RADIOCARBON DATES FROM THE OXFORD AMS SYSTEM: *ARCHAEOMETRY* DATELIST 36

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KEYWORDS
Radiocarbon, archaeology, AMS dating, Palaeolithic, Mesolithic, Neolithic, ultrafiltration.

ABSTRACT

This is the thirty-sixth list of AMS radiocarbon determinations measured at the Oxford Radiocarbon Accelerator Unit (ORAU). Amongst some of the sites included here are the latest series of determinations from the key sites of El Mirón Cave and Sutton Courtney, as well as others dating to the Palaeolithic, Mesolithic and later periods. Comments on the significance of the results is provided by submitters of the material.

INTRODUCTION

This is the thirty-sixth list of dates measured at the Oxford Radiocarbon Accelerator Unit (ORAU). The dates presented here include those measured through the NERC/AHRC-funded NERC Radiocarbon Dating Service (NRCF, formerly ORADS), those funded by Historic England, and those submitted to the laboratory on a commercial basis.

Methods

All dates have been measured using the procedures outlined by Brock et al. (2010). All AMS determinations here were measured after conversion of the pretreated samples into graphite (Dee and Bronk Ramsey 2000). FM

In accordance with international radiocarbon convention all dates are expressed in radiocarbon years before AD 1950 (years BP) using the half-life of 5568 years. Errors are quoted as one standard deviation (1σ) and are based on an assessment of all the contributions to the error in the laboratory isotope ratio measurement. Natural fractionation of carbon isotopes is accounted for by measuring the $\delta^{13}C$ values relative to VPDB (with errors of approximately 0.3‰).

All combining procedures and significance tests are based on Ward and Wilson (1978). Comments composed by the Laboratory on the basis of information supplied by submitters are given without attribution.

All calendrical dates quoted have been calibrated using the OxCal computer program of Bronk Ramsey (2009) using atmospheric data from 'INTCAL13' (Reimer *et al.* 2013), and are quoted to 95.4% probability.

Previous *Archaeometry* datelists are referred to in the form: *Arch.List* 30.

Details of methods applied are described in detail in our in-house documentation. This is regularly updated and archived, so the exact method used for any sample is always fully recorded.

OxA-X numbers are given when there is an experimental pre-treatment applied, or where the analytical data associated with the measurement is out of expected range. In these latter cases, the sample ought to be viewed with something of a health warning in terms of its accuracy. Usually, this is because of low collagen weights, either less than 10 mg or <1%wt. collagen. These are our minimum thresholds for acceptability.

Laboratory comments are provided without attribution.

ACKNOWLEDGEMENTS

The Datelist is greatly enhanced by submitters' contributions and we would like to thank those who have provided comments on their dates shown below. Funding for the laboratory comes from the Natural Environment Research Council (NERC). The Arts and Humanities Research Council (AHRC) and Historic England have also contributed significant funding. The staff of the ORAU, past and present, are gratefully acknowledged for their careful work.

HUMAN REMAINS

United Kingdom
West Hanney

Samples of bone and a tooth from the site of West Hanney, Oxfordshire, UK, submitted by H. Hamerow, Institute of Archaeology, University of Oxford, 34-36 Beaumont Street, Oxford, OX1 2PG, UK.

OxA-30141	bone, *Homo sapiens*, Hanney 1, $\delta^{13}C$=-19.2‰	1414 ± 24
OxA-30142	tooth, *Homo sapiens*, Hanney 2, $\delta^{13}C$ =-20.1‰	1383 ± 25
OxA-30143	bone, *Homo sapiens*, Hanney 3, $\delta^{13}C$ =-19.3‰	1368 ± 25

Comment (H. H.): the results from the human burial at West Hanney are extremely helpful. The combined dates have enabled me to establish that the burial dates to between 644-659 calAD. This answers the two key questions I had: whether the garnet-inlaid brooch it contained was old when buried (answer: no) and whether it dates to the period when the West Saxons were in control of the region and before the Mercian take-over (answer: yes).

Guam
Naton Beach

Sample of bone from the site of Nation Beach (13 31'11"N 144 48'12"E), Guam, submitted by R. Hunter-Anderson, 1513 Wellesley Drive, Albuquerque, New Mexico 87106, USA.

