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Tree-Ring Analysis of Oak Samples from Bushmead Priory,
near Colmworth, Bedfordshire

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Summary

Seven sections were removed from six timbers in Bushmead Priory during repair work in AD 1981. These were subsequently analysed by David Haddon-Reece though the analysis remained unpublished. This report describes the reanalysis of the timber sections. Only one timber contained sufficient rings for analysis. This timber is thought to represent a purlin associated with a dormer and was felled in the period AD 1709-41.

Keywords

Dendrochronology
Standing Buildings

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Introduction

This document is a technical archive report on the tree-ring analysis of timbers from Bushmead Priory, near Colmworth, Bedfordshire (TL 116607; Figs 1 and 2). It is beyond the dendrochronological brief to describe the structure in detail or to undertake the production of detailed drawings. This analysis may in the future form a component part of a multi-disciplinary series of studies on the site and thus the conclusions presented here may be modified in the light of subsequent work.

The extant structure represents a rare survival of an Augustinian priory's medieval refectory with its original timber roof structure, wall paintings and stained glass. It was founded in AD 1195 and dissolved in AD 1536. In AD 1537 the priory was passed to Sir William Gascoigne of Cardington. In AD 1562 William Gery from Cambridgeshire purchased the estate and it remained the property of the Gery family, subsequently the Wade-Gerys, until the mid AD 1970s when it was transferred to the guardianship of English Heritage.

In AD 1981 seven sections were removed from six timbers undergoing repairs. These were collected by David Haddon-Reece from the Ancient Monuments Laboratory for dendrochronological analysis. Six sections (five timbers) were associated with what is thought to be the original medieval roof which consists of six crown post trusses (Fig 3) but one section was associated with the later insertion of a dormer. The initial analysis was undertaken with the aim of providing independent dating evidence for the medieval roof and a subsequent alteration. However the original study remained unpublished so this study was commissioned by English Heritage in order to document the analysis.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The following summarises relevant methodological details used for the reanalysis of the timbers from Bushmead Priory.

Oak (*Quercus* spp.) is currently the only species used for routine dating purposes in the British Isles, although research on other species is being undertaken (Groves 2000; Tyers 1998a). Timbers with less than 50 annual growth rings are generally considered unsuitable for analysis as their ring patterns may not be unique (Hillam *et al* 1987).

The ring sequence of each sample was revealed by sanding until the annual growth rings were clearly defined. Any samples that fail to contain the minimum number of rings or have unclear ring sequences are rejected. The sequence of growth rings in suitable samples were measured to an accuracy of 0.01mm using a purpose-built travelling stage attached to a microcomputer-based measuring system (Tyers 1999). The ring sequences were plotted onto semi-logarithmic graph paper to enable visual comparisons to be made between them with the aid of a lightbox. In addition, cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The Student's *t*-test is then used as a significance test on the correlation coefficient. The *t*-values

quoted below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A t -value of 3.5 or over is usually indicative of a good match (Baillie 1982), provided that high t -values are obtained at the same relative or absolute position with a series of independent sequences and that the visual match is satisfactory.

Dating is usually achieved by comparing, or crossmatching, ring sequences within a phase or structure and combining the matching patterns to form a phase or site master curve. This master curve and any remaining unmatched ring sequences are then tested against a range of reference chronologies, using the same matching criteria as above. The position at which all the criteria are met provides the calendar dates for the ring sequences. A master curve is used for absolute dating purposes whenever possible as it enhances the common climatic signal and reduces the background 'noise' resulting from the local growth conditions of individual trees.

The crossdating process provides precise calendar dates only for the rings present in the timber. The nature of the final ring in the sequence determines whether the date of this ring also represents the year the tree from which the timber was derived died. Oak consists of inner inert heartwood and an outer band of active sapwood. If the sample ends within the heartwood of the original tree, a *terminus post quem* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings that are missing. This is the date after which the timber was felled but the actual year of felling may be many decades later depending on the number of outer rings removed during timber conversion. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimate applied throughout this report is a minimum of 10 and maximum of 46 rings, where these figures indicate the 95% confidence limits of the range and are applicable to oak trees of all periods from England and Wales (Tyers 1998b). Alternatively, if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination of felling season must be treated cautiously. The delicate nature of sapwood, particularly on waterlogged timbers, increases the likelihood of damage/degradation to the outermost surface of the sample and hence increases the difficulties of positive identification of bark-edge.

The felling dates produced do not by themselves necessarily indicate the construction date of the structure from which they are derived. At this stage, factors such as seasoning, reuse, and stockpiling have to be considered. Evidence suggests that seasoning of timber for structural purposes was a fairly rare occurrence until relatively recent times and timber was generally felled as required and used whilst green (Hollstein 1980; Rackham 1990; Charles and Charles 1995). However, the reuse of timber has been a common practice since prehistoric times and stockpiling, albeit potentially short-term, may occur. Therefore, although the production of tree-ring dates is an independent process, the interpretation of these dates may be refined by drawing on other archaeological evidence.

Results

The first stage of the analysis was to determine which sub-sections in the form of cross-sectional slices and other fragments related to which timber section listed on the original sample sheet (Fig 4). This was successfully achieved, although it highlighted several labelling discrepancies (eg 813988). This problem may be a result of labels having become detached sometime over the last 20 years and then subsequently reattached to the wrong sub-section/section. Each original section could be reconstructed in the way of a three dimensional jigsaw. Initially 813989 appeared to be represented by two sections that could not be rejoined. However using visual evidence in the form of peg holes, scars, and the presence of a pair of narrow rings and by allowing for the removal of the sample that was to have provided a radiocarbon sample, the original single section can be reconstructed. Photographs of each timber section, annotated with dimensions and label numbers are given in Figures 5-10. It was also hoped that it would be feasible to determine the precise location from which each timber section was obtained. However it was not possible to relate the little information existing to the available plans.

All of the sections were oak but only one was suitable for analysis. The five timbers (six sections) thought to be associated with the original medieval roof all contained too few rings for successful analysis. Details of the timbers are presented in Table 1. The measured ring sequence from 813990 was compared with a range of dated reference chronologies from Britain. It was successfully dated to the period AD 1599-1709 (Fig 11, Tables 2 and 3).

Interpretation/Discussion

The section thought to represent the dormer purlin has been successfully dated. It has a felling date range of AD 1709-41. This indicates that it was initially used in construction in the first half of the eighteenth century. This may indicate the date of modifications or repairs to the building. However this suggestion relies on only a single timber which could be have been reused or stockpiled.

The timbers thought to be associated with the medieval roof are all derived from relatively fast grown young trees and it has therefore not been possible to provide any independent dating evidence. This implies that the medieval roof is constructed of material unsuitable for dendrochronological analysis. The original samples were taken in the form of large sections from timbers being partially or wholly replaced. However dendrochronological sampling techniques for standing buildings have altered. Whilst slices/sections are still taken when possible the vast majority of samples are now in the form of cores and hence sampling is no longer restricted to those timbers being repaired or replaced. Coring has therefore greatly extended the number of timbers available for sampling in any structure. Consequently it may well be worthwhile undertaking a dendrochronological assessment of the entire structure in order to determine whether any of the extant medieval timbers are suitable for dendrochronological analysis and therefore whether it may be possible to provide independent dating evidence for this currently undated structure.

