Appendix 1: Radiocarbon dating

by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley

INTRODUCTION
by Paul Garwood

The radiocarbon date assemblage from Barrow Hills is by far the largest from any British Neolithic and Bronze Age ritual-funerary complex, and is especially notable for the large number of high-value dates derived from short-life sources. Including the adjacent Abingdon causewayed enclosure, there are 56 radiocarbon dates from Barrow Hills relating to Neolithic or Bronze Age activity (see Table A.1). There are only four comparable date assemblages from site concentrations of a similar size in England and Wales: from Raunds, Northamptonshire (Irthlingborough, Stanwick and West Cotton), presently consisting of about 50 dates (J Humble pers. comm.); from the central Dorchester area, Dorset (Greyhound Yard — Fordington — Alington Avenue — Flagstones — Mount Pleasant), consisting of 36 dates (Wainwright 1979; Woodward 1991, 170–72; Bellamy 1991, 130); from the dispersed round barrow group in the Brenig valley, Clwyd, consisting of 32 dates (Lynch 1993, 213–19); and from Stonehenge and the Avenue for which there some 50 dates (Cleal *et al.* 1995).

Even more important is the quality of the radiocarbon date assemblage, which includes a large number of dates from short-life sources: there are 41 dates on unburnt human bone, cattle bone and antler samples from Barrow Hills. In comparison, there are only 21 dates from bone or antler samples from Raunds (with six further dates on short-life charcoal or plant samples), 22 from the central Dorchester area, and none from the Brenig valley (though there are 10 dates from short-life charcoal samples). In addition, most of the Barrow Hills samples were recovered from secure contexts in direct stratigraphic association with the artefact assemblages, funerary deposits and structures being dated. Qualitatively, therefore, as well as quantitatively, the radiocarbon date assemblage is outstanding.

Its analytical and interpretive value is apparent at several spatial and temporal scales. The dating and chronological analysis of the Neolithic and Bronze Age ritual-funerary complex are particularly important as the structuring of monumental space and the ordering of ritual practices at such sites over time are poorly understood. In addition, the numerous radiocarbon dates relating to the round barrows allow for a serious assessment of the chronological development of a large Wessex-type linear barrow group for the first time. These dates, particularly those from the pond barrow (4866) and the small ring ditches (201, 602, 801 and barrow 4A), are also helpful for the typo-chronological definition of certain round barrow forms (Garwood in prep.). At a more specific level there are several groups of dates which provide important new chronological evidence: the dates from the earlier Neolithic inhumations and linear mortuary structure; those from early Bronze Age non-Beaker funerary contexts with grave assemblages (one with a bronze awl, another with a dagger, and two with Food Vessels); and above all those from the Beaker graves, which are relevant to recent considerations of British Beaker typology and chronology (Kinnes *et al.* 1991).

An important feature of the work on the radiocarbon dates in this report has been the rigorous assessment of the *value* of each date; this value is assigned in terms of the inherent integrity of the sample source, its material context and its stratigraphic and associational status. These values are given specifically with the dating and interpretation of the site in mind; obviously in a broader context results may have a variable utility depending on the type and scale of research questions they are to address.

There has been very little systematic evaluation of radiocarbon dates to define their value for interpretive purposes — the assessment of the radiocarbon chronology for Dutch Beakers by Lanting and van der Waals (1976, 36–41) remains exceptional — and it is becoming increasingly evident that existing radiocarbon date lists include many dates that are unreliable or contextually irrelevant. In the case of round barrows in England and Wales, for example, of the several hundred dates presently available, some 80% are of little or no real dating value (Garwood in prep.). Failure to reject poor quality radiocarbon dates and undisciplined use of dates which have no stratigraphic or associational value have created serious confusion with regard to round barrow typo-chronology, the study of artefact assemblages and the interpretation of late Neolithic/early Bronze Age ritual-funerary traditions. It is essential that prehistorians subject individual radiocarbon determinations to far more critical scrutiny than is presently the case, using consistent criteria, and with far more concern for their contextual relevance (cf Kinnes and Thorpe 1986; Whittle 1988, 15–17; Kinnes *et al.* 1991, 36–7).

METHODOLOGICAL AND INTERPRETIVE ISSUES
by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley

Measurement

The radiocarbon dating of the samples was undertaken at both the British Museum and Oxford AMS laboratories, the British Museum measurements being made in batches over a period of some years. The British Museum results were calculated using liquid

Total or extensive excavation of ring ditch 611 and the ditches of the oval barrow and barrow 12 revealed interesting patterns of deposition, and demonstrated the need for methods geared to their recognition and recovery. There is a strong case for either excavating barrow interiors before total destruction or switching attention to the ditch deposits, with the emphasis on greater control of finds recovery, both artefactual and environmental. In the case of barrows 12 and 4A deposits of animal bone in the ditches were products of the same funerary rituals as the central burials. Ditches are not just quarries; they can also contain post structures, as in the oval barrow, and act as traps for the subsequent record.

There is a lack of contemporary domestic settlement in the immediate area and this is a good reason to prioritise adjoining areas between the terrace and the river Thames, as the evidence would serve to complement the complex funerary activity at Barrow Hills. Further, opportunities for systematic field survey within the immediate environs should be considered if the wider issues of landscape history are to be understood.

