Centre for Archaeology Report 115/2002

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ISSN 1473-9224

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Summary

A tree-ring dating programme was commissioned of timbers in the nave roof of the church of St Constantine and St Aegidius, Milton Abbot, Devon, by English Heritage in AD 2002. The tree-ring results indicate that timbers felled in the first half of the sixteenth century are present in the nave roof. The absence of surviving sapwood prevents a precise felling or construction date from being obtained.

Keywords

Dendrochronology
Standing Building

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TREE-RING ANALYSIS OF OAK TIMBERS FROM THE NAVE ROOF OF THE CHURCH OF ST CONSTANTINE AND ST AEGIDIUS, MILTON ABBOT, DEVON

Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the nave roof of the church of St Constantine and St Aegidius, Milton Abbot, Devon (NGR SX 4071 7927). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the building.

The church of St Constantine and St Aegidius lies in the centre of Milton Abbot, a village perhaps more architecturally notable for the Lutyens cottages that surround the churchyard (Cherry and Pevsner 1989). The village lies in the western edge of Devon with Launceston in Cornwall *c* 10km north-west, and Plymouth *c* 25km south (Figs 1 and 2). The remarkable decorated wagon roof of the church nave is undergoing English Heritage grant aided repairs. This roof has moulded ribs and carved bosses and is thought to date from the later fifteenth or early sixteenth century. Tree-ring analysis was commissioned by Rebecca Child, the local English Heritage architect, to inform the repair programme.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The methodology used for this building was as follows.

The building was initially visited and an assessment of the dendrochronological potential of the building was undertaken. This assessment aimed to identify whether oak timbers with suitable ring sequences for analysis existed in the material proposed for sampling. This assessment identified that the nave roof contained some suitable material, although access was considered less than ideal.

The dendrochronological sampling programme attempted to cover the suitable material by obtaining samples from as broad a range of timbers, in terms of structural element types, scantling sizes, carpentry features, and surface condition as was possible within the terms of the request.

The most promising timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were left open to aid ventilation. The ring sequences in the cores were revealed by sanding.

The complete sequences of growth rings in the cores that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1999a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported 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, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These, and any remaining unmatched ring sequences, were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* 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 which are missing. This *tpq* may be many decades prior to the real felling date. 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 estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range (Tyers 1998). These figures are applicable to oaks from England and Wales. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers, seasoning, and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

Twelve timbers were selected for sampling from a much larger number that were examined within the ceiling structure. These sample were numbered **1-12** (Table 1). Sample locations throughout the nave were recorded by a combination of the truss number (following the numbering scheme of Hugh Harrison, and also adopted by Stuart Brown on site, where T1-T12 are the decorated trusses starting at the east of the nave, with the intermediate trusses labelled T1a and T1b etc, see Fig 3), and the structural element description (Fig 4).

One of the samples (**2**) when examined in the laboratory was rejected because it had too few rings for reliable analysis. The tree-ring series from the remaining eleven timbers were measured and the resultant series were then compared with each other. Four sequences were found to match together to form an internally consistent group (Table 2). A 85-year site mean chronology was calculated, named MLTNABBT. This site mean, and the seven unmatched samples, were then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well correlated position was identified for the MLTNABBT sequence. Table 3 shows example correlations at its identified dating position against independent reference chronologies. Table 1 provides the chronological dates identified for each component sample by this process and their interpretation. Figure 5 graphically shows the chronological position identified for each component sample. Appendix 1 lists the individual sample series. The remaining seven measured samples did not match either the rest of the material from Milton Abbot nor reference chronologies and are thus undated by this analysis.

Discussion

The 85-year chronology MLTNABBT is dated AD 1410 to AD 1494 inclusive. It was created from four timbers. All of the dated samples were complete to the original heartwood/sapwood boundary (Table 1). All the timbers are oak (*Quercus* spp).