OxA-33764	bone, *Homo sapiens*, Sample 8 mandible, $\delta^{13}C$=-18.6‰	2483 ± 27

Comment (R. H. A.): the Sample 8 radiocarbon date marks the apparent beginning of the practice of human interment in the Mariana Islands and is a milestone of sorts because archaeological evidence for human presence extends back another thousand years. Human interment only at this time implies an adaptive shift toward actual settlement of the islands vs

transient occupations. This date conforms our expectations based upon the date range of associated pottery. We intend to perform aDNA analysis on this individual in future.

OLD WORLD PALAEOLITHIC AND MESOLITHIC

United Kingdom
Dream Cave

Sample of resin from the site of Dream Cave (54 4'26.40"N 1 35'38.40"E), United Kingdom, submitted by D. McFarlane, Keck Science Centre, The Claremont Colleges, 925 North Mills Avenue, Claremont, CA, 91711, USA.

OxA-33959 bone, *Bos*, DAM 16-01, $\delta^{13}C$=-21.1‰ 43300 ± 1800

Comment (R.B.): the age on this auroch bone is consistent with an indirect age on the deposit based on U-Th dating of overlying calcite, published by us in 2000 (McFarlane *et al*. 2000).

United Kingdom
Crosby Garrett

Samples of charcoal from the site of Crosby Garrett, Cumbria, United Kingdom, submitted by C. Healey, 14 Briery Street, Lancaster, LA1 5RD, United Kingdom.

OxA-33231 charcoal, 6, $\delta^{13}C$=-23.2‰ 55200 ± 3900
OxA-33232 charcoal, 7, $\delta^{13}C$=23.7‰ > 55300

Comment (C. H.): the above dates are very much older than the expected dates from both the originating contexts, which contained Roman and later material. These very early dates suggest contamination by old carbon, presumably the limestone ubiquitous in the sample location. The results may suggest that historic ploughing, perhaps coincidental with limestone quarrying, over the past few hundred years has caused these very early sample dates. Both activities are known to have been carried out at or close to the site in the post-medieval period (*c*. AD1540-1900).

Spain
El Mirón Cave

Samples of bone from the site of El Miron Cave (43 14'43"N 3 27'9"W), Cantabria, Spain, submitted by L.G. Straus & M.R. González Morales, Department of Anthropology, University of New Mexico, Albuquerque, NM 87131-001 USA & Instituto Internacional de Investigaciones Prehistóricas, Universidad de Cantabria, 39005 Santander, Spain. Comment by L. Straus.

OxA-33515 bone, *Cervus elaphus*, X10a, Lev.130, spit34, no.329 (MIR2015), $\delta^{13}C$ = -19.7‰ 45900
OxA-33516 bone, X10a, Lev.130, spit26, no.286 (MIR2015), $\delta^{13}C$ = -20.3‰ 48200 ± 3300
OxA-33960 bone, *Cervus sp. and Capra sp.*, MIRJ56, $\delta^{13}C$ = -20.3‰ 16760 ± 90

OxA-33961 bone, *Cervus sp*. and *unknown*, MIRJ78, $\delta^{13}C$ = -20.2‰ 15510 ± 90
OxA-33965 bone, *Cervus sp*., MIRJ39, $\delta^{13}C$ = -20.4‰ 15660 ± 80

Comment (L.S.): El Mirón Cave is located midway between Santander and Bilbao in the foothills of the Cantabrian Cordillera mountain range. Straus and González Morales have been excavating this large site since 1996. Its long cultural sequence (Middle Paleolithic through to the Bronze and Middle Ages) has been dated by a total of 89 radiocarbon assays (Straus and González Morales 2012).

