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Tree-Ring Analysis of Timbers from the Bellframe, Church of St Mary, Church Street, Attleborough, Norfolk

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Summary

Samples were taken from various elements of the bell frame, and one of two foundation beams, thought to be of thirteenth century date. The sample from the foundation beam did not match the others, but neither did it give consistent matches against the reference material, and it remains undated. Seven of the longer series from the frame matched each other and were combined into a 97-year long site chronology dating to the period AD 1418-1514. The most likely felling date range for these timbers is AD 1520-35.

Keywords

Dendrochronology
Standing Building

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Introduction

The Church of St Mary, Attleborough (NGR TM 0489 9539; Fig 1) is a Norman cruciform church, the chancel of which was demolished in AD 1541. The central tower dates from the eleventh century in its lower stages, and the early thirteenth century in its upper parts (Fig 2). A major project is underway to repair the bell frame (Fig 3), and dendrochronological dating of the frame was requested as part of a much wider investigation into its history being conducted by English Heritage.

The bell frame (Fig 3) sits on a pair of foundation beams that it is thought may be of thirteenth century date. Above these is another set of foundation beams that are original to the construction of the present bell frame. Above these are the bearers, followed by the sill beams of the bell frame trusses. Major repairs were undertaken in the eighteenth century, as evidenced by a carved date of AD 1736 to be seen on one of the headpieces.

Methodology

The site was visited in March AD 2003, along with Richard Bond (English Heritage), who was carrying out complimentary research on the bell frame structure, and was able to give background information on the site. 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. The cores were glued to wooden laths, labelled, and stored for subsequent analysis. When sanded, some sequences were found to have less than 50 rings, those with more than 40 were measured and analysed.

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. The software used in measuring and subsequent analysis was written by Ian Tyers (1999).

Ring sequences were plotted to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements when the samples crossmatch. Statistical comparisons were made using Student's *t*-test (Baillie and Pilcher 1973; Munro 1984). The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973). Those *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches, and give consistent matching positions.

When crossmatching between samples is found, their ring-width sequences are meaned 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, which 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.