The nave roof consists of 11 bays from the tower to the chancel arch. It is constructed of 12 visible decorated, bossed, and arch braced principal trusses (Fig 3 and 4). In between these are 23 intermediate or secondary trusses that are normally invisible above the ceiling. There are pairs of these in most of the bays but three in the wider bay between T11 and T12. The samples were all obtained within the roof space above the central ceiled area, above collar height. The samples were obtained from principal truss rafters, the rafters of the intermediate trusses, and the collars. The timbers selected for sampling are quartered trees and are all of similar scantling size. The cores contain reasonable numbers rings, but almost no sapwood survives on any of this material although the curving surfaces derived from the heartwood/sapwood boundary were observed on many. On some timbers this surface was accessible for coring. The dates of the latest rings in each dated sample are spread over only five years with the earliest, sample **4**, ending at AD 1490, whilst sample **10** ends at AD 1494. This limited variation in the end dates strongly suggests these are derived from a single construction event. Applying the estimate for the number of missing sapwood rings on each datable sample indicates the group was felled between AD 1504 and AD 1536.

Conclusion

Assuming the timbers were freshly felled, and this was normal practice in the medieval period (Charles and Charles 1995), the structure is likely to be of pre-Reformation date.

Devon has been the subject of fairly extensive tree-ring studies over the past few years following its recognition as a 'difficult' area for dendrochronological work (Groves pers comm). The material from Milton Abbot has provided a short dated data set from the western part of the county well away from the areas hitherto examined. The composite series matches data from southern and western England much better than it does any contemporaneous data from Devon itself (Table 3). Whether this is a reflection of differences in source of these timbers is currently unknown.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. Stuart Brown kindly discussed his observations on site and supplied the originals of Figures 3 and 4. Hugh Harrison kindly discussed the structure and its interpretation. The churchwarden Mrs Vigars kindly facilitated access to the church. Peter Marshall from English Heritage kindly put together the request documentation, and Cathy Groves kindly provided useful discussion of the results.

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Figure 1 Location of Milton Abbot within England and Wales.

