Report **/2006

Tree-Ring Analysis of Timbers from the Former Church of St Mary Magdalene, Boveney, near Eton, Buckinghamshire

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Summary

The wooden tower to this former church has a complex structure with an inner and an outer frame, and additional strengthening members. Dendrochronological investigation was carried out with a view to phasing these various components. A total of sixteen samples was taken from various elements in the timber tower, the majority of which looked to have sufficient rings for dating. After preparation of the samples, it was found that several contained abrupt growth changes, and could not be dated. Four samples did date, one retaining a single sapwood ring, and having a likely felling date range of AD 1451–83, and three others which appear to form a single group most likely felled in the period AD 1487–1519.

Keywords
Dendrochronology
Standing Building

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Introduction

This grade I listed former church (NGR SU 939 776; Fig 1) is of chalk and flint coursed rubble with ashlar dressings, thought to be of twelfth-century origin. The weather-boarded tower, undergoing repairs at the time of this study, was the subject of dendrochronological investigation at the request of Clare Charlesworth, English Heritage. It consists of an upper bell chamber with pyramidal roof, a sounding chamber, and a lower part within the body of the church. The frame has an inner and an outer component, with some later additional strengthening members, and is therefore a complex structure, which it was hoped that dendrochronology would be able to simplify in terms of phasing.