Acknowledgements

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References

Arnold, A J, Howard, R E, and Litton, C D, 2003a *Tree-Ring Analysis of Timbers from the De Grey Mausoleum, St John the Baptist Church, Flitton, Bedfordshire*, Centre for Archaeol, **48/2003**

Arnold, A J, Howard, R E, and Litton, C D, 2003b *Tree-Ring Analysis of Timbers from the Roof of the Keep or "Little Castle", Bolsover Castle, Derbyshire*, Centre for Archaeol, **15/2003**

Baillie, M G L, 1982 *Tree-ring Dating and Archaeology*, London

Baillie, M G L, and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7-14

Charles, F W B, and Charles, M, 1995 *Conservation of timber buildings*, London

English Heritage, 1998 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates*, London

Groves, C, 2000 Belarus to Bexley and beyond: dendrochronology and dendroprovenancing of conifer timbers, *Vernacular Architect*, **31**, 59-66

Hillam, J, Morgan, R A, and Tyers, I, 1987. Sapwood estimates and the dating of short ring sequences. in Applications of tree-ring studies (ed R G W Ward), BAR Int Ser, **333**, 165-85

Hollstein, E, 1980 *Mitteleuropäische Eichenchronologie*, Mainz am Rhein

Howard, R E, Laxton, R R, and Litton, C D, 1998 *Tree-ring analysis of timbers from Chicksands Priory, Chicksands, Bedfordshire*, Anc Mon Lab Rep, **30/98**

Howard, R E, Laxton, R R, and Litton, C D, 1999 *Tree-ring analysis of timbers from Bay Hall, Hall Lane, Benington, Lincolnshire*, Anc Mon Lab Rep, **61/98**

Howard, R E, Laxton, R R, and Litton, C D, forthcoming *Tree-Ring Analysis of Timbers from The Riding School, Bolsover Castle, Bolsover, Derbyshire*, Centre for Archaeol Rep

Munro, M A R, 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bulletin*, **44**, 17-27

Rackham, O, 1990 *Trees and woodland in the British Landscape, 2nd edn*, London

Tyers, I, 1992 *Dendrochronology report: Cressing Temple Barley Barn*, MoLAS Dendro Rep, **01/92**

Tyers, I, 1998a *Beech Dendrochronology*, in *Magor Pill medieval wreck* (N Nayling), CBA Res Rep, **115**, 123-8

Tyers, I, 1998b *Tree-ring analysis and wood identification of timbers excavated on the Magistrates Court Site, Kingston upon Hull, East Yorkshire*, ARCUS Rep, **410**

Tyers, I, 1999 *Dendro for Windows program guide 2nd edn*, ARCUS Rep, **500**

Tyers, I, 2002 *Dendrochronological spot-dates of samples from Ballingdon Bridge, Sudbury (BCB 012), Suffolk*, ARCUS Rep, **573c**

Tyers, I, and Hibberd, H, 1993 *Dendrochronology, wood identification, and wattle analysis for the Fleet Valley developers report*, MoLAS Dendro Rep, **03/93**