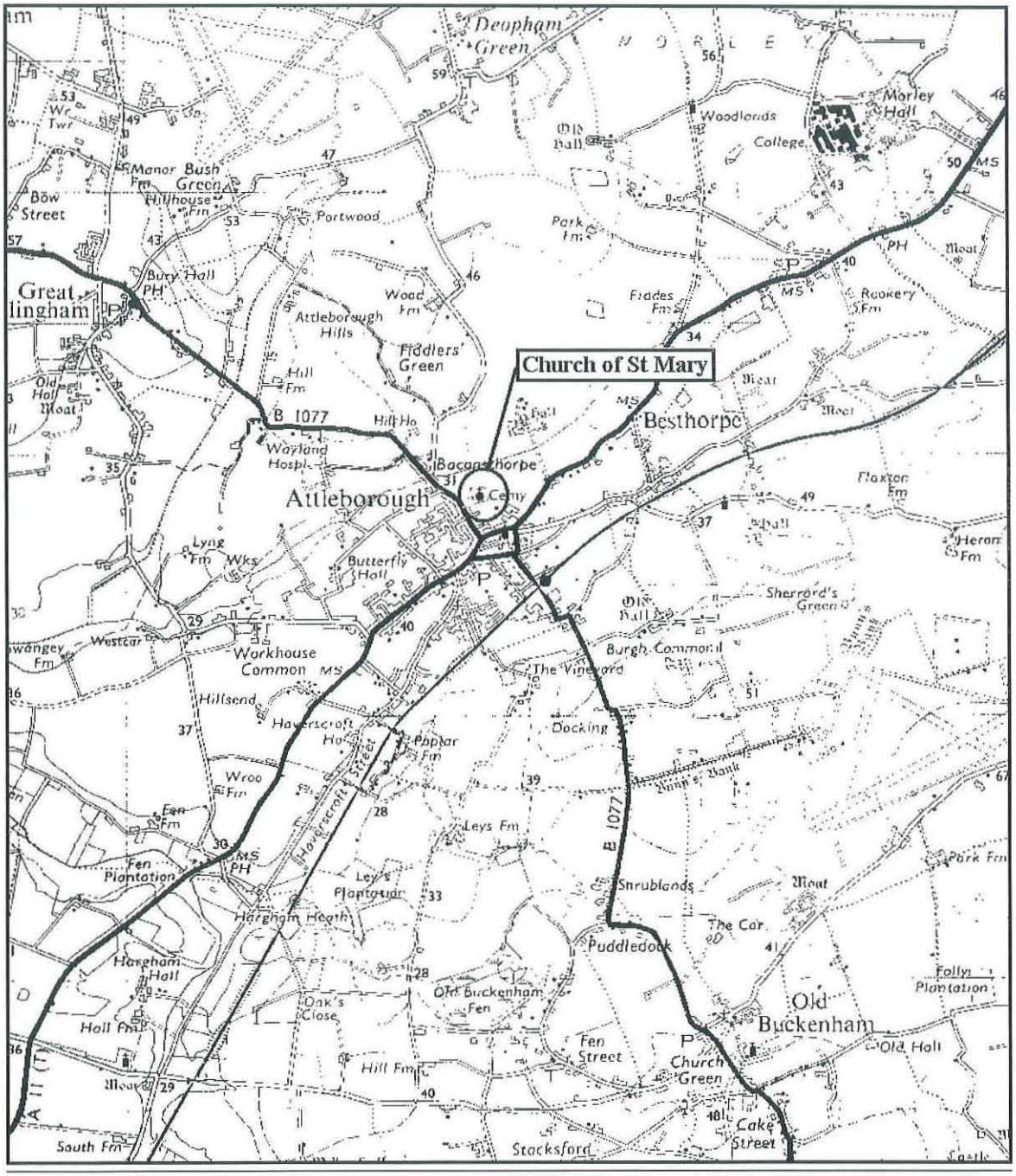


Figure 1: Map showing the location of the Church of St Mary, Attleborough

The dates thus obtained represent the time of formation of the rings available on each sample. Interpretation of these dates then has to be undertaken to relate these findings to the construction date of the phase under investigation. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. In this instance, the sapwood estimates are based on those proposed for this area by Miles (1997), in which 95% of samples are likely to have from 9 to 41 sapwood rings. Where bark is present on the sample the exact date of felling of the tree used 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 re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