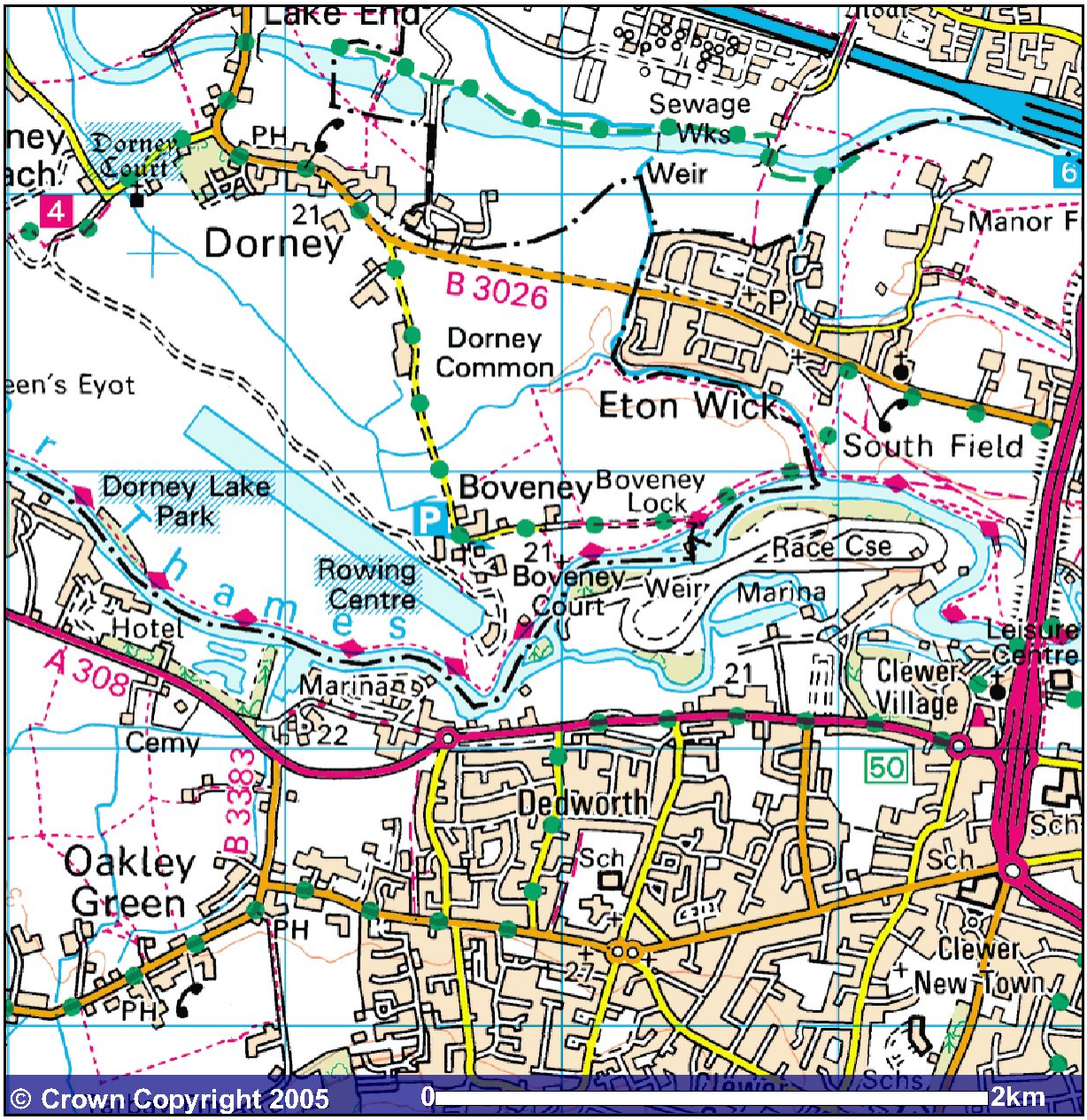

Figure 1: Map centred on the location of the former church of St Mary Magdalene, Boveney, near Eton, Buckinghamshire.

Methodology

The site was sampled in June AD 2004 following a preliminary assessment. Oak timbers with more than 50 rings, traces of sapwood, and accessibility were the main considerations in the initial assessment. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill (Figs 2–5). The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were prepared for measuring by sanding, using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (1999). Cross-matching and dating was accomplished by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted to allow visual comparisons to be made between sequences on a light table. This method provides a measure of quality control in identifying any errors in the measurements when the samples cross-match.

In comparing one sequence or site sequence against another, *t*-values over 3.5 are considered significant, although in reality it is common to find *t*-values of 4 and 5 which are demonstrably spurious because more than one matching position is indicated. For this reason, it is necessary to obtain some *t*-values of 5, 6, and higher, and for these to be well replicated from different, independent chronologies and with local and regional chronologies well represented, unless the timber is imported. Where two individual sequences match with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they most likely came from the same tree.

When cross-matching between samples is found, their ring-width sequences are averaged to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established. This is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the measured rings in each sample. These dates require interpretation for the construction date of the phase under investigation to be determined. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. The sapwood estimates used here are based on those proposed for this area by Miles (1997a), in which 95% of oaks contain 9–41 rings. Where complete sapwood or bark is present, the exact date of tree felling may be determined.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the reuse of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