Figure 1

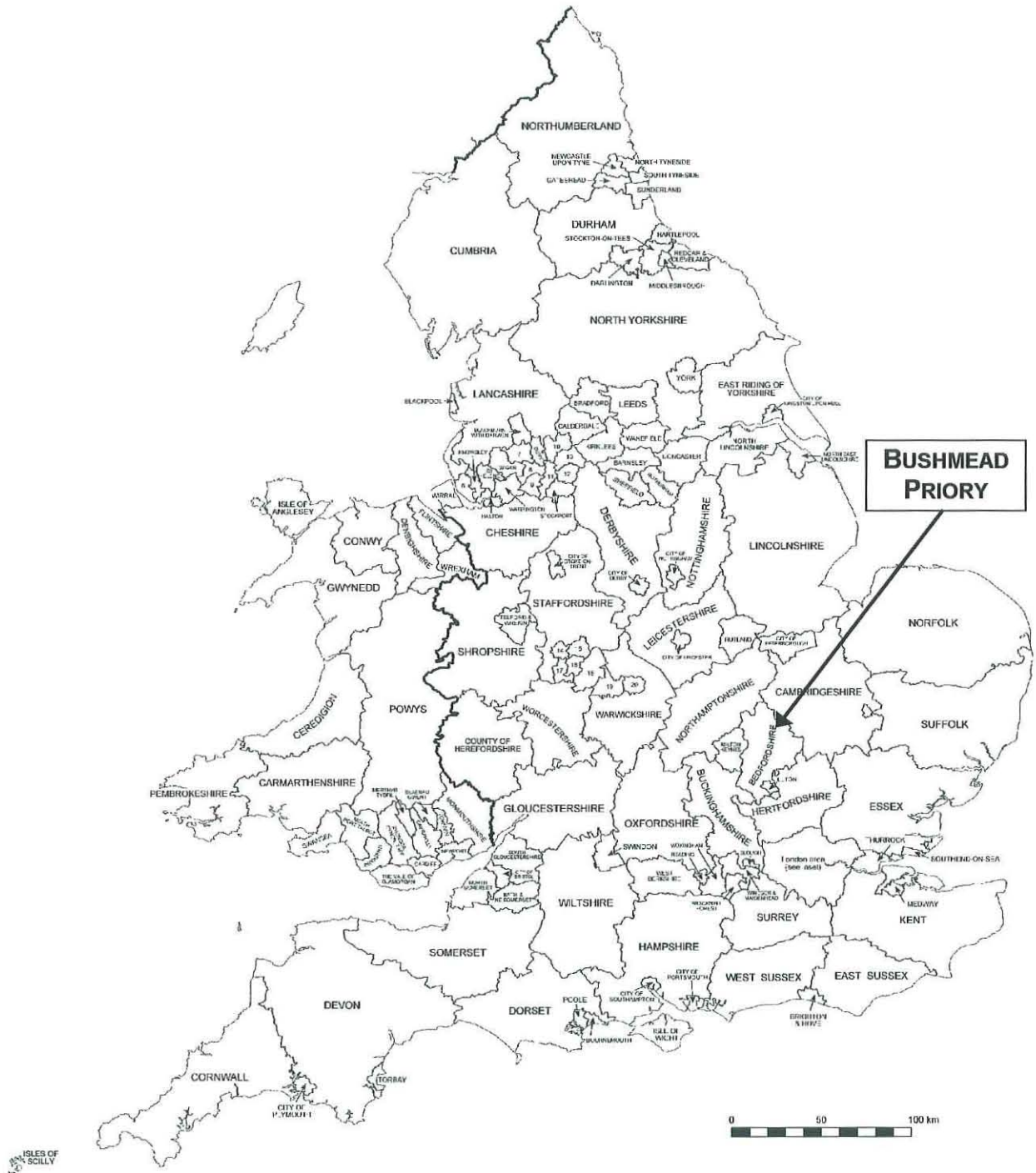


Figure 2 Location of Bushmead Priory, near Colmworth, Bedfordshire

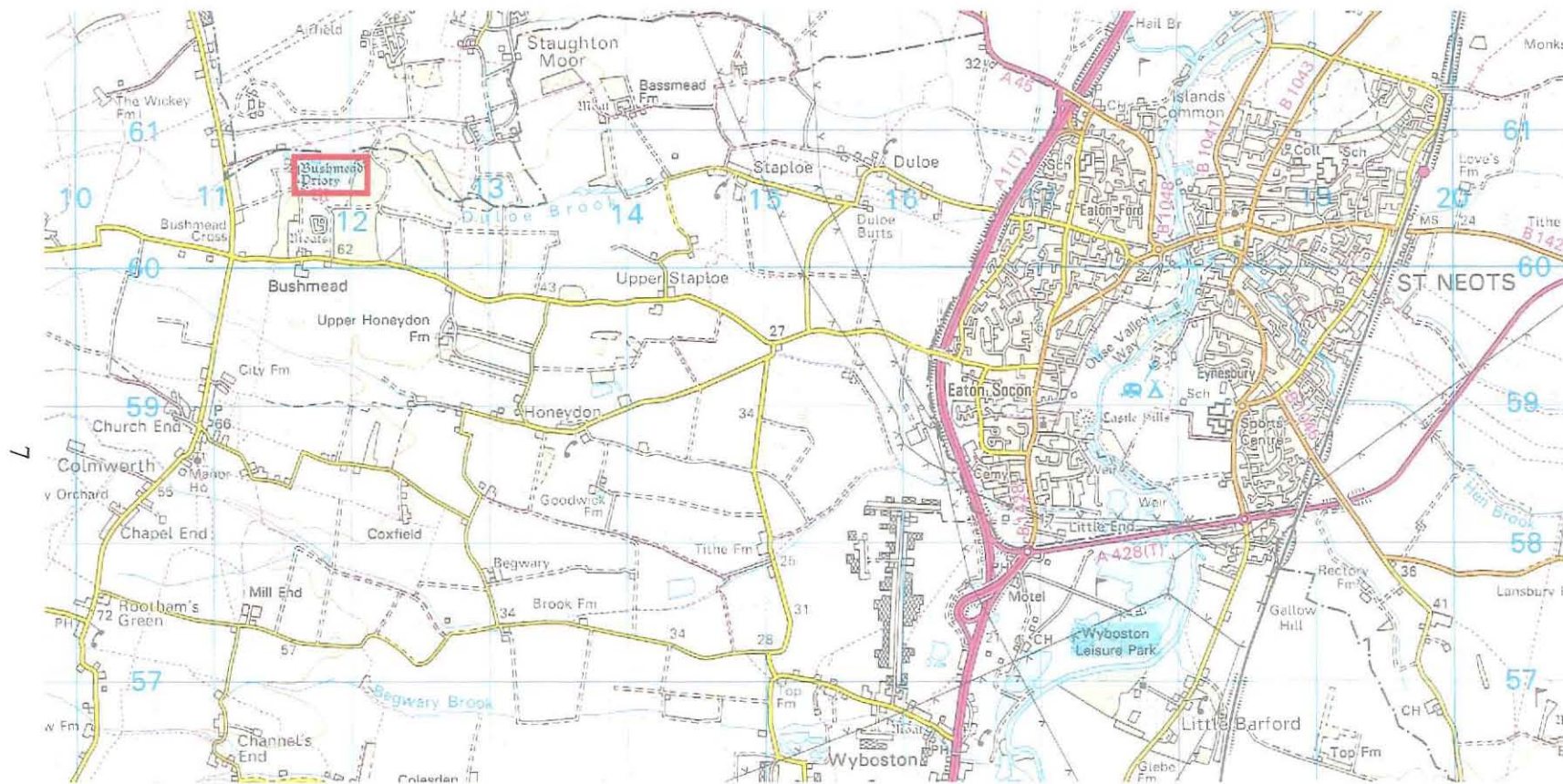


Figure 3 Longitudinal section looking north and cross-section looking east (Department of the Environment: Ancient Monuments Branch 1976)

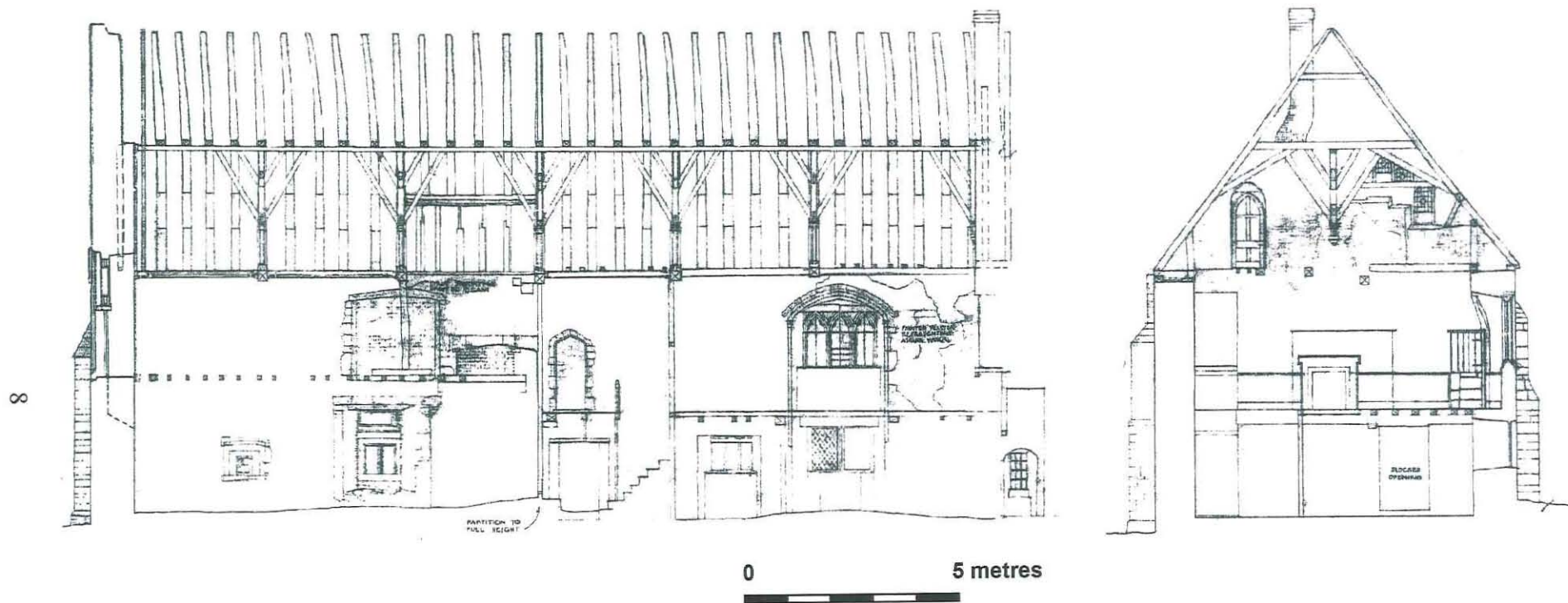


Figure 4 The original sample sheet indicating the seven sections taken from the six timbers collected in September 1981

LIST OF ENVIRONMENTAL SAMPLES SENT TO THE ANCIENT MONUMENTS LABORATORY

SITE: BUSHMEAD PRIORY SHEET NO.
 COUNTY: BEDS. GRID REF.
 PERIOD: Medieval DATE SENT 30. SEPT 1981
 EXCAVATION DATE (Collected by DHR)
 EXCAVATOR'S NAME, ADDRESS AND TELEPHONE NUMBER FOR FUTURE COMMUNICATION.

Refer to D. SHERLOCK, IAM.

MATERIAL: Please complete a separate sheet for each category ringing the appropriate material from those shown below.

*Animal bones/Human bones/Mollusca/Stones/Soil/Wood/Charcoal/Seeds/
 Fibres/Insects/Other material.....*

Please give full details of archaeological and stratigraphic context, and state the nature of problem to be investigated. For fuller details see reverse of this sheet. Diagrams, on the back of this sheet, or separate, should be included where necessary. Please state whether samples were packed wet or dry.

