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Scientific Dating

Beckfoot Roman Cemetery, Beckfoot, Cumbria Radiocarbon Dating

Peter Marshall, Christine Howard-Davis, Elaine Dunbar, and Paula Reimer

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BECKFOOT ROMAN CEMETERY
BECKFOOT
CUMBRIA

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SUMMARY
This report contains details of the radiocarbon determinations obtained on samples of cremated human bone and charcoal from Beckfoot Roman cemetery.

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Thank you to Helen Webb (Oxford Archaeology) for helping with identification of the cremated bone.

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INTRODUCTION

This document is a technical archive report on the radiocarbon dating of cremated human bone and charcoal from an archaeological evaluation conducted in 2006 at the site of the Roman cemetery at Beckfoot, Cumbria (NGR NY 0876 4868, Fig 1). Archaeological work was undertaken to assess the extent and survival of the Roman cemetery (Fig 2) which had undergone considerable erosion by the sea during the past 100 years. It is beyond the brief of this document to describe the archaeology of the site in detail – this can be found in Howard-Davis *et al* 2017.

OBECTIVES

The cremation ritual at Beckfoot appears to be highly varied and a key objective of the dating programme was to therefore determine whether there was any temporal variation in the type of cremation being undertaken. Burials on the Northern Frontier have traditionally not been well dated and therefore it was also hoped to refine the chronology of the cremation cemetery and to place it in its regional and national context.

RADIOCARBON LABORATORY METHODS

Four samples were submitted to the Scottish Universities Environmental Research Centre (SUERC); two cremated human bones and two charcoal samples. The cremated bone was pretreated following the method outlined in Lanting *et al* (2001) and the charcoal as described by Stenhouse and Baxter (1983). One of the cremated human bone samples (GU36299) failed during pretreatment as it provided insufficient carbon. CO_2 obtained from the remaining three pretreated samples was combusted in precleaned sealed quartz tubes (Vandeputte *et al* 1996) and then converted to graphite (Slota *et al* 1987). The samples were dated by Accelerator Mass Spectrometry (AMS) as described by Freeman *et al* (2010).

Four charcoal samples were dated by AMS at the ^{14}CHRONO Centre, The Queen's University Belfast according to the methods described in Reimer *et al* (2015). The samples were graphitised using hydrogen reduction (Vogel *et al* 1984).

Both laboratories maintain continual programmes of quality assurance procedures, in addition to participating in international inter-comparisons (Scott 2003; Scott *et al* 2010). These tests indicate no significant offsets and demonstrate the validity of the precision quoted.

RADIOCARBON RESULTS

The radiocarbon results are given in Table 1 and are quoted according to the international standard set at the Trondheim convention (Stuiver and Kra 1986). These are conventional radiocarbon ages (Stuiver and Polach 1977). These ages have been calculated using the fractionation correction provided by the $\delta^{13}C$ values measured on the dated material in the AMS. The $\delta^{13}C$ measurements reported in Table 1 are those measured on sub-samples of the combusted CO_2 by conventional mass spectrometry. In the case of cremated bone (SUERC-58013) the meaning of this value is currently unclear, as the natural isotopic ratio of the original bone has been fractionated during both the ancient cremation process and by the selective acid digestion of the bone used during pretreatment. It is reported, however, in the hope that its meaning will become clear in the future.

The radiocarbon result has been calibrated with data from Reimer *et al* (2013), using OxCal (v4.2) (Bronk Ramsey 1995; 1998; 2001; 2009). The date ranges given in Table 1 have been calculated by the maximum intercept method (Stuiver and Reimer 1986), at two sigma (95% confidence). The ranges are quoted in the form recommended by Mook (1986) and rounded outwards to 10 years or 5 years if the error is less than ±25. The probability distributions of the calibrated dates (Fig 3) were obtained by the probability method (Stuiver and Reimer 1993).

THE SAMPLES

Although most of the cremated bone was well calcined the very fragmentary nature of the material (most fragments were had a mass >1g) meant that the potential number of samples was very low. All the samples were visually inspected for surface and interior colour and burn cracks prior to submission to ensure they were fully calcined. As part of the burning process cremated human bone undergoes a range of changes in colour which varies from a charred black appearance through a range of shades of grey and grey/blue to white (Brickley, 2007).