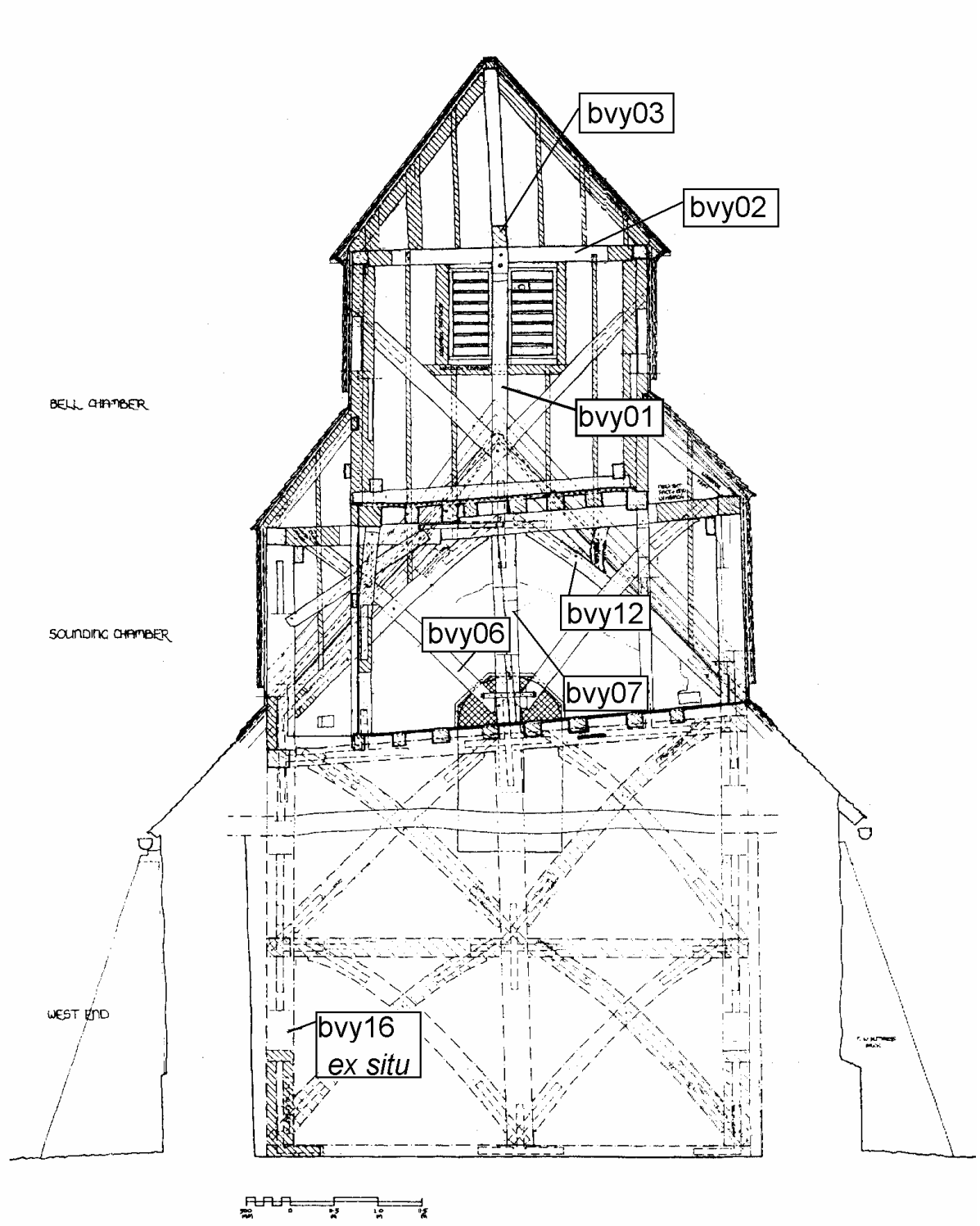

Figure 2: West internal elevation showing the timbers sampled for dendrochronology. Adapted from an original drawing by Nicola Westbury