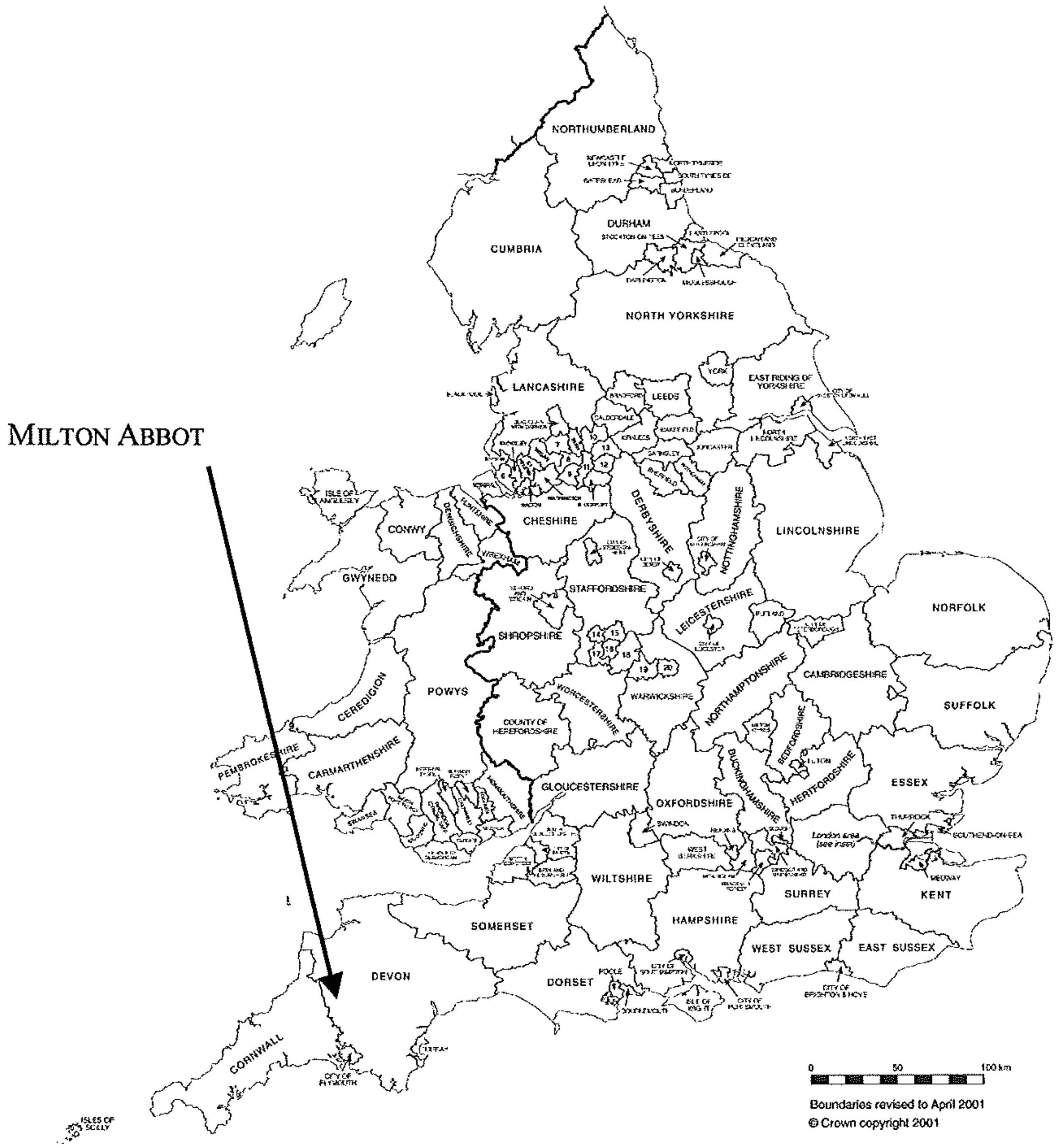


Figure 2 Location of the Church of St Constantine and St Aegidius, Milton Abbot

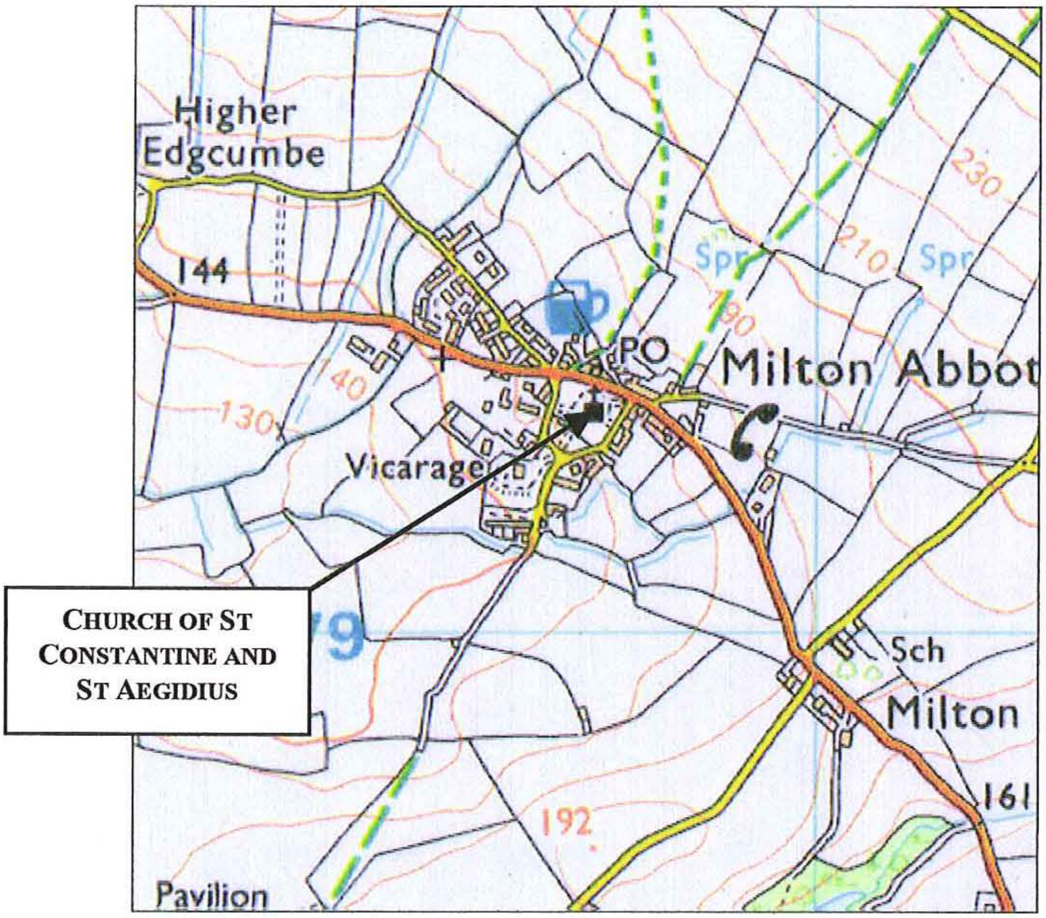


Figure 4 Composite elevation of a primary nave truss from the