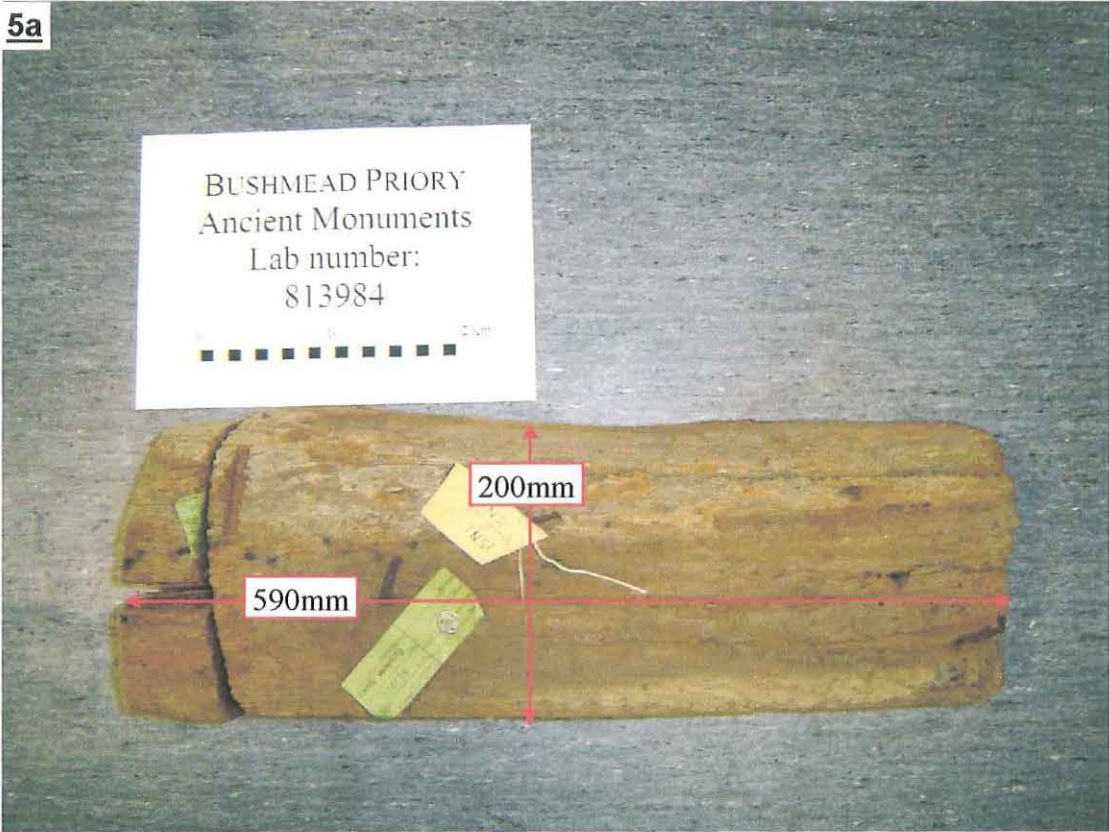
Please send these lists to RECORDS OFFICE, ROOM 522, FORTRESS HOUSE, 23 SAVILE ROW, LONDON W1X, under separate cover. Boxes should be labelled ON THE OUTSIDE with site name and contents and contain identification label.

WORK CANNOT BEGIN UNLESS LISTS ARE RECEIVED

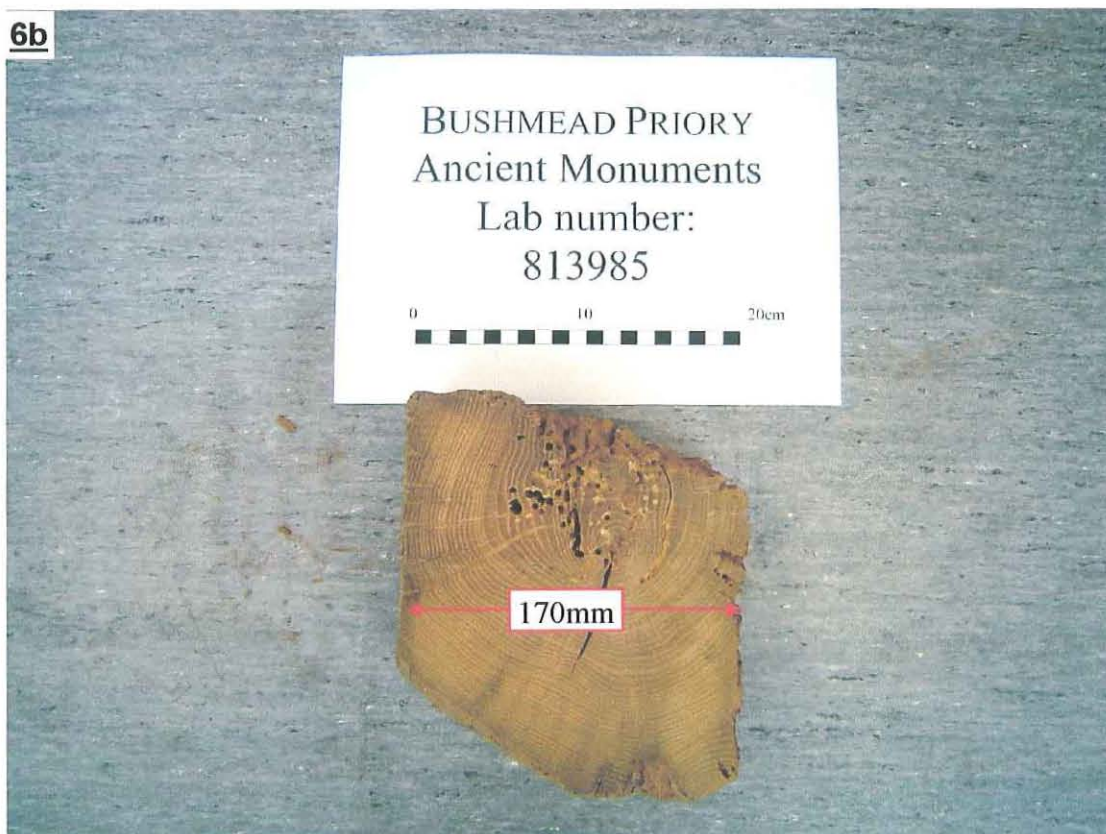
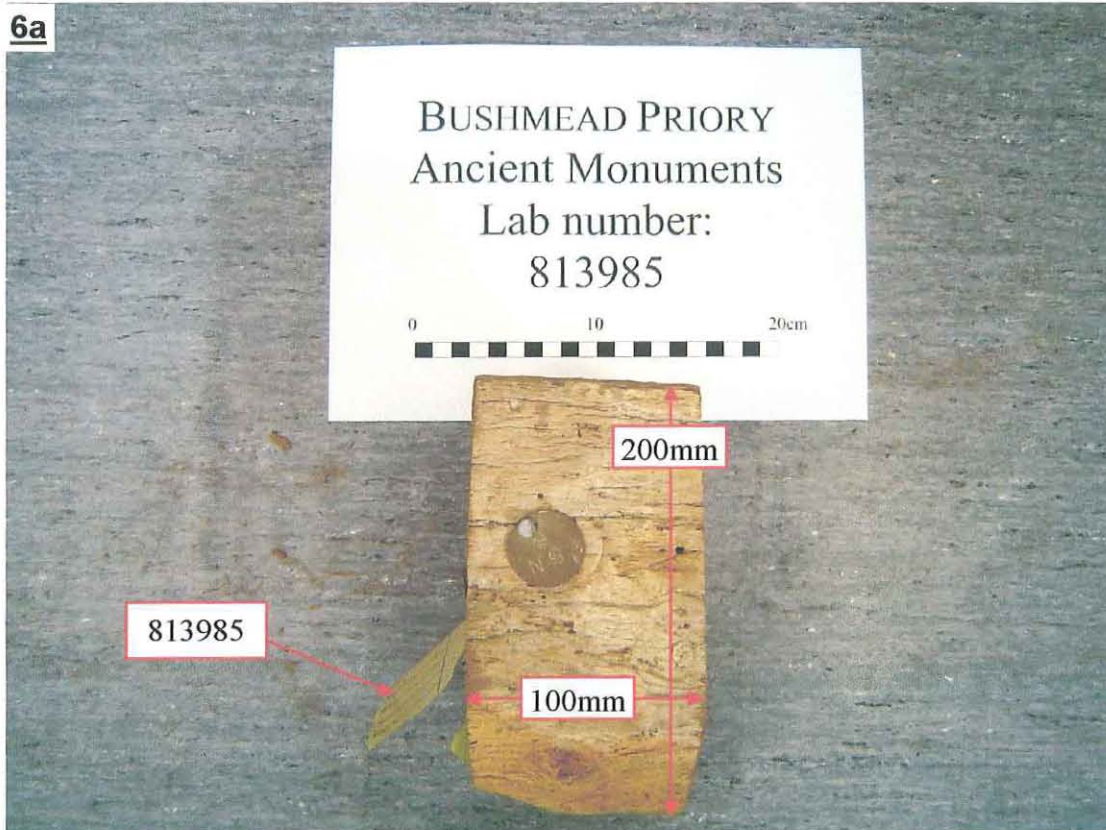
Excavator's no separate entry for each item	AM Lab no	Archaeological and Stratigraphic context & Problem to be investigated
	813984	15N1
	813985	9N9
	813986	N. end of tie beam 12
	813987	16S1 (i)
	813988	16S1 (ii)
	813989	16N1
	813990	? SECTION OF DORMER PURLIN

SECTIONS OF
 OAK BEAMS
 FOR DENDRO.

