ranges of cal AD 1310 (95.4%) 1440 (OxA-9579) and cal AD 1400 (95.4%) 1450 (OxA-9769). These give a combined date of cal AD 1398 (95.4%) 1443. As the *qasabah* at Jarma is unusual in its morphology and construction mode in the Wadi al-Ajal, it is possible that the correlation here relates to a specific set of political circumstances. The fourteenth to fifteenth centuries are a shadowy period in the history of Fazzan (see Mattingly 2003, 90–98, especially table 3.3). This seems to be a period when the domination of Fazzan by the Kanimi kingdom ended and the sources mention a period of rule by the Khurman, who can plausibly be identified as the descendants of the Garamantes still living in the Wadi al-Ajal, with their principal centre at Jarma. During this period of revived Khurman power, they apparently established their capital at Zuwila. The attempt by the Khurman to consolidate their rule over eastern Fazzan could well also have been marked by the construction of new fortified villages and the cross-fertilisation of new techniques of construction and new architectural forms both in the Murzuq area and at the Khurman centre of Jarma. The rule of the Khurman in eastern Fazzan was evidently resisted by local groups, leading to political anarchy before the inauguration of the Awlad Muhammad dynasty in the late fifteenth or early sixteenth century. The dates obtained at present appear to fall precisely into this transitional period of Khurman power between the Kanimi kingdom and the dominance of the Awlad Muhammad. Further dates and archaeological exploration are required to confirm this hypothesis, but it is an intriguing possibility.

Murzuq and the dispersed villages

A sample from the *qasabah* of Murzuq and from the enceinte of the abandoned southern part of Murzuq returned post-1600 dates, strengthening the association between this city and the Awlad Muhammad dynasty that ruled in Fazzan from the 1550s. The sample from the *qasabah* relates to a possible late buttress on the east side and it is difficult to narrow down the date range with any confidence, but it could relate to Ottoman- or even Italian-era modifications to the building. The walls of Murzuq are of major interest, first described by Lyon when he arrived in 1817 (1821, 97) and likely in existence when Hornemann visited

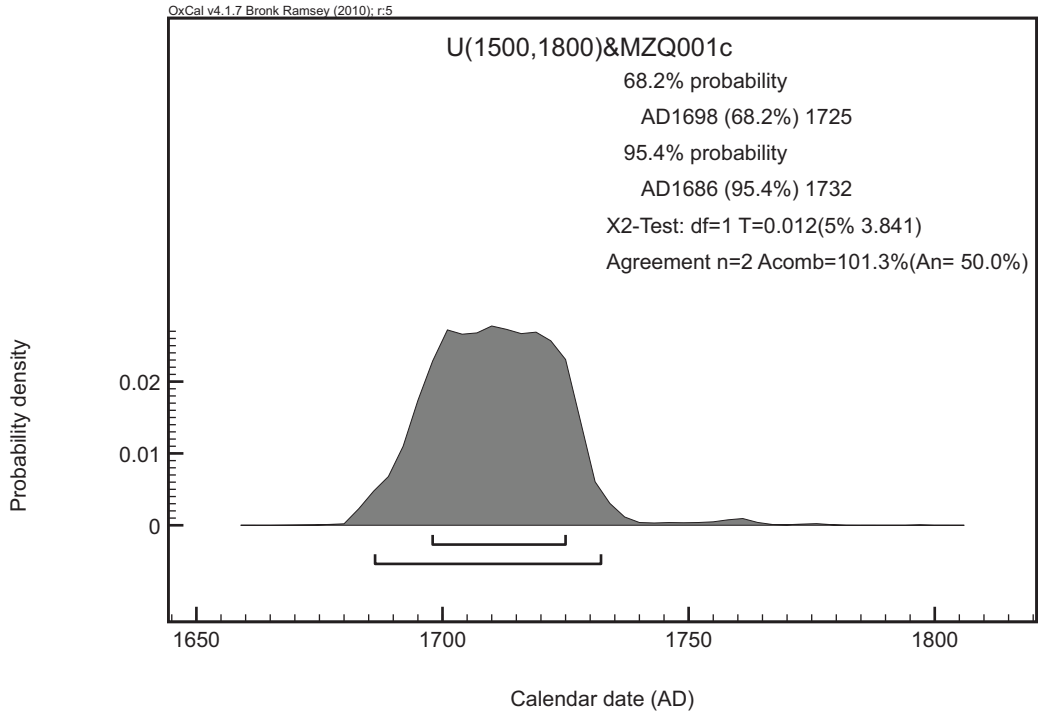


Figure 7. Calibrated radiocarbon result for the Murzuq city walls (MZQ001, OxA-25827) calculated with chronological boundaries AD 1500–1800.