church of St Constantine and St Aegidius, Milton Abbot showing the nomenclature followed in this report, based on a figure supplied by Stuart Brown

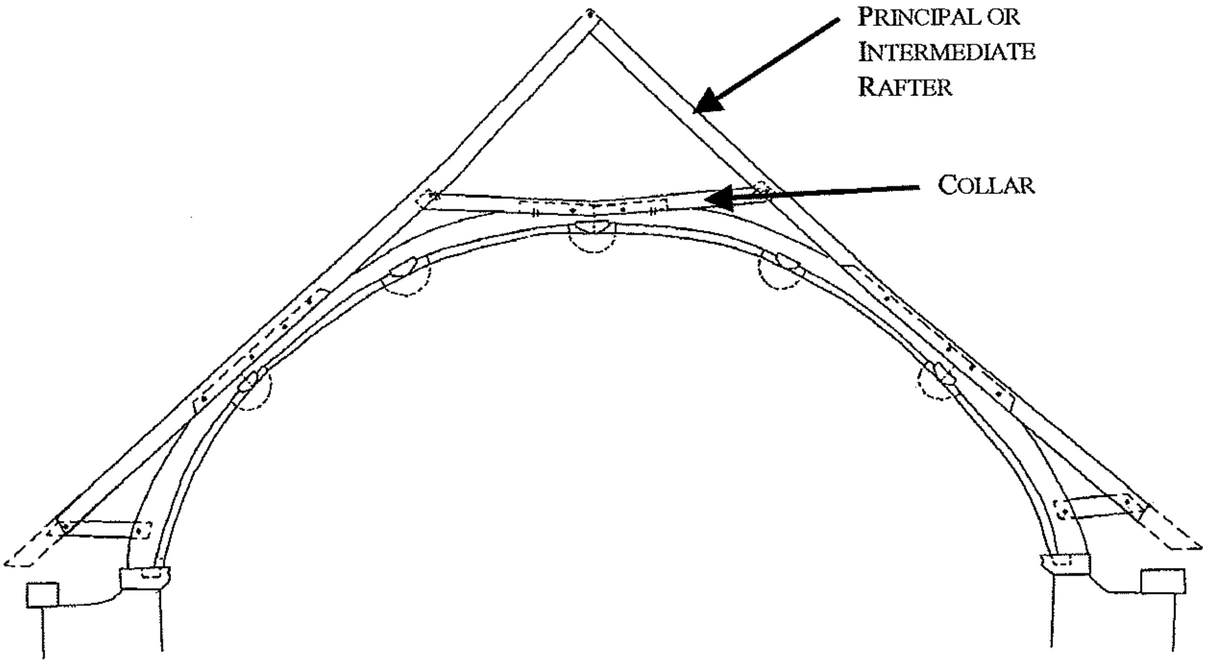
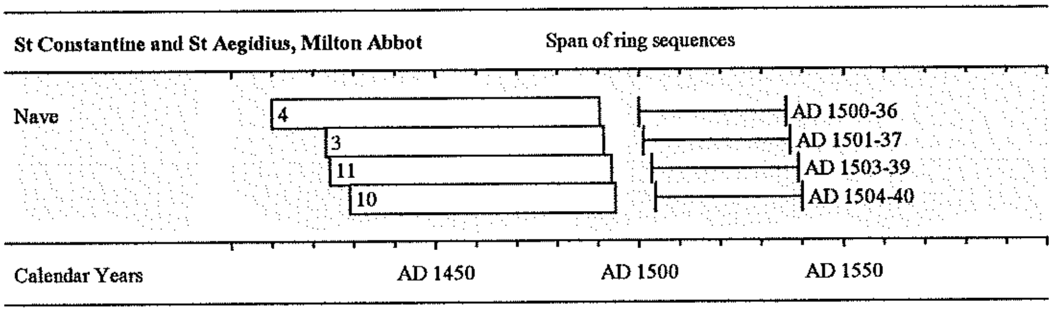