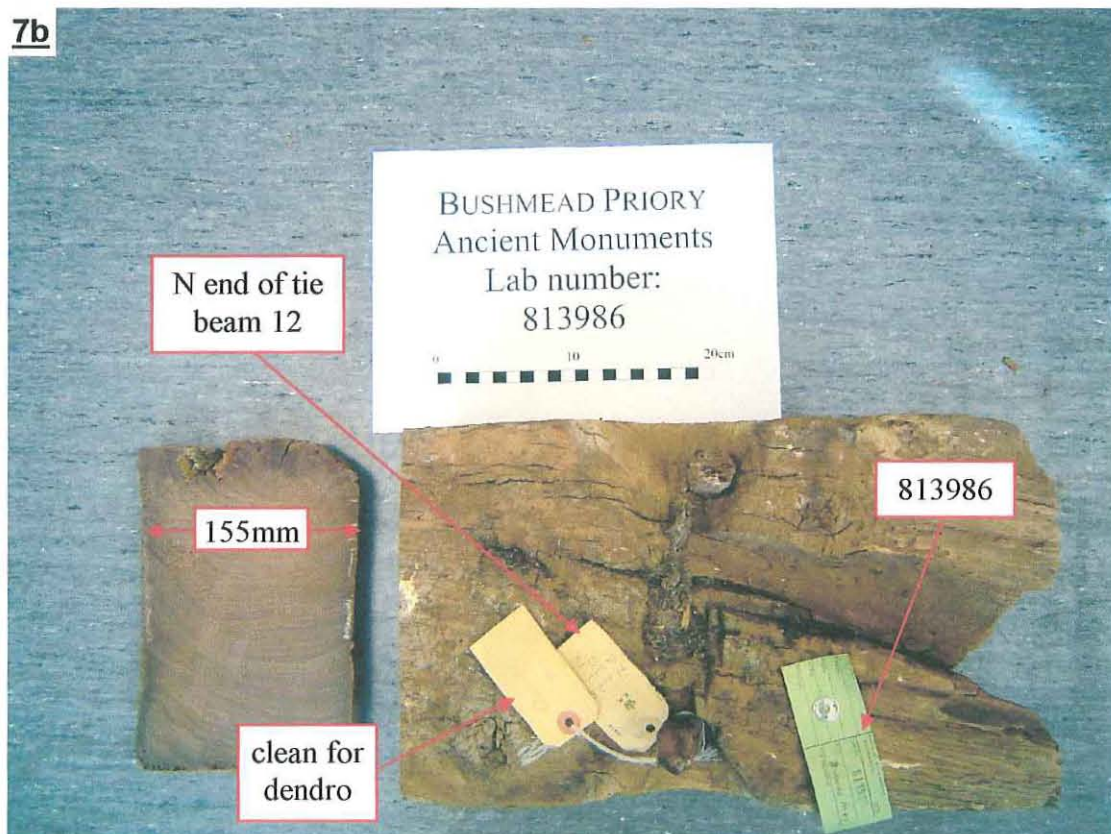
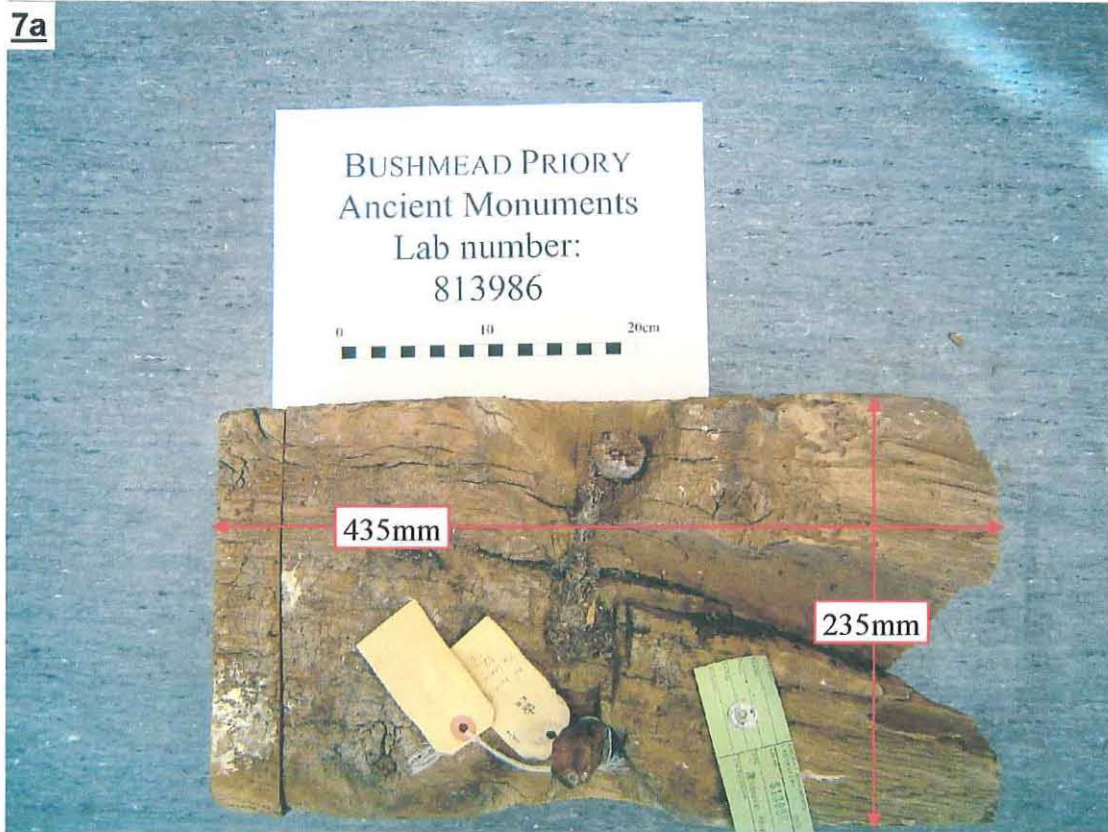
Figures 5a and 5b Section 813984. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)