The Neolithic 'flat' grave cemetery at the edge of the excavated area (Figs 1.10, 3.9–10) raises the possibility that more graves could exist. The grouping of three single graves of this period so far remains unique in Britain. Two points can be stressed: there is probably a greater need for an off-site or landscape approach and there is a case for acquiring radiocarbon determinations for unaccompanied burials.

The current and future threat

The surviving part of the barrow cemetery, including unexcavated barrows 8–10, is gradually being destroyed through ploughing. It is possible that any burial deposits and mounds have already been largely destroyed. Similarly, less visible features between the barrows are also likely to have been destroyed. In 1994 the cropmarks of two possible pit circles were observed between barrows 14 and 15. There is a need to assess the potential of the surviving archaeological deposits and prevent the further erosion of the site by instigating a management agreement.

scintillation counting and the methods described by Ambers, Matthews and Bowman (1987) for BM-2390 to -2393 (measured in 1986) and BM-2520 to -2588 (measured in 1988), and the methods described by Ambers and Bowman (1994) for BM-2696 to -2716 and BM-2896 (measured in 1990 and 1993 respectively). Those undertaken at Oxford were measured by accelerator mass spectrometry using the methods described by Hedges *et al.* (1989 and 1992). The Oxford results were also measured at different times. The first group (OxA-1872 to -1889 and OxA-1903) were undertaken in 1988 using an iron-graphite ion source, the second (OxA-4355 to -4359) in 1993 with a carbon dioxide gas ion source (Bronk and Hedges 1990). Both laboratories maintain quality assurance procedures, and the results of the recent IAEA organised interlaboratory comparison (Rozanski *et al.* 1992) indicate no laboratory offsets. The full details of the radiocarbon dates and assessments of their value are integrated with the archaeological descriptions in Chapters 3–6.

Measurement problems

Humic acid contamination

BM-2707 and BM-2708 from the burials at the centre of the oval barrow, rejected by Richard Bradley mainly on interpretive grounds (1992a, 138), were measured prior to the publication of work (Gillespie 1989) suggesting that contamination problems can occur where bones have been subject to chemical degradation and the collagen directly exposed to humic acid in the soil. The extracted protein was poor in both these cases and would not now be analysed.

The possibility of humic acid contamination of bone collagen, particularly in shallow and/or disturbed contexts, raises some fundamental questions about the accuracy of existing radiocarbon chronologies, especially as the thin time-width and zero age-at-death offset of bone samples have been highly valued (eg Kinnes *et al.* 1991, 36–7). At Barrow Hills, where the vast majority of the radiocarbon dates (41 out of 57) derive from bone or antler collagen, it has obviously been essential for the material state and position of dated bone to be fully assessed. It would be generally helpful if in future the condition of bone samples was reported on by radiocarbon laboratories, and the possibility of contamination explicitly evaluated.

Charred Bone

Six of the AMS measurements (OxA-1872, -1873, OxA-1876 to -1879) were on charred human bone. As a general rule, bone which has been 'blackened' by burning contains very little protein, but it does contain a variable — sometimes a high — amount of elemental carbon. Bone which has been burnt to the point of appearing white or blue has, in contrast, very little carbon. It is usually possible to extract humic material by alkaline extraction and acid precipitation, and after decalcification, to be left with a carbonaceous residue. ^{14}C determinations on humic and carbonaceous extracts from burnt bones (eg Batten *et al.* 1986) have shown that the humic extracts frequently correspond to the radiocarbon age of the immediate burial environment, whereas the carbonaceous residue generally reflects the age of the bone. However, it is difficult to guarantee for any given sample that no contaminating exogenous organic material with a different ^{14}C age has remained (cf Bowman 1990, 29). $\delta^{13}C$ measurements can help to determine whether any contamination remains, in that most of the carbon in burnt bone is collagen-derived (and thus has $\delta^{13}C$ values of around -20‰), as against carbohydrate-derived carbon (which has values of *c.* -25‰). Unfortunately, in the case of the Barrow Hills charred bone determinations, the work was undertaken when the means to make such $\delta^{13}C$ measurements were not available. In the absence of such information it is not possible to check whether significant quantities of a contaminant remained in the three samples that produced archaeologically anomalous results (OxA-1876 to -1878), compared to the three which gave acceptable ones (OxA-1872, -1873 and -1879). Given the highly individual nature of burnt bone, it is perhaps not altogether surprising that the failure to totally remove all exogenous carbon has been specific to individual samples. It is interesting to note that the contaminant has sometimes been younger and sometimes older than the bone.

The questionable accuracy of dates on charred bone is now recognised as a serious problem by radiocarbon laboratories, though the significance of the issue has yet to be fully appreciated by archaeologists. In effect, while it is possible to assume that many such samples will suffer from carbon contamination, there are no reliable methods for distinguishing between determinations likely to be accurate and those which are not. Reference to an 'expected' age for *deciding* accuracy (in relation to other similar dated contexts) is entirely misleading as it ultimately devolves on circular argument. (The use of the relative chronological order of dates is not circular, however, since this relies on the stratigraphic relationship between samples). Until some method of establishing the reliability of dates on charred bone emerges, the interpretive use of such dates remains extremely dubious. In British prehistory this problem raises most acute difficulties for early and middle Bronze Age studies, where the existing absolute chronology is partly based on radiocarbon dates from cremation burials. At Barrow Hills, all six of the dates on charred bone (OxA-1872, -1873 and -1876 to -1879) must be considered unreliable, though in three cases they do conform to predicted date order within stratigraphic sequences. Rejection of these dates as a whole is unfortunate as they mainly derive from cremation deposits in association with urn-type ceramics (Collared and Biconical Urns) that are otherwise undated on the site.