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in 1800.The sample obtained from the southern abandoned sector of the walls (recorded as such on Barth's 1857/8 map), thus gives strong evidence for the construction date of the walls (and by inference the greatest extent of the city) in the range cal AD 1686 (95.4%) 1732 (Fig. 7). There were several occasions in this period when the Awlad Muhammad were in conflict with the Ottoman/Qaramanli governors of Tripoli. The latter power was frequently represented in Fazzan by members of the notorious al-Mukni family – specifically, 1682, 1689–91, 1699–1700, 1716–18 and 1732–33. Of these instances, the treasury of Murzuq was captured in 1682, the town was besieged and sacked in 1689, besieged unsuccessfully three times between 1716–18, and, in the final recorded attack, the town was captured again in 1732. Within the sources there is also mention of partial demolition of the defences of Murzuq in 1733 and repair to the walls in the period 1745–54 (el-Hesnawi 1990, 80–97; Mattingly 2003, 98–103). While it is not clear whether the defences were erected by Awlad Muhammad rulers to resist the Ottoman attacks, or by the al-Muknis

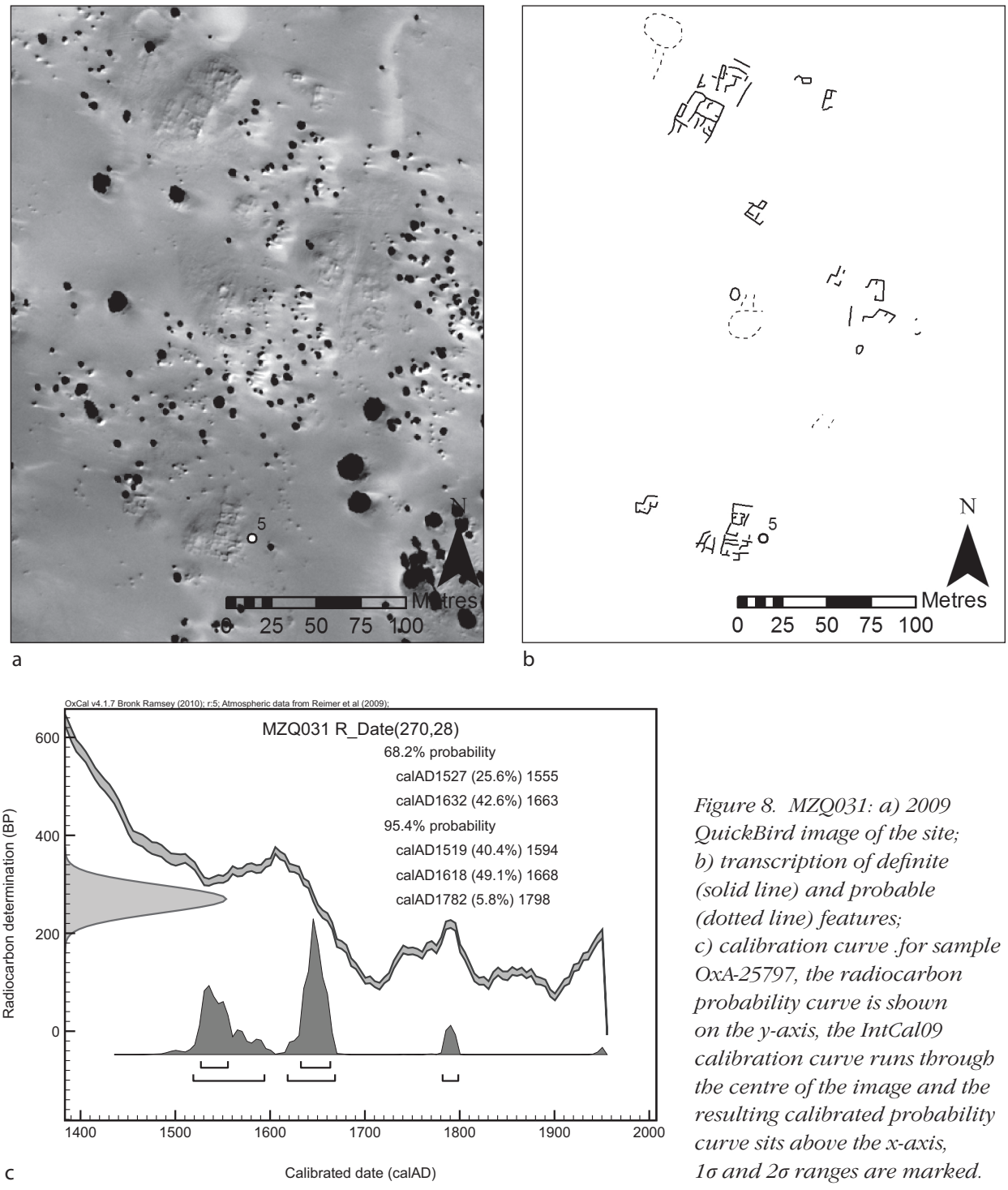


Figure 8. MZQ031: a) 2009 QuickBird image of the site; b) transcription of definite (solid line) and probable (dotted line) features; c) calibration curve .for sample OxA-25797, the radiocarbon probability curve is shown on the y-axis, the IntCal09 calibration curve runs through the centre of the image and the resulting calibrated probability curve sits above the x-axis, 1σ and 2σ ranges are marked.

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to consolidate their temporary dominance having captured Murzuq, it is evident that the D-shaped towers, and possibly the walls themselves relate to this phase of activity. An earlier (second) period of revived Khurman power from 1623–27, when they again ruled from the Eastern Fazzan capital, at Murzuq by this time, appears to predate the erection of the walls that are extant today.

Samples from two dispersed villages of stone, plastered mud and *zariba* (palm frond) dwellings, MZQ031 (Fig. 8) and GAT007, were also sent for analysis. Our starting assumption from structural indications and surface finds was that both of these settlements were likely to be of post-AD 1500 date. The radiocarbon calibration curve creates an artificial plateau, which reduces the sensitivity of dates, though the probability modelling would favour the sixteenth or seventeenth century. It is difficult to extrapolate from two dates, but it is possible that this form of architecture, or its variants, remained in use throughout the early modern period.