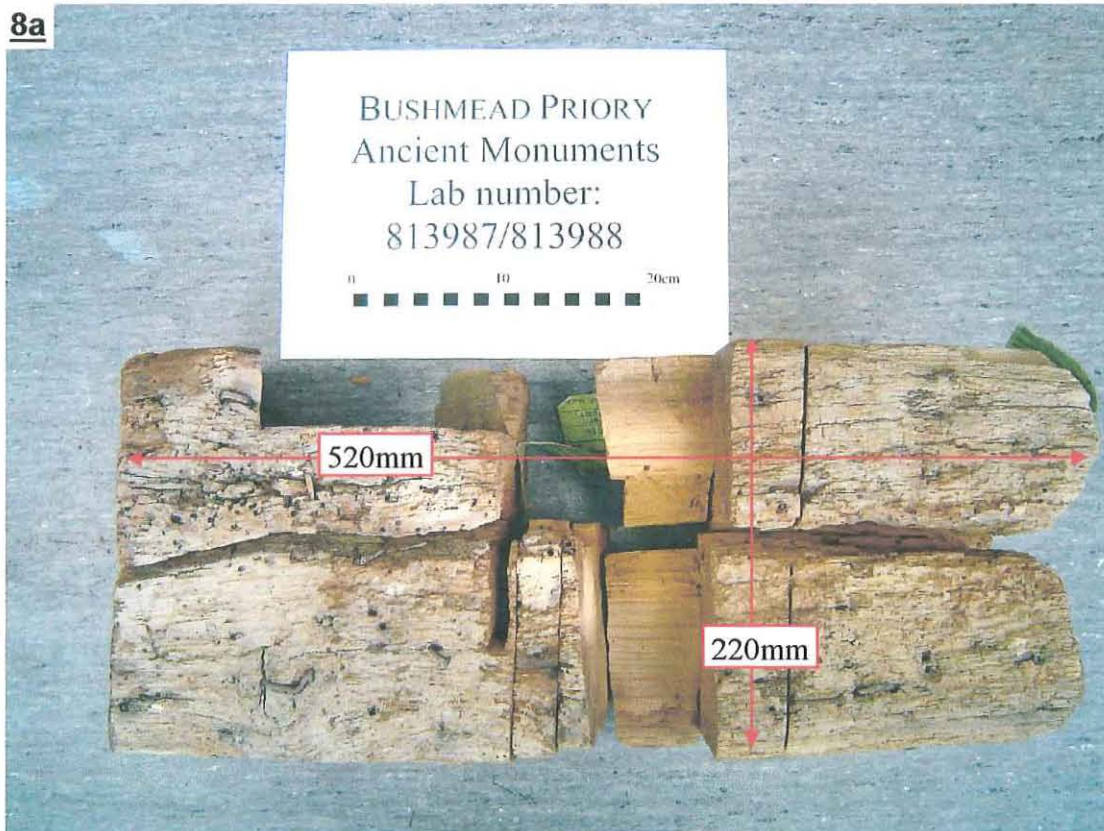
Figures 6a and 6b Section 813985. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)



Figures 7a and 7b Section 813986. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)

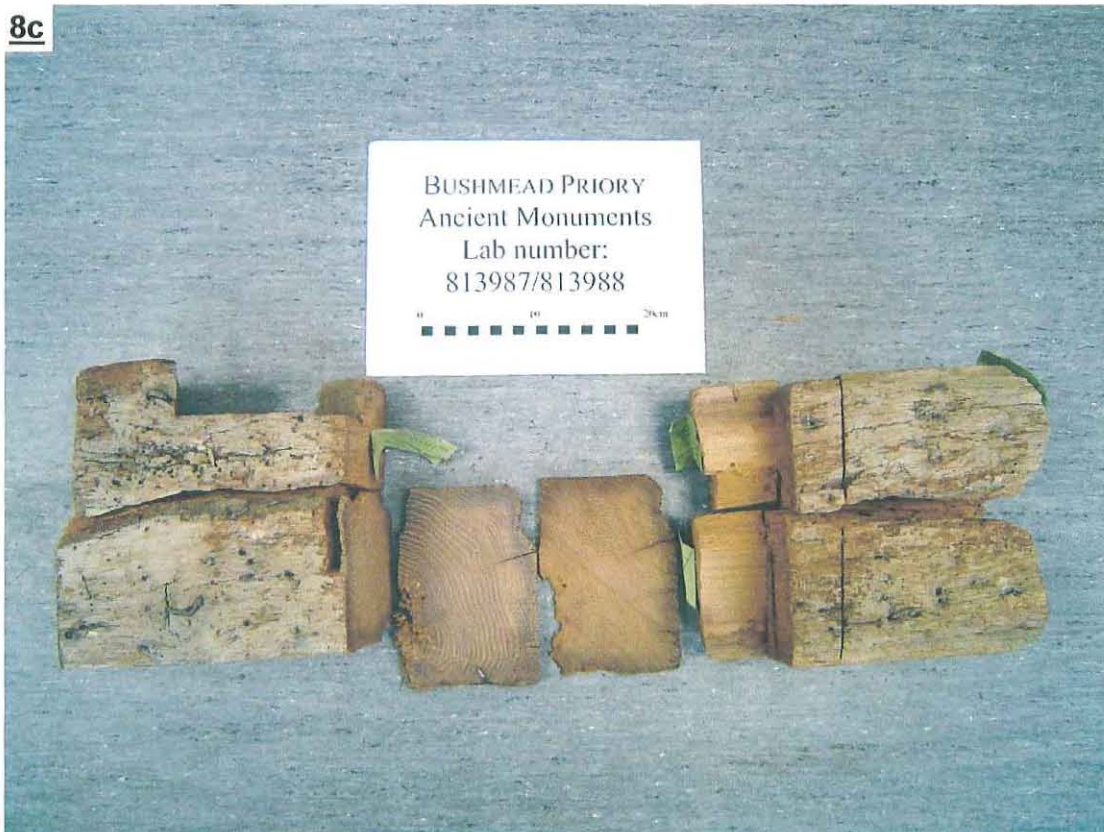


Figures 8a, 8b, 8c and 8d Sections 813987/813988. These are adjoining sections from the same timber. There are a number of mislabelled fragments. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)

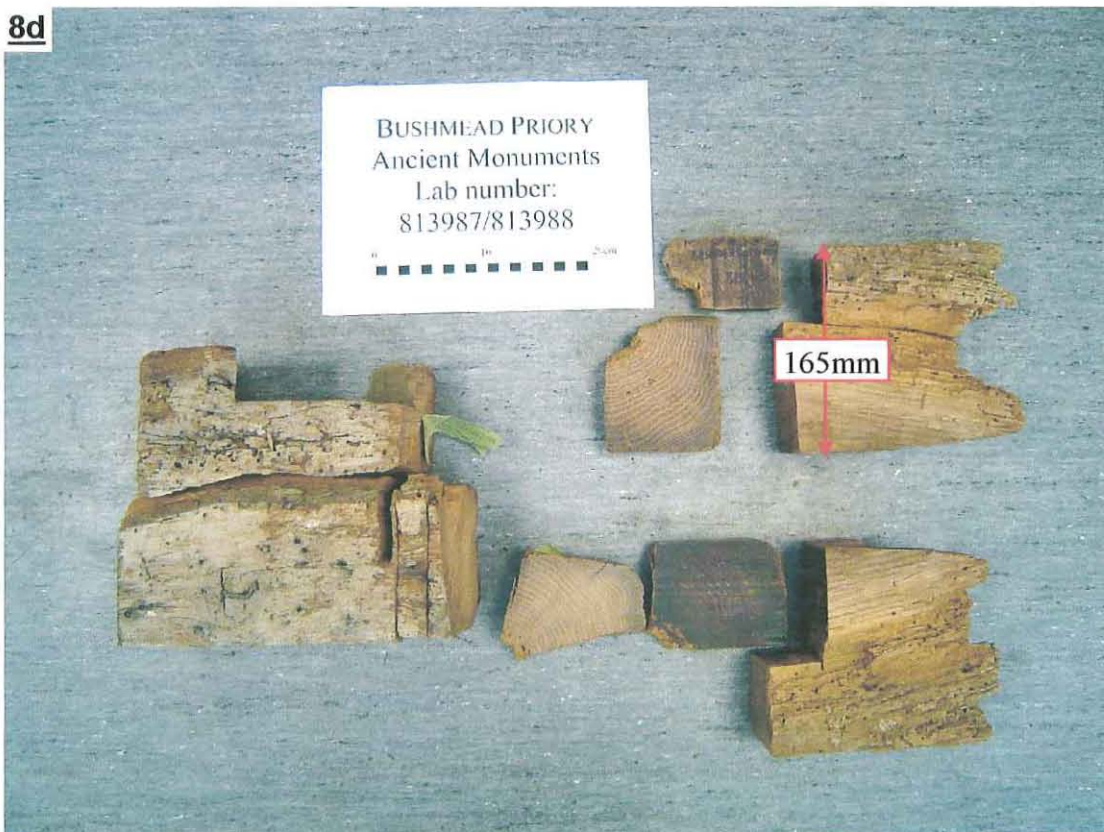


Figures 8a, 8b, 8c and 8d (continued) (photograph by C Groves)

