UNCORRECTED ARCHIVE REPORT

APPENDIX 2 – RADIOCARBON DATING

By W D Hamilton, P D Marshall, C Hayden, and C Bronk Ramsey

Introduction

Context

A total of 21 samples were processed and measured as part of this programme of radiocarbon dating at AERE Harwell (HAR) and at the Oxford Radiocarbon Accelerator Unit (ORAU) at Oxford University.

Sixteen samples were submitted to Harwell in 1981. These consisted of four samples of charcoal, four samples of human bone, five samples of animal bone, and three samples of wood. The samples were prepared as described by Otlet and Warchal (1978), then combusted to carbon dioxide and synthesised to benzene using a method similar to that initially described by Tamers (1965) and a vanadium based catalyst (Otlet 1977). The radiocarbon content was measured using liquid scintillation counting as described by Otlet (1979).

The four samples of human bone and a boar's tusk, submitted to ORAU in 2006, were processed according to the method outlined in Bronk Ramsey *et al* (2004a), and were measured according to the procedures described in Bronk Ramsey *et al* (2004b).

The Oxford laboratory maintains a continual programme of quality assurance procedures, in addition to participation in international inter-comparisons (Scott 2003). These tests indicate no laboratory offsets and demonstrate the validity of the measurements quoted.

Objectives and Sampling

The primary objective of the dating programme was to provide a chronological framework for the various features at the Mount Farm site, which span the Neolithic to Anglo-Saxon periods. More specific objectives were to provide:

1. Dating evidence for Neolithic activity represented by pits, timber circle, and the Oval Barrow,
2. A date for the secondary Beaker burial in the Oval Barrow,
3. A date for the Bronze Age burial activity identified around the Round Barrow and evidenced by both inhumations and cremations,
4. Dating evidence for late Bronze Age to Anglo-Saxon activity represented by

waterholes, burials and other settlement features.

The first stage in sample selection was to identify short-lived material, which was demonstrably not residual in the context from which it was recovered. The taphonomic relationship between a sample and its context is the most hazardous link in this process, since the mechanisms by which a sample came to be in its context are a matter of interpretative decision rather than certain knowledge. Although many samples consisted of single entities (Ashmore 1999), four of the earlier charcoal samples submitted to Harwell were bulk samples.

Results

The results, given in Table A1:1, are conventional radiocarbon ages (Stuiver and Polach 1977), and are quoted in accordance with the international standard known as the Trondheim convention (Stuiver and Kra 1986).

The calibrations of these results, relating the radiocarbon measurements directly to calendar dates, have been calculated using the calibration curve of Reimer *et al* (2004) and the computer program OxCal (v3.10) (Bronk Ramsey 1995; 1998; 2001). The calibrated date ranges for these samples are given in Table 1 and have been calculated using the maximum intercept method (Stuiver and Reimer 1986). They are quoted in the form recommended by Mook (1986), with the end points rounded outwards to 10 years if the error term is greater than or equal to 25 radiocarbon years. The graphical distributions of the calibrated dates, shown in Figures 1 and 2, are derived from the probability method (Stuiver and Reimer 1993).

The $\delta^{13}C$ and $\delta^{15}N$ values from the inhumations at this site suggest a very small marine component in the diet, which is not likely to affect the radiocarbon dating significantly (Chisholm *et al* 1982; Schoeninger *et al* 1983). The C:N ratios suggests that bone preservation was sufficiently good to have confidence in the radiocarbon determinations (Table 1; Masters 1987; Tuross *et al* 1988).

Analysis and Interpretation

The earliest dated material from the site is a bulk charcoal sample from an earlier prehistoric pit containing cereal grain (HAR-4820; 8960 ±100BP; Fig 2). This sample, however, has a calibrated date range of 8320–7750 cal BC (95% confidence). There is no clear archaeological explanation of this apparently anomalous determination, but it is not considered reliable.

Bulk charcoal samples were submitted from two pits from different parts of the site containing Neolithic flintwork (F160 and F38 – HAR-4819 and -4821, respectively). The two measurements on bulk charcoal samples from these features are statistically consistent (T′=; ν=1; T′(5%)=3.8; Ward and Wilson 1978) and could therefore be contemprary.