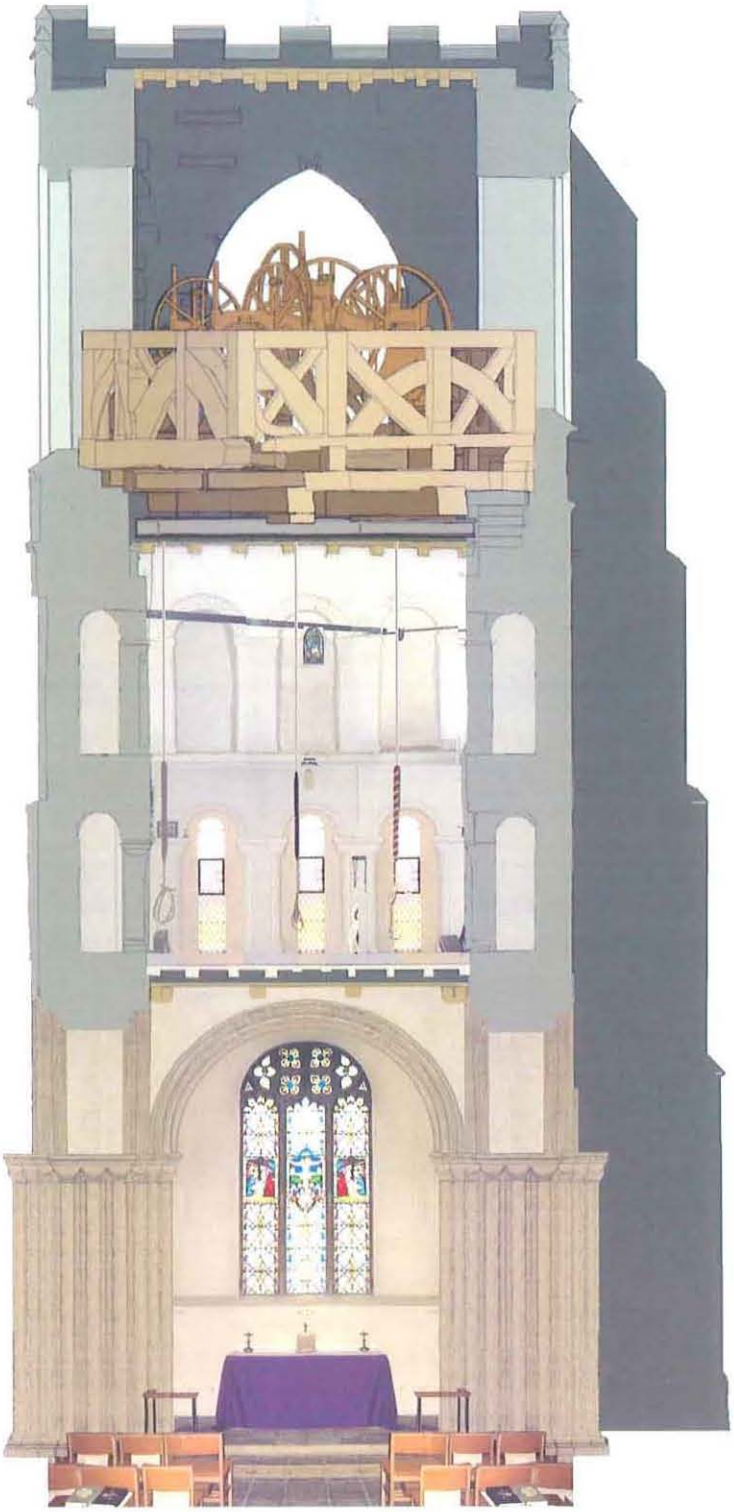
Results

All the timbers sampled were of oak (*Quercus* spp.). The main area of study was the timbers thought to be original to the main structure of the bell frame, although the lower foundation beams were also of interest. These were sampled as they were large timbers, thought to have many rings, which may possibly have given a date, despite there only being two of them. Details of the timbers sampled are given in Table 1 and illustrated in Figure 4. Several of the timbers were judged as unsuitable for sampling as they had too few rings, despite being of large scantling. This has been encountered before in work on bell frames (eg Bridge 1998a), where it appears that fast-grown oaks have been chosen for their strength.

Crossmatching was found between seven of the ten timbers sampled (Table 2) and a 97-year long site chronology, ATTLBRGH, was formed, which subsequently dated to the period AD 1418 – 1514, the best matches being shown in Table 3. The relative positions of overlap of the dated timbers are shown, along with their interpreted likely felling dates, in Figure 5. The data for the site master chronology, ATTLBRGH, are given in Table 4.

Table 1: Oak (*Quercus* spp.) timbers sampled from Attleborough Bellframe. h/s represents the heartwood-sapwood boundary, figures in brackets represent additional unmeasured rings

Sample number	Origin of core	Total no of years	Average growth rate (mm yr^{-1})	Sapwood details	Heartwood -sapwood boundary date (AD)	Date of sequence AD	Felling date of timber AD
ATB01	Central north-south sill	68	2.33	-	-	1441-1508	after 1517
ATB02	South-east corner post	77	2.58	?h/s	1494?	1418-1494	1503–35?
ATB03	East arch brace, south-east corner	46	2.38	?h/s	-	undated	unknown
ATB04	South central post	53	4.82	17	-	undated	unknown
ATB05	South-west post to central bell pit	71	2.46	12	1502	1444-1514	1514-43
ATB06	South foundation beam (inserted?)	90	2.03	-	-	undated	unknown
ATB07	Bearer above ATB06	53	3.25	-	-	1442-94	after 1503
ATB08	East sill to central bell pit	55	3.16	h/s	1509	1455-1509	1518–50
ATB09	North-east post to central bell pit	70	3.01	h/s	1511	1442-1511	1520–52
ATB10	North-west post to central bell pit	83	3.13	2	1502	1422-1504	1511-43



St Mary's Church, Attleborough, Norfolk

Figure 2: Internal elevation of east wall of tower, showing position of the bellframe, English Heritage, July 2003