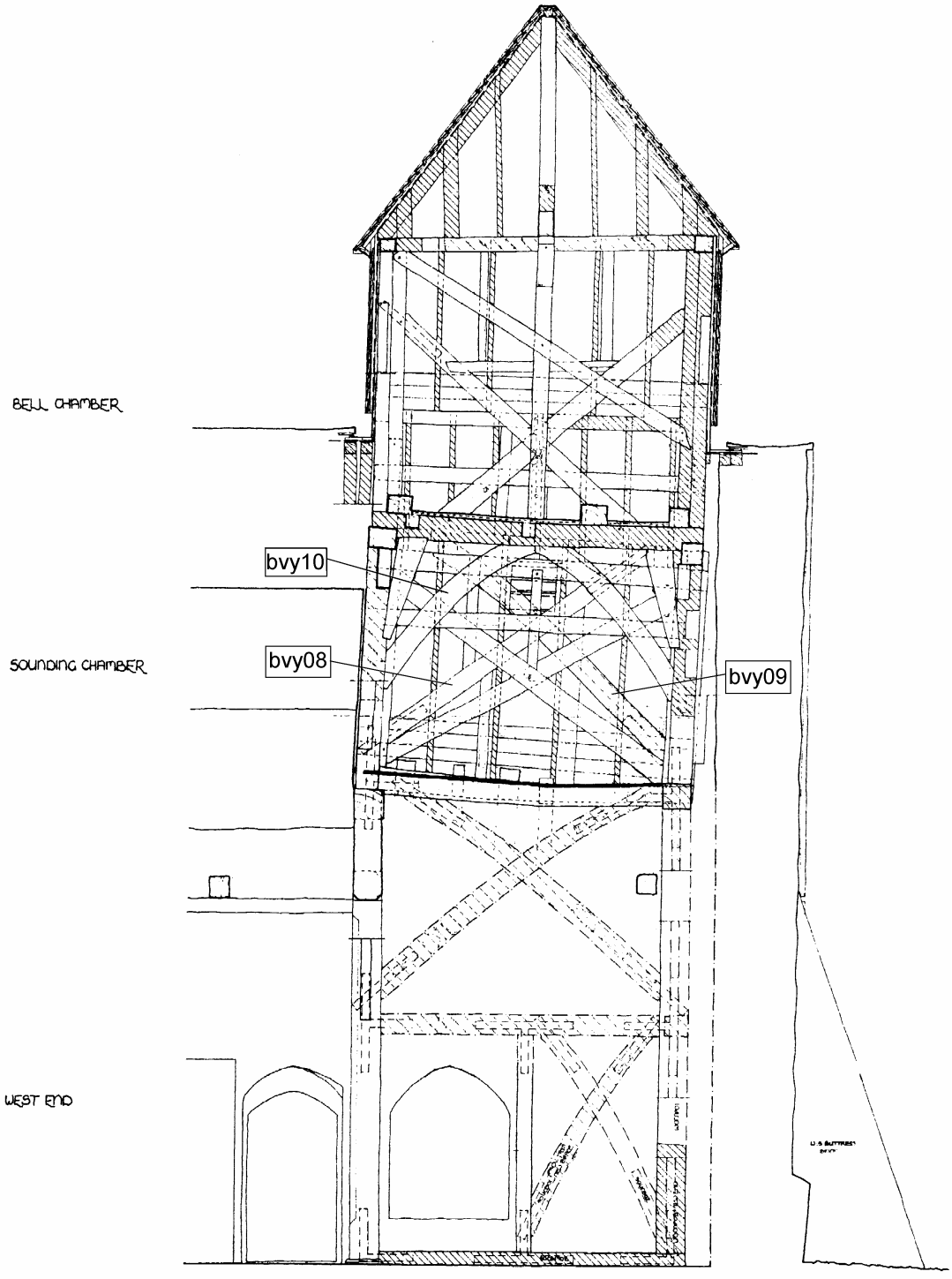

Figure 3: South internal elevation, showing timbers sampled for dendrochronology. Adapted from an original drawing by Nicola Westbury

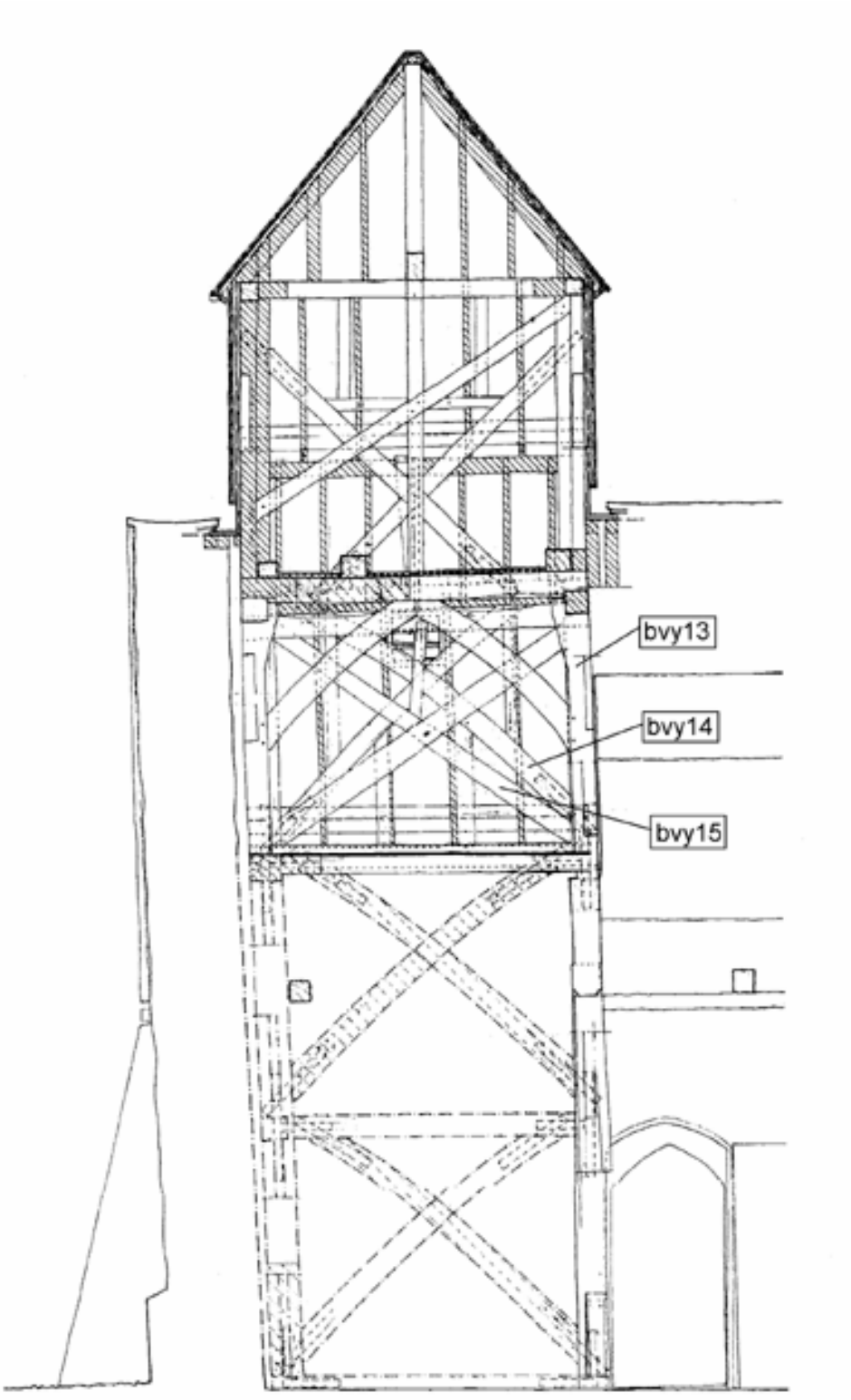

Figure 4: North internal elevation, showing timbers sampled for dendrochronology. Adapted from an original drawing by Nicola Westbury