Charcoal was well preserved in the cremation deposits but very few fragments of short-lived species survived amongst an assemblage dominated by *Quercus*, this resulted in only a few potential samples being identified for radiocarbon dating.

INTERPRETATION

A sub-circular pit *707* in Trench 7 (Fig 2) contained a (probably) late third-century BB1 jar that had been placed upright in the centre of the pit on a deposit of pyre debris (*711*) with similar material (*706*) used to backfill it. Radiocarbon determinations (SUERC-58011 and UBA-28001) on two fragments of charcoal from the fill of the cremation vessel *708* are statistically consistent (T'=0.1, T'(5%)=3.8, ν=1) and could therefore be of the same actual date.

Burial *406* like *707* contained an upright pottery vessel (*408* – BB1 Beaker) in a circular pit filled with cremated bone and other pyre debris. The cremation vessel contained a mix of cremated bone and charcoal along with the pit fill (*407*) and was recorded as below the 'Roman soil layer' (*402* and *405*). Single entity samples of cremated bone and charcoal were submitted for dating, but the cremated bone failed to produce sufficient CO_2.

Cremation burial *315* lay close to the current coastline and was different to the other burials in that it was located in an irregularly shaped pit or trench, cut into *302* a dark layer of sandy subsoil which sealed most archaeological features. 302 sealed layers of pyre debris 305–310 from which measurements on fragments of charcoal (UBA-27998 and SUERC-58012) from *305*, are statistically consistent at 99% confidence (T'=4.9, T'(1%)=6.0, ν=1; Ward and Wilson 1978).

The fill *312* of burial *315* contained a concentration of burned bone at its northern end with larger pieces of charcoal at the southern end but had been disturbed by animal burrowing. The single cremated bone sample (SUERC-58013) that was dated from *312* is clearly much earlier than the charcoal sample (UBA-27999) and the stratigraphically earlier pyre debris (*305*). SUERC-58013 is also considerably older than any of the other dated features associated with funerary activity and is also at odds with the interpretation of the site as a Roman cemetery.

The success of radiocarbon dating of cremated bone depends on the exposed temperature during the cremation process and the degree of recrystallisation of the inorganic bone matrix. Although great care was taken to select cremated bones for dating that were completely 'white' the $\delta^{13}C$ measurement, −20.7‰ for SUERC-58013, could be an indication of the fact that this bone was not fully calcined (Olsen *et al* 2008). Whilst experimental work has demonstrated that partially cremated bones usually produce radiocarbon ages that are too young, SUERC-58013 is considerably older than expected. An explanation for the offset between the age of the bone and charcoal in *312* could therefore be that exchange reactions took place between the partially recrystallised bio-apatite bone fraction and soil carbonates. Alternatively given the unusual nature of the burial compared with others on the site is may be that 315 is not a 'burial' but a feature filled with cremation and other 'debris' that included a fragment of residual bone. Pottery from ditches 902 and 1112 contained small fragments of late Bronze Age or early Iron Age pottery which may attest to early activity on the site.

Given that SUERC-58013 does not appear to be dating the 'cremation' event associated with the Roman cemetery it has been excluded from the model described below.

CHRONOLOGICAL MODEL

The radiocarbon dates on charcoal from features associated with funerary activity clearly fall into a coherent group concentrated in the first half of the first millennium cal AD (Fig 3), excluding SUERC-58013. The measurements are though, not statistically consistent (T'= 80.1; T'(5%)= 11.1; ν= 5; Ward and Wilson 1978), and so they certainly represent more than one episode of funerary activity. Excluding the measurement from burial *406* (UBA-28000) the remaining five determinations are statistically consistent (T'= 8.0; T'(5%)= 9,0; ν= 4) and could be of the same actual age.

Simple visual inspection of the calibrated radiocarbon dates does not allow us to assess the date of Roman funerary activity at Beckfoot accurately, since the calibration process does not allow for the fact that this group of radiocarbon dates are related – they all come from the same site. Bayesian statistical modelling is required to account for this dependence (Buck *et al* 1992; Bayliss *et al* 2007), which we have undertaken using OxCal v.4.2 (Bronk Ramsey 1995; 1998; 2001; 2009). The date ranges from the model are given in italics to distinguish them from simple, calibrated radiocarbon dates.