Charcoal

The problematic archaeological use of dates from charcoal samples, particularly in relation to age-at-death offsets, has often been commented upon (eg Bowman 1990, 51; Waterbolk 1971, 22-4). Although only seven of the Barrow Hills dates are from charcoal samples

(BM-2705; OxA-1883, OxA-1885 to -1889), none of these derives exclusively from short-life species or outer tree rings. It is therefore likely that all or some of them include large age-at-death offsets. In addition, there is always the possibility of contamination by redeposited charcoal, or that some of the timbers represented were derived from objects or standing structures in use for some period before final burning and deposition (perhaps even selected deliberately because of their age). Unless it is possible to argue for the exclusive presence of short-life material in the dated sample, which is not the case for any of the Barrow Hills dates, it will be necessary to make allowance for a possible age offset if the date is to be used interpretively (Warner 1990).

Contexts of deposition

The recovery of most of the samples from contexts which might be termed 'ritual'(graves, other deposits associated with funerary monuments, and apparently non-domestic pits), raises questions about the pre-depositional history of the dated materials and the objects with which they were associated. In particular, where ritual traditions celebrated, curated and redeployed material derived from past cultural contexts — which may be the case in the British late Neolithic/ early Bronze Age (see Garwood 1991, 14–17, for a discussion of round barrow monumentalism and the perception of mytho-historical landscapes), it is possible that ancient objects were sought out for use in practices that demanded reference to the past (cf Lane 1986). If ancient wooden objects or building materials were selected for cremation pyres, for example, this would seriously affect the dating of burials, monuments and associated artefacts. Similarly, the deposition of objects perhaps centuries after their manufacture could easily confuse typological analysis where this depended on the radiocarbon dating of final depositional events alone (eg Beaker typologies; cf Kinnes *et al.* 1991). While it is impossible to demonstrate this kind of practice at Radley (though we might question the nature of the Beaker grave assemblages), it is clear that an uncritical reading of depositional context and cultural practices in the past may itself introduce chronological problems.

Ancient disturbance

Finally, there are several dates from Radley which derive from samples found in grave contexts that were probably disturbed in antiquity (BM-2520, BM-2703, BM-2711, OxA-4357). In three cases the grave fills contained scattered or broken artefacts; in the other a complete Beaker possibly remained in its original position though the grave fill and burial were disturbed. While it is tempting to associate the dated samples and artefacts in these contexts, disturbance means associations are suspect and it is stressed that these samples were analysed as a means of dating the burial rituals. Rigorous assessment of the stratigraphic and associational value of every radiocarbon date should obviously be integral to an interpretive discussion, but it is surprising how frequently this basic tenet is transgressed (cf Kinnes and Thorpe 1986, for a discussion of this problem).

Representation of calibrated age ranges

The interpretive use and presentation of calibrated age ranges in archaeological reports needs some comment, especially as there are few consistent conventions applied by prehistorians for using calibrated dates. Until recently the use of radiocarbon dates has generally involved reference to easily-remembered, uncalibrated 'spot-dates' with the one standard deviation range indicated alongside. This has sometimes led to simplistic treatment of radiocarbon dates as though they represented 'historical' points in time (Whittle 1988, 31). It is now recognised that only calibrated age ranges should be used, preferably at one *and* two standard deviations (Pearson 1987, 103), which will inevitably make it more difficult for users to remember individual dates or compare them directly with others. This will become increasingly evident as ever greater numbers of calibrated radiocarbon dates are published. It is also likely to encourage a far more selective, interpretive and discursive approach to the use of dates in archaeological reports, rather than mechanistic repetition of every 'relevant' date. In this context it is essential that the reader has some means to evaluate the dates being used, both in relation to the interpretations being presented and in wider cultural terms. This not only demands full publication of all dates in site reports and their proper evaluation, but points to the need for corpora of radiocarbon dates, appropriately calibrated and easily up-dated, and chronological overviews that transcend material divisions in the evidence.

Faced with such a plethora of radiocarbon age ranges, some form of graphic presentation is clearly essential for any discussion of relative dating (Kinnes *et al.* 1991, 38). The Barrow Hills date assemblage as a whole is presented graphically in two ways (graphic information provided by Janet Ambers): Figure 9.1 shows the dates in order of age with a broad period division indicated; Figure 9.2 shows them grouped according to spatial associations or monuments.

Discussion of date evaluations
by Paul Garwood

Although it is difficult to define the value of a radiocarbon date assemblage as a whole in relation to specific interpretive issues, because of the distinct contextual relevance of each dated sample, it is clear that the Barrow Hills assemblage (59 dates including those from the causewayed enclosure) is exceptional for the number of individually high-value and moderate-value dates (see table). In fact only ten dates appear to be of such low-value that their use for interpretive purposes is negligible (BM-348, BM-349, BM-350, BM-351, BM-353 from the causewayed enclosure; OxA-1883, OxA-1889 and OxA-4357 from other prehistoric contexts; BM-2705 and OxA-1885 from Roman/post-Roman contexts). Six dates on charred bone samples are, however, of uncertain value because of the sample material concerned, though otherwise their artefactual or stratigraphic relationships would appear to favour a high valuation: they are largely excluded from the discussion below.

