

BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS XXIII

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INTRODUCTION

The following list consists of dates for archaeological samples measured mostly between October 1989 and November 1990. Charcoal and grain samples were pretreated with 1M HCl followed by washing in water and, in the majority of cases, with dilute alkali for the removal of humic acids. Wood samples were treated in the same way, or, if large enough, reduced to cellulose with chlorine dioxide produced *in situ*. Antler and bone samples were treated with cold dilute acid. We use the term “collagen” to mean the acid-insoluble organic fraction produced by this treatment rather than the true biochemical definition.

The dates were obtained by liquid scintillation counting of benzene in low potassium glass vials, specially selected for similar backgrounds (Ambers, Leese and Bowman 1986) in an LKB Rackbeta 1217 (with “Kangaroo” package) and an LKB Quantulus 1220™, using butyl-PBD as scintillator. The maximum sample size was 5.5 ml; smaller samples were made up to this volume with “dead” benzene. Samples were counted for a minimum of 2000 min in sequences containing at least 2 background, 2 modern (NBS Oxalic Acid II) and 1 known-age sample prepared from cellulose extracted from dendrochronologically dated wood supplied by Drs. Pilcher and Baillie of the Belfast Laboratory. We replaced the standards at staggered and regular rates and monitored the count rates. We compiled results from these known-age woods, which confirm the accuracy and precision quoted in this list. Figures for the relevant period are: 2878 ± 42 BP (weighted mean and standard error based on 3 determinations) for wood from the same period as that measured to 2886 ± 12 BP by Pearson *et al.* (1986); 1022 ± 32 BP (4 determinations) for wood equivalent to that measured by Pearson *et al.* at 1020 ± 17 BP; and 4348 ± 25 BP (5 determinations) for wood equivalent to that measured by Pearson *et al.* at 4345 ± 17 . Each sample in the train was counted in successive 50-min periods to achieve quasi-simultaneous counting.

Dates are expressed as suggested by Stuiver and Polach (1977), *i.e.*, in ^{14}C years relative to AD 1950, based on the Libby half-life of 5568 yr, and corrected for isotopic fractionation ($\delta^{13}\text{C}$ values are given relative to PDB). We followed the 1986 recommendations adopted by the 12th International Radiocarbon Conference on the expression of calibrated and uncalibrated dates (Mook 1986). Errors quoted are the counting error for the sample combined with an estimate of the errors contributed by the modern and background samples. This estimate includes both counting and non-counting errors, the latter being computed from differences in the overall count rates observed among the individual backgrounds and moderns. The overall error is given as ± 1 standard deviation (σ). National Grid References are abbreviated to NGR. Descriptions, comments and references to publications are based on information supplied by submitters.

ACKNOWLEDGMENT

Many of these samples were synthesized and pretreated by Mr. A. Simpson.

British Isles*England***Diddington Series**

Samples from ring ditch monument at Diddington, terrace of River Ouse, near Huntingdon, Cambridgeshire (52°15'N, 0°15'E; NGR: TL 208660). Collected 1986 and submitted by C. Evans, Cambridgeshire Archaeological Unit.

BM-2623. Diddington

Modern
 $\delta^{13}C = -19.4\text{‰}$

Charcoal from large timber, ref. F503/102, apparently from cremation pyre set at edge of massive pit.

BM-2624. Diddington

1910 ± 50
 $\delta^{13}C = -27.4\text{‰}$

Wood from twigs, ref F500/101, from primary fill of recut ring ditch terminal.

Comment (J.A.): Results do not agree with expectations.

Great Langdale Series

Samples from Neolithic stone quarries at Great Langdale, Cumbria (Bradley and Edmonds 1988). Collected 1987 and submitted by R. J. Bradley, University of Reading.

BM-2625. Great Langdale

4870 ± 50
 $\delta^{13}C = -25.3\text{‰}$

Charcoal (*Betula*, 3–25 yr; Pomoideae, 3–25 yr; *Salix/Populus*, 3–25 yr; *Quercus*, 20–75 yr, mostly 20–35 yr) identified by M. Robinson, University Museum, Oxford, from Trench 1, Harrison Stickle, Gt. Langdale, Cumbria (54°25'N, 3°10'W; NGR: NY 283071), “axe finishing” site, where roughouts and blocks, extracted from elsewhere at Langdale, were worked. Sample associated with axe-finishing flakes in fill of shallow platform on hillside.

BM-2626. Great Langdale

4880 ± 50
 $\delta^{13}C = -24.8\text{‰}$

Charcoal (*Betula*, 3–25 yr; Pomoideae, 3–25 yr; *Salix/Populus*, 3–25 yr; *Corylus avellana*, 3–25 yr) identified by M. Robinson, from Trench IV, Harrison Stickle; site close to that dated by BM-2625, above, associated with axe-finishing flakes in fill of natural hollow in hillside.