Pit F160 (HAR-4819) was probably cut by one of the postholes (F184) of a post-ring, of which another posthole F91 was cut by Bronze Age burial F161 (HAR-4791). The implication is that the date of the post ring should lie between these measurements. However, the difference between the measurements is over two millennia, and so not very precise.

Two measurements were made on bone from burial 602 (OxA-15748 and HAR-4673). These two dates are not statistically consistent ($T'=7.2$; $\nu=1$; $T'(5\%)=3.8$; Ward and Wilson 1978). Although either measurement could be a statistical outlier, improvements in pre-treatment of bone should mean that the more recent measurement from the Oxford laboratory is more accurate.

Three measurements were made on human bone (replicates OxA-15747 and HAR-4792) and a boar's tusk (OxA-15787). The two measurements on the human bone are statistically consistent ($T'=0.8$; $\nu=1$; $T'(5\%)=3.8$; Ward and Wilson 1978) and can be combined by weighted mean to give a new date for this sample of 3801 ±32BP. Furthermore, all three dates are statistically consistent ($T'=1.2$; $\nu=2$; $T'(5\%)=6.0$; Ward and Wilson 1978) and therefore the human burial and boar's tusk could be of the same actual age.

Three inhumations and charcoal from one cremation, representing four different burials inside Ring Ditch F101 were dated (HAR-4791, HAR-4822, OxA-15785, and OxA-15786). The four measurements on these samples are statistically consistent ($T'=3.0$; $\nu=3$; $T'(5\%)=7.8$; Ward and Wilson 1978) and could therefore be of the same actual age.

A sample of animal bone from the upper fill of the Ring Ditch, HAR-4796, has produced a measurement of 3080 ±90BP (1520–1050 cal BC at 95% confidence). Two samples were submitted from a late Bronze Age waterhole (F162) which cut the secondary fill of the Ring Ditch. The two measurements from oak sapwood in the same layer (162/A/16) are statistically consistent ($T'=1.2$; $v=1$; $T'(5\%)=3.8$; Ward and Wilson 1978) and could therefore be of the same actual age. All three of these samples in this sequence are statistically consistent ($T'=3.3$; $v=2$; $T'(5\%)=6.0$; Ward and Wilson 1978) and suggests that a short time interval passed between the final phase of Ring Ditch silting and the initial silting of the waterhole.

Three samples of animal bone were submitted from three pits containing Iron Age pottery assemblages (F328 HAR-4674; F118 HAR-4790, and F652 HAR-4793, the latter on an articulated backbone and pelvis of cattle). The measurements on these samples are statistically consistent ($T'=2.3$; $v=2$; $T'(5\%)=6.0$; Ward and Wilson 1978) and could therefore be of the same actual age, though the calibrated ranges are very wide and not entirely consistent with the pottery (possibly in the case of F652 suggesting significant redeposition of earlier material in soil used to backfill the pit over the articulated limb bones.

One sample of animal bone was submitted from F676 a middle–late Iron Age waterhole/pit that was cut by a Roman ditch. This sample (HAR-4795; 2330 ±70BP) provides a date for this feature of 740–200 cal BC (95% confidence) and suggests an early–middle Iron Age use for this feature, the pottery suggesting middle Iron Age.

A single sample of animal bone was submitted from F505 a presumed middle Iron Age part of the rectilinear system of paddocks and fields. This sample (HAR-4794; 2100 ±80BP) provides a date for this feature of 280 cal BC–cal AD 70 (95% confidence) which is consistent with the pottery.

Finally a single sample from the wooden stakes from a wattle-lined well were submitted (HAR-4799; 1420 ±80BP), which provide a date of cal AD 430–770 (95% confidence) for the construction/use of this Anglo-Saxon feature.