OxA-33515 and 33516 are dates from Level 130, the lowest horizon to be reached during excavations at this site. Level 130 located at the rear of the El Mirón vestibule consists of a large clay and sandy-silt deposit full of cobbles and medium-large limestone blocks. These were tested in a 2m² trench (squares W10 and X10). In total, one and a half metres of Level 130 was excavated. Judging from the results of core boring, the site appears to continue for at least another one and a half metres. Although culturally very poor, (at least in this peripheral part of the vestibule), the layer did yield several stone flakes, notched artifacts, scattered charcoal flecks and bones of both macro and micro-mammals. Many of the latter attest to carnivore activity (A.B. Marín Arroyo, personal communication, 2015). An earlier Geochron Labs AMS assay without ultrafiltration on charcoal from spit 36 in X10 yielded a date of 41,280±1120 BP. The sample for OxA-33516 was from well above that date and 33515 from only slightly above it. Given the likely greater accuracy of the OxA assays with ultrafiltration, it is apparent that at least the upper part of Level 130 formed probably rather rapidly, given its position at the base of the erosional face of the alluvial infilling of the inner cave (see Farrand 2012), before around 46,000 uncalibrated years BP. The three assays date the evidence of (presumably alternating) hominin and carnivore activity in El Mirón Level 130 to the late Middle Paleolithic, as is typical of many cave sites in this and other regions.

The three other OxA assays were run to try to resolve numerous contradictions among the nearly two dozen previously run dates from early Magdalenian levels. Several levels dated so far by more than one assay had displayed both “old” and “young” results and there are numerous inter-level date inversions, without any consistent pattern (e.g., up- versus down-slope). The three new dates do not resolve the problems of incoherence. Although levels were often more clearly distinguished at the south-eastern corner of this 10m² excavation area than at the western and northern ends, great care was taken to excavate by very thin spits following the “lay of the land”. These were indicated by elongated bones, limestone clasts, cobbles and artifacts, ochre patches and hearths. The early (i.e., Initial, Lower and possibly Middle) Magdalenian levels (119-108) are extraordinarily rich in artifacts; humanly-accumulated ungulate bones, fish remains, manuports and structural features. There are no sterile or even archeologically poor levels within this horizon.

Level 110 has now been dated by five assays on bones: two of around 16.5 uncal kya from the eastern end of the area (16,520±40 BP [UG-10628 AMS] and 16,130±250 BP [GX-23396]) and three on the same bone from the center row of squares (14,795±75 BP [OxA-22092], 14.760±70 [OxA-22091] and now 15,660±80 BP [OxA-33965]). It is possible in this instance that what was defined as Level 110 in the east is not the same unit, but rather a higher level in the west. This however would not explain the 900 year uncalibrated difference (also indicated by the calibrated ages) between the new and previous OxA ultrafiltration dates on bones from the adjacent U7 and U8 squares in the south-central sector of the excavation area.

The new Level 114 date (16,760±90 BP [OxA-33960]) coincides well with the earlier AMS date, also on bone, from further west and north in this layer: 16,460±50 BP (GX-28209). However, the dates are older than one of the previous dates and the new date from two separate areas underlying Level 116. This suggests that incorrect correlations of Levels

"114" and "116" were made during excavation. These were made between areas to the east and west of a mass of rocks (a possible man-made wall) that straddled the boundary between the U and T rows of squares.

For Level 116, both the oldest date 17,400±80 BP [GX-29439] AMS on charcoal, (perhaps from an underlying hearth) and the youngest date (15,220±100 [GX-23416] AMS on bone) are from the southeast corner of the excavation area. The new date 15,510±90 BP [OxA-33961] (AMS on bone) is from the southwest corner of the excavation area - coinciding well with the younger of the dates from the southeast. This sample was chosen specifically because it comes from the same square (T7), subsquare (b), level (116) and spit (35) as a complete single-bevel based grooved antler point (González Morales and Straus 2005: Fig.5.3). This selection was made because G.Sauvet 2014: 22-24, Fig.7 has recently argued for the presence of a connection between the early Middle Magdalenian of France and the Cantabrian region. This includes El Mirón Level 116, based upon the distribution of such "Lussac-Angles" *sagaies*. The new OxA date shows that this *sagaie* dates to an early part of the Cantabrian Lower Magdalenian, about 18,800 calibrated years ago - penecontemporaneous with a human burial found 5 meters to the east (Straus et al. 2015). This is unless it had migrated downward from a higher level as a result of human activity (pit or hearth construction, trampling, etc.). It is also possible that the Lussac-Angles point is not an absolute temporally diagnostic weapon type and that it could have been independently invented at different times and places within the Magdalenian of western Europe. The French "Lussac-Angles" Middle Magdalenian is believed to date to about 14.7-13.8 uncal kya (Delage 2012), many centuries before the 15.5 uncal kya date apparently well-associated with the antler point in El Mirón. When tracing supposed inter-group diffusion of ideas or objects, careful chronometric dating (independent of artifact types) is clearly critical to demonstrate contemporaneity and therefore possible social connections.