BM-2627. Great Langdale

4590 ± 50
 $\delta^{13}C = -24.8\text{‰}$

Charcoal (*Betula*, 3–75 yr, mostly 20–35 yr; *Quercus*, 20–75 yr, mostly 20–35 yr; *Salix/Populus*, 3–25 yr; *Corylus avellana*, 3–75 yr) identified by M. Robinson, from horizon of charcoal in fill of Neolithic quarry at Pike O'Stickle; Gt. Langdale, Cumbria (54°30'N, 3°10'W; NGR: NY 273073) sealed by tip of axe-making debris and sealing earlier fire-setting waste.

BM-2628. Great Langdale**4760 ± 50** $\delta^{13}\text{C} = -25.3\text{‰}$

Charcoal (*Betula*, 3–25 yr; Pomoideae, 3–25 yr; *Salix/Populus*, 3–25 yr; *Quercus*, 20–75 yr, mostly 20–35 yr) identified by M. Robinson, from lower fill in Neolithic quarry dated by BM-2627, above, sealed by fire-setting waste and sealing axe-making debris and freshly quarried rubble.

Comment (R.J.B.): Samples come from two types of axe production sites at Great Langdale. Stratigraphic evidence suggests that these were broadly successive. The simpler production system involved a series of extraction sites on a stone source and axe finishing sites in the surrounding area where later stages of tools were produced. Two finishing sites on Harrison Stickle were investigated (BM-2625 and -2626). Results agree well with OxA-2181 (4790 ± 80 BP), which provides *terminus ante quem* for a similar site at Stake Beck. BM-2627 and -2628 derive from a stone quarry on Pike O'Stickle, attributed to later production system and dates span site occupation. Together, the dates suggest that change in production methods occurred early to mid-5th millennium BP.

BM-2629. Fishbourne**1910 ± 50** $\delta^{13}\text{C} = -23.9\text{‰}$

Cellulose extracted from section of tree trunk (*ca.* 35 rings wide), from a jetty support or mooring post in Roman waterway at Fishbourne Millpond, 400 m SW of Fishbourne Roman Palace, Chichester, W Sussex (50°50'N, 0°50'W; NGR: SU 483005). Collected 1987 and submitted by H. Wallace, Sussex Archaeological Society, as check on previous determination on wood from same site (BM-2465: 2900 ± 45, Ambers, Matthews and Bowman 1989).

Comment (H.W.): Dates timber structure at *ca.* the same age as masonry structures around it, which, on architectural and coin evidence, belong to construction period of main Roman palace *ca.* AD 70.

Beaker Series

Samples dated as part of systematic investigation of the dates of British Beaker burials.

BM-2642. Manston**3630 ± 50** $\delta^{13}\text{C} = -20.7\text{‰}$

Collagen from human right femur from burial in grave within ring ditch associated with S2 Beaker, jet button and flint knife, at Manston Aerodrome, Manston, Kent (51°20'N, 1°20'E; NGR: TR 351652). Collected 1987 by D. R. J. Perkins, Trust for Thanet Archaeology.

BM-2643. Lambourne**3360 ± 50** $\delta^{13}\text{C} = -21.6\text{‰}$

Collagen from human long bone from isolated Beaker inhumation in partially stone-lined feature in extensive round barrow cemetery at Lambourne, Berkshire (51°30'N, 1°30'W; NGR: SU 325830). Collected 1979 by J. Richards, Trust for Wessex Archaeology.

BM-2644. The Wig**3500 ± 50** $\delta^{13}\text{C} = -21.2\text{‰}$

Collagen from human long bone from Beaker inhumation adjacent to "The Wig" plantation, Ablington Down, Salisbury Plain, Wiltshire (51°00'N, 1°40'W; NGR: SU 187477), associated with Beaker. Collected 1986 and submitted by J. Richards.

BM-2725. Cottington**3630 ± 60**
 $\delta^{13}C = -21.4\text{‰}$

Collagen from skull and femoral fragments from human burial in flat grave at Cottington Lane, Ebbsfleet, Kent (51°20'N, 1°20'E; NGR: TR 337639) associated with East Anglian Beaker. Collected 1990 and submitted by D. Perkins.

Comment (J.A.): Full details of Beaker dating project are published in Kinnes *et al.* 1991.

Runnymede Series

Samples from Neolithic and Bronze Age site, Runnymede Bridge, Berkshire (51°30'N, 1°30'W; NGR: TQ 018718). Collected 1978–1989 and submitted by S. P. Needham, Department of Prehistoric and Romano-British Antiquities, British Museum.

BM-2646. Runnymede**2680 ± 50**
 $\delta^{13}C = -28.6\text{‰}$

Cellulose from branch wood, ref. ERB78 A6 F163/2 (*Acer* sp.) identified by Rowena Gale, from debris on slope of ancient river bank, presumed clearance material from beginning of occupation of Area 6.

BM-2647. Runnymede**2640 ± 50**
 $\delta^{13}C = -26.1\text{‰}$

Cellulose from branch wood, ref. ERB78 A6 F164/9 (*Quercus* sp.) identified by R. Gale, from laid structure on foreshore, presumed hard-standing, close to waterfront 2.

BM-2648. Runnymede**2560 ± 50**
 $\delta^{13}C = -23.5\text{‰}$

Collagen from bone, ref. ERB85 A16 824 5512 (cattle and sheep fragments) identified by Dale Serjeantson, Extra-Mural Department, University of London, from refuse in lower part of Phase 3 midden in Late Bronze Age settlement.