Figure 5 Bar diagram showing the chronological positions of the dated timbers from the nave roof at the Church of St Constantine and St Aegidius, Milton Abbot. The estimated felling period for each sequence is also shown



KEY for figure 5

Table 1 List of samples from timbers from the south transept and nave roofs of the Church of St Constantine and St Aegidius, Milton Abbot

Core No	Origin of core	Cross-section size (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
1	T11b north intermediate rafter	130 x 105	63	H/S	2.18	undated	-
2	T11a collar	130 x 120	*c* 37	-	-	unmeasured	-
3	T11 north principal rafter	130 x 105	69	H/S	1.75	AD 1423-AD 1491	AD 1501-37
4	T11 south principal rafter	135 x 100	81	H/S	1.73	AD 1410-AD 1490	AD 1500-36
5	T9a south intermediate rafter	130 x 100	68	H/S	1.82	undated	-
6	T9a north intermediate rafter	135 x 90	54	H/S	1.92	undated	-
7	T8 north principal rafter	130 x 105	49	-	2.89	undated	-
8	T7b south intermediate rafter	140 x 100	71	H/S	2.07	undated	-
9	T6b north intermediate rafter	130 x 105	87	H/S	1.26	undated	-
10	T5b south intermediate rafter	140 x 105	66	H/S	1.66	AD 1429-AD 1494	AD 1504-40
11	T4a north intermediate rafter	130 x 110	70	H/S	1.67	AD 1424-AD 1493	AD 1503-39
12	T3 collar	130 x 120	50	H/S	2.34	undated	-

KEY for Table 1 Total rings = all measured rings. Sapwood rings: H/S heartwood/sapwood boundary. ARW = average ring width of the measured rings

Table 2

t-value matrix for the timbers forming the chronology MLTNABBT.

	4	10	11
3	7.08	4.26	8.05
4		4.02	5.76
10			7.88

Table 3

Dating the mean sequence MLTNABBT, AD 1410-1494 inclusive. Example *t*-values with independent reference chronologies.

Area	Reference chronology	*t*-values
Hampshire	Winchester College panels (Lewis 1995)	6.87
Herefordshire	Preston Wynne (Tyers and Groves 1999)	5.57
Herefordshire	Woodhouse Farm Staplow (author unpubl)	5.94
Kent	Longport Farmhouse (Tyers 1996)	5.21
Nottinghamshire, etc	East Midlands regional master (Laxton and Litton 1988)	6.02
Oxfordshire	Chastleton House (Tyers 2001)	5.48
Staffordshire	Black Ladies nr Brewood (Tyers 1999b)	5.33
Surrey	Witley Church (Tyers 2002)	6.80
Sussex East	Falmer Court Barn (Howard *et al* 1998)	6.31
Sussex West	Wenham Manor Barn Rogate (Miles 1998)	5.78
Wiltshire	The Old Mansion Clarendon (Tyers 1999c)	5.36
Worcestershire	Crowle Court Barn (Hillam 1997)	5.42

Appendix 1 Ring width data for measured samples from the Church of St Constantine and St Aegidius, Milton Abbot, Devon, 100 = 1mm