As most of the excavated area had been heavily truncated by ploughing, the radiocarbon dates mainly derive from stratigraphically isolated features: from single depositional contexts representing short duration events (eg burials); and from contexts within short stratigraphic sequences that are otherwise spatially isolated. There are 24 radiocarbon dates from single undisturbed grave contexts, which are of direct dating use only for the depositional episode represented (ie the funerary context, deposition of associated artefacts, grave backfill, etc). In several instances the location of the dated grave context also suggests a spatial association with other features (with no stratigraphic relationship), indicating possible contemporaneity of construction or use. This could be argued in the case of the central graves within the ring ditches of sites 801 (OxA-1888), 201 (BM-2700), barrow 1 (OxA-1886), barrow 3 (OxA-4355), and barrow 4A (OxA-4356); and the arc of single graves around pond barrow 4866 (BM-2696, BM-2997, BM-2698, OxA-1880, OxA-1903). Nineteen of these 24 dates are of high-value because of their sample type, contextual integrity and structural or artefactual associations, though their use for defining site phases — given their wide calibrated age ranges — is inevitably limited without relative stratigraphic evidence.

There are only four stratigraphic sequences from Barrow Hills that are dated by more than one sample: the fills of the oval barrow ditches (BM-2390 to BM-2393); pit 5352 / long mortuary structure (BM-2709, BM-2714, BM-2716, OxA-1881); ring ditch 611 and outer ditch of barrow 12 (BM-2712, BM-2713, BM-2896, OxA-1873, OxA-1872); and the series of pits and grave deposits at the centre of barrow 12 (BM-2699, OxA-1884, OxA-1887). Although detailed assessments of these date series in relation to precise depositional and constructional sequences may be questionable because of the small number, low precision and variable value of the dates in each case, they do provide a way of assessing the general reliability of the dating programme. In three of these sequences the stratigraphic order of dated contexts corresponds exactly with the radiocarbon date order; in the other, the aberrant date (OxA-1887) can be explained by a large age-at-death offset for the charcoal sample (derived from a large oak timber). This correspondence of sequences must increase confidence in the general reliability of the Radley dates, particularly those from bone and antler samples, and suggests that some at least of the charred bone samples from Radley may have produced reliable dates (ie OxA-1873 and OxA-1872). It must be borne in mind, however, that using stratigraphic orders in this way can also be questionable because of the potentially unreliable taphonomy of some of the samples. While this form of evaluation is only appropriate to multiple radiocarbon date series from coherent stratigraphic sequences, rare in British Neolithic and Bronze Age archaeology, it does provide a possible means of isolating dates derived from redeposited material, allowing for more sensitive selection of dates for the definition of site phasing sequences. In this respect the two dated stratigraphic sequences from the Abingdon causewayed enclosure (from sections BII and CII; Avery 1982) are far less helpful than might be expected, mainly because of the poor quality of the charcoal samples in terms of their material integrity, possible large age-at-death offsets, possible redeposition, and low precision (see Appendix 2). Nonetheless, a comparison of the three bone / antler and three charcoal samples interstratified in section CII shows that the dates on bone and antler are consistently later by 200-400 years. This suggests that the charcoal deposits, at least, were redeposited or derived from old wood sources, and are therefore of low value for dating the ditch deposits (*ibid.*, 49; cf R Bradley 1992a, 139–40).

The dating of material assemblages from Radley is of particular interest because of the large number of high and moderate value dates associated with assemblages or individual artefacts. There are four dates associated with earlier Neolithic flintwork (BM-2707, BM-2708, BM-2710, OxA-1882), two of these being from the central grave within the oval barrow (about which there are doubts regarding accuracy). There is one date on a Neolithic antler comb from the causewayed enclosure (BM-355). There are two dates associated with Grooved Ware and related material (BM-2706, BM-2715), four from Beaker grave contexts (BM-2700, BM-2704, OxA-1874, OxA-4356), and two from other early Bronze Age grave contexts with copper or bronze objects (BM-2698, OxA-4355). There are two dates associated with Food Vessels (BM-2698, OxA-1884) and two from early Bronze Age graves with antler deposits (BM-2697, OxA-1884). Finally, there are two dates from the deliberate bone and antler arrangement near the base of ring ditch 611 (BM-2712, BM-2713). All of these derive from short-life bone or antler samples with zero age-at-death offsets, from sealed contexts mostly representing very short duration burial events (with minimal depositional offsets) in direct association with the material being dated. In addition, there are six further moderate-value dates which may be used, with greater reservation, for dating artefacts or other objects: three dates on human bone from contexts with Beakers (BM-2520, BM-2703, OxA-1875); two on charcoal from early Bronze Age graves (OxA-1886, OxA-1888); one from cattle bone in a Grooved Ware pit (BM-2715); and one from a large carbonized wooden object with a cremation burial (OxA-1887).