The model (Fig 4) shows good agreement (Amodel: 67) between the radiocarbon dates and assumption the funerary activity took place at a uniform rate over a period of time (Buck *et al* 1992). Given the very limited number of samples the estimates derived from the chronological model for the start and end of funerary activity are too broad to be of any archaeological significance. Calculating the first and last dated activity from the dated samples does though provide us with some idea of the chronology of the cemetery albeit from a very small number of sampled features. These parameters suggest the first dated cremation took place in *cal AD 65–185* (*95% probability*; *first_cremation*; Fig 4) and probably *cal AD 80–145* (*68% probability*) and the last in *cal AD 385–535* (*95% probability; last_cremation;* Fig 4) probably *cal AD 390–440* (*62% probability*) or *cal AD 490–510* (*6% probability*).

The latest dated sample, *UBA-28000*, is significantly later than the other dated features, and the ceramic evidence from burial 406 suggesting a date in the mid-late third century AD (*c* AD 240-70). It is therefore possible that the charcoal fragment (UBA-28000) represents an intrusive fragment from later activity on the site. An alternative model (Fig 5) that excludes both UBA-28000 and SUERC-58013 has good overall agreement (Amodel=67) and suggest the main phase of dated cremation activity probably took place in the second and early third centuries cal AD.

DISCUSSION

The main phase of dated cremation activity at Beckfoot probably took place in the second and early third centuries cal AD and is broad agreement with the ceramic evidence. Given the site lies within actively eroding coastal dunes it is probably not surprising that the radiocarbon results are not entirely as expected given the archaeological evidence. Should further excavation of those burials that were only assessed during the evaluation take place or additional features be excavated then the submission of further samples for radiocarbon dating has the potential to provide a much more precise understanding of the chronology of the Roman burial activity at Beckfoot.

REFERENCES

Bayliss, A, Bronk Ramsey, C, van der Plicht, J, and Whittle, A, 2007 Bradshaw and Bayes: towards a timetable for the Neolithic, *Cambridge Journal of Archaeology*, **17.1**, supplement, 1–28

Brickley, M B, 2007 A case of disposal of a body through burning and recent advances in the study of burned human remains, in M B Brickley and R Ferllini (eds), *Forensic Anthropology,* Charles C. Thomas: Springfield, 69–85

Bronk Ramsey, C, 1995 Radiocarbon calibration and analysis of stratigraphy: the OxCal program, *Radiocarbon*, **37**, 425–30

Bronk Ramsey, C, 1998 Probability and dating, *Radiocarbon*, **40**, 461–74

Bronk Ramsey, C, 2001 Development of the radiocarbon calibration program OxCal, *Radiocarbon*, **43**, 355–63

Bronk Ramsey, C, 2009 Bayesian analysis of radiocarbon dates, *Radiocarbon*, **51**, 337–60

Buck, C E, Litton, C D, and Smith, A F M, 1992 Calibration of radiocarbon results pertaining to related archaeological events, *Journal of Archaeological Science*, **19**, 497–512

Freeman, S P H T, Cook, G T, Dougans, A B, Naysmith, P, Wicken, K M, and Xu, S, 2010 Improved SSAMS performance, *Nuclear Instruments and Methods B*, **268**, 715–7

Howard-Davis, D, Leary, R, and Ward, M, 2017 Evaluation of Beckfoot Roman Cemetery, 2006, *Transactions of Cumberland and Westmorland Antiquarian and Archaeological Society,* Third Series, **17**, 43–84

Mook, W G, 1986 Business meeting: recommendations/resolutions adopted by the twelfth International Radiocarbon Conference, *Radiocarbon*, **28**, 799

Olsen, J, Heinemeier, J, Bennike, P, Krause, V, Margrethe Hornstrup, K, and Thrane, H, 2008 Characterisation and blind testing of radiocarbon dating of cremated bone, *Journal of Archaeological Science*, **35**, 791–800