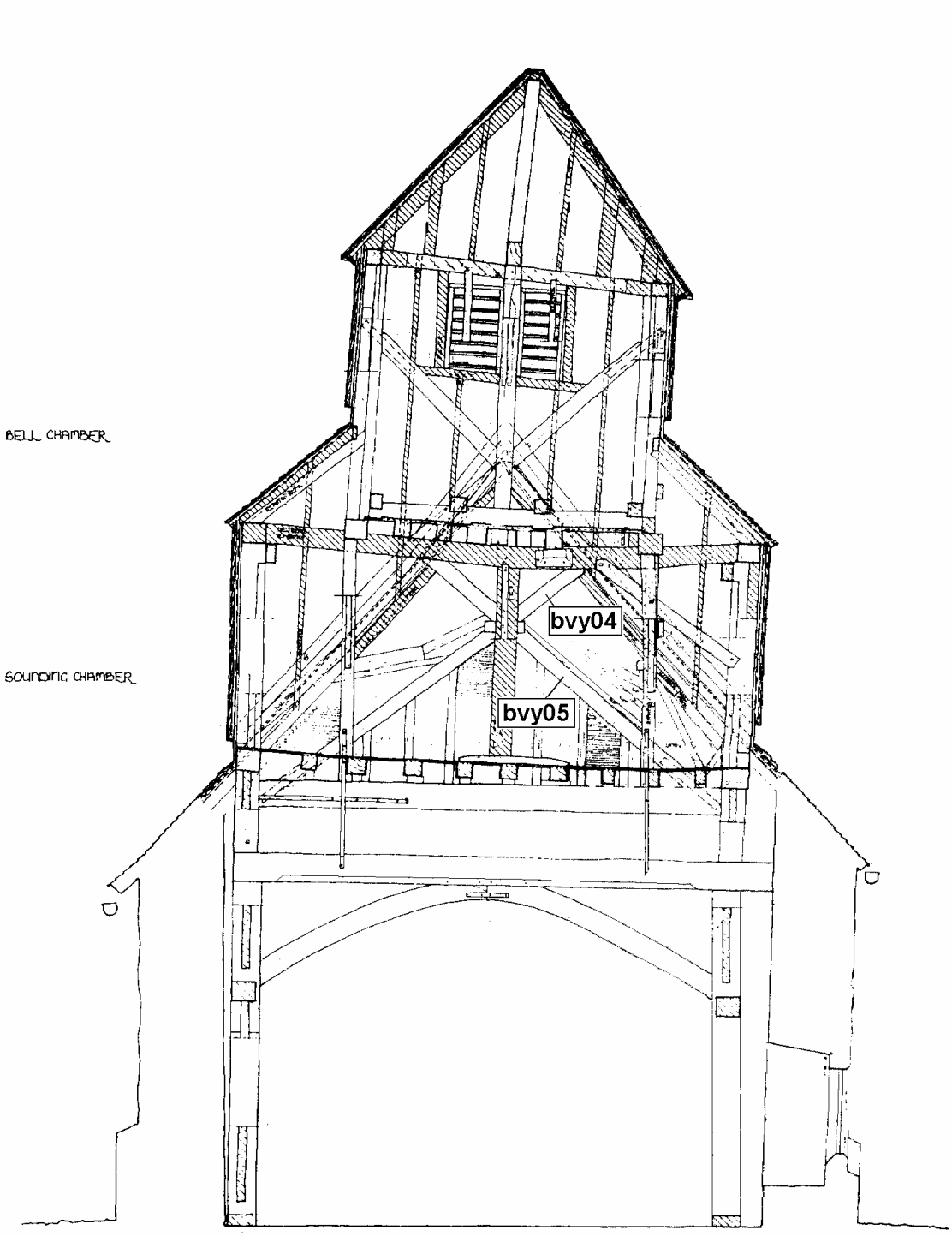

Figure 5: East internal elevation, showing timbers sampled for dendrochronology. Adapted from an original drawing by Nicola Westbury

Results

All of the samples taken were of oak (*Quercus* spp.). Basic information about the samples and their locations is given in Table 1. Cross-matching was attempted between all samples, and acceptable matches were found between some of these.