The Radley radiocarbon dates in many cases clearly have a high value for dating individual burials and other formal depositional contexts, together with some associated artefacts and assemblage types. They are far less helpful for dating monuments and depositional sequences: the majority of the dated samples have no stratigraphic relationship with constructional features, and where they do it is mainly in the form of material in ditch or pit fills that accumulated over an uncertain length of time as a result of erosional processes of uncertain temporal separation from constructional episodes. This kind of dating problem is particularly apparent where all above-surface stratigraphy has been destroyed, creating truncated sites (like ring ditches) where subsurface deposits are likely to consist of short sequences that are stratigraphically isolated. This again emphasises the need for multiple dates for stratigraphic sequences (cf Needham 1990, 440–1), and in particular the need to undertake very large and intensive radiocarbon dating programmes (if possible) wherever above-surface stratigraphies are encountered; the potential value of these for establishing sensitive monument typo-chronologies and defining constructional/depositional sequences cannot be overstated.

Table A.1. Radiocarbon dates from Radley Barrow Hills (1)

by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley (contexts and evaluations by Paul Garwood) * to simplify this table, some very minor age ranges have not been included; the probabilities listed therefore do not always add up to 68% and 95%. Actual percentage probabilities for each range are given after the figures.

Site	Sample No.	Conventional Date BP	$\delta^{13}C$: ‰ relative to PDB	Calibrated age range Calendar years BC *ca* 1σ*	*ca* 2σ*	Sample	Context	Evaluation
Oval barrow	BM-2390	4320±130	-20.6	3350-2650 68%	3350-2600 95%	red deer antler	middle fill Bradley's phase 4 ditch	moderate value date
Oval barrow	BM-2391	4330±80	-21.8	3100-2880 67%	3350-2650 95%	red deer antler	primary fill Bradley's phase 5 ditch	moderate value date
Oval barrow	BM-2392	4500±60	-20.0	3340-3090 68%	3370-3030 92%	red deer antler	base of Bradley's phase 3 ditch	?high value date
Oval barrow	BM-2393	4420±70	-22.1	3300-3240 (16%); 3110-3020 (27%): 3000-2920 (23%)	3340-2910 95%	red deer antler	middle fill ditch Bradley's phase 4	moderate value date
Oval barrow	BM-2707	4120±60	-19.9	2878-2800 (18%); 2780-2600 (50%)	2890-2570 91%	human femur and tibia	burial 2127	high value date
Oval barrow	BM-2708	3860±50	-23.0	2460-2290 68%	2490-2190 94%	human long bone	burial 2128	high value date
Ring ditch 201	BM-2520	3630±60	-21.8	2130-2070 (20%); 2050-1930 (48%)	2200-1870 95%	human tibia, fibula and skull fragments	grave 206	moderate or low value date
Ring ditch 201	BM-2700	3360±50	-20.9	1740-1610 67%	1770-1520 93%	human femur	grave 203	high value date
Pond barrow 4866	OxA-1879	3720±80	-21.0 (estimated)	2290-2030 67%	2500-1900 95%	protein fraction (?), charred human bone	cremation 4866/I	?high value date
Pond barrow 4866	OxA-1903	3480±80	-21.0 (estimated)	1910-1690 68%	2040-1610 95%	human long bone and skull fragments	grave 5274	high value date
Pond barrow 4866	OxA-1880	3490±80	-21.0 (estimated)	1930-1700 68%	2040-1620 95%	red deer antler	grave 4969	high value date

Table A.1. Radiocarbon dates from Radley Barrow Hills (2)

by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley (contexts and evaluations by Paul Garwood) * to simplify this table, some very minor age ranges have not been included; the probabilities listed therefore do not always add up to 68% and 95%. Actual percentage probabilities for each range are given after the figures.

Site	Sample No.	Conventional Date BP	$\delta^{13}C$: ‰ relative to PDB	Calibrated age range Calendar years BC *ca* 1σ*	*ca* 2σ*	Sample	Context	Evaluation
Pond barrow 4866	BM-2698	3500±50	-20.1	1890-1750 68%	1970-1690 95%	human long bone	grave 4970	high value date
Pond barrow 4866	BM-2697	3320±50	-20.5	1680-1590 (46%) 1570-1520 (22%)	1740-1510 95%	human long bone	grave 4968	high value date
Barrow 12	BM-2699	3720±60	-19.4	2210-2030 63%	2330-1950 95%	human femur	grave 607	high value date
Barrow 12	OxA-1872	3450±80	-21.0 (estimated)	1890-1680 68%	1980-1590 92%	protein fraction (?), charred human bone	cremation 601/B/3	?high value date
Barrow 12	OxA-1884	3670±80	-21.0 (estimated)	2200-1940 68%	2350-1750 95%	human humerus and skull	grave 605	high value date
Barrow 12	OxA-1887	3830±70	-26.0 (estimated)	2460-2200 59%	2500-2130 93%	oak charcoal	grave 605	moderate value date
Pond barrow 4583	BM-2701	2930±50	-21.0	1220-1060 63%	1310-1000 95%	human femur	burial A/B (4583/C/1 and 2)	moderate value date
Pond barrow 4583	BM-2702	2760±50	-19.9	940-840 55%	1020-810 95%	human femur	burial C (4583/D/1)	moderate value date
'Flat' grave 950	BM-2703	3720±50	-22.1	2200-2030 68%	2300-1970 95%	human humerus and ulna	grave 950	low-moderate value date
'Flat' grave 4660	BM-2704	3650±50	-21.3	2140-2070 (31%); 2050-1960 (37%)	2190-1890 95%	human femur	grave 4660	high value date
Grooved Ware pit 3196	BM-2706	3830±90	-21.0 (estimated)	2460-2190 66%	2600-2000 95%	cattle bone	pit 3196	moderate value date
Linear mortuary structure 5352	BM-2709	4270±100	-20.6	3040-2860 (43%); 2820-2660 (25%)	3350-2550 95%	human femur and tibia	burial C	moderate value date
Linear mortuary structure 5352	BM-2714	4470±70	-19.0	3340-3320 (31%); 3190-3030 (37%)	3360-3020 84%	human femur tibia and fibula	burial B	moderate value date
Linear mortuary structure 5352	BM-2716	4600±70	-20.5	3510-3410 (27%); 3390- 3310 (22%); 3240-3180 (14%)	3650-3050 95%	human long bone	burial A	high value date
Linear mortuary structure 5352	OxA-1881	5140±100	-21.0 (estimated)	4040-3780 67%	4240-3700 95%	red deer antler	primary gravel fill of pit 5352	moderate value