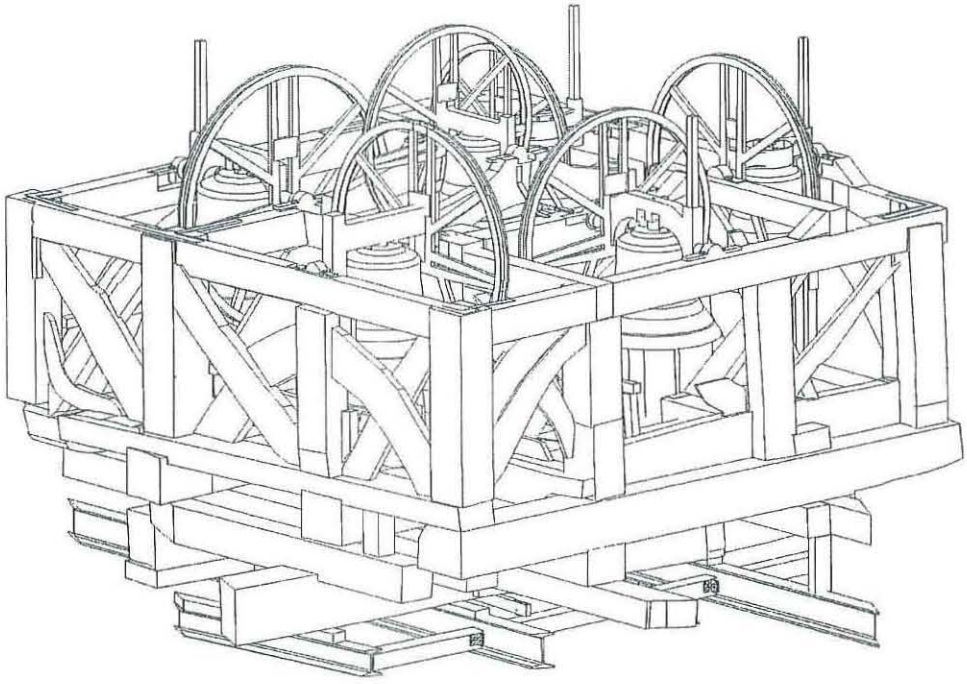


Figure 3: View of the bellframe as existing, showing the arrangement of the bells and the position of the timber foundation beams and inserted steel beams, English Heritage, July 2003