Croatia
Mujina pećina

Sample of bone from the site of Mujina pećina, Dalmatia, Croatia submitted by I. Karavanic, Department of Archaeology, University of Zagreb, Ivana Lucica 3, HR-10000 Zagreb, Croatia.

OxA-31938 bone, *Cervus*, E6E2Bsredina371, $\delta^{13}C$=- 19.1‰ >44300

Comment (I. K.): Mujina pećina is located in Dalmatia (south Croatia) north of Kaštela and west of Split. All levels in this Cave contain Mousterian industry. Electron spin resonance dating was conducted on two teeth from Level E1 while five bone samples and one charcoal sample coming from five different strata were dated by AMS 14C (Rink et al. 2002). The interface between Level E2 and E1 has been dated by AMS to about 45 uncal. ky BP (Rink et al. 2002). New Oxford date (OxA-31938) is obtained on bone sample (*Cervus*) from Mousterian level E2B of Mujina pećina (>44300 uncal. BP), which is stratigraphically below E2/E1 interface. The date is in agreement with previously published AMS date for E2/E1 interface, because obtained age of E2B level can be older than the age obtained for E2/E1 interface, as we expect based on stratigraphy.

United Kingdom
Hartygrove

Sample of charcoal from the site of Hartygrove (NGR ST626876), United Kingdom, submitted by J. R. Adnams, Vine Cottage, Cowhill, Oldbury-on-Severn, Bristol, BS35 1QH.

OxA-32861 charcoal, JRA1, $\delta^{13}C$ =-25.1‰ 977 ± 26

Comment (J.R.A): the 95% probability of the sample lying between 997AD and 1155AD agrees very well with our other dating estimations for the site, a possible Norman hunting lodge. We have coin data of William II, Henry I, and Henry II and we have pottery estimations from a pottery expert (Mike Ponsford) as "mostly Ham Green Ware, 1100AD to 1150AD". Historical data indicates royal visits to the associated deer park in 1093, c1106 and 1121. Indications are that the site was abandoned c1200, when the park passed into baronial hands and contracted in area. With an earliest date for the post hole of 997AD, we cannot yet confirm that this represents a timber building preceding the associated stone building, but it still looks to be a possibility.

United Kingdom
Sutton Courtenay

Samples of bone from the site of Sutton Courtenay, Berkshire, UK, submitted by H. Hamerow, Institute of Archaeology, University of Oxford, 34-6 Beaumont Street, Oxford, OX1 2PG, UK.

OxA-30138 bone, *Bovid*, 304, $\delta^{13}C$ =-21.6‰ 1565 ± 23 BP
OxA-30139 bone, *Bovid*, 404, $\delta^{13}C$ =-21.4‰ 1550 ± 23 BP
OxA-30140 bone, *Bovid*, 404, $\delta^{13}C$ =-21.4‰ 1567 ± 24 BP

Comment (H. H.): the results from Sutton Courtenay were mixed: the two samples from the SFB (30138 and 30139) made it possible to establish that the structure had been backfilled well before the construction of the 'great hall' complex. The fragment of cattle mandible from a posthole in the largest great hall, however, has turned out to be (relatively -- between 50-150 years) old when buried.

United Kingdom
Smallbridge

Sample of antler from the site of Smallbridge (51 57'45"N 0 48'25"E), Suffolk, UK, submitted by H. Hargrove, Brialey Hall, Wissington Uplands, Nayland, Suffolk, CO6 4JQ, UK.