Table A.1. Radiocarbon dates from Radley Barrow Hills (3)

by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley (contexts and evaluations by Paul Garwood) * to simplify this table, some very minor age ranges have not been included; the probabilities listed therefore do not always add up to 68% and 95%. Actual percentage probabilities for each range are given after the figures.

Site	Sample No.	Conventional Date BP	$\delta^{13}C$: ‰ relative to PDB	Calibrated age range Calendar years BC *ca* 1σ*	*ca* 2σ*	Sample	Context	Evaluation
Pit 2142	BM-2705	1570±50	-24.5	AD430-540 68%	AD390-600 95%	oak charcoal	pit 2142	low value date
Neolithic grave 5355	BM-2710	4530±50	-20.1	3240-3100 50%	3380-3090 92%	human femur	grave 5355	high value date
Neolithic grave 4359	OxA-4359	4700±100	-21.1	3540-3360 52%	3800-3100 95%	human femur and tibia	grave 5356	high value date
Neolithic grave 5354	OxA-1882	4650±80	-21.0 (estimated)	3530-3340 61%	3650-3100 95%	human bone	grave 5354	high value date
Ring ditch 611	OxA-1873	3510±80	-21.0 (estimated)	1950-1740 68%	2040-1640 92%	protein fraction(?), charred human bone	urned cremation on layer 4	?high value date
Ring ditch 611	OxA-1889	3600±70	-26.0 (estimated)	2040-1880 58%	2190-1760 95%	charcoal	ring ditch 611, layer 2	low value date
Ring ditch 611	BM-2712	3860±80	-22.8	2470-2270 58%	2600-2000 95%	red deer antler	ring ditch 611, layer 13	moderate value date
Ring ditch 611	BM-2713	3950±80	-20.7	2580-2340 68%	2900-2200 95%	red deer antler	ring ditch 611, layer 14	high value date
Ring ditch 611	BM-2896	2820±40	-23.0	1020-920 68%	1100-890 94%	cattle bone	ring ditch 611, layer 1	moderate value date
Pit 411	OxA-1885	1710±70	-26.0 (estimated)	AD240-410 68%	AD130-460 93%	charcoal, charred grain	pit 411	low value date
tree throw hole 5353	OxA-1883	8100±120	-26.0 (estimated)	7270-6990 46%	7450-6600 95%	charcoal	tree throw hole 5353	low value date
Pit 942	BM-2711	4020±60	-20.3	2620-2470 58%	2700-2450 77%	human femur and tibia	inhumation 942	?low value date
Pit 917	BM-2715	3940±60	-22.1	2510-2350 54%	2700-2200 95%	cattle bone	pit 917	moderate value date
'Flat' grave 919	OxA-1874	3930±80	-21.0 (estimated)	2510-2310 58%	2700-2100 93%	human radius and skull	grave 919	high value date
'Flat' grave 919	OxA-1875	3990±80	-21.0 (estimated)	2620-2450 52%	2900-2250 95%	human ribs and humerus	grave 919	moderate value date
Cremation 4245	OxA-1876	2740±70	-21.0 (estimated)	940-820 58%	1060-800 95%	charred human bone	cremation 4245	?high value date
Cremation 4321	OxA-1877	2770±70	-21.0 (estimated)	1000-840 68%	1130-800 95%	protein fraction (?), charred human bone	cremation 4321	?high value date

Table A.1. Radiocarbon dates from Radley Barrow Hills (4)

by Janet Ambers, Sheridan Bowman, Paul Garwood, Robert Hedges and Rupert Housley (contexts and evaluations by Paul Garwood) * to simplify this table, some very minor age ranges have not been included; the probabilities listed therefore do not always add up to 68% and 95%. Actual percentage probabilities for each range are given after the figures.