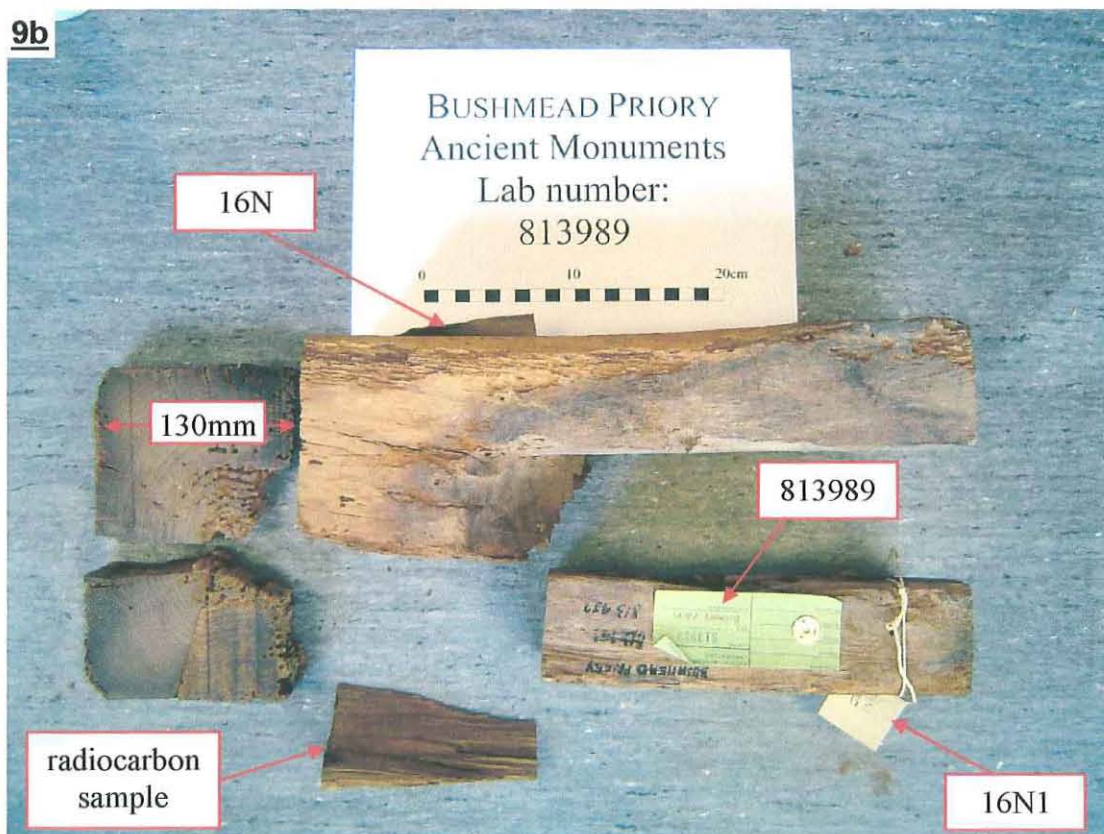
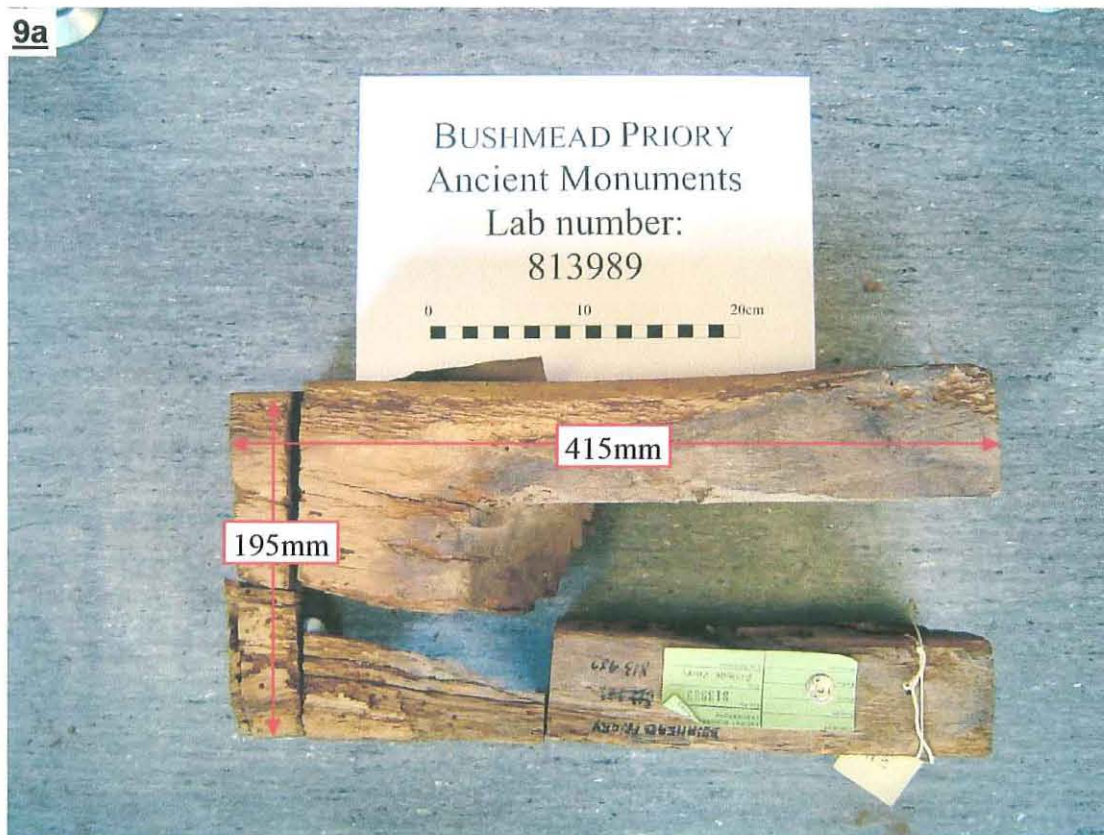
8c



8d

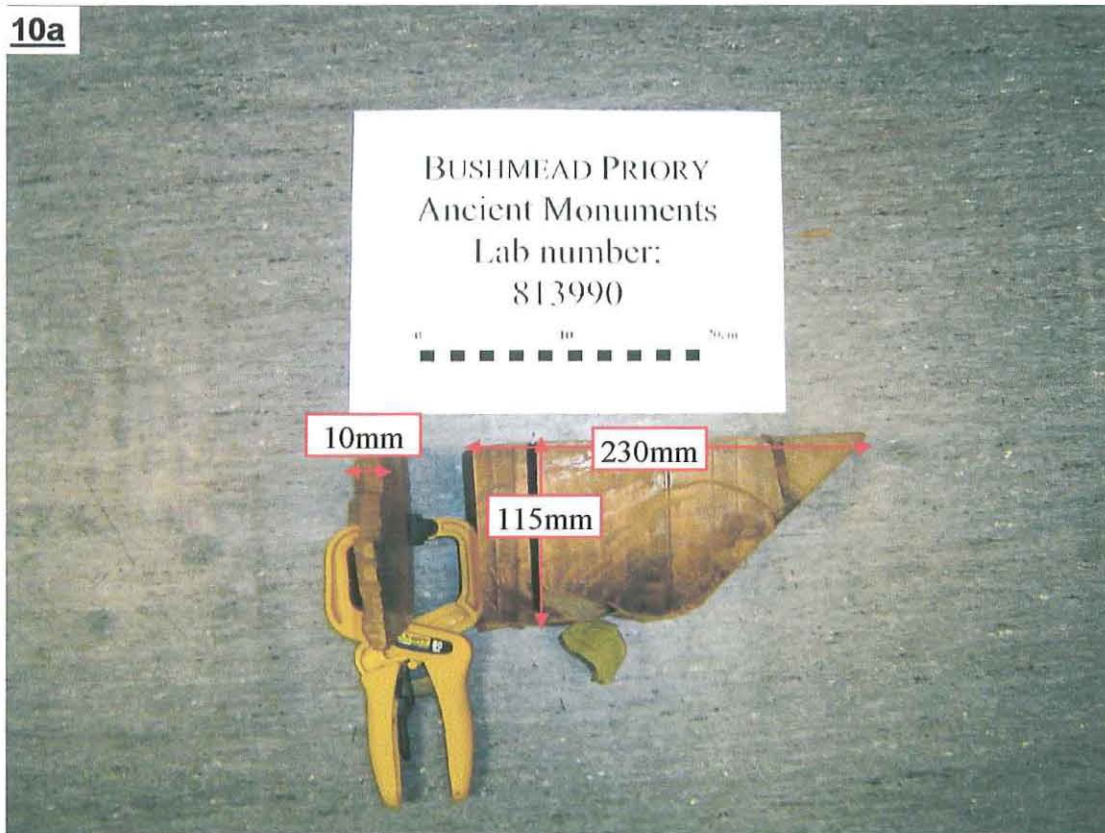


Figures 9a and 9b Section 813989. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)