OxA-32602 antler, *Dama dama*, Antler, $\delta^{13}C$=-22.1‰ 281 ± 24

Comment (H. H): the earlier of the two date periods (1516 - 1595) is the more likely based on other historical information. The sample is from a complete antler apparently deliberately placed at a threshold, probably when the medieval manor house was demolished and the Tudor house that replaced it was built by the Waldegraves around 1560.

Slovenia
Sinja Gorica

Sample of wood from the site of Sinja Gorica (45 58'18.60"N 14 18'32.34"E), Slovenia, submitted by Miran Erič, Institute for the Protection of Cultural Heritage of Slovenia, Metelkova 6, SI-1000, Ljubljana, Slovenia.

OxA-19598 wood, SI-80/08, $\delta^{13}C$=-25.5‰ 2143 ± 26

Comment (M.E): from an early Roman ship, on which there are two publications: Erič *et al* 2014 and Čufar *et al* 2014.

Sample of wood from the site of Sinja Gorica (45 58'31.80"N 14 18'52.70"E), Slovenia, submitted by Miran Erič, Institute for the Protection of Cultural Heritage of Slovenia, Metelkova 6, SI-1000, Ljubljana, Slovenia.

OxA-19866 wood, SIG_08-900-3, $\delta^{13}C$=-26.5‰ 38490 ± 330

Comment (M.E): from a Palaeolithic wooden point. Suspect it is the oldest very well designed dated point, and it is much more advanced than earlier solutions (e.g. Clacton-on-Sea, Lehringen, Schöningen, Mannheim, etc.). See Gaspari *et al* 2011.

Slovenia
Ljubljana

Sample of leather from a prayerbook, Ljubljana, Slovenia, submitted by Miran Erič, Institute for the Protection of Cultural Heritage of Slovenia, Metelkova 6, SI-1000, Ljubljana, Slovenia.

OxA-31546 skin, ME-SKIN2015, $\delta^{13}C$=-21.3‰ 94 ± 25

Comment (M.E): From a personal praying booklet. The result is intriguing as the ownership records and multiple experts had indicated that the book could indeed be very old (perhaps older than 1500 years). An additional date from Beta Analytic (Beta 404882) dates to 102.4 ± 0.3 pMC. Uncertainties in the calibration curve in the last few hundred years do not allow a very precise estimate of the age of the book, with a potential range from 1690 – 1926 AD at the 95.4% confidence interval. Thus, the book may be about 300 years old. An alternative hypothesis is that the leather has become severely contaminated over the years from repeated handling.

Arabian Peninsula
Parchment manuscript

Sample of parchment from a manuscript containing Qur'anic text. Written in ink, in Hijazi script. Possibly from the Hejaz region of the Arabian Peninsula. The manuscript is part of the University of Birmingham's Mingana Collection of Middle Eastern Manuscripts. The collection was acquired during the 1920s and 1930s, funded by Quaker philanthropist Sir Edward Cadbury, to raise the status of Birmingham as an intellectual centre for religious studies. The collection is now held in the Cadbury Research Library at the University of

Birmingham. Submitted by S. Kilroy, Head of Conservation and Programming, Cadbury Research Library, University of Birmingham, Edgbaston, Birmingham, B15 2TT.

OxA-29418 Parchment, *goat?*, MS1572 Cadbury Research Library, $\delta^{13}C$=-21.0‰ 1456 ± 21 BP

Comment (S. R. K): at the time of testing the manuscript consisted of 9 folios bound together (the binding was probably carried out around the 1940s). Research by Alba Fedeli identified, through codicology, that the folios originated from two separate manuscripts of Qur'anic text; one section consisting of 2 folios and the other section consisting of 7 folios. The manuscript has subsequently been separated and is now treated as two separate manuscripts, identified as: 1572A and 1572B. OxA-29418 is from the 2 folio section, 1572A.

Madagascar
Lakatorn-Bato Tony

Samples of shell from the site of Lakatorn-Bato Tony (22 4'53.90"S 43 14'28.61"E), Madagascar, submitted by K. Douglass, Department of Anthropology, NHB 112, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012, USA.