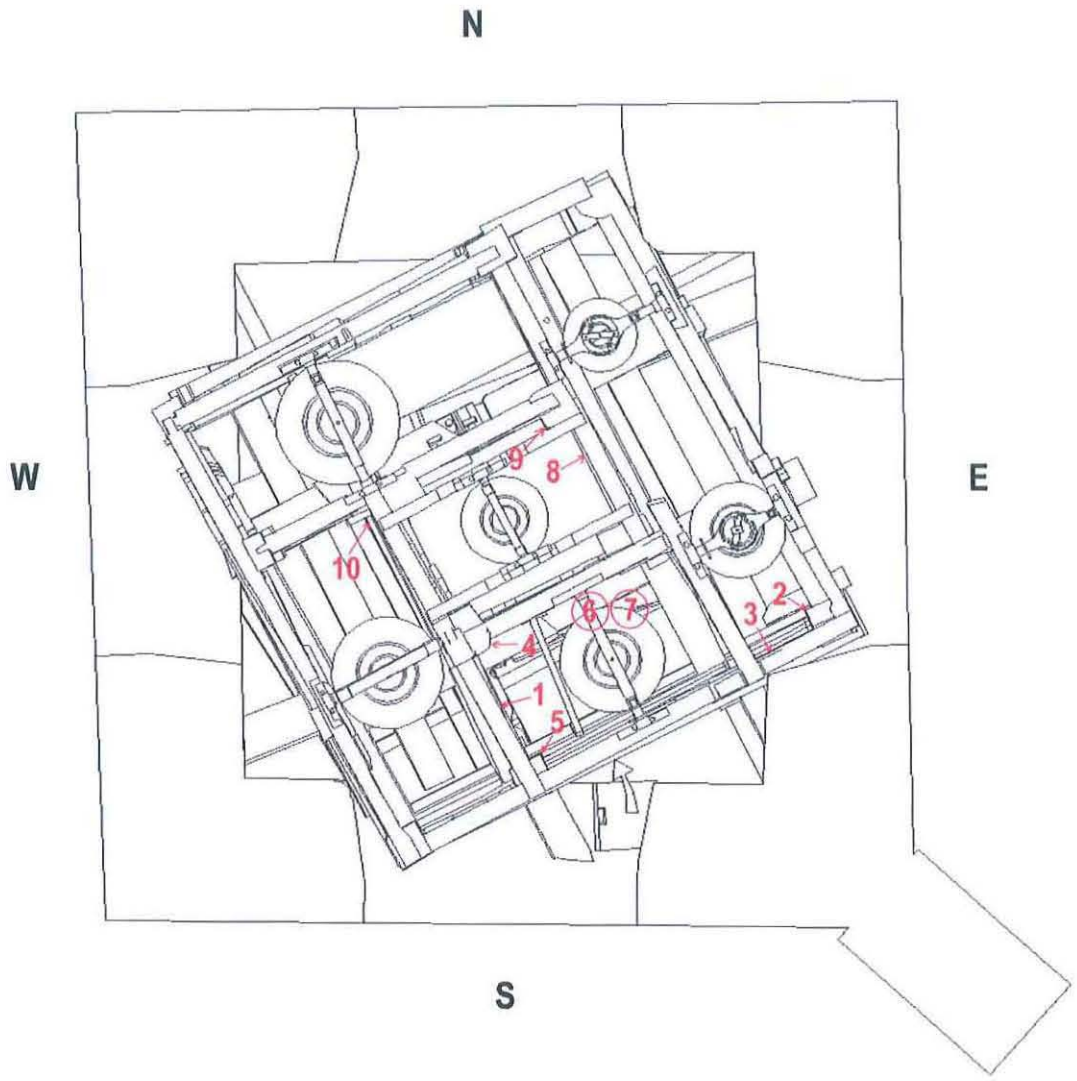


Figure 4: Plan of the bellframe showing the locations of the samples taken for dendrochronology, English Heritage, July 2003

Table 2: Crossmatching between the dated samples from Attleborough bellframe, a (-) indicates a *t*-value of less than 3.0

	t - values					
Sample	**ATB02**	**ATB05**	**ATB07**	**ATB08**	**ATB09**	**ATB10**
ATB01	-	3.8	-	4.6	4.8	3.2
ATB02		4.4	5.0	-	3.8	3.7
ATB05			-	-	6.2	6.5
ATB07				3.1	-	3.2
ATB08					3.6	4.3
ATB09						6.3

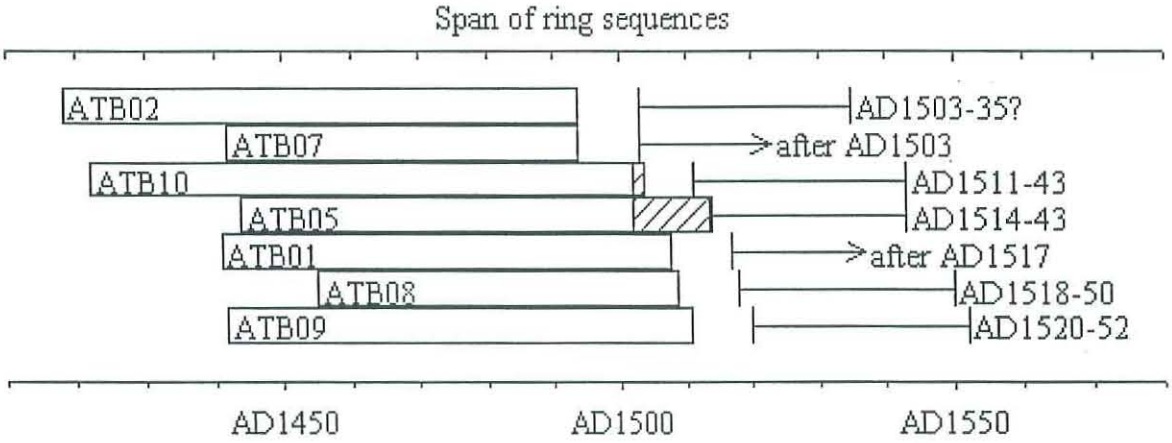


Figure 5: Bar diagram showing the relative positions of overlap of the dated timbers from the bellframe at St Mary's Church, Attleborough, Norfolk, along with their interpreted felling dates

Table 3: Dating of the oak site chronology ATTLBRGH, the upper section contains multi-site regional chronologies, the lower section contains individual site chronologies

		ATTLBRGH AD 1418-1514	
Dated reference or site master chronology	**Dates spanned (AD)**	***t*-value**	**Overlap (yrs)**
Kent (Laxton and Litton 1989)	1158-1540	4.8	97
Wales97 (Miles pers comm)	404-1981	4.8	97
Hants02 (Miles pers comm)	443-1972	4.6	97
Southern England (Bridge 1988)	1083-1589	4.3	97
Bruce Castle, London (Bridge 1998b)	1434-1542	6.3	81
Drinkstone, Suffolk (Bridge 2001)	1464-1586	6.3	51
Oldbrfa1, Wales (Miles and Worthington 1998)	1347-1500	5.7	70
Oracle3, Berkshire (Miles pers comm)	1345-1517	5.4	97
Clunbury, Shropshire (Tyers 2000)	1239-1494	5.4	77
Wimbish, Essex (Miles *et al* forthcoming)	1440-1563	5.3	75
Wycombe, Buckinghamshire (Miles and Worthington 2000)	1395-1531	5.2	97
PlasMawr2, Wales (Miles and Haddon-Reece 1996)	1360-1578	5.2	97
Cobham Hall, Kent (Arnold *et al* 2003)	1317-1662	5.1	97
Elland Hall, Yorkshire (Hillam 1983)	1372-1574	5.1	97
Peniarth, Wales (Miles and Haddon-Reece 1996)	1385-1550	5.1	97
Fawsley1, Northamptonshire (Howard *et al* 1999)	1427-1575	5.0	88
Cathedral Barn, Hereford (Tyers 1996)	1359-1491	4.9	74