Reimer, P J, Bard, E, Bayliss, A, Beck, J W, Blackwell, P, Bronk Ramsey, C, Buck, C E, Cheng, H, Edwards, R L, Friedrich, M, Grootes, P M, Guilderson, T P, Haflidason, H, Hajdas, I, Hatté, C, Heaton, T J, Hoffmann, D L, Hogg, A G, Hughen, K A, Kaiser, K F, Kromer, B, Manning, S W, Niu, M, Reimer, R W, Richards, D A, Scott, E M, Southon, J R, Staff, R A, Turney, C S M, and van der

Plicht, J, 2013 IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP, *Radiocarbon*, **55**, 1869–87

Reimer, P J, Hoper, S, McDonald, J, Reimer, R, Svyatko, S, and Thompson, M, 2015 *The Queen's University, Belfast Radiocarbon Protocols used for AMS Radiocarbon Dating at the ^{14}CNRONO Centre*, Engl Her Res Re Ser **5-2015**

Scott, E M, 2003 The third international radiocarbon intercomparison (TIRI) and the fourth international radiocarbon intercomparison (FIRI) 1990–2002: results, analyses, and conclusions, *Radiocarbon*, **45**, 135–408

Scott, E. M, Cook G, and Naysmith, P, 2010 The fifth international radiocarbon intercomparison (VIRI): an assessment of laboratory performance in stage 3, *Radiocarbon*, **53**, 859–65

Slota Jr, P J, Jull, A J T, Linick, T W and Toolin, L J, 1987 Preparation of small samples for ^{14}C accelerator targets by catalytic reduction of CO, *Radiocarbon*, **29**, 303–6

Stenhouse, M J and Baxter, M S 1983 14C reproducibility: evidence from routine dating of archaeological samples, *PACT*, **8**, 147–61

Stuiver, M, and Kra, R S, 1986 Editorial comment, *Radiocarbon*, **28**, ii

Stuiver, M, and Polach, H A, 1977 Reporting of ^{14}C data, *Radiocarbon*, **19**, 355–63

Stuiver, M, and Reimer, P J, 1986 A computer program for radiocarbon age calculation, *Radiocarbon*, **28**, 1022–30

Stuiver, M, and Reimer, P J, 1993 Extended ^{14}C data base and revised CALIB 3.0 ^{14}C age calibration program, *Radiocarbon*, **35**, 215–30

Vandeputte, K, Moens, L, and Dams, R, 1996 Improved sealed-tube combustion of organic samples to CO_2 for stable isotope analysis, radiocarbon dating and percent carbon determinations, *Analytical Letters*, **29**, 2761–73

Vogel, J S, Southon, J R, Nelson, D E, and Brown, T A, 1984 Performance of catalytically condensed carbon for use in Accelerator Mass Spectrometry, *Nuclear Instruments and Methods in Physics Research Ser B*, **233**, 289–93

Ward, G K and Wilson, S R, 1978 Procedures for comparing and combining radiocarbon age determinations: a critique, *Archaeometry*, **20**, 19–31

TABLE

Table 1: Beckfoot – radiocarbon results

Laboratory number	Sample reference	Material & context	δ^{13}C (‰)	Radiocarbon Age (BP)	Calibrated Date (95% confidence)	*Posterior Density Estimate cal AD (95% probability)*
Pyre debris 305						
UBA-27998	305a	Carbonised *Corylus avellana* nutshell, single fragment (D Druce) from *305* a discreet dump of pyre debris	−24.5	1785±24	cal AD 135–335	*130–225*
SUERC-58012	305b	Charcoal, *Alnus glutinosa*, single fragment (D Druce) – as UBA-27998	−26.5	1870±30	cal AD 60–240	*75–215*
Burial 315						
SUERC-58013	312	Cremated human bone, adult ?tibia shaft (H Webb) from *312* the fill of burial *315*	−20.7	2547±30	800–500 cal BC	-
UBA-27999	312c	Twig fragment, ?3 years growth (D Druce)	−28.1	1863±25	cal AD 70–240	*155–240*
Burial 407						
GU36299	407	Cremated human bone, juvenile ?humerus shaft (H Webb) from the main backfil of burial *407*, surrounding vessel *408* in pit *406*	Failed – insufficient carbon			
UBA-28000	407c	Charcoal, *Betula* sp. single fragment, (D Druce) – as UBA-27998	−25.1	1610±24	cal AD 390–540	*385–535*
Burial 707						
SUERC-58011	708a	Charcoal, *Alnus glutinosa*, single fragment, (D Druce) from 708 the fill of a burial *707*	−26.6	1854±30	cal AD 70–240	*85–240*
UBA-28001	708b	Charcoal, *Betula* sp. single fragment, (D Druce) – as UBA-27998	−25.9	1871±37	cal AD 50–240	*75–240*