OxA-34215	shell, *Aepyornis*, TONY2A9_S_1, $\delta^{13}C$ = -12.8‰	2012 ± 37
OxA-34216	shell, *Aepyornis*, TONY2B8_1_1, $\delta^{13}C$ = -13.6‰	2004 ± 37
OxA-34217	shell, *Aepyornis*, TONY1SE_2_1, $\delta^{13}C$ = -11.8‰	8470 ± 75
OxA-34274	shell, *Mullerornis*, TONY10B3_S_1, $\delta^{13}C$ = -8.7‰	1677 ± 27
OxA-34640	shell, *Aepyornis*, TONY1NE_S_1, $\delta^{13}C$ = -13.1‰	2010 ± 25

Comment (K.D.): the dates from TONY2A9_S_1, TONY2B8_1_1 and TONY 10B3_S_1 are significantly older than a previously dated charcoal sample collected a few centimeters below these fragments. The charcoal returned a calibrated date range of AD 1663-present, which suggests that it is either intrusive or that the shelter was re-used at a later date. The latter is more likely to be true as traces of ash were also found surrounding the charcoal. This context contained a number of worked pieces of Aepyornis eggshell, indicative of human use for the production of liquid containers and potentially beads. It is unknown whether these eggshell fragments came from freshly laid eggs that were harvested, or whether old egg shell fragments were gathered for secondary use. This research aims to examine whether the eggshell dates are contemporary with human occupation and activity at this site.

Traces of worked shell that suggest that liquid containers were being produced could not have been made with eggs that had hatched naturally. The shell was worked so that a relatively restricted circular perforation was created. It is more likely that still unhatched or even infertile eggs which may have remained intact at old nesting sites were instead gathered. A second line of evidence involves on-going analysis to detect whether eggshell in this context underwent structural changes that are due to respiration of an embryo, and if so, how much respiration took place. If an egg was harvested from an active nest by people, then it is hypothesized that the full degree of embryonic development and respiration will not have taken place. If the analysis reveals that these eggs were indeed harvested from active nests, then the dates obtained for these samples represent the earliest documented interactions between human communities and elephant birds in Madagascar.

The same can be said for the dates obtained for TONY1SE_2_1, although the gap between the initially obtained charcoal from this context and the eggshell is much larger. The charcoal from this context came back with a calibrated range of AD 884-981. In this case

however no ash lens was recorded. The uncalibrated date obtained is very early by Madagascan standards. There are no confirmed archaeological contexts of this age known in Madagascar. The same analysis is being done to confirm whether the eggshell fragments in this context came from harvested eggs from active nests.

Iraq
Erbil Citadel

Samples of charcoal from the site of Erbil Citadel, Kurdistan, Iraq, submitted by J. MacGinnis, McDonald Institute for Archaeological Research, Downing St, Cambridge, CB2 3ER, UK. Further comments by David Michelmore, Consultancy for Conservation and Development, Horbury Wakefield, WF4 6LT, UK.

OxA-31856	charcoal, Sample 1, $\delta^{13}C$=-24.9‰	1847 ± 24
OxA-31859	charcoal, Sample 2, $\delta^{13}C$=-25.2‰	1859 ± 25
OxA-32012	charcoal, Sample 3, $\delta^{13}C$=-26.4‰	1737 ± 29

Comment (J. M. and D. M.): these samples were taken from a thick ash layer underneath the upper fortification wall of the citadel of Erbil. This must be the wall in place when it was besieged by Nadir Shah in 1743 AD. Two years later the Sultan Mahmut I ordered the walls of both Erbil and Kirkuk to be surveyed and repaired. While this process may have been started, it was certainly never finished, and by the end of the end of the eighteenth century the walls had been levelled, paving the way for the construction of the ring of mansions around the perimeter so characteristic of the citadel to this day. But while we can say that this fortification was last in use in the eighteenth century AD, until now there has been no clue as to when the wall, which exhibits multiple phasing, was first constructed. It was with this in mind that we submitted for analysis three charcoal samples from the band of ash underlying the lowest masonry of the wall. This layer is up to 50cm thick and runs underneath the wall across the complete length where it has been exposed, a stretch of 23m. This is a massive single-event accumulation of ash and charcoal which has every appearance of being a destruction layer. Obtaining a date for this layer should therefore be of interest both for the dating of the layer itself and for giving a *terminus post quem* for the construction of the wall. The results obtained by the ORAU have fully met this expectation.