Conclusion

These ^{14}C dates are strong evidence of several chronologically discrete phases of oasis settlement and agriculture in the Murzuq region (Table 2). The first of these, the Classic to Late Garamantian period (second to sixth centuries), relates to eight of the sampled sites. These were all square mudbrick *qsur* with associated settlements, some of which were surrounded by a further enceinte. The dated samples suggest that they were constructed across an extended period, not in a single colonising event, though with a Late Garamantian flourish of new foundations. Following this phase there is a gap of eight centuries in which no evidence of settlement construction has been located, despite the broad range of sites sampled. Some sites may have continued on in some form and a reliance on less permanent forms of domestic architecture is quite possible, but it is notable that the second identifiable phase from the ^{14}C samples, the Medieval period (fourteenth to fifteenth centuries) is associated with a radical new type of architectural form (the *medina* type of fortified village), a distinctive construction technique (salt-enriched mud lumps instead of mudbrick) and the earliest known mosques in the locality (older mosques are certainly known in Fazzan at Jarma and Zuwila). The location of these villages on the edges of salinas and away from the field systems of the Garamantian *qsur* is strong evidence that by this point many earlier settlements and agricultural infrastructure had fallen into disuse. The final phase, the Ottoman/Qaramanli era, is linked to the appearance of dispersed villages built from cobbles and the construction of Murzuq, at least in its largest walled form. Although not sampled for dating, the survey also visited a number of irregularly-shaped *qsur* that can be confidently dated to this period from the musket loops built into the wall fabric. Whilst the transition from the Garamantian to the Medieval periods seems to have been characterised by abandonment and relocation, the Medieval to Ottoman periods are less easily divided. Many of the *medina* sites continued in use into the early modern period as was the case at similar sites in the Wadi al-Ajal, although they were certainly abandoned by the time of the first Italian colonial census-taking in the 1930s. Little is known of the ultimate origins of Murzuq – was it entirely a sixteenth-century construction or, as seems likely, do the remains of Medieval and even Garamantian precursors underlie the city?