FIGURES

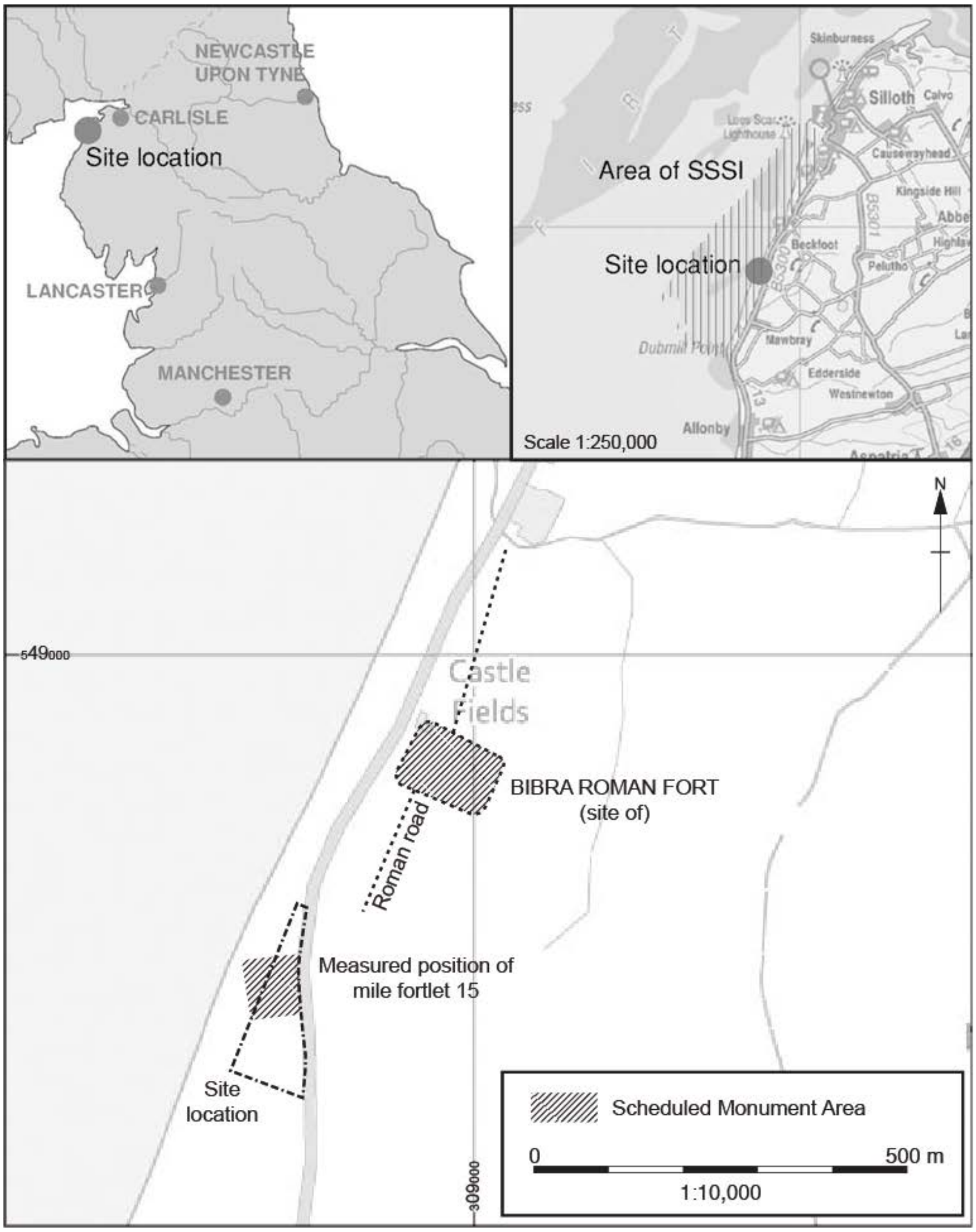


Figure 1: Beckfoot location plan (© Oxford Archaeology Ltd)