BM-2649. Runnymede**2490 ± 60**
 $\delta^{13}C = -23.4\text{‰}$

Collagen from bone, ref. ERB85 A16 829 5712 (radius and ulna, *Bos* sp. and ribs, species unknown) identified by D. Serjeantson, from base of Phase 3 midden in Late Bronze Age settlement.

BM-2650. Runnymede**2570 ± 50**
 $\delta^{13}C = -22.7\text{‰}$

Collagen from bone, ref. ERB85 A16 865 5512 (distal portion of femur, *Bos* sp.) identified by D. Serjeantson, from deep in Phase 2 midden.

BM-2651. Runnymede**2590 ± 50**
 $\delta^{13}C = -22.3\text{‰}$

Collagen from bone, ref. ERB85 A16 872 5813 (distal portion of tibia, *Bos* sp.) identified by D. Serjeantson, from primary spread of refuse over truncated subsoil and earlier structural phase.

BM-2652. Runnymede **2730 ± 50**
 $\delta^{13}\text{C} = -25.2\text{‰}$

Cellulose from trunk wood, ref. ERB78 A6 F117c (*Quercus* sp., young trunk, 32 rings to bark) identified by R. Gale. Trunk was sharpened at one end and found *in situ*, used as part of river bank revetment (waterfront 1).

BM-2657. Runnymede **5130 ± 50**
 $\delta^{13}\text{C} = -27.8\text{‰}$

Branch wood, ref. ERB89 A32 040 (*Alnus* sp.) identified by R. Gale, from waterlogged alluvial silt beneath 0.8-m-deep floodplain accumulation under Neolithic ground surface.

BM-2659. Runnymede **2720 ± 50**
 $\delta^{13}\text{C} = -22.1\text{‰}$

Collagen from bone, ref. ERB89 A31 609 (metacarpal and humerus, *Bos* sp.) identified by D. Serjeantson, from layer of bone refuse, overlying natural sediments and underlying coarse pottery dump.

BM-2661. Runnymede **2900 ± 50**
 $\delta^{13}\text{C} = -24.9\text{‰}$

Cellulose from twigs and small branches, ref. ERB89 A31 665 (*Acer*, *Cornus*, *Prunus* spp. and subfamily Pomoideae) identified by R. Gale, from dense mat of twiggy material, including many pieces with signs of beaver chewing.

BM-2662. Runnymede **3870 ± 50**
 $\delta^{13}\text{C} = -24.5\text{‰}$

Cellulose from felled tree trunk, ERB89 ref. A31 676 (*Alnus* sp., ca. 30-yr growth) identified by R. Gale, from waterlogged alluvial silt beneath 1.5-m-deep floodplain accumulation overlain by Late Bronze Age deposits.

Comment (S.P.N.): BM-2646, -2647 and -2652 are replicates on 3 of 4 contexts from Late Bronze Age river channel dated several times by Harwell Laboratory. Dates were run to ensure comparability between Harwell series (for rescue excavations) and ongoing BM dating program (research excavations). Dates compare well and new dates add further weight to 9th century cal BC age (Needham 1991) of early to middle phases of Late Bronze Age settlement. BM-2648, -2649, -2650 and -2651 date *in-situ* bone material from four levels within deep three-phase midden in Area 16 East (Needham and Stig Sorensen 1988). Results suggest deposition in 8th and 7th centuries cal BC. Sequence postdates part of Area 6 river channel dated by BM-2646, -2647 and -2652. BM-2657, -2659, -2661 and -2662 were measured to help fill out alluvial chronology of site and to supplement Harwell series (Needham 1991) and previous BM dates (BM-2435, -2436, -2550, -2551; Ambers, Matthews and Bowman 1989). BM-2657 is *terminus post quem* for layer of silt 0.8 m below Middle Neolithic occupation surface dated elsewhere on site to ca. 3800–3500 cal BC. Two-sigma calibrated range for BM-2657 of 4037–3788 cal BC indicates short period of aggradation for intervening silt. BM-2662 gives *terminus post quem* of 2479–2200 cal BC for late layer in Neolithic channel fill. It agrees well with BM-2435 and -2436 (Ambers, Matthews and Bowman 1989) on beaver-gnawed wood from similar deposits nearby. BM-2659 and -2661 effectively bracket channel-edge aggradation of channel, which cut back into floodplain built up during 2nd millennium BC. Early stage of this aggrada-

tion is dated to *ca.* 1263–979 cal BC by BM-2661, measured on fresh beaver-gnawed wood, which was probably *in situ*. Stabilized surface after aggradation ceased lay 1.5 m above and was covered by *in-situ* Late Bronze Age refuse, lowest layer of which yielded scatter of fresh large bone including sample BM-2659. Beginning of Late Bronze Age accumulation in this zone is placed within 987–807 cal BC (2σ).

BM-2668. Chapel Farm

1740 ± 50
Est. $\delta^{13}C = -25\%$

Charcoal from slag in iron smelting slag pit at Chapel Farm, Little Totham, Essex (51°45'N, 0°45'E; NGR: TM 883094). Collected 1988 and submitted by C. Blick, Historical Metallurgy Society, for P. Adkins.