The dates obtained from this first batch of samples processed from the Murzuq region clearly vindicate the approach taken and open up discussion of the phasing and motivation of human colonisation of the desert landscape. There are further samples to process that should lead to greater security for our initial conclusions (or introduce further complexities). With these we may be able to correlate some of these phases with historical events and/or groups of dates already obtained in the Wadi al-Ajal. We are hopeful that with additional dates it may be possible to deploy Bayesian methods to narrow some of the date ranges and to understand better the chronology of different parts of Fazzan (see e.g. Manning *et al.* 2006). Already, several clusters of dates seem to relate

Table 2. Major archaeological phases distinguished from the ^{14}C results.

Phase	Date Range	Archaeological characteristics
Garamantian	2nd–6th centuries cal AD	Rectangular *qsur* with associated villages and encientes
Medieval (possibly Khurman)	14th–15th centuries cal AD	Fortified villages (*medinas*), some rectangular *qsur*
Ottoman/Qaramanli	16th–19th centuries cal AD	The city of Murzuq, dispersed villages, irregular-shaped *qsur*

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plausibly to significant moments in the history of the central Sahara, from a late Garamantian florescence of settlement near Murzuq, to the brief renaissance of Khurman power in Fazzan in the fifteenth century, or the Ottoman/Awlad Muhammad contestation for control of Saharan trade in the late seventeenth–early eighteenth centuries AD.

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References

Barker, G., Gilbertson, D, Jones, B. and Mattingly, D. 1996. *Farming the Desert. The UNESCO Libyan Valleys Archaeological Survey. Volume 1: Synthesis.* (editor, G. Barker), UNESCO, Paris, Department of Antiquities, Tripoli and the Society for Libyan Studies, London.

Barth, H. 1857/1858. *Travels and Discoveries in North and Central Africa*. (Reprint 1965), London.

Bronk Ramsey, C. 2010 OxCal 4.1.7 http://c14.arch.ox.ac.uk/oxcal/OxCal.html (consulted 1st May 2012)

el-Hesnawi, H.W. 1990. *Fazzan under the Rule of the Awlad Muhammad. A study in political, economic, social and intellectual history.* Sabhā.

Higham, T.F.G., Bronk Ramsey, C., Brock, F., Baker, D. and Ditchfield, P. 2007. Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 32. *Archaeometry* 49, S1: S1–S60.

Liverani, M. (ed.) 2006. *Aghram Nadarif. A Garamantian citadel in the Wadi Tannezzuft*. All'Insegna del Giglio, Firenze.

Lyon, G.F. 1821. *A Narrative of Travels in Northern Africa in the Years 1818–1819 and 1820.* (1966 reprint), London.

Manning, S.W., Bronk Ramsey, C., Kutschera, W., Higham, T., Kromer, B., Steier, P. and Wild, E.M. 2006. Chronology for the Aegean Late Bronze Age 1700–1400 BC. *Science* 312(5773): 565–9.

Mattingly, D.J., Edwards, D.N. and Dore, J.N. 2002. Radiocarbon dates from Fazzan, southern Libya. *Libyan Studies* 32: 9–19.

Mattingly, D.J. (ed.) 2003. = Mattingly, D.J., Daniels, C.M., Dore, J.N., Edwards, D. and Hawthorne, J. 2003. *The Archaeology of Fazzān. Volume 1, Synthesis.* Society for Libyan Studies, Department of Antiquities, London.

Mattingly, D.J. (ed.) 2007. = Mattingly, D.J., Daniels, C.M., Dore, J.N., Edwards, D. and Hawthorne, J. 2007. *The Archaeology of Fazzān. Volume 2, Site gazetteer, pottery and other survey finds.* Society for Libyan Studies, Department of Antiquities, London.

Mattingly, D.J. (ed.) 2010. = Mattingly, D.J., Daniels, C.M., Dore, J.N., Edwards, D. and Hawthorne, J. 2010. *The Archaeology of Fazzān. Volume 3, Excavations carried out by C.M. Daniels.* Society for Libyan Studies, Department of Antiquities, London.

Reimer, P.J., Baillie, M.G. L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C. E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J. and Weyhenmeyer, C.E. 2009. IntCal09 and Marine09 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon* 51:1111–1150.

Sterry, M. and Mattingly, D. (with contributions by Ahmed, M., Savage, T., White, K. and Wilson, A.) 2011. DMP XIII: reconnaissance survey of archaeological sites in the Murzuq area. *Libyan Studies* 42: 103–116.

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