In terms of Mesopotamian chronology the dates fall within the Parthian period. Taking the first two, if we look for possible events within this timeframe there is indeed one episode that stands out as an excellent candidate. This is Trajan's Mesopotamian campaign of 115 AD. After setting out from Antioch the previous year, Trajan went on to capture the whole of Adiabene - of which Erbil was capital - before turning south to take Babylon and Ctesiphon. It is therefore proposed that the level from which the samples came is a destruction layer from the time of Trajan's conquest of Erbil. In addition to being of extraordinary interest in itself, it suggests that rich discoveries may await a fuller investigation of the remains on the citadel dating to this time. With respect to the fortification wall, the dates obtained do indeed give a *terminus post quem* for its construction, though at the time of writing it is not clear how long after the Trajan event the construction of the wall in question may have commenced.

The question of why the third date, which comes from the same layer, does not overlap with first two is unresolved.

Afghanistan
Bimaran 2

Sample of resin from the site of Bimaran 2 (34N 70E), Afghanistan, submitted by R. Bracey, British Museum, Russell Street, WC1B 3DG, United Kingdom.

OxA-33821 resin, 1, $\delta^{13}C$=-32.1‰ 248 ± 28

Comment (R.B.): the sample you have was a coating in two parts applied on the inside of a Buddhist reliquary, the resin substance first and then the orange material (which I have always presumed is a clay slip of some sort). The relic deposit was prepared in the early second century AD (or very late first century) but the date of the reliquary has long been a matter of dispute (deposits were frequently re-interred and this was a secondary employment of the reliquary). When the deposit was excavated in 1833 the finder reported a coating, which matched the description of the sample.

Opinions have varied widely, as to whether the coating was applied when the reliquary was made, whether it was a repair at some subsequent time, or if it was applied after the excavation. So various people suggested various different dates for the sample before it was tested, from AD 50-1200 and from 1833-1900. What was entirely unexpected was any date that fell between 1200 and 1833 when the sample would have been held in a stone casket sealed within several metres of stone and rubble. Thus my surprise yesterday and request for any literature you might be able to supply on the possibility of contamination.

China
East Helanshan & Yuguang Graben Faults

Samples of wood, charcoal, plant remains, insect remains and shell from the site of Suyukou, along the East Helanshan Fault (38 42’39”N 106 1’58”E), China, submitted by T.A. Middleton and Professor R.T. Walker, Department of Earth Sciences, University of Oxford, South Parks Road, Oxford, OX1 3AN. Comment by T.A. Middleton.

OxA-30917 wood, *Gymnosperm (conifer)*, 1b, $\delta^{13}C$=-23.9‰ 279 ± 28
OxA-30936 charcoal, 1c, $\delta^{13}C$=-21.5‰ 1130 ± 31
OxA-30937 plant remains, Grass, 2[a], $\delta^{13}C$=-13.8‰ 1.16959 ± 0.00365 FM
OxA-30938 plant remains, 2b, $\delta^{13}C$=-18.1‰ 1.15839 ± 0.00388 FM
OxA-30939 shell (Bivalve), 3, $\delta^{13}C$=-2.7‰ 2099 ± 31

Comment (T. A. M): we collected five samples from Suyukou, a set of earthquake fault scarps along the East Helanshan Fault in the Yinchuan Graben on the western side of the Ordos Plateau in northern China. The Yinchuan Graben was the site of a major earthquake in 1739, in which around 50,000 people are believed to have been killed. Despite the large size of this earthquake, there has been much debate in the literature about the causative fault for this event. We therefore dated samples from the East Helanshan Fault in order to establish if it could have been responsible for the 1739 earthquake. Samples 2a and 2b were from a post-earthquake soil overlying a colluvial wedge in a road-cutting through the scarp. Samples 1b, 1c and 3 were from alluvial deposits in the immediate footwall of the earthquake scarps.