Comment (P.A.): Results indicate Roman date for furnace and is older than TL (DUR TL 90-1AS: AD 530 ± 290) and ^{14}C (GU-2151: 1380 ± 60 BP) dates for iron smelting at Little Totham Site 2, *ca.* 600 m away.

Windmill Hill Series

Samples from causewayed enclosure at Windmill Hill Neolithic Site, near Avebury, Wiltshire (51°25'N, 1°50'W; NGR SU 087713). Collected 1988 and submitted by A. Whittle, University College of Wales, Cardiff.

BM-2669. Windmill Hill

4740 ± 50
 $\delta^{13}C = -21.9\%$

Collagen from bone, ref. 23200 (*Bos* sp.) identified by Caroline Grigson, Royal College of Surgeons, from placed bone deposit 229 in primary chalk fill at base of outer ditch (Trench B).

BM-2670. Windmill Hill

4670 ± 90
 $\delta^{13}C = -22.8\%$

Collagen from bone, ref. 4374 (*Bos* sp.) identified by C. Grigson, from single bone in scatter in primary fill 418 in middle ditch (Trench D).

BM-2671. Windmill Hill

4550 ± 50
 $\delta^{13}C = -21.2\%$

Collagen from bone, ref. 12278 (*Bos* sp.) identified by C. Grigson, from placed deposit 525 at junction of primary and secondary fills in middle ditch (Trench E).

BM-2672. Windmill Hill

4370 ± 50
 $\delta^{13}C = -21.4\%$

Collagen from bone, ref. 6389 (*Bos* sp.) identified by C. Grigson, from placed deposit 629 at junction of primary and secondary fills of inner ditch (Trench F).

BM-2673. Windmill Hill

4310 ± 60
 $\delta^{13}C = -23.0\%$

Collagen from bone, ref. 3915 (*Bos* sp.) identified by C. Grigson, from placed deposit 317 in upper part of outer ditch (Trench C).

Comment (A. W.): Results agree well with OxA series for same site and establish date of enclosure at ca. 4700 BP. BM-2671 to -2673 show later depositions in same tradition as primary use; BM-2672 might be a little young, or indicate relatively slow rate of silting.

Radley Series

Samples from SW end of multiperiod cemetery site at Radley Barrow Hills, near Abingdon, Oxfordshire (51°40'N, 1°15'W; NGR: SU 514982). Samples from 1983–1985 excavation of part of extensive ritual complex, including oval barrow, ring ditches, pond barrows and areas between monuments. Submitted by Oxford Archaeological Unit. Comment supplied by A. Barclay, Oxford Archaeological Unit.

BM-2696. Radley 3380 ± 50
δ¹³C = -21.1‰

Collagen from human long bone identified by M. Harman, ref. F4906, from inhumation in arc of burials associated with pond barrow, F4866.

BM-2697. Radley 3320 ± 50
δ¹³C = -20.5‰

Collagen from human long bone identified by M. Harman, ref. F4968 II, from adult inhumation overlain by infant inhumation, within arc of burials associated with pond barrow.

BM-2698. Radley 3500 ± 50
δ¹³C = -20.1‰

Collagen from human long bone identified by M. Harman, ref. F4970, from adult inhumation associated with Food Vessel, within arc of burials associated with pond barrow.

BM-2699. Radley 3720 ± 60
δ¹³C = -19.4‰

Collagen from human bone (femur) identified by M. Harman, ref. L607/2, from crouched inhumation (male), primary burial of Barrow 12, associated with flint and bronze awl.

BM-2700. Radley 3360 ± 50
δ¹³C = -20.9‰

Collagen from human bone (femur) identified by M. Harman, ref. F203, from crouched inhumation, central burial of small ring ditch adjacent to Barrow 1, associated with S4 Beaker, flint tools, bronze awl and other grave goods.

BM-2701. Radley 2930 ± 50
Est. δ¹³C = -21.0‰

Collagen from human bone (femur) identified by M. Harman, ref. L4583/C/I, from disarticulated inhumation, laid in two deposits, in pond barrow south of segmented ring ditch.

BM-2702. Radley

2760 ± 50
 $\delta^{13}C = -19.9\text{‰}$

Collagen from human bone (femur) identified by M. Harman, ref. L4583/D/I, from articulated inhumation on edge of same pond barrow as that dated by BM-2701, above, associated with animal bone, flint and Beaker sherds.

BM-2703. Radley

3720 ± 50
 $\delta^{13}C = -22.1\text{‰}$

Collagen from bone (humerus and ulna) identified by M. Harman, ref. F950, from disarticulated inhumation associated with Wessex/Middle Rhine Beaker and barbed and tanged arrowhead.

BM-2704. Radley

3650 ± 50
 $\delta^{13}C = -21.3\text{‰}$

Collagen from human bone (femur) identified by M. Harman, ref. F4660, from flat burial (male), SW of Barrow 12 associated with flint tools, European Beaker, tanged copper dagger and other grave goods.