Sample **BVY02** matched **BVY03** (*t* = 6.5 with 78 years overlap). It was noticed however that the very early years of the sequence **BVY02** contained a very uncharacteristic decline and recovery in ring-width, and these were edited out. The shortened series, **BVY02o** contained the outer 90 rings, as opposed to the 105 rings of the original sequence, and this matched better with series **BVY03** (*t* = 6.7 with 72 years overlap). A new 96-year sequence, **BVY02o3**, was made, but this did not give any satisfactory matches with other sequences from the site, nor with dated reference material.

Samples **BVY06** and **BVY13** matched each other (*t* = 6.6 with 54 years overlap). These were combined into a single 113-year sequence, **BVY0613**, which also failed to match other site sequences and dated reference material. The sequence contains some abrupt growth changes, as illustrated in Figure 6.

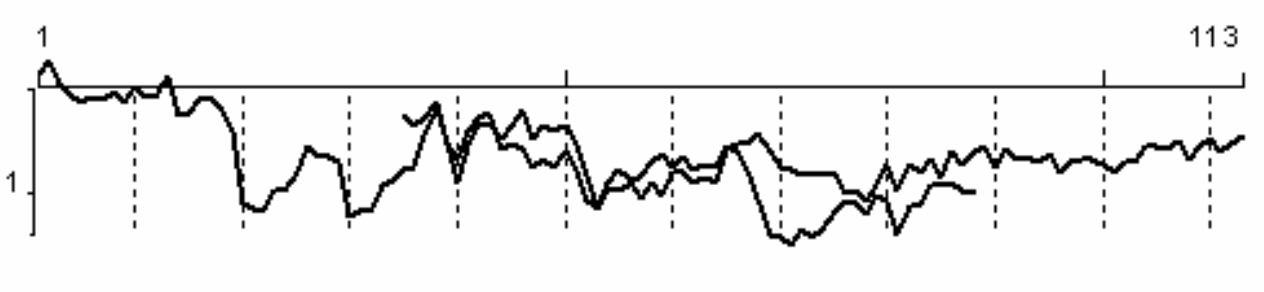

Figure 6: Plot of the two matching ring width sequences, **BVY06** and **BVY13**, showing their abrupt growth changes. The vertical axis represents the ring widths (mm) on a logarithmic scale

Four other sequences matched each other (Table 2) and were combined into a single 117-year site sequence, **BOVENEY1**. The site master chronology **BOVENEY1** was dated to the period AD 1364–1480 by comparison with the dated reference chronologies, the best results being shown in Table 3. The data for this sequence are given in Table 4, and the relative positions of overlap of the dated samples are illustrated, along with their interpreted likely felling date ranges, in Figure 7.

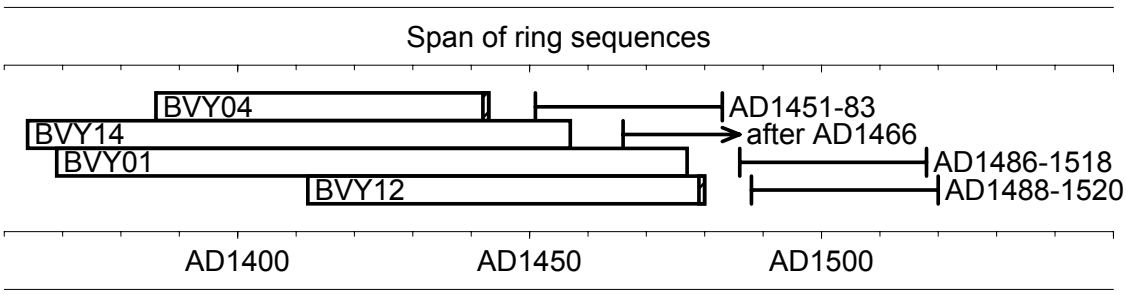

Figure 7: Bar diagram showing the relative positions of overlap of the dated timbers in chronology **BOVENEY1**, along with their interpreted felling dates.

Table 1: Details of oak (*Quercus* spp.) timbers sampled from the tower of the former church of St Mary Magdalene, Boveney