References

Ashmore, P, 1999 Radiocarbon dating: avoiding errors by avoiding mixed samples, *Antiquity*, **73**, 124–30

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, Higham, T, Bowles, A, and Hedges, R E M, 2004a Improvements to the pre-treatment of bone at Oxford, *Radiocarbon*, **46(1)**, 155–63

Bronk Ramsey, C, Higham, T, and Leach, P, 2004b Towards high precision AMS: progress and limitations, *Radiocarbon*, **46(1)**, 17–24

Chisholm, B S, Nelson, D E, and Schwarcz, H P, 1982 Stable carbon isotope ratios as a measure of marine versus terrestrial protein in ancient diets, *Science,* **216**, 1131-32

Masters, P M, 1987 Preferential preservation of non-collagenous protein during bone diagenesis: implications for chronometric and stable isotope measurements, *Geochimica et Cosmochimica Acta*, **51**, 3209–14

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

Otlet, R L, 1977 Harwell radiocarbon measurements II, *Radiocarbon* **19**, 400–23

Otlet, R L,1979 An assessment of laboratory errors in liquid scintillation methods of ^{14}C dating, in Berger, R and Suess, H E (eds), *Proceedings of the Ninth International Radiocarbon Conference*, 256–67. Univ California Press

Otlet, R L, and Warchal, R M, 1978 Liquid scintillation counting of low-level ^{14}C dating, *Liquid Scintillation Counting*, **5**, 210-18

Reimer, P J, Baillie, M G L, Bard, E, Bayliss, A, Beck, J W, Bertrand, C J H, Blackwell, P G, Buck, C E, Burr, G S, Cutler, K B, Damon, P E, Edwards, R L, Fairbanks, R G, Friedrich, M, Guilderson, T P, Hogg, A G, Hughen, K A, Kromer, B, McCormac, G, Manning, S, Bronk Ramsey, C, Reimer, R W, Remmele, S, Southon, J R, Stuiver, M, Talamo, S, Taylor, F W, van der Plicht, J, and Weyhenmeyer, C E, 2004 IntCal04 Terrestrial radiocarbon age calibration, 0–26 Cal Kyr BP, *Radiocarbon*, **46**, 1029–58

Schoeninger, M J, Deniro, M J, and Tauber, H, 1983 Stable nitrogen isotope ratios of bone collagen reflect marine and terrestrial components of prehistoric diets, *Science,* **216**, 1381–3

Scott, E M (ed), 2003 The Third International Radiocarbon Intercomparison (TIRI) and the Fourth International Radiocarbon Intercomparison (FIRI) 1990–2002: results, analysis, and conclusions, *Radiocarbon*, **45**, 135–408

Stuiver, M, and Kra, R S, 1986 Editorial comment, *Radiocarbon*, **28(2B)**, 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

Tamers, M A, 1965 Routine carbon-14 dating using liquid scintillation techniques, *in* Chatters, R M and Olson, E A (eds) *Radiocarbon and Tritium Dating: Proceedings of the Sixth International Conference on Radiocarbon and Tritium Dating*, 53–67, Washington D C

Tuross, N, Fogel, M L, and Hare, P E, 1988 Variability in the preservation of the isotopic composition of collagen from fossil bone, *Geochimica Cosmochimica Acta*, **52**, 929–35

Ward, G K and Wilson, S R, 1978 Procedures for comparing and combining radiocarbon age determinations: a critique, *Archaeometry,* **20(1)**, 19–31