BM-2705. Radley

1570 ± 50
 $\delta^{13}C = -24.5\text{‰}$

Charcoal (*Quercus* sp.) from clearance horizon identified by Jill Thompson and Mark Robinson, University of Oxford Museum.

BM-2706. Radley

3830 ± 90
Est. $\delta^{13}C = -21\text{‰}$

Collagen from cattle bone fragments identified by M. Harman, ref. L3196/3, from lower fill of 1 of 6 similar pits, possibly associated with segmented ring ditch, containing bone, charcoal, struck flint and Grooved Ware sherds. Second of these pits dated by BM-2715, below.

BM-2707. Radley

4120 ± 60
 $\delta^{13}C = -19.9\text{‰}$

Collagen from human bone (femur and tibia) identified by M. Harman, ref. F2127, from crouched (male) inhumation with belt slide. Part of double inhumation grave at center of oval barrow.

BM-2708. Radley

3860 ± 50
 $\delta^{13}C = -23.0\text{‰}$

Collagen from human long bone identified by M. Harman, ref. F2128, from crouched female inhumation associated with polished flint knife, from double inhumation dated by BM-2707, above.

BM-2709. Radley

4270 ± 100
 $\delta^{13}C = -20.6\text{‰}$

Collagen from human bone (femur and tibia) identified by M. Harman, ref. F5352/3, from Burial 3 of three inhumations in same grave. Burial 1 dated by BM-2716 and Burial 2 dated by BM-2714, below.

BM-2710. Radley **4530 ± 50**
 $\delta^{13}\text{C} = -20.1\text{‰}$

Collagen from human bone (femur) identified by M. Harman, ref. F5355, from adult inhumation associated with three flint blades.

BM-2711. Radley **4020 ± 60**
 $\delta^{13}\text{C} = -20.3\text{‰}$

Collagen from human bone (femur and tibia) identified by M. Harman, ref. L942/1, from disarticulated inhumation in pit, south of Barrow 12.

BM-2712. Radley **3860 ± 80**
 $\delta^{13}\text{C} = -22.8\text{‰}$

Collagen from antler (red deer) ref. L611/A/13, from one of several deliberate deposits of articulated animal bone and antler on floor of Neolithic ring ditch.

BM-2713. Radley **3950 ± 80**
 $\delta^{13}\text{C} = -20.7\text{‰}$

Collagen from antler (red deer) ref. L611/A/14, from similar context to that of BM-2712, above, one of several deliberate deposits of articulated animal bone and antler on floor of Neolithic ring ditch.

BM-2714. Radley **4470 ± 70**
 $\delta^{13}\text{C} = -19.0\text{‰}$

Collagen from human bone (femur, fibula and tibia), ref. F5352/3, from Burial 2 of three burials in same grave pit. Burial 1 dated by BM-2716, below and Burial 3 dated by BM-2709, above.

BM-2715. Radley **3940 ± 60**
 $\delta^{13}\text{C} = -22.1\text{‰}$

Collagen from cattle bone fragments, ref. L917/A/2, from lower fill of 1 of 6 similar pits, associated with formal deposits of animal bones, flint artifacts, a Group I axe and Grooved Ware sherds. Similar pit dated by BM-2706, above.

BM-2716. Radley **4600 ± 70**
 $\delta^{13}\text{C} = -20.5\text{‰}$

Collagen from human long bone identified by M. Harman, ref. F5352/3I, from Burial 1 in grave containing three inhumations. Burial 2 dated by BM-2714 and Burial 3 dated by BM-2709, above.

Comment (A.B.): See OxA results for same site in Hedges *et al.* (1990). BM-2696 to -2698 come from 3 of 7 flat graves positioned with respect to pond barrow 4866. BM-2698 agrees with OxA-1880 (3490 ± 80) and OxA-1903 (3480 ± 80). Collectively, results suggest cemetery was secondary to pond barrow (dated by OxA-1879: 3720 ± 80). BM-2701 and -2702 are for insertions into silted-up pond barrow 4583. Results suggest burials are from late Bronze Age with secondary insertions into monument; this is satisfactory, given their position high in pond barrow fill. BM-2703, -2704, -2711 all satisfactorily date Late Neolithic flat graves. BM-2700, also for flat grave, is later than expected. BM-2705 is clearly unrelated to prehistoric use of site, and may be intrusive or mis-

associated. Although BM-2707 and -2708 date inhumations assumed by excavator to be contemporary, results do not overlap at 95% probability level, and both are young for grave associations. Both samples were poorly preserved and were disturbed in antiquity. BM-2709, -2714 and -2716 are from burials in free-standing linear mortuary structure. Results are spread but overlap at 95% probability level, confirming structure to be Neolithic as expected and indicating probable contemporaneous phase among nearby Abingdon causewayed enclosure, oval barrow (BM-2391; Ambers, Matthews and Bowman 1987) and Neolithic flat cemetery (BM-2710). BM-2710 confirms Neolithic date of flat burial. BM-2712 and -2713 for deliberately placed antler deposits agree with results for Grooved Ware pits (BM-2715 and -2706) and form part of sequence of eight results (BM-2699, OxA-1872, -1873, -1884, -1887, -1889) from three intercutting barrows. BM-2715 and -2706 for Grooved Ware pits are consistent and suggest Late Neolithic dates for these features. Results are also comparable with BM-2712 and -2713 for Late Neolithic ring ditch.