Sample Number	Timber and position	No of rings	Mean width (mm)	Mean sens (mm)	Dates AD Spanning	H/S bdry AD	Sapwood complement	Felling seasons and dates/date ranges (AD)
Bell chamber								
BVY01	Central post, west wall	109	1.48	0.14	1369–1477	1477	h/s	1486–1518
BVY02	North-south roof beam	105	1.88	0.24	undated	-	11	unknown
BVY03	East-west roof beam	78	2.49	0.26	undated	-	h/s	unknown
Sounding chamber								
BVY04	East wall upper strut, south	58	2.39	0.21	1386–1443	1442	1	1451–1483
BVY05	East wall lower strut, south	<50	NM	NM	undated	-	-	unknown
BVY06	West wall lower strut, south	79	1.70	0.18	undated	-	-	unknown
BVY07	West wall central post	<50	NM	NM	undated	-	-	unknown
BVY08	South wall, outer low strut	<50	NM	NM	undated	-	-	unknown
BVY09	South wall, inner low strut	68	1.95	0.27	undated	-	20 ?C	unknown
BVY10	South wall, inner arch brace	73	0.98	0.13	undated	-	12	unknown
BVY11	Central strut notched into post	64	2.24	0.24	undated	-	?h/s	unknown
BVY12	West wall, upper strut	69	1.95	0.17	1412–80	1479	1	1488–1520
BVY13	North east corner, inner frame	88	2.06	0.22		--	h/s	unknown
BVY14	North wall, brace to outer frame	94	1.44	0.19	1364–1457	-	-	after 1466
BVY15	North wall, inner diagonal brace	70	2.09	0.22	undated	-	-	unknown
Lower section								
BVY16	*Ex situ* corner post WOCNP01	<50	NM	NM	undated	-	-	unknown

Key: C = complete sap, winter felling; h/s bdry = heartwood/sapwood boundary - last heartwood ring date; mean sens = mean sensitivity; NM = not measured. Sapwood estimate of 9–41 used (Miles 1997a)

Table 2: Cross-matching between the four sequences forming the site chronology **BOVENEY1**

***t*- values**			
Sample No	**BVY04**	**BVY12**	**BVY14**
BVY01	3.2	5.0	4.7
BVY04		2.7	4.3
BVY12			7.4

Table 3: Dating evidence for the site chronology **BOVENEY1,** AD 1364–1480 (regional multi-site chronologies have the file name in **bold**)

County/ region:	***Chronology name:***	***Short publication reference:***	***File name:***	***Spanning: (yrs AD)***	***Overlap (yrs)***	***t-value***
Herefordshire	Kings Pyon barn	(Groves and Hillam 1993)	KINGPYON	1346–1480	117	7.6
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	117	7.4
Southern England	Southern England Master	(Bridge 1998)	**SENG98**	944–1790	117	7.4
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	117	7.4
Oxfordshire	Whittles Farm	(Miles and Haddon-Reece 1993)	MDM11X	1355–1454	54	7.0
Gloucestershire	Mercer's Hall, Gloucester	(Howard *et al* 1996)	GLOUCMH	1289–1541	117	7.0
Shropshire	Moat House, Longnor	(Miles and Haddon-Reece 1993)	MOATHSE1	139–-1466	76	6.9
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	117	6.9
Worcestershire	St Nicholas' Church, Warndon	(Tyers 1998)	WARNDON2	1391–1498	90	6.8
Worcestershire	St Cuthbert's, Wick	(Bridge 1983)	WICK	1255–1496	117	6.8
Herefordshire	Farmer's Club, Hereford	(Tyers 1996)	HEREFC	1313–1640	117	6.8
Gloucestershire	St Andrew's Chapel, Frocester	(Fletcher *et al* 1985)	FROC247	1385–1476	92	6.8
Herefordshire	Cradley Village Hall	(Miles *et al* 2004)	CRADLEY	1347–1530	117	6.7

Interpretation and Discussion

The atypical growth characteristics found in several of the sequences from this site, as illustrated by the plots in Figure 5, meant that few of the samples could be dated. Four samples did date, however. One of these, **BVY04**, gave relatively weak matches against the other dated sequences (Table 2), but was dated independently. This timber had a likely felling date range (AD 1451–83) earlier than that for the other three. Assuming sample **BVY14**, which did not retain the heartwood-sapwood boundary, to be part of the same group of timbers felled at approximately the same time, and taking the mean heartwood-sapwood boundary date for the other two dated timbers of AD 1478, the most likely felling date range for the three remaining dated timbers is AD 1487–1519. Insufficient data are available to comment more fully on the relative dating of the internal and external frames of the tower. The nave roof, not part of the brief for this investigation, and not inspected on this occasion, may provide further useful information relating to the building of the tower.

The site chronology gives stronger matches with site chronologies from west and north of the location of the tower (Fig 8), which may indicate a source area for these timbers well away from their current location, although dendro-provenancing of timbers is a relatively inexact science at this scale (Bridge 2000).