Site	Sample No.	Conventional Date BP	δ[13]C: ‰ relative to PDB	Calibrated age range Calendar years BC *ca* 1σ*	*ca* 2σ*	Sample	Context	Evaluation
Cremation 4700	OxA-1878	4150±70	-21.0 (estimated)	2830-2610 60%	2910-2570 93%	protein fraction (?), charred human bone	cremation 4700	?high value date
Barrow 1	OxA-1886	3520±70	-26.0 (estimated)	1940-1750 68%	2040-1680 95%	charcoal, grass, seeds	grave 11	moderate value date
Ring ditch 801	OxA-1888	3450±70	-26.0 (estimated)	1880-1690 68%	1970-1600 94%	mixed charcoal	cremation 802	moderate value date
Barrow 3	OxA-4355	3785±90	-21.6	2360-2130 57%	2500-1950 95%	human femur	central grave	high value date
Barrow 4A	OxA-4356	3880±90	-21.4	2500-2270 61%	2650-2000 95%	human femur	central grave	high value date
Barrow 15	OxA-4357	3660±80	-21.4	2140-1930 64%	2300-1750 95%	human humerus	pit 1	low value date
Barrow 17	OxA-4358	3660±90	-20.9	2200-1920 68%	2350-1750 95%	human femur	pit 1	moderate value date

Appendix 2: Radiocarbon dates from the Abingdon causewayed enclosure

by Janet Ambers, Sheridan Bowman and Paul Garwood,

(contexts, assessments and evaluations by Paul Garwood)

Critical evaluations of the radiocarbon dates for the Abingdon causewayed enclosure are presented here, in accordance with the principles outlined in Appendix 1.

FORMAT AND CONVENTIONS

Each date is described in the format presented below, in order of laboratory number. The conventions used and the criteria applied for evaluation purposes are outlined under each appropriate heading.

Lab. No. Conventional date BP; δ[13]C fraction‰ relative to PDB
Calibrated date: Discussed above.
Sample: i. Dated material; ii. Source of dated material
Context: i. Condition and arrangement of source material (object / deposit); ii. Stratigraphic position of source object / deposit (feature / layer / context); iii. Details of location of dated context within site.
Associations: Artefacts in direct stratigraphic association with dated sample material.
Assessment: i. Contextual integrity (degree of disturbance, contamination, etc.); ii. Temporal duration of context dated (eg single, short duration burial

event, long duration soil accumulation process, etc.); iii. Physical integrity of sample (possibility of mixing of samples of different ages); iv. Age-at-death offset (specially relevant to charcoal); v. Depositional offset (eg possibility of sample redeposition, reuse of material; redeposition, etc.); vi. Relevance of the radiocarbon sample to artefact and context dating/ interpretation.

Evaluation: An evaluation, based on the date assessment above, of the reliability of the radiocarbon determination for dating purposes and archaeological interpretation. High-value dates are those which derive from single source materials in good condition with minimal age-at-death offsets, derived from sealed contexts representing short duration events or processes, in direct stratigraphic association with the objects, deposits or features which it is intended to date. Moderate-value dates must have the same qualities, except: (a) for an acceptance of large age-at death offsets providing these are properly considered in any interpretive discussion; and/or (b) an acceptance of less direct spatial rather than stratigraphic associations, providing there are good reasons for accepting the relationships defined (eg the use of a central burial context to date a surrounding ring ditch); and/or (c) dating contexts representing long-term depositional processes, providing the temporal relevance of these are clearly understood. Low-value dates which do not comply with these criteria are mostly of no dating relevance, and should normally be excluded from interpretation.

BM-348 4730±135 BP; $\delta^{13}C$: Not measured
Calibrated date: 3690-3360 cal BC (68% confidence); 3900–3000 cal BC (95% confidence).
Sample: i. Charcoal; ii. Unidentified.
Context: i. Small dispersed comminuted charcoal flecks in a fine gravel matrix; ii. A primary fill (layer 17) of secondary recut (phase 2) of ditch segment or large pit (section BII); iii. Probably inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Probable short duration process (primary silt accumulation); iii. Possibly mixed origin; iv. Age-at-death offset possibly large; v. Depositional offset unknown (possibly redeposited); vi. Primary silting of recut ditch segment, sealed by further silting and probable deliberate backfill.
Evaluation: Low-value date: poor quality dispersed sample material, probably mixed origin and age-at-death offset, possibly includes redeposited charcoal.

BM-349 6020±110 BP; $\delta^{13}C$: Not measured
Calibrated date: 5060-4790 cal BC (68% confidence); 5250–4600 cal BC (95% significance).
Sample: i. Charcoal; ii. Unidentified.
Context: i. Small dispersed comminuted charcoal flecks in a silt-sand matrix also containing cultural material; ii. A middle fill, probably part of deliberate backfilling (layer 6c) of secondary recut (phase 2) of ditch segment or large pit (section BII); iii. Probably inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Probable short duration process (backfilling); iii. Possibly mixed origin; iv. Age-at-death offset possibly large; v. Depositional offset unknown though may be redeposited (*ibid.*, 22); vi. Fill of recut ditch segment, sealed by probable deliberate backfill.
Evaluation: Low-value date: poor quality dispersed sample material, probably mixed origin and age-at-death offset, possibly includes redeposited charcoal.