Wawcott Series

Samples from Mesolithic occupation site at Wawcott XXX, Kennet Valley, Berkshire (51° 25'N, 1° 20'W; NGR: SU 413676). Collected 1974 and submitted 1988 by J. Cook, Department of Prehistoric and Romano-British Antiquities, British Museum, for F. R. Froom.

BM-2718. Wawcott

10,960 ± 100
 $\delta^{13}C = -22.5\text{‰}$

Collagen from bone (distal metacarpal, *Alces*, identified by S. Payne, English Heritage, and femur, *Bos primigenius*, identified by A. Carrant, Natural History Museum) from Square Q7, area with concentration of bone and Mesolithic flint.

BM-2719. Wawcott

6130 ± 100
 $\delta^{13}C = -21.8\text{‰}$

Collagen from bone (tibia, *Bos* sp., identified by S. Payne) from Square Q6, area with concentration of bone and Mesolithic flint.

Comment (F.R.F., J.A.): Samples submitted from Wawcott XXX were recovered from same context as early Mesolithic flint assemblage. Collagen preservation was bad in both samples and unforeseen contamination may have affected results. It is also possible that bones used for BM-2718 could be derived from underlying late glacial gravel.

Isle of Man

Rhendhoo Series

Samples from Late Mesolithic site (McCartan and Woodman 1990) at Rhendhoo, Andreas (54°20'N, 4°30'W; NGR: SC 391977), believed to represent occupation, associated with flintknapping floor. Collected 1989 and submitted by S. McCartan, Department of Archaeology, University College, Cork.

BM-2693. Rhendhoo

5790 ± 50
 $\delta^{13}C = -27.9\text{‰}$

Charcoal, ref. C.008 (*Quercus* sp.) identified by J. Ambers, from dump deposit also containing three pieces of flint.

BM-2694. Rhendhoo

6110 ± 50
 $\delta^{13}\text{C} = -25.9\text{‰}$

Charcoal, ref. C.012 (*Quercus* sp.) identified by J. Ambers, from second dump deposit close to that dated by BM-2693, above, and containing piece of flint.

BM-2695. Rhendhoo

5170 ± 50
 $\delta^{13}\text{C} = -25.2\text{‰}$

Charcoal, ref. C.026, (*Quercus* sp.) identified by J. Ambers, from fill of hearth close to two dumps dated by BM-2693, -2694, above, and associated with flintknapping floor.

Comment (S. McC.): Excavations revealed evidence for Late Mesolithic site with hearth, two charcoal dumps and flintknapping floor, adjacent to Lhen Trench, modern drainage channel following course of postglacial river. Results agree with findings and are first independent dating evidence for period from Isle of Man. They also confirm contemporaneity between Manx and Irish Late Mesolithic.

*Jersey***BM-2691. St. Helier**

4490 ± 50
Est. $\delta^{13}\text{C} = -25.0\text{‰}$

Cellulose from tree branch found inside granite cist, believed to be Late Neolithic (Wedgewood and Mourant 1954) at Gasworks site, St. Helier, Jersey (49°10'N, 2°05'W). Collected in 1952 and submitted by H. Stuart-Williams, Jersey Museum.

Comment (M. Patton, Jersey Museum): Calibrated date ranges fall within Late Neolithic, supporting opinions of Wedgewood and Mourant (1954). This ties in with models of megalithic development in Channel Isles, which suggest proliferation of small monuments at end of Neolithic period.

*Wales***Great Orme Series**

Samples from copper working mine associated with hammerstones at Great Orme, Llandudno, Gwynedd (53°20'N, 3°50'W; NGR: SH 771831). Submitted as part of investigations into early Welsh mining.

BM-2641. Great Orme

3000 ± 50
 $\delta^{13}\text{C} = -25.6\text{‰}$

Charcoal, ref. GO89.VS1, (*Quercus* sp., branches and twigs) identified by M. P. Denne, School of Forestry, UCNW Bangor, from large deposit on surface of spoil in 13-m level, Vivian's Shaft, believed to be from a fireset. Collected 1989 and submitted by D. A. Jenkins, University College of North Wales, Bangor.

Comment (J.A.): Date corroborates other results for similar sites in Wales (see, e.g., BM-2581 to -2586; Ambers, Matthews and Bowman 1991: 59).

BM-2645. Great Orme

3290 ± 60
 $\delta^{13}\text{C} = -22.4\text{‰}$

Collagen from bone fragments, ref. 001, 012 and 019, from context 022, undisturbed primary

deposit in short gallery, which also produced charcoal dated by CAR-1184, 3370 ± 80 BP. Collected 1989 and submitted by L. Dutton, Gwynedd Archaeological Trust.

Comment (L.D.): Until recently, period of working from which bone artifacts were taken was not known, despite association with dated charcoal deposits. Bone date corroborates both age of deposit and associated mine operation.