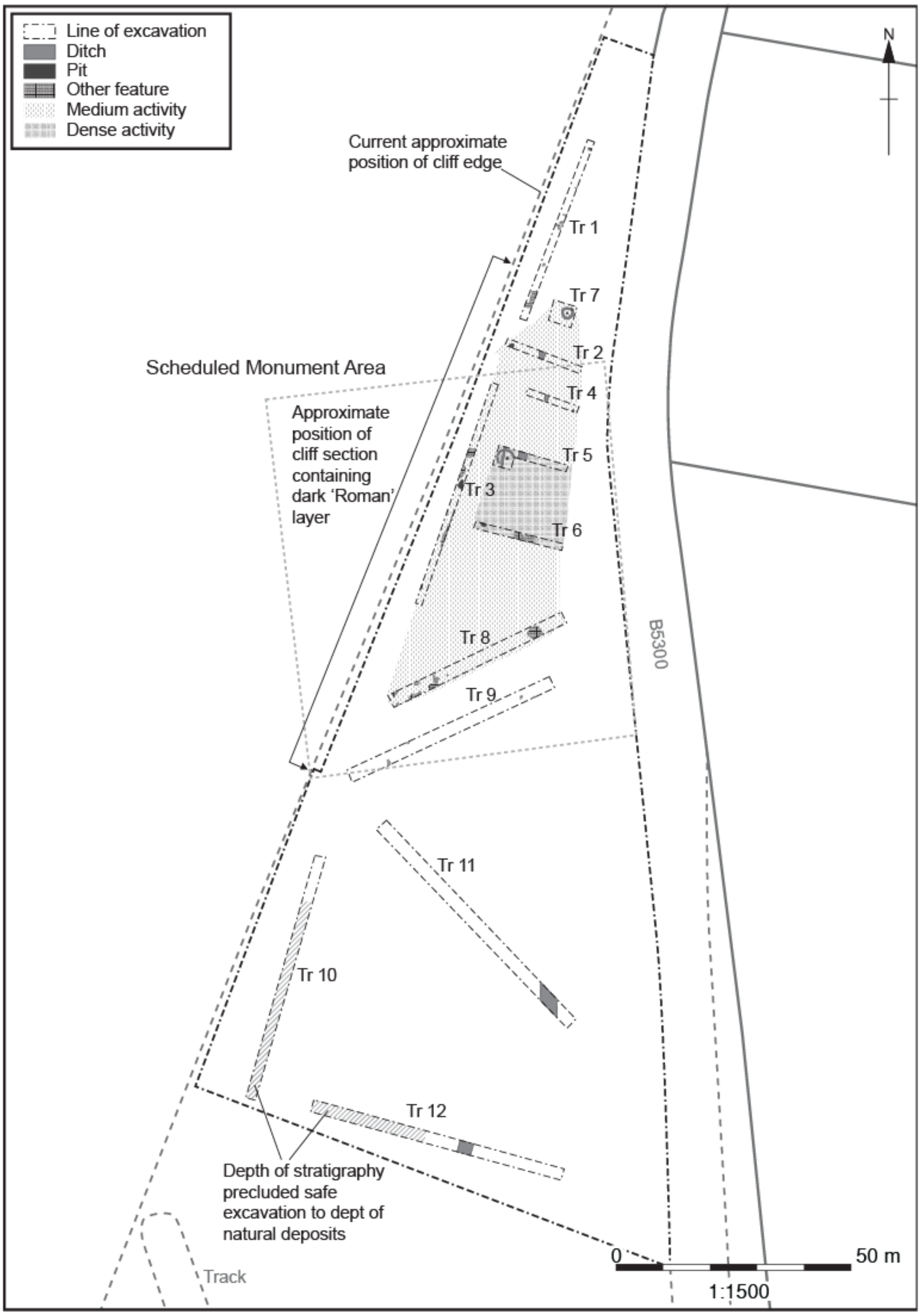


Figure 2: Beckfoot overview of trenches and features, showing Scheduled Monument Area and concentrations of archaeological activity (© Oxford Archaeology Ltd)