Table A2:1: Details of results of radiocarbon dating

Lab ID	*Sample ID/ context*	*Material*	*Contextual Information*	*δ^{13}C (‰)*	*δ^{15}N (‰)*	*C:N*	*Radiocarbon Age (BP)*	*Calibrated Date (95%)*
Prehistoric Pit								
HAR-4820	MF343 343/A/1S	charcoal	pit with cereals	-25.2	—	—	8960 ±100	8320–7750 cal BC
Early Neolithic Pits								
HAR-4819	MF160 160/A/2S	charcoal	Neolithic pit with flintwork	—	—	—	5120 ±110	4240–3650 cal BC
HAR-4821	MF38 38/A/1	charcoal	Neolithic pit with flintwork	—	—	—	5030 ±90	4040–3640 cal BC
Middle Neolithic Burial								
HAR-4673	MF602 602/A/1	human bone	inhumation within oval ring ditch	-22.9	—	—	4460 ±90	3490–2890 cal BC
OxA-15748	MF602 602/A/1	human bone	replicate of HAR-4673	-20.9	11.5	3.2	4738 ±35	3640–3370 cal BC
Beaker Burial 618								
HAR-4792	MF618 618/A/1	human bone	inhumation within oval ring ditch	-23.9	—	—	3710 ±90	2460–1880 cal BC
OxA-15747	MF618(1) 618/A/1	human bone	replicate of HAR-4792	-20.9	11.0	3.2	3814 ±34	2440–2140 cal BC
OxA-15787	MF618(2) 618/A/1	boar tusk	recovered with MF618 (1)	-20.6	8.6	3.1	3836 ±32	2460–2150 cal BC
Early–Middle Bronze Age Burials								
HAR-4822	MF121 121/A/2S	charcoal	cremation burial within ring ditch	—	—	—	3380 ±100	1940–1430 cal BC
OxA-15785	MF178 178/A/1	human bone	inhumation within ring ditch	-21.0	12.0	3.2	3372 ±38	1750–1530 cal BC
OxA-15786	MF177 177/A/1	human bone	inhumation within ring ditch	-19.8	9.8	3.1	3359 ±32	1740–1530 cal BC
HAR-4791	MF161 161/A/1	human bone	inhumation within ring ditch	-23.2	—	—	3170 ±70	1610–1290 cal BC
HAR-4796	MF101 101/G/1	bone	upper fill of Ring Ditch	-20.4	—	—	3080 ±90	1520–1050 cal BC
Later Bronze Age Waterhole								
HAR-4797	MF162(1) 162/A/16	*Quercus* sp. s/w	later Bronze Age waterhole	-27.2	—	—	3000 ±80	1440–1000 cal BC
HAR-4798	MF162(2) 162/A/16	*Quercus* sp. s/w	later Bronze Age waterhole	-26.2	—	—	2850 ±70	1260–830 cal BC
Early Iron Age Pits								
HAR-4790	MF118 118	bone	early Iron Age pit	-23.0	—	—	2210 ±80	410–40 cal BC
HAR-4674	MF328 328/A/1	bone	early Iron Age pit	-23.3	—	—	2130 ±80	390 cal BC–cal AD 50
HAR-4793	MF652 652/A/1	articulated bone	early Iron Age pit	—	—	—	1980 ±90	200 cal BC–cal AD 240
Middle–Late Iron Age Ditch and Waterhole								
HAR-4795	MF676 676/B/2	bone	middle-late Iron Age pit/waterhole	—	—	—	2330 ±70	740–200 cal BC
HAR-4794	MF505 505/C+D/1	bone	?middle Iron Age ditch segment	-22.5	—	—	2100 ±80	280 cal BC–cal AD 70
Saxon Well								
HAR-4799	MF821 82	wooden stakes	early Saxon wattle-lined well	—	—	—	1420 ±80	cal AD 430–770