BM-350 4910±110 BP; $\delta^{13}C$: Not measured
Calibrated date: 3820-3620 cal BC (54% confidence); 4000–3350 cal BC (95% confidence).
Sample: i. Charcoal; ii. Sample not clearly identified, though sample contexts contained oak, hazel, maple and whitebeam.
Context: i. Small dispersed comminuted charcoal flecks in a dark loam matrix, also containing animal bones, pottery and flintwork; ii. A partly organic backfill (layers 18a–c, 19a) in the middle fills of secondary recut (phase 2) of ditch segment (section CII); iii. Inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Probable short duration event (dumping of refuse?); iii. Dispersed and probably mixed origin; iv. Age-at-death offset possibly large; v. Depositional offset unknown (possibly redeposited from phase 1); vi. Middle backfill of recut ditch segment, sealed by further deliberate backfill and silting (*ibid.*, 12).
Evaluation: Low-value date: poor quality dispersed sample material, probably mixed origin and age-at-death offset, possibly includes redeposited charcoal.

BM-351 5060±130 BP; $\delta^{13}C$: Not measured
Calibrated date: 4000-3700 cal BC (68% significance); 4250-3500 cal BC (95% significance).
Sample: i. Charcoal; ii. Sample not clearly identified, though sample context contained oak and probably crab apple.
Context: i. Small dispersed comminuted charcoal flecks in a dark loam matrix, also containing animal bones, pottery and flintwork; ii. A partly organic layer (13) in the middle fills of secondary recut (phase 2) of ditch segment (section CII). Animal bone from the same layer also dated (see BM-352); iii. Inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Possible short duration process (deposition of organic refuse ?); iii. Dispersed and probably mixed origin; iv. Age-at-death offset possibly large; v. Depositional offset unknown (possibly redeposited from phase 1); vi. Middle fill of recut ditch segment, probably representing occupation debris, sealed by further silting or backfill (*ibid.*, 12).
Evaluation: Low-value date: poor quality dispersed sample material, probably mixed origin and age-at-death offset, possibly also includes redeposited charcoal.

BM-352 4710±135 BP; $\delta^{13}C$: Not measured
Calibrated date: 3690–3340 cal BC (68% confidence); 3800–3000 cal BC (95% confidence).
Sample: i. Collagen; ii. Animal bone.
Context: i. One of a large number of animal bones in a dark loam layer also containing large quantities of charcoal, pottery and flintwork; ii. A partly organic layer (13) in the middle fills of secondary recut (phase 2) of ditch segment (section CII). Charcoal from the same layer also dated (see BM-351); iii. Inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Possible short duration process (deposition of organic refuse ?); iii. Single origin; iv. Age-at-death offset minimal; v. Depositional offset unknown (possibly redeposited from phase 1); vi. A middle fill of recut ditch segment, probably representing occupation debris, sealed by further silting or backfill (*ibid.*, 12).
Evaluation: Moderate-value date: derived from occupation debris, though sample material possibly redeposited and this would lessen its value.

BM-353 4970±130 BP; $\delta^{13}C$: Not measured
Calibrated date: 3950–3640 cal BC (68% confidence); 4050–3350 cal BC (95% confidence).
Sample: i. Charcoal; ii. Sample unidentified.
Context: i. Small dispersed comminuted charcoal flecks in a dark loam matrix, also containing animal bones, pottery and flintwork; ii. A partly organic layer (5d) in the upper fills of recut (phase 2) ditch segment (section CII); iii. Inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Possible short duration process (deposition of organic refuse ?); iii. Dispersed and probably mixed origin; iv. Age-at-death offset possibly large; v. Depositional offset unknown (possibly redeposited from phase 1); vi. Upper fill of recut ditch segment, probably representing occupation debris, sealed by further silting or backfill (*ibid.*, 12).
Evaluation: Low-value date: poor quality dispersed sample material, probably mixed origin and age-at-death offset, possibly also includes redeposited charcoal.

BM-354 4450±145 BP; $\delta^{13}C$: Not measured
Calibrated date: 3340–3020 cal BC (55% confidence); 3650–2650 cal BC (95% confidence).
Sample: i. Collagen; ii. Animal bone.
Context: i. One of several animal bones in a silt-sand layer; ii. An upper layer (4c) in the fill of secondary recut (phase 2) of ditch segment (section CII); iii. Inner ditch of causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Possible short duration process (backfill of ditch segment ?); iii. Single origin; iv. Age-at-death offset minimal; v. Depositional offset unknown (possibly redeposited from phase 1 or earlier phase 2 activity); vi. Upper fill of recut ditch segment, sealed by further silting or backfill (*ibid.*, 12).
Evaluation: Moderate-value date for late activity within causewayed enclosure site, though sample material possibly redeposited and this would lessen its value.

BM-355 4460±140 BP; $\delta^{13}C$: Not measured
Calibrated date: 3340–3020 cal BC (57% confidence); 3650–2700 cal BC (95% confidence).
Sample: i. Collagen; ii. Antler artefact.
Context: i. Antler comb; ii. An upper layer (3d) in the fill of secondary recut (phase 2) of ditch segment (section CII); iii. Inner ditch of Abingdon causewayed enclosure (Avery 1982).
Associations: None.
Assessment: i. Sealed context; ii. Possible short duration process (backfill of ditch segment ?); iii. Single origin; iv. Age-at-death offset minimal; v. Depositional offset unknown (possibly redeposited from phase 1 or earlier phase 2 activity); vi. Upper fill of recut ditch segment, sealed by further silting or backfill (*ibid.*, 12).
Evaluation: Moderate-value date for late activity within causewayed enclosure site, though sample material possibly redeposited. Directly dates the antler comb, although the possiblity of residuality would lessen its value for dating activity within the site.