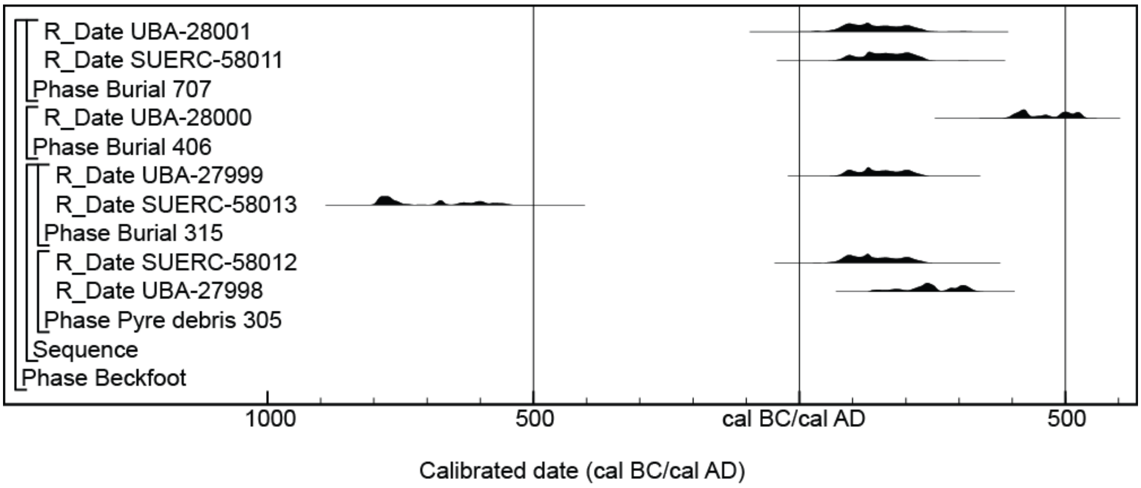


Figure 3: Probability distributions of dates from Beckfoot. The distributions are the result of simple radiocarbon calibration (Stuiver and Reimer 1993)