Interpretation and Discussion

A range of elements from the bell frame matched each other, and appear to have come from a single batch of timbers. The one timber sampled that came from a beam thought to be of thirteenth-century date (ATB06) did not match the other sequences, neither did it give consistent crossmatching against the reference material, and it remains undated, as do two other timbers (ATB 03 and 04).

The crossmatching between the individual dated timbers was not particularly strong statistically (Table 2) although visually the plots look well-matched (Fig 6). The dated series appear to be quite sensitive, ie show high year-to-year variability, and this may possibly reflect some management of the trees, or simply growth on a site sensitive to small changes in the year-to-year growing conditions.

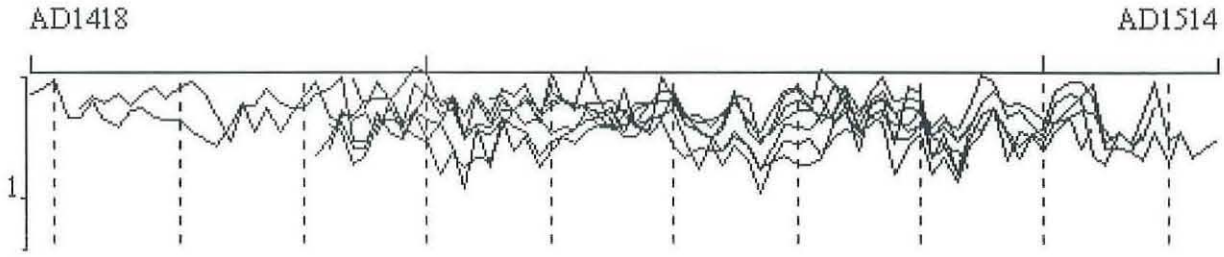


Figure 6: Overlying plots of the seven dated tree-ring series from the bell frame, plotted on a logarithmic scale (mm), showing the similarities in growth and crossmatching

The site chronology gave good matches with a range of reference material, both from the East Anglian region and from much further to the west, notably from Wales and Herefordshire. It is thus not possible to say where the timbers may have originated, although it seems likely that they were relatively local to the site, probably from within 20 – 30 km.

It is possible to calculate the most likely felling period for these timbers in one of two ways; either by adding the sapwood estimate appropriate to this region to the average heartwood-sapwood boundary date (AD 1504), or by looking at the common overlap between the likely felling dates of the individual series, a less statistically rigorous method. In this case, both give the same result, assuming that the trees come from a single batch felled together, and adjusting the result of the first method by excluding the early years in which some trees are still growing. There is thus a 95% chance that the trees were felled in the period AD 1520 – 35. Interestingly, this is just a few years before the known date of removal of the chancel (AD 1541). This finding is at odds with the carved date of AD 1736, which may relate to the time of insertion of the foundation beams.

Acknowledgments

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Table 4: Ring width data for the dated site chronology ATTLBRGH, AD 1418-1514

ring widths (0.01mm)										no of trees									
383	415	468	282	303	359	307	317	320	354	1	1	1	1	2	2	2	2	2	2
352	318	353	343	299	245	233	335	281	365	2	2	2	2	2	2	2	2	2	2
290	311	348	336	271	317	264	258	312	317	2	2	2	3	5	5	6	6	6	6
276	352	326	270	297	203	278	245	324	292	6	6	6	6	6	6	6	7	7	7
322	253	315	300	285	334	295	285	290	271	7	7	7	7	7	7	7	7	7	7
294	354	341	257	230	224	230	303	242	181	7	7	7	7	7	7	7	7	7	7
222	286	298	276	299	313	343	247	324	352	7	7	7	7	7	7	7	7	7	7
251	286	301	198	230	179	232	318	360	247	7	7	7	7	7	7	7	5	5	5
251	249	227	301	345	336	306	197	213	193	5	5	5	5	5	5	5	4	4	4
226	339	188	233	169	188	213				4	3	2	2	1	1	1			