Figures 10a and 10b Section 813990. Dimensions are approximate and are rounded to the nearest 5mm (photograph by C Groves)

10a



10b

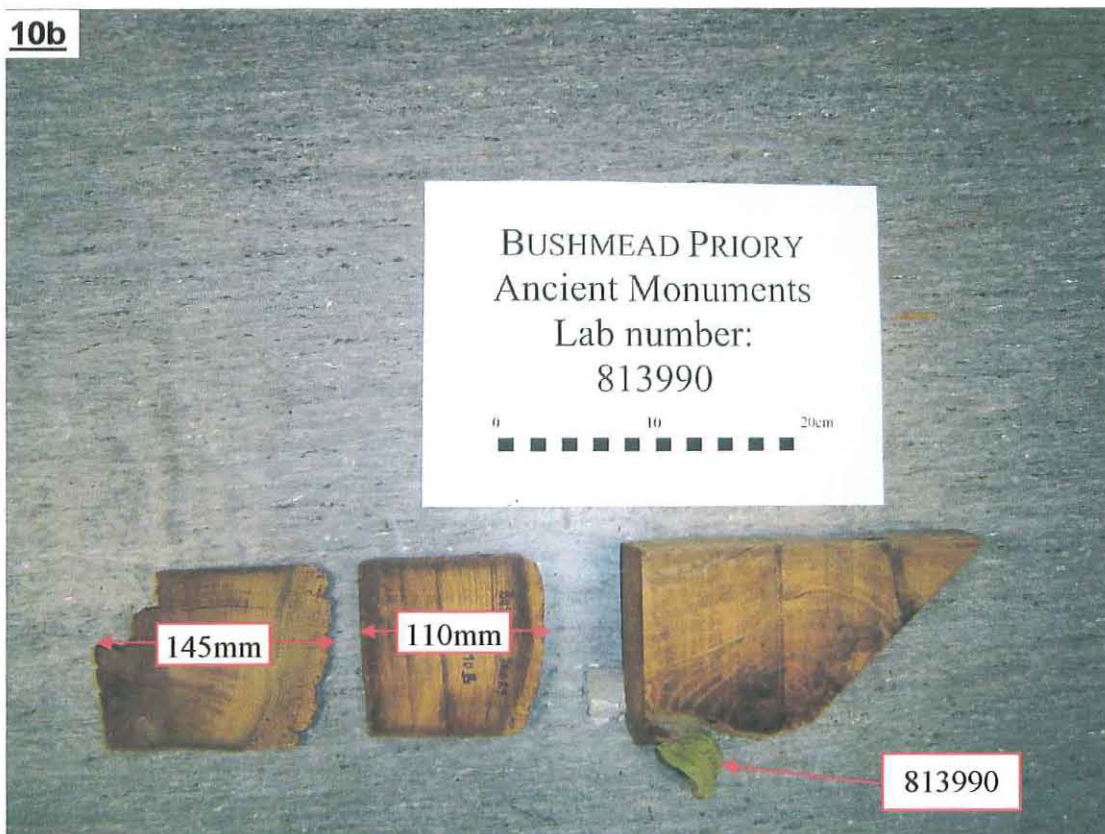
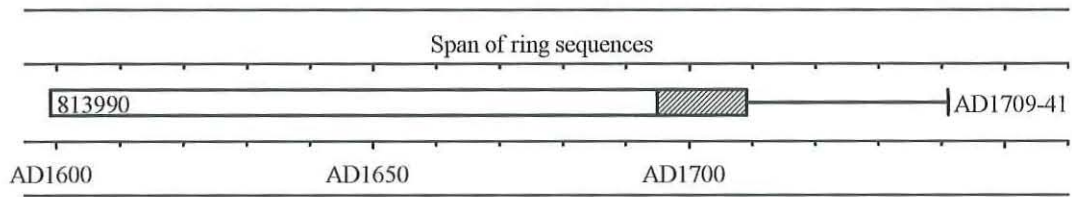


Figure 11 Bar diagram showing the dating position and felling date range of sample 813990



KEY

 heartwood

Table 1 Details of the samples from Bushmead Priory, Colmworth, Bedfordshire

AM lab number	Number of rings	Sapwood rings	Average Ring Width (mm)	Cross-section type	Cross-section dimensions (mm)	Date of measured sequence
813984	c30	-	c3.8	halved	195 x 110	-
813985	c60	-	c1.9	halved	200 x 170	-
813986	c50	-	c4.6	halved	230 x 155	-
813987/813988	c35	-	c3.7	whole	220 x 170	-
813989	c30	-	c4.5	whole	130 x 110	-
813990	111	14	1.26	quartered	145 x 115	AD 1599-1709

Number of rings - total number of measured rings including both heartwood and sapwood;

Sapwood rings – number of measured sapwood rings only

Table 2 Ring width data from sample **813990** from Bushmead Priory, dated AD 1599-1709 inclusive

Date	Ring widths (units of 0.01mm)									
AD1599									330	228
AD1601	36	31	50	55	55	98	82	98	121	158
	195	148	141	126	104	49	140	158	73	61
	92	138	101	120	92	109	105	107	130	66
	46	56	58	64	87	84	114	98	103	135
	98	88	72	67	54	84	58	54	60	49
AD1651	48	47	27	28	66	77	49	79	94	104
	113	139	157	94	92	86	102	177	181	156
	156	154	195	169	144	91	189	170	112	165
	116	174	105	92	78	152	178	318	254	176
	228	185	182	168	191	248	239	260	158	148
AD1701	161	144	262	257	126	184	169	196	240	

Table 3 Dating sample **813990**, AD 1599-1708 inclusive. Example *t*-values with some relevant reference chronologies

Area	Reference chronology	Date span	<i>t</i> -value
East Anglia	East Anglia region (Tyers pers comm)	AD 781-1899	6.96
East Midlands	East Midlands region (Tyers pers comm)	AD 1045-1805	6.24
Bedfordshire	Chicksands Priory, Chicksands (Howard <i>et al</i> 1998)	AD 1611-1814	4.81
Bedfordshire	De Grey Mausoleum, Flitton (Arnold <i>et al</i> 2003a)	AD 1510-1726	6.09
Derbyshire	The Keep/Little Castle, Bolsover Castle (Arnold <i>et al</i> 2003b)	AD 1532-1749	6.21
Derbyshire	Riding School Bolsover Castle (Howard <i>et al</i> forthcoming)	AD 1494-1744	5.51
Essex	Barley Barn, Cressing Temple (Tyers 1992)	AD 1661-1737	6.03
Lincolnshire	Bay Hall, Benington (Howard <i>et al</i> 1999)	AD 1591-1717	7.51
London	Fleet Valley (Tyers and Hibberd 1993)	AD 1654-1728	7.26
Suffolk	Ballington Bridge, Sudbury (Tyers 2002)	AD 1484-1790	4.95