Cyprus

BM-2692. Skouriotissa

2220 ± 90
 $\delta^{13}C = -10.7\text{‰}$

Rope fiber from early copper mine, known to have been worked during Roman and Phoenician periods, at Skouriotissa Hill, near Lefka ($35^{\circ}10'N$, $32^{\circ}40'E$). Collected 1956 and submitted 1989 by B. Cook, Department of Greek and Roman Antiquities, British Museum, for S. Thom.

Comment (J.A.): Result confirms expected early date for rope.

India

Harappan Series

Samples from three Harappan sites in Gujarat. Collected and submitted by K. T. M. Hegde, University of Baroda.

Nageswar

Wood charcoal from Nageswar, Saurashtra, Gujarat ($22^{\circ}20'N$, $69^{\circ}00'E$). Collected 1984.

BM-2610. Nageswar

3790 ± 60
Est. $\delta^{13}C = -25.0\text{‰}$

Charcoal, ref. sample 1, from Trench 1, Layer 6, depth 1.46 m, in first structural phase, Period 1A of Mature Harappan culture.

BM-2611. Nageswar

3540 ± 60
 $\delta^{13}C = -24.6\text{‰}$

Charcoal, ref. 2, from Trench 1, Layer 7, depth 1.80 m, in first structural phase, Period 1A of Mature Harappan culture.

Vagad

Wood charcoal from Vagad, Saurashtra, Gujarat ($22^{\circ}20'N$, $71^{\circ}50'E$). Collected 1982.

BM-2612. Vagad

3690 ± 50
 $\delta^{13}C = -25.4\text{‰}$

Charcoal, ref. sample 1, from Trench B, Layer 3, depth 0.35 m, from third structural phase, Period 1C of Harappan culture.

BM-2613. Vagad **3720 ± 50**
 $\delta^{13}C = -25.3\text{‰}$

Charcoal, ref. sample 2, from Trench C, Layer 4, depth 0.6 m, from second structural phase, Period 1B of Harappan culture.

BM-2614. Vagad **3650 ± 50**
 $\delta^{13}C = -23.7\text{‰}$

Charcoal, ref. 3, from Trench C, Layer 5, depth 0.8 m, from first structural phase, Period 1A of Mature Harappan culture.

BM-2615. Ratanpur **3640 ± 50**
 $\delta^{13}C = -26.1\text{‰}$

Wood charcoal, ref. sample 1, from Pit 1, Mound IV, depth 0.7 m at Ratanpur, Mehsana District, Gujarat (23°30'N, 71°50'E) from Period 1 of Harappan culture. Collected 1985.

Comment (K.T.M.H.): Results fall within expected range.

Zawar Series

Samples associated with widespread mining at Zawar, a large region that includes Agucha, Zawar Mala, Zawar proper and Dariba (Craddock *et al.* 1989, 1990), in Udaipur District, Rajasthan (*ca.* 23°N, 75°E). Collected 1987 and submitted by P. T. Craddock, Department of Scientific Research, British Museum, as part of continuing project (*cf.*, BM-2381, -2482 to -2492, Ambers, Matthews and Bowman 1989: 24; BM-2338, -2381, -2356, Ambers, Matthews and Bowman 1987: 188; BM-2222, -2223, -2243, Ambers, Leese and Bowman 1986: 519).

Agucha Series

Samples from Agucha mine, Rajasthan (25°50'N, 74°40'E).

BM-2630. Agucha **2320 ± 50**
 $\delta^{13}C = -27.1\text{‰}$

Wood, ref. RA/LW/87/13, from timber stump (*Anogeissus* sp.) identified by T. Lawrence, Royal Botanic Gardens, Kew, from south wall, exposed by modern opencast working.

BM-2631. Agucha **2380 ± 130**
 $\delta^{13}C = -26.5\text{‰}$

Wood, ref. RA/LW/87/11, from small branches made into basket, extracted from old mine, Site 11.

BM-2632. Agucha **2240 ± 50**
 $\delta^{13}C = -27.6\text{‰}$

Wood, ref. RA/LW/87/10, from outer ten rings of timber post in gallery of Site 11.

- BM-2633. Agucha** **2140 ± 50**
 $\delta^{13}C = -25.0\text{‰}$
Charcoal from Site 1, Layer 3, old ground surface below slag heap, 70 m NE of underground mine.
- Zawar Series*
Samples from mines at Zawar, Rajasthan (24°30'N, 73°50'E).
- BM-2634. Zawar Mala** **1340 ± 100**
 $\delta^{13}C = -25.6\text{‰}$
Charcoal, ref. ZW/LW/87/26, from firehole in small top chamber in underground mine.
- BM-2638. Zawar** **Modern**
 $\delta^{13}C = -26.5\text{‰}$
Charcoal from mouth of furnace block, beneath layer containing hoard of coins freshly minted in AD 1593.
- BM-2639. Zawar, Pratap Khan** **2040 ± 70**
 $\delta^{13}C = -25.9\text{‰}$
Charcoal, ref. ZW/LW/22, debris from fire near "audience chamber" in Pratap Khan mine.
- BM-2666. Zawar Mochia** **390 ± 50**
 $\delta^{13}C = -25.6\text{‰}$
Charcoal, ref. ZW/LW/87/32, from loose heap of rock and soil in opencast mine.
- Dariba Series*
Samples from Dariba, Chittor District, Rajasthan (24°25'N, 74°00'E).
- BM-2635. Dariba** **2220 ± 50**
 $\delta^{13}C = -26.0\text{‰}$
Wood, ref. RD/LW/87/10, from single piece with less than ten rings extracted from massive timber revetment in south lode area.
- BM-2636. Dariba** **2160 ± 50**
 $\delta^{13}C = -25.0\text{‰}$
Cellulose from wood, ref. DM/85/LW/3, forming part of support timber in gallery of mine.
- BM-2637. Dariba** **2040 ± 50**
 $\delta^{13}C = -26.6\text{‰}$
Charcoal, ref. RD/LW/87/7, from small chamber off large drainage shaft in Dariba mine.
- BM-2640. Dariba** **160 ± 50**
 $\delta^{13}C = -22.8\text{‰}$
Charcoal from Site 15, small slag heap 100 m west of north lode opencast.