All three footwall samples (1b, 1c and 3) predate 1739. The only possible exception is that, within the two standard deviation range, there is a very small probability (1.9%) that sample 3 is younger than 1739. Nonetheless, taken together, the samples indicate that the material preserved in the immediate footwall was almost certainly deposited prior to 1666 (the limiting age of sample 3 for a probability of 93.5%). Combined with the modern ages for the post-earthquake soil (samples 2a and 2b), we therefore have strong evidence that the

uplift of these earthquake scarps has occurred between 1666 and the present day. The only recorded earthquake of any significant magnitude (*Mw*>5) in this time frame and at this location is the 1739 event. We therefore conclude that the 1739 Yinchuan earthquake did occur on the East Helanshan Fault (Middleton et al., 2016).

Samples of plant remains and wood from the Yuguang Graben Fault (39 52'40"N 114 46'19"E), China, submitted by T.A. Middleton and Professor R.T. Walker, Department of Earth Sciences, University of Oxford, South Parks Road, Oxford, OX1 3AN. Comment by T.A. Middleton.

OxA-30918	plant remains, Grass, 6, $\delta^{13}C$=-19.1‰	1.02877 ± 0.00338 FM
OxA-30940	wood, *Gymnosperm*, 7, $\delta^{13}C$=-25.4‰	1.02109 ± 0.00371 FM

Comment (T. A. M): unfortunately, the modern age of these samples indicate that they are not representative of the age of the sedimentary deposits in which they were found. We were therefore unable to draw conclusions from these results.

NEW WORLD

Peru
Samanco

Samples of charcoal and plant remains from the site of Samanco (9 15'15.55"S 78 24'54.60"W), coastal Peru, submitted by M. R. Helmer, Sainsbury Centre for Visual Art, University of East Anglia, Sainsbury Research Unit, NR4 7TJ, UK.

OxA-30550	plant remains, *Zea mays*, Cr32, $\delta^{13}C$ =-10.3‰	2255 ± 29
OxA-30630	charcoal, *Prosopis alba*, Cr42, $\delta^{13}C$ =-26.4‰	2141 ± 29
OxA-30631	charcoal, *Prosopis alba*, Cr45, $\delta^{13}C$ =-25.9‰	6533 ± 39
OxA-30632	charcoal, *Prosopis alba*, X59, $\delta^{13}C$ =-26.2‰	2238 ± 29
OxA-30633	plant remains, *Zea mays*, X50, $\delta^{13}C$ =-9.3‰	2139 ± 29
OxA-30634	charcoal, *Prosopis alba*, X52, $\delta^{13}C$ =-9.4‰	2270 ± 28
OxA-30635	charcoal, *Prosopis alba*, Cr22, $\delta^{13}C$ =-26.0‰	2204 ± 29
OxA-30636	plant remains, *Zea mays*, Cr39, $\delta^{13}C$ =-9.7‰	2166 ± 29
OxA-30637	charcoal, *Prosopis alba*, Tomb X75, $\delta^{13}C$ =-26.8‰	2240 ± 29

Comment (M.R.H.): the radiocarbon dates from Samanco help to fill an occupational time gap between 500 and 1 BCE, after the decline of the first Andean pan-regional culture known as Chavín and before the fluorescence of the Moche kingdoms. Dates from both charcoal and maize yielded similar ranges. One date (OxA 30631) resulted in a date of 5539-5358 BCE, believed to be a statistical anomaly since it predates the proposed site occupation by some 5000 years. Otherwise, calendar ranges span between 384-53 BCE, and fit precisely where we hypothesized based on material culture and settlement patterns. Our work focuses on questions of incipient urbanism. The conformity of dates between site sectors help to support arguments of central planning, settlement nucleation, and sustained occupation across the

site's 40 hectare extent. Future dating is needed, but preliminary inferences from the nine samples suggest that construction began around 400 BCE, with a renovation phase occurring around 200 BCE, and abandonment taking place at the turn of the 1st millennium CE.

ENVIRONMENTAL SAMPLES

APPENDIX

Withdrawn OxA numbers

OxA Number	Site	Replacement determinations
OxA-9339		
OxA-9340		
OxA-9341		

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