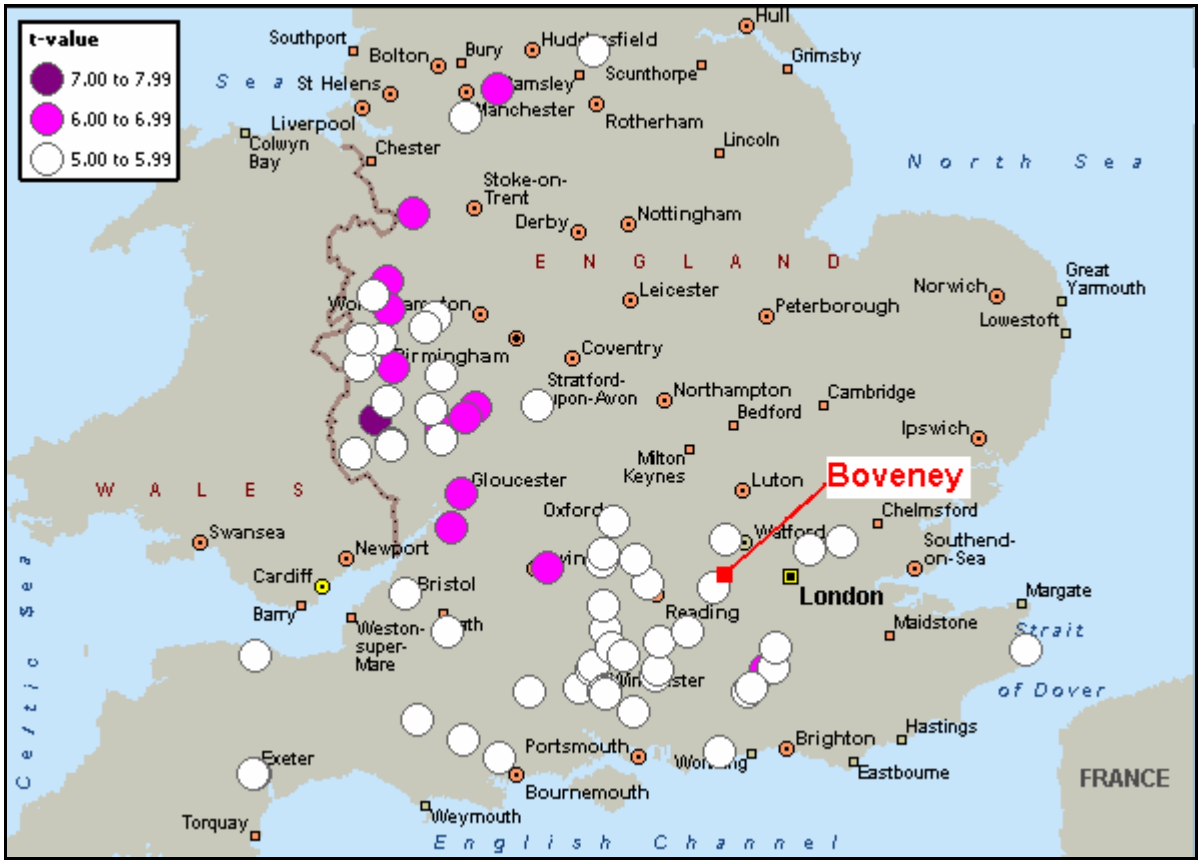

Figure 8: Plot of sites matching the site chronology **BOVENEY1** showing the tendency for stronger matches with sites to the north and west of the location of the timber tower

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Table 4: Ring width data for the site chronology **BOVENEY1**, AD 1364–1480

Ring widths (0.01mm)										no of trees									
82	75	104	98	104	141	115	110	68	61	1	1	1	1	1	2	2	2	2	2
61	59	68	56	83	150	143	137	79	96	2	2	2	2	2	2	2	2	2	2
67	83	145	189	190	171	179	214	171	177	2	2	3	3	3	3	3	3	3	3
189	230	250	282	286	290	315	288	185	278	3	3	3	3	3	3	3	3	3	3
295	287	241	227	280	318	259	235	225	200	3	3	3	3	3	3	3	3	4	4
191	157	144	171	199	117	126	124	106	147	4	4	4	4	4	4	4	4	4	4
158	134	139	125	190	202	189	193	185	152	4	4	4	4	4	4	4	4	4	4
168	195	169	192	178	141	143	149	172	166	4	4	4	4	4	4	4	4	4	4
224	179	151	161	165	183	143	190	172	162	3	3	3	3	3	3	3	3	3	3
211	178	177	168	156	135	155	120	136	145	3	3	3	3	2	2	2	2	2	2
100	111	131	142	155	187	167	147	174	169	2	2	2	2	2	2	2	2	2	2
162	174	162	133	119	151	201				2	2	2	2	1	1	1			