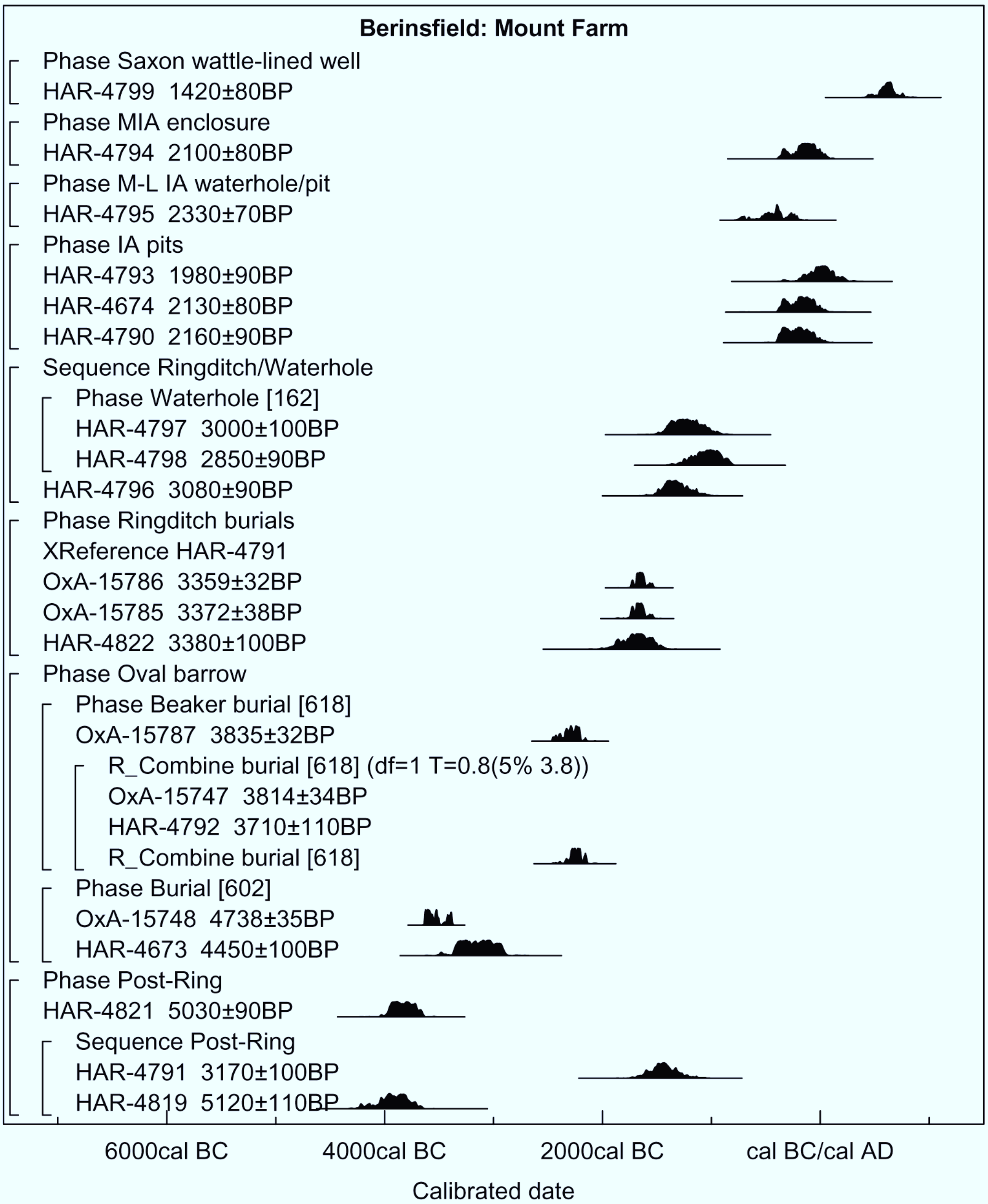

Figure A2:1 Calibrated radiocarbon dates from Berinsfield: Mount Farm. The probability distributions have been calculated following Stuiver and Reimer (1993). (NB: HAR-4820, from a ?Beaker pit has been omitted and is shown in Fig 2)

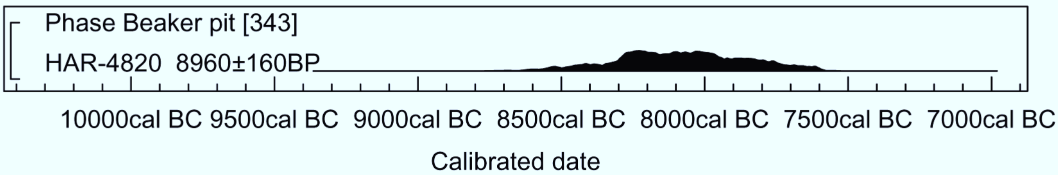

Figure A2:2 Calibrated radiocarbon date from the possible Neolithic or Beaker pit F343 from Berinsfield: Mount Farm. The probability distribution has been calculated following Stuiver and Reimer (1993)