MILA01

501	341	556	735	889	614	393	257	266	193
193	204	285	325	233	223	228	263	182	183
177	226	245	194	192	262	260	210	209	179
122	176	104	77	114	119	109	87	104	111
131	171	138	180	283	175	173	125	150	177
162	189	146	98	118	71	76	81	146	125
225	143	136							

MILA03

397	433	485	369	319	442	295	231	318	378
296	296	311	307	321	193	194	260	227	154
180	156	175	125	150	155	173	147	125	137
143	152	184	131	107	141	84	127	108	116
144	128	107	116	124	170	130	150	86	72
94	95	103	139	83	97	121	101	129	105
110	143	94	79	84	57	55	63	79	

MILA04

256	267	415	413	268	382	402	342	421	311
498	311	312	277	342	366	353	227	290	228
161	210	199	140	128	166	158	182	136	81
137	152	98	107	120	129	92	116	117	123
106	92	92	95	110	85	90	93	124	108
128	118	132	147	111	122	161	114	154	94
109	74	79	85	75	115	142	91	99	120
122	128	113	120	162	102	139	111	100	87
92									

MILA05

238	276	308	282	290	138	161	274	288	244
391	319	252	332	429	384	375	400	273	372
265	281	186	202	234	258	173	114	79	144
192	188	137	244	210	79	53	75	92	49
67	44	114	133	58	129	66	167	95	116
113	131	178	120	121	119	44	83	98	106
67	94	130	191	143	128	115	126		

MILA06

359	211	328	384	373	365	312	342	323	297
244	453	376	432	329	378	271	363	350	400
193	158	160	114	92	116	142	138	176	217
245	151	62	43	51	89	93	64	82	58
66	57	56	66	44	60	48	52	43	63
93	96	116	158						

MILA07

491	407	440	418	506	368	318	246	272	286
296	272	377	408	475	218	280	325	257	287
249	330	459	384	271	238	247	315	315	251
246	207	199	214	253	169	153	210	169	179
150	196	252	330	273	266	232	245	226	

MILA08

276	327	321	254	332	255	272	342	241	331
394	427	325	427	538	462	439	311	201	279
189	217	244	222	141	81	106	93	63	70
87	120	107	160	201	119	114	126	133	145
180	149	144	232	212	200	144	162	162	141
179	127	174	216	189	137	121	162	215	167
140	174	215	176	181	183	155	160	123	148
166									

MILA09

208	234	246	235	190	295	310	326	296	311
222	210	228	186	213	176	139	75	86	70
51	40	41	74	63	85	84	88	97	79
60	69	99	61	63	91	91	89	91	87
103	88	116	110	117	178	210	184	117	185
208	186	138	142	176	127	150	100	144	152
93	113	84	107	106	101	113	108	94	106
85	101	81	88	81	70	76	52	94	73
81	68	69	49	52	60	63			

MILA10

342	225	386	440	442	339	434	319	389	246
309	164	233	198	189	182	147	108	130	191
206	157	151	170	171	190	143	110	128	128
101	117	132	150	150	112	95	128	147	160
87	102	72	75	104	108	142	127	74	95
98	116	112	110	123	156	102	128	126	77
87	96	92	93	106	106				

MILA11

547	482	431	303	433	325	217	320	313	296
225	296	207	251	175	139	129	145	119	131
115	103	99	135	159	188	198	134	129	142
153	149	130	122	133	86	150	147	135	152
128	79	102	135	200	99	168	85	79	91
96	157	146	79	112	100	121	142	125	109
145	82	107	138	91	92	107	108	115	104

MILA12

346	386	375	394	299	386	338	473	259	299
370	428	278	306	198	162	151	158	224	226
147	188	162	115	110	179	195	236	200	156
249	196	135	104	129	154	170	204	199	211
126	179	189	167	203	189	254	394	297	187

Figure 3 Plan of the church of St Constantine and St Aegidius, Milton Abbot showing the nave truss numbering scheme adopted for this report (based on a figure supplied by Stuart Brown). There are pairs of intermediate trusses in all the bays except the one between T11 and T12 where there are three. These are labelled T1a, T1b etc from the east through to T11c at the west. The smaller arrows indicate the approximate sampling locations