Comment (P.T.C.): Dates are from three major lead/silver/zinc mines in Aravalli Hills of Rajasthan (Craddock *et al.* 1989). Together with those from earlier series, dates show massive exploitation of silver in second half of 1st millennium BC, apparently ending abruptly in first century BC, probably in connection with collapse of Mauryan Empire and end of silver coinage. Zinc mining seems to have resumed at Zawar where an industry of zinc production by distillation thrived by the 14th century AD. The process continued into the early 19th century when the mines closed (Craddock *et al.* 1990).

Italy

Canàr Series

Waterlogged wood from an Early to Middle Bronze Age palafitta-type settlement (Salzani 1986; ACCORDIA 1988) at Canàr, Castelnovo Bariano, Rovigo (45°20'N, 11°40'E). Four samples from >120 posts were uncovered. Collected 1987 and submitted by R. Whitehouse, Queen Mary College, London University.

BM-2653. Canàr **3620 ± 70**
 $\delta^{13}C = -27.1\text{‰}$

Wood, ref. 44/1, from base of wooden post, below occupation level.

BM-2654. Canàr **3600 ± 50**
 $\delta^{13}C = -26.6\text{‰}$

Wood, ref. 54/4.

BM-2655. Canàr **3660 ± 50**
 $\delta^{13}C = -27.8\text{‰}$

Wood, ref. 59/1.

BM-2656. Canàr **3610 ± 100**
 $\delta^{13}C = -28.0\text{‰}$

Wood, ref. 61/2.

Comment (R.W.): Results are consistent and suggest single building phase representing initial construction of lake village. If we assume that this occurred over a short period of time, the results can be combined, giving possible calendar age ranges for construction of 2130 to 1910 BC, at 95% confidence level, or 2035 to 1945 BC, at 68%. Thus, *ca.* 2000 BC seems reasonable for local Early Bronze Age. The Early Bronze Age of northern Italy dates traditionally to *ca.* 1800–1600/1500 BC, but calibrated chronology derived from nearly 40 dates indicates range for Polada culture (closely related to material from Canàr) of *ca.* 2400 to 1600 cal BC (Fasani 1984). Dates for Canàr fit comfortably into middle of range for Polada and are entirely acceptable.

Jordan

Tell um Hammad Series

Samples from settlement site at Tell um Hammad, Jordan Valley (32°05'N, 35°35'E). Collected 1984 and submitted by S. W. Helms, British Institute at Amman for Archaeology and History.

BM-2621. Tell um Hammad3750 ± 50
 $\delta^{13}C = -25.6\text{‰}$

Wood charcoal, ref. 6/15032, from fill of stone-lined pit sealed by occupation layers in "EB IV" village sealed by "EB IV" occupation layers.

BM-2622. Tell um Hammad3690 ± 60
 $\delta^{13}C = -25.5\text{‰}$

Charcoal, ref. 7/7075, from fill of pit sealed by occupation layers and later ("EB IV") structures.
Comment (S.W.H.): Dates agree with range expected on basis of pottery typology.

Syria**Tell Brak Series**

Samples from occupation site at Tell Brak, near El Haseke, NE Syria (36°40'N, 41°00'E). Collected and submitted by J. Oates.

BM-2687. Tell Brak3700 ± 80
 $\delta^{13}C = -25.6\text{‰}$

Wood from fill of antecella of shrine in "Akkadian" ceremonial complex, Area SS, above floor dated by BM-2688, below.

BM-2688. Tell Brak3780 ± 50
 $\delta^{13}C = -25.1\text{‰}$

Wood from floor of antecella of shrine, below fill dated by BM-2687, above.

BM-2717. Tell Brak3680 ± 50
 $\delta^{13}C = -21.8\text{‰}$

Charred grain, ref. ER/2 27, from burned house probably destroyed at end of Agade occupation. Repeat measurement of BM-1763, revised to BM-1763R, 3730 ± 100 (Bowman, Ambers and Leese 1990).

Comment (J.A.): Compare BM-2511, -2531, -2554 to -2556 for same site (Ambers, Matthews and Bowman 1989: 31).

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