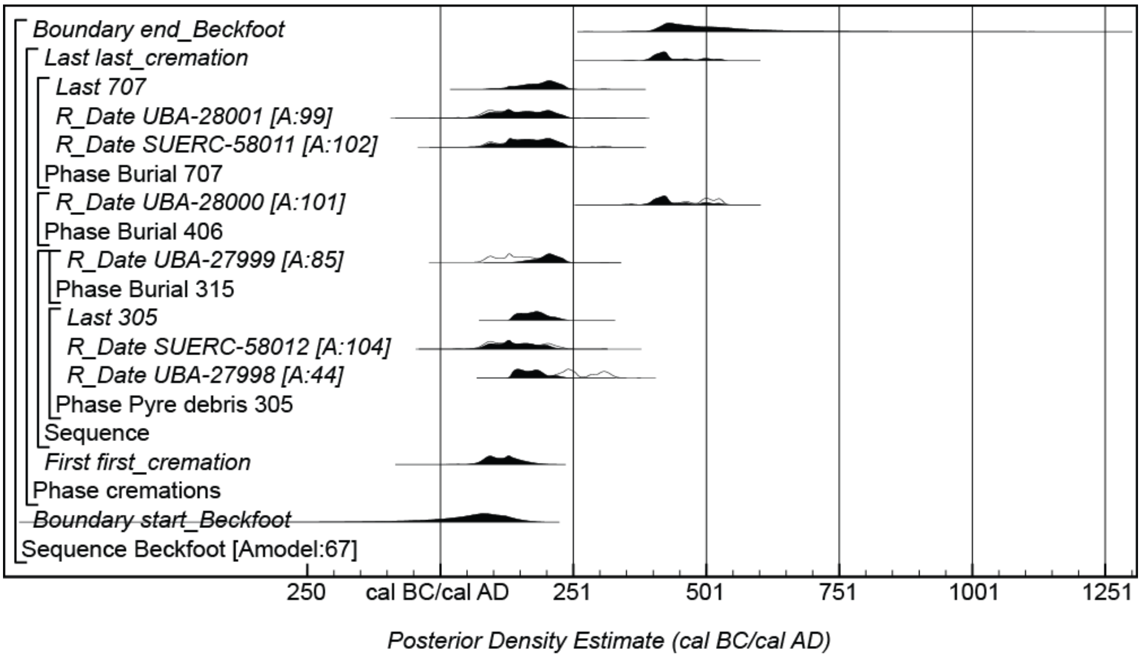


*Figure 4: Probability distributions of dates from Beckfoot. Each distribution represents the relative probability that an event occurs at a particular time. For each radiocarbon date, two distributions have been plotted: one in outline which is the result of simple radiocarbon calibration, and a solid one based on the chronological model used. The other distributions correspond to aspects of the model. For example, the distribution '*Boundary start_Beckfoot*' is the estimate for when burial activity started. The large square brackets down the left-hand side of the diagram and the OxCal keywords define the overall model exactly.*

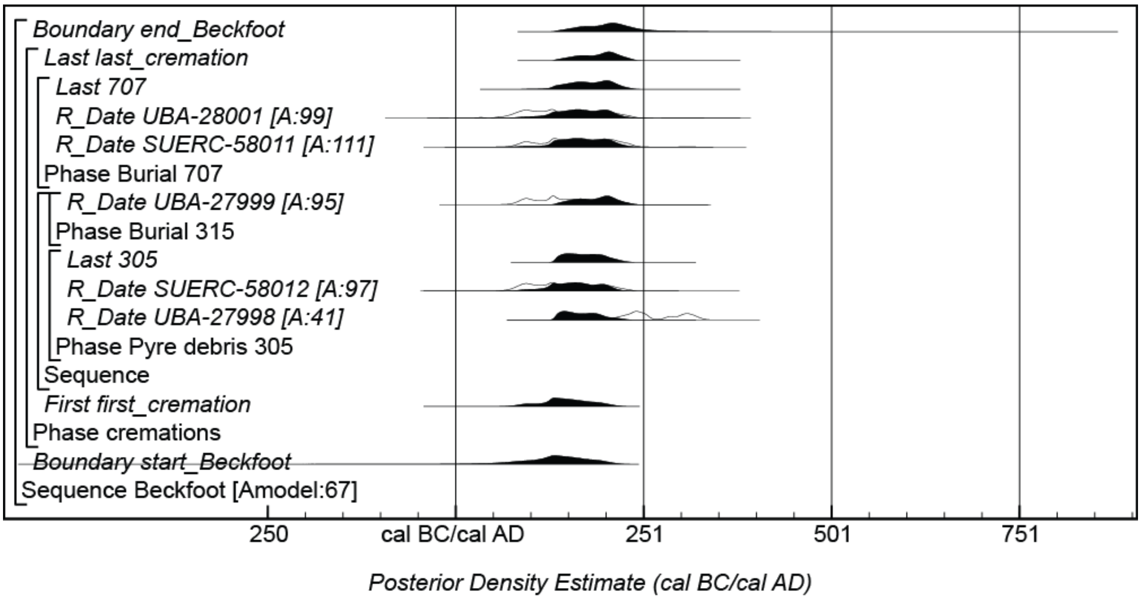
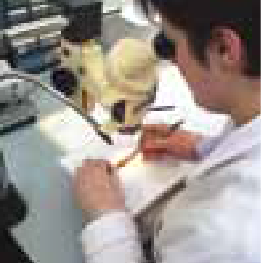
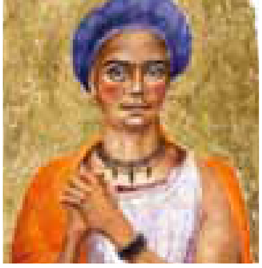
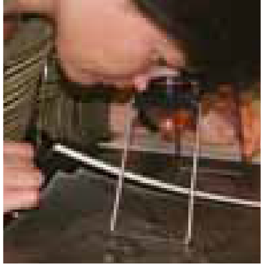


Figure 5: Probability distributions of dates from Beckfoot (Burial 406 *excluded). Each distribution represents the relative probability that an event occurs at a particular time. The format is